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DOCTORAL THESIS

FIRST LANGUAGE ATTRITION IN INSTRUCTED SETTINGS: INTERPRETATION AND PROCESSING OF RELATIVE CLAUSES IN L1 SPANISH-L2 ENGLISH BILINGUALS

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Para vosotros, abuelos.

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Abstract

Bilingualism and second language acquisition research has traditionally focused on L1-to-L2 influence, providing extensive evidence of such influence. However, more recent studies have paid increasing attention to the opposite scenario: the effect that L2 use and exposure may exert on L1 production, processing and comprehension. Despite the growing interest in this process, typically referred to as L1 attrition, data are scarce and restricted to a specific bilingual population, i.e., long-term immigrants in L2 naturalistic settings who are dominant in their L2 and have limited L1 use/exposure (Cairncross et al., 2023; Chamorro et al., 2016; Cuza, 2010; Gürel, 2004; Kaltsa et al., 2015). Consequently, it remains largely unknown whether L1 attrition may emerge in other L2 exposure contexts such as L2 classroom settings. Only few studies have addressed these contexts, reporting bidirectional influence in instructed bilinguals (Długosz, 2021; Martín-Villena, 2023; Requena & Berry, 2021). Thus, this PhD thesis explores bilinguals in an under-researched L2 exposure setting within L1 attrition research, i.e., bilinguals immersed in their L2 in a university classroom setting. It employs data triangulation from different measures and includes two monolingual control groups.

Building on such limited data, the present thesis aims to examine the true scope of L1 attrition by exploring the potential emergence of attrition in a bilingual population that does not meet assumed pre-requisites for it to emerge. To do so, L1 attrition will be studied in L1 Spanish-L2 English bilinguals living in an L1-dominant environment, Spain, who receive extensive L2 exposure in a classroom university setting. This instructed bilingual population represents a novel focus, given the assumption that they are not susceptible to undergo L1 attrition. Potential attrition effects will be explored regarding participants' L1 relative clause attachment (RCA) disambiguation preferences.

This syntactic ambiguity creates an ideal ground to test attrition hypotheses since Spanish and English have opposite disambiguation strategies. For instance, in (1) below, a native Spanish speaker would typically perceive *the servant* / *el criado* as the one on the balcony, while a native English speaker would interpret it was *the actress / la actriz*. These two strategies are referred to as high attachment (HA) and low attachment (LA), respectively.

(1) *Someone shot the servant$_i$ of the actress$_j$* ***who***$_{i/j}$ *was on the balcony*
Alguien disparó contra el criado$_i$ de la actriz$_j$ **que**$_{i/j}$ estaba en el balcón con su marido

However, L1 attrition effects on RCA biases have not yet been examined in L2 instructed settings. To do so, three groups will be tested: (1) L1 Spanish-L2 English adult bilinguals, (2) Spanish monolinguals, (3) and English monolinguals. The former group is composed of undergraduate students enrolled in the degree of English Studies in Granada, Spain. The fact that English is the medium of instruction during the four-year degree ensures extensive L2 exposure in an instructed setting while these bilinguals are settled in an L1 Spanish-dominant context. This will allow to assess whether immersion in such instructed setting may influence L1 preferences to a similar extent than L2 naturalistic immersion.

This PhD thesis follows a triangulating approach to investigate L1 attrition from several perspectives. Triangulating data from three complementary experimental tasks, all of them completed by the same participants, will offer a complete understanding of the nature and scope of L1 attrition in instructed bilinguals. Data were collected through an auditory sentence-picture verification task (PVT) and a visual world eye-tracking (ET) experiment with a picture selection task (PST) component. The PVT was designed to explore online processing cost and garden-path effects, while the eye-tracking experiment aimed to tap into participants' online preferences, and the PST sought to assess offline attachment preferences. Eye-tracking data represent a novel contribution as, unlike previous studies that employed eye-tracking while reading, this investigation uses the visual world paradigm (VWP). This approach will offer insights into the time course of disambiguation, which has not been previously examined. Given the aim to test bilinguals in their L1 Spanish, all tasks were administered in participants' first language, i.e., Spanish for both the Spanish monolingual and bilingual group, and English for English monolingual one. Additionally, all tasks included the same stimuli to avoid potential differences across tasks to be due to variability in the stimuli employed.

Results revealed attrition effects in the L1 Spanish of instructed L1 Spanish-L2 English bilinguals across all tasks. L1 attrition was manifested as increased optionality due to a stronger LA bias (the typical strategy in their L2 English) and an attenuated HA preference (which is expected in their L1 Spanish). PST data illustrated that bilinguals were significantly less likely to select a HA interpretation for ambiguous sentences. This correlated with the increased processing cost observed in the PVT data among bilinguals, who required additional time to accept a HA interpretation and reject a LA one. Such additional processing time resolving ambiguous sentences may be due to the increased optionality found in offline data. The fact that bilinguals tolerate both interpretations (HA and LA) may result in additional processing cost when making a decision about their attachment preference. Finally, eye-tracking data supports this pattern, as bilinguals showed no preference for either HA or LA as ambiguous sentences unfold. Instructed bilinguals show optionality in their final attachment choices of ambiguous sentences, which correlated with higher processing cost when resolving such ambiguities.

This PhD thesis also explored the modulating role of individual factors, particularly language dominance and length of L2 immersed instruction. Regarding the former, an effect was only found in the PVT, in which slower responses were associated with more L2-English dominant bilinguals, as expected. No effect was found for either the PST or eye-tracking data, which may indicate that dominance effects may be better captured in online measures such as response times, which reflect processing cost. In addition to dominance, although attrition was evidenced in instructed bilinguals, length of immersed instruction did not explain variability in the bilingual data. In particular, bilingual students in the final years of the English Studies degree did not exhibit stronger attrition effects, as initially predicted.

Based on this, the present PhD thesis offers a relevant contribution to the field of bilingualism in general, and to L1 attrition research in particular, especially regarding the profile of the bilingual population tested (i.e., instructed bilinguals). To be more precise, we found attrition effects in L1-dominant bilinguals living in an L1 environment who receive extensive L2 exposure in an instructed, university setting. Such effects manifested as increased optionality in RCA preferences and increased processing cost for ambiguous sentences, in line with previous studies on RCA biases in naturalistically immersed bilinguals (Dussias, 2003; Dussias & Sagarra, 2007; Jegerski, VanPatten, et al., 2016; Papadopoulou & Clahsen, 2003). We conclude that, similarly to L2 naturalistic immersion, instructed exposure can influence L1 syntactic interpretation and processing regarding RCA preferences. These findings evidence the need to broaden the scope of L1 attrition, as suggested by Schmid and Köpke (2017, 2019), and include not only naturalistically immersed bilinguals but also bilinguals immersed in L2 instructed settings. Future research should move beyond L2 naturalistic contexts to gain a complete understanding of the linguistic and extralinguistic factors influencing L1 attrition.

Resumen

La investigación sobre bilingüismo y adquisición de segundas lenguas se ha centrado tradicionalmente en la influencia de la L1 sobre la L2, aportando numerosas pruebas de dicha influencia. Sin embargo, estudios más recientes han prestado mayor atención al escenario opuesto: el efecto que el uso y la exposición a la L2 puede ejercer sobre la producción, procesamiento y comprensión de la L1. A pesar del creciente interés por este proceso, denominado atrición de la L1, los datos son escasos y se restringen a una población bilingüe específica: inmigrantes de larga duración en entornos naturalistas, dominantes en su L2, y con un uso de/exposición a la L1 limitado (Cairncross et al., 2023; Chamorro et al., 2016; Cuza, 2010; Gürel, 2004; Kaltsa et al., 2015). Por tanto, sigue siendo en gran medida desconocido si la atrición puede surgir en otros contextos de exposición a la L2, como los entornos instrucción formal en el aula. Sólo unos pocos estudios han abordado estos contextos, mostrando influencia bidireccional en bilingües instruidos (Długosz, 2021; Martín-Villena, 2023; Requena & Berry, 2021). Esta tesis explora a bilingües en un contexto de exposición a la L2 poco investigado en relación con atrición: bilingües inmersos en su L2 en un aula universitaria. Para ello, se emplea triangulación de diferentes tareas, y se incluyen dos grupos de control monolingües.

Esta tesis pretende examinar el verdadero alcance de la atrición de la L1 explorando su posible aparición en una población bilingüe que no cumple los requisitos tradicionales para que surja. Se estudiará la atrición en bilingües L1 español-L2 inglés que viven en un entorno dominado por la L1, España, y que reciben una amplia exposición a la L2 en un aula universitaria. Esta población bilingüe representa un enfoque novedoso, debido a la suposición de que no son susceptibles de experimental atrición. Los posibles efectos de la atrición se estudiarán en las preferencias de desambiguación de cláusulas relativas

(RCA) en su L1 español. Esta ambigüedad sintáctica crea un terreno ideal, ya que el español y el inglés tienen estrategias de desambiguación opuestas. Por ejemplo, en (2), un hablante nativo de español percibiría al *criado / servant* como el que está en el balcón, mientras que un hablante nativo de inglés interpretaría que es la *actriz* / *actress*. Estas dos estrategias se denominan de alto apego (HA) y bajo apego (LA), respectivamente.

(2) *Someone shot the servant$_i$ of the actress$_j$ **who**$_{i/j}$ was on the balcony*
Alguien disparó contra el criado$_i$ de la actriz$_j$ **que**$_{i/j}$ estaba en el balcón con su marido

Sin embargo, aún no se han examinado los efectos de la atrición de la L1 en los sesgos de RCA en contextos de instrucción de la L2. Para ello, se examinarán tres grupos: (1) adultos bilingües L1 español-L2 inglés, (2) monolingües españoles, y (3) monolingües ingleses. El primer grupo está compuesto por estudiantes universitarios del grado de Estudios Ingleses en Granada, España. El hecho de que el inglés sea el medio de instrucción durante los cuatro años del grado garantiza una amplia exposición a la L2 en un entorno instruido, mientras que estos bilingües viven en un contexto donde domina su L1 español. Esto permitirá evaluar si la inmersión en dicho entorno instruido puede ejercer una influencia similar a la inmersión naturalista en la L2.

Esta tesis se basa en la triangulación para investigar la atrición de la L1 desde varias perspectivas. La triangulación de datos de tres tareas experimentales complementarias, todas ellas completadas por los mismos participantes, ofrecerá una visión completa de la naturaleza y el alcance de la atrición en bilingües instruidos. Los datos se recogieron mediante una tarea auditiva de verificación frase-imagen (PVT) y un experimento de seguimiento ocular (ET), que incluía un componente de selección de imágenes (PST). La PVT se diseñó para estudiar el coste de procesamiento, mientras que el experimento de seguimiento ocular pretendía explorar las preferencias conforme se procesa el lenguaje, y la PST pretendía evaluar las interpretaciones finales. Los datos de seguimiento ocular representan una contribución novedosa ya que, a diferencia de estudios anteriores que empleaban el seguimiento ocular durante la lectura, esta tesis utiliza el paradigma del mundo visual (VWP). Esto ofrecerá información sobre el curso temporal de la desambiguación, que no se ha examinado anteriormente. Todas las tareas se realizaron en la L1 de los participantes, es decir, español para los españoles monolingües y bilingües, e inglés para el grupo de inglés monolingüe. Además, todas las tareas incluían los mismos estímulos para evitar que posibles diferencias entre tareas se debieran a la variabilidad de los estímulos empleados.

Los resultados revelaron efectos de atrición en la L1 de los bilingües instruidos L1 español-L2 inglés en todas las tareas. La atrición de la L1 se manifestó como opcionalidad debido a un sesgo hacia LA más fuerte (propia de su L2 inglés) y una preferencia atenuada hacia HA (propia de su L1 español). Los datos de la PST mostraron que los bilingües eran significativamente menos propensos a seleccionar una interpretación HA para las frases ambiguas. Esto correlacionó con el mayor coste de procesamiento observado en los datos de los bilingües en la PVT, que necesitaron más tiempo para aceptar una interpretación HA y rechazar una LA. Este tiempo adicional para resolver frases ambiguas puede deberse a la mayor opcionalidad encontrada en los datos offline. El hecho de que los bilingües toleren ambas interpretaciones (HA y LA) puede suponer un mayor coste de procesamiento a la hora de tomar una decisión sobre su preferencia de adjunción. Por último, los datos de seguimiento ocular apoyan este patrón, ya que los bilingües no mostraron preferencia ni por HA ni por LA a medida que se desarrollan las frases ambiguas. Los bilingües instruidos muestran opcionalidad en sus interpretaciones finales, lo que se relaciona con un mayor coste de procesamiento al resolver estas ambigüedades.

Esta tesis también exploró el papel modulador de factores individuales como la dominancia lingüística y la duración de la instrucción inmersa en la L2. En cuanto a dominancia, sólo se encontró un efecto en la PVT, donde las respuestas más lentas se asociaron a bilingües con mayor dominio de la L2 inglés, como era de esperar. No se encontró ningún efecto ni en la PST ni en los datos de seguimiento ocular. Esto puede indicar que los efectos de dominancia pueden captarse mejor en medidas online como los tiempos de respuesta, que reflejan coste de procesamiento. Además de la dominancia, la duración de la instrucción inmersa en la L2 no explicó variabilidad en los datos bilingües. En particular, los estudiantes bilingües de los últimos cursos del grado en Estudios Ingleses no mostraron una atrición más pronunciada, como se predijo inicialmente.

En base a estos hallazgos, esta tesis ofrece una contribución relevante al campo del bilingüismo en general, y a la investigación sobre atrición en particular. Especialmente en relación con el perfil de la población bilingüe analizada (bilingües instruidos). Se ha visto atrición en bilingües dominantes en su L1 que reciben una amplia exposición a la L2 en un entorno universitario con instrucción. Dichos efectos se manifestaron como una mayor opcionalidad en las preferencias de interpretación de oraciones ambiguas y un mayor coste de procesamiento, en línea con estudios previos sobre RCA y bilingües inmersos de forma naturalista (Dussias, 2003; Dussias & Sagarra, 2007; Jegerski, VanPatten, et al., 2016; Papadopoulou & Clahsen, 2003). De forma similar a la inmersión naturalista, la exposición formal a la L2 puede influir en la interpretación y el procesamiento en la lengua materna de hablantes bilingües. Estos hallazgos evidencian la necesidad de ampliar el concepto de atrición, como sugieren Schmid y Köpke (2017, 2019), incluyendo no solo a los bilingües inmersos de forma naturalista, sino también a los bilingües inmersos en entornos instruidos de L2. Esto es necesario para comprender los factores lingüísticos y extralingüísticos que influyen en la atrición de la L1.

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AJT	Acceptability Judgement Task
ATH	Activation Threshold Hypothesis
BLP	Bilingual Language Profile
CEFR	Common European Framework of Reference for Languages
EMI	English-Medium Instruction
ERP	Event-Related-Potential
HA	High Attachment
HS	Heritage Speaker
LA	Low Attachment
LoI	Length of Instruction
LoII	Length of Immersed Instruction
LoR	Length of Residence
L1	First Language
L2	Second Language
NP	Noun Phrase
OQPT	Oxford Quick Placement Test
PST	Picture Selection Task
PVT	Picture Verification Task
RC	Relative Clause
RCA	Relative Clause Attachment
RE	Referring Expression
RT	Response Time or Reading Time
SD	Standard Deviation

SLA	Second Language Acquisition
SPRT	Self-Paced Reading Task
US	United States
UK	United Kingdom
VWP	Visual World Paradigm
VP	Verb Phrase
WM	Working Memory

Chapter 1: Introduction

Bilingualism is the norm in current societies, but becoming bilingual is a complex process that involves a constant interaction of two, at least, linguistic systems in the bilingual mind. Research on second language acquisition (SLA) has traditionally accounted for the influence that the L1 may exert on the learning process of an L2 (Hamada & Koda, 2008; Ionin & Montrul, 2010). In contrast, the opposite direction has received considerably fewer attention, although the interactions between a bilingual's L1 and L2 have been proved to be bidirectional rather than monodirectional. Not only may the L1 modulate L2 acquisition, processing and production, but extensive L2 exposure and use may also lead to changes in the L1, a phenomenon typically referred to as L1 attrition (Bardovi-Harlig & Stringer, 2010; Cook, 2003; Gallo et al., 2021; Gürel, 2004; Schmid & Köpke, 2019; Seliger & Vago, 1991a).

The present PhD thesis examines L1 grammatical attrition in late sequential L1 Spanish-L2 English bilinguals. Our approach to L1 attrition builds on Schmid and Köpke's (2017, 2019) proposal to broaden the traditionally restricted scope of L1 attrition, which had been assumed to involve permanent changes at a representational level in naturalistically immersed bilinguals with limited L1 use and exposure. Following Schmid and Köpke's (2017, pp. 637–638), L1 attrition involves "any of the phenomena that arise in the native language of a sequential bilingual as the consequence of the co-activation of languages, crosslinguistic transfer or disuse, at any stage of second language development and use". L1 attrition is considered to encompass both online and offline (temporal and permanent) L1 changes along a continuum and therefore, this thesis will explore online and offline data. This perspective will serve as the basis for the approach to L1 attrition in this thesis, whose scope is wider than that of previous research.

In fact, the scope of L1 attrition has been rather restrictive, traditionally associated with specific conditions regarding limited L1 use and exposure, and extensive naturalistic immersion in the L2 environment. Consequently, most studies have explored L1 attrition in naturalistically immersed bilinguals, frequently immigrants, who settled in an L2-speaking country and have lived there for extensive period with reduced use and exposure of their L1. Typically, their L1 was a minority language while their L2 was the dominant one, which resulted in these bilinguals being L2 dominant. Ample evidence has been provided of attrition in this bilingual population, particularly in grammatical attrition, which is the focus of this PhD thesis (Chamorro et al., 2016; Domínguez, 2013; Gürel, 2004; Kaltsa et al., 2015; Tsimpli et al., 2004).

However, to date, there is scarce evidence on the potential effect of other L2 exposure types such as instructed exposure. In fact, despite the growing number of L1 attrition studies, our current understanding of the phenomenon remains incomplete. The present PhD thesis builds on, as Hicks et al. (2024, p. 145) point out, the need for additional investigation to uncover the characteristics of L1 attrition: "further empirical investigation is required to reveal the fundamental characteristics of the phenomenon: what grammatical properties can undergo attrition; to what extent; under what linguistic and extralinguistic conditions?" This investigation builds on the need to identify the extralinguistic conditions under which attrition may manifest, i.e., which bilingual populations are susceptible to experience it and the contexts where it may emerge.

To do so, L1 attrition will be tested in a **bilingual population** which does not meet traditionally assumed criteria to be considered susceptible of attrition, focusing on late sequential bilinguals who live in an L1 environment but receive extensive L2 exposure in a classroom instructed setting. Specifically, L1 Spanish-L2 English bilinguals living in Spain who are completing a degree in English Studies, which is delivered in L2 English. Thus, this thesis will explore L2 instructed settings, but more precisely, contexts of *L2 immersed instruction*.

This academic setting ensures an extensive amount of daily L2 input and exposure, creating a specific context that differs from more general contexts of instructed exposure. For instance, bilinguals attending L2 courses few times per week, who have significantly lower use and exposure to the L2. Additionally, *L2 immersed instruction* contrasts with the more commonly studied context of *naturalistic immersion* in L1 attrition research. Throughout the thesis, the term *immersed instruction* will be used to refer to the specific language environment of the bilinguals tested, and this is justified by the specific characteristics of the setting examined. The bilingual group in this investigation is completing a degree delivered in their L2 English, which requires daily and extensive exposure to the L2 at university, but also at home doing assignments, reading and preparing for their exams. Thus, they are immersed in an English formal environment while living in an L1-speaking country. The distinction between bilinguals attending L2 courses few times per week and bilinguals in this thesis is essential, with the term *immersed instructed exposure* better capturing the specificities of their language environment. Findings obtained from these bilinguals will provide valuable insights into the true scope of L1 attrition, demonstrating the need to broaden it, including other contexts and populations, and to avoid past practices in which attrition was limited to long-immersed bilinguals in a naturalistic setting with limited L1 use and exposure.

Along with the experimental group of late L1 Spanish-L2 English bilinguals, data were also collected from two **control groups** of Spanish functional monolinguals and English functional monolinguals. The term *functional* is particularly relevant, as participants in the control groups cannot be considered pure monolinguals. They had at some point studied an L2 at school or high school, so they had some prior L2 experience and some knowledge. However, efforts were made to ensure they were as close to what a monolingual would be by controlling, for instance, that their L2 proficiency was as low as possible and that they had no L2 contact at the time of testing (see Section 5.1 for further participation criteria). In fact, monolingual adult speakers are increasingly less frequent in current societies. The tendency to include monolingual control groups comes from bilingualism and SLA research, which consider them to be the norm or benchmark that bilinguals should be compared with. However, given that so-called monolinguals may often not be true monolinguals and that variability within this population has also been attested (Castro et al., 2022; L. S. P. Cheng et al., 2021; Dąbrowska, 2012), this practice has been questioned (Dewaele et al., 2021; Ortega, 2013; Rothman et al., 2023).

An alternative solution is to include native groups controlling as carefully as possible participants’ profile. This was the methodological decision made in this thesis, with “monolingual” participation restricted to those with low L2 proficiency, high L1 dominance, no current exposure to or use of any L2, etc. Finally, according to Domínguez and Arche (2021), if the inclusion of a native control group is considered relevant, this should be justified. In the present PhD thesis, the control group of Spanish functional monolinguals will be tested as an approximation of what instructed bilinguals may have looked like prior to extensive immersed instruction in the L2. English functional monolinguals will be tested to establish a baseline for native English using the same tasks and stimuli. This will allow us to interpret bilinguals' behaviour as aligning with their L1, their L2 or following a different pattern. Additionally, previous research has extensively examined relative clause attachment preferences, the structure of interest for this thesis, in native Spanish and native English speakers. Including both control groups will enable comparison with native data obtained and established patterns in the literature. Although *functional monolinguals* is a more appropriate term for these control groups, they will be referred to as *monolinguals* throughout the thesis for simplification purposes.

Another aspect that deserves special attention is the **linguistic structure** examined. L1 attrition will be investigated regarding bilinguals' preferences to resolve ambiguous relative clauses (RCs). The structure under study is composed of a complex noun phrase (NP) of the form *NP1 of NP2* followed by a RC, which allows two potential syntactic configurations, resulting in two different semantic interpretations. Taking (3) below as an example, the ambiguity arises because the relative pronoun *who*, not marked for gender, may refer to either NP1, *the servant*, or to NP2, *the actress*, and therefore, it is necessary to resolve the ambiguity by attaching *who* to one of the previous NPs.

(3) *Someone shot the servant$_i$ of the actress$_j$* ***who***$_{i/j}$ *was on the balcony*[1]

The preference to attach the relative clause to either NP1 or NP2 involves two separate disambiguation strategies: high attachment (HA) and low attachment (LA), respectively. RCA preferences have received considerable attention given the cross-linguistic variation attested in prior research, i.e., these preferences are language-specific as they vary across native speakers of different languages (Cuetos & Mitchell, 1988; Papadopoulou & Clahsen, 2003; Zagar et al., 1997). Importantly for this investigation, while native Spanish tends to favour a HA interpretation, native English seems to show a LA preference (Y. Cheng et al., 2021; Cuetos & Mitchell, 1988; Dussias, 2003; Dussias & Sagarra, 2007). This variation offers an ideal testing ground to examine potential L1 attrition on instructed L1 Spanish-L2 English bilinguals regarding their strategies to resolve RCA ambiguities in their native Spanish.

[1] In example sentences throughout the thesis, subindexes will be provided only for potential antecedents of the relative clause. Thus, *someone* in the present example does not include a subindex.

RCA preferences will be tested using a **variety of tasks** from both an online and offline perspective. Online data reflect how speakers process language in real-time as it produced, whereas offline interpretation occurs afterwards once a sentence has been completely uttered. To do so, data were gathered from different experimental tasks: a sentence-picture verification task and a visual-world eye-tracking experiment. However, the latter was designed in such a way that it enabled the investigation of two types of data: eye-tracking data on real-time processing, and offline final interpretative preferences as participants selected either a HA or LA interpretation for each ambiguous sentence. The different nature of these data led us to treat them as two separate tasks throughout the thesis: an eye-tracking experiment for the online data, and picture selection task for the offline response data. Thus, results for each data will be presented in two different chapters: Chapter 6 for the so-called PST and Chapter 8 for the eye-tracking experiment. Results for the picture verification task will be presented in Chapter 7.

Based on the above, this PhD thesis offers a **novel and original contribution** to the literature for several reasons. Firstly, against the traditional concern in SLA research on L1-to-L2 influence, it focuses on the opposite direction, i.e., L1 attrition. Although research has been conducted in this field, available data is still way fewer in comparison. The fact that there is no sufficient data is further limited by the fact the existing findings on L1 attrition come from a very specific population: bilinguals, typically L2 dominant, immersed in L2 naturalistic environments with limited L1 use and exposure. Therefore, our current understanding is incomplete, particularly regarding the extralinguistic conditions associated with the potential emergence of L1 attrition effects. This thesis will tackle this issue, providing relevant insights into the existence of L1 attrition effects in instructed bilinguals, who were not traditionally considered as susceptible to this. Findings will show that L1 attrition is an observable phenomenon not only in naturalistic settings, but also in instructed contexts. If we compare the bilinguals in this investigation with those of prior studies in naturalistic settings, both populations are immersed in their L2, but in different ways (*naturalistic immersion* vs. *immersed instruction*) and different percentages of exposure. Our results from the processing and interpretation of ambiguous RCs will extend previous findings from L1 Spanish-L2 English bilinguals undergoing attrition in naturalistic settings (Dussias, 2003; Dussias & Sagarra, 2007) to a new, underexplored L2 exposure context, i.e., immersed instruction.

Secondly, this investigation not only explores the potential existence of L1 attrition effects in instructed bilinguals, but also how these effects, if any, are further modulated by **individual variables**. In particular, it focuses on language dominance and length of L2 immersed instruction, whose role has been largely unexplored, and findings are still inconclusive. Previous attrition studies have focused on long-term, immersed bilinguals in L2-speaking environments where their L2 is the functional, majority language, and therefore, has become their dominant language. L1 attrition has been extensively attested in this L2-dominant population (Cuza, 2010; Dussias & Sagarra, 2007; Gürel, 2004; Kasparian & Steinhauer, 2016, 2017). However, little is known about whether L2 dominance is a condition for attrition to emerge or whether it may also emerge in bilinguals who remain L1 dominant. This thesis will tackle this issue by testing L1-dominant bilinguals, although their L1 dominance is lower that their monolingual counterparts. Crucially, while language dominance has often been treated categorically, with bilinguals classified as either L1 or L2 dominant, this thesis will analyse dominance as a continuous predictor based on the scores provided by the Bilingual Language Profile (BLP) questionnaire (Birdsong et al., 2012). This approach will better capture individual variability in language dominance, allowing us to test whether differences in dominance can predict variability in attachment preferences. This investigation will offer valuable evidence of attrition in L1-dominant instructed bilinguals, challenging the traditional view that L2 dominance is required for attrition to surface.

A second variable explored will be length of L2 immersed instruction. It refers to the number of years bilingual participants have been enrolled in the degree of English Studies and thus, it represents the academic year they were in at the time of testing. It is predicted that bilinguals in the final years of the degree, i.e., those with longer immersed instruction, will exhibit stronger attrition effects. The motivation comes from previous L1 attrition research, in which length of naturalistic immersion has been a main variable. However, its role as a modulating factor in attrition effects remain inconclusive, with some studies reporting an effect, while others do not (Schmid, 2019; Tsimpli et al., 2004; Wilson, 2009). Thus, it seems necessary to address this variable in an instructed setting.

In addition, another novelty of this thesis relies on data triangulation, as it adds to the limited body of research simultaneously exploring L1 attrition from both an online and offline perspective. RCA preferences will be tested with both online and offline measures using different methods, which include a picture selection task, a picture verification task, and an eye-tracking experiment. These were implemented using different software like Experiment Builder (*SR Research Experiment Builder*, 2020) and Open Sesame (Mathôt et al., 2012; Mathôt & March, 2022), gathering data from offline responses, response times and eye-fixations. Together, these measures will offer a fully rounded understanding of L1 attrition. Importantly, all tasks were completed by the same participants. Keeping participants constant across tasks will strengthen the findings obtained as reliable comparisons can be stablished between all tasks administered. This will help us determine the actual scope and extent of L1 attrition from different angles.

An additional strength of this PhD thesis lies in the careful way data were collected, particularly **controlling variables** that could influence the results. Several factors proved to influence L1 attrition outcomes and RCA preferences were controlled to ensure that results would not be affected by them. Some of these variables were controlled via candidates' responses to questionnaires administered, where they were asked about their language experience. This is exemplified in the participation criteria for bilinguals and monolingual speakers (further details in Section 5.1). Additionally, other variables were controlled via background tasks, such as L2 proficiency and working memory. To ensure homogeneity among participants, they all completed an L2 proficiency test and a working memory task. As for the former, L2 proficiency, most studies on bilingual RCA biases have assessed proficiency via self-reports (Bergmann et al., 2008; Dussias, 2003; Dussias & Sagarra, 2007; Jegerski, VanPatten, et al., 2016).

Another controlled variable was working memory. It was assessed since attachment of a RC with two potential antecedents requires keeping such referents active in working memory for subsequent retrieval, and differences in WM capacity seems to modulate attachment preferences (Y. Cheng et al., 2021; Hopp, 2014; J. H. Kim & Christianson, 2017). Although most of this research has focused on L2 processing, and this PhD thesis focuses on L1 processing, the evidence of such influence in bilinguals' L2 together with the lack of conclusive data in L1 processing led us to control for this variable. To do so, participants completed a working memory task (see Section 5.3.3), with participants in this study having similar working memory capacity. WM will not be included in the inferential analyses but was controlled to ensure homogeneity among participants.

Finally, the present PhD is organised as follows. Chapter 2 discusses the phenomenon of L1 attrition and its scope. It begins by contextualising attrition studies within the larger field of bilingualism research. Then, it offers an overview of the terminological debate about the scope of L1 attrition that serves as the basis for the approach to L1 attrition adopted in this thesis. Then, some modulating factors in L1 attrition effects are discussed, focusing particularly on language dominance and length of extensive exposure to the L2, as these are the ones explored in this thesis. Chapter 3 describes in detail the linguistic structure examined, namely relative clause attachment ambiguities. The chapter then introduces the crosslinguistic variation in RCA biases, which challenges general principles of language economy like Late Closure, and presents several theoretical frameworks that have accounted for it. This is followed by a review of previous literature on RCA in native Spanish and English, along with bilingual speakers.

Chapter 4 introduces the research questions and hypotheses addressed in the present PhD thesis. These are task-specific, meaning that they have been formulated to be answer with data from each specific task. Thus, research questions and their corresponding hypotheses will be presented separately for each experimental task. Chapter 5 describes the general methodology of the thesis. This includes a description of the participants' profile, general procedure followed regarding task sequencing, an overview of the background tasks used (i.e., the L2 placement tests, the Bilingual Language Profile to measure language dominance and the working memory task), and a thorough description of the stimuli employed in the experimental tasks.

The following three chapters report the results from each task, ending with a discussion of the findings obtained for each task. Chapter 6 focuses on picture selection task data, while Chapter 7 focuses on results from the sentence-picture verification task, and Chapter 8 focuses on the visual-world eye-tracking experiment. To conclude, Chapter 9 offers a final, more general discussion combining the findings from the three experimental tasks administered. The present PhD thesis concludes with Chapter 10, which summarises and emphasises the main conclusions that can be drawn, along with the acknowledgement of some limitations and relevant considerations for future research.

Chapter 2: First language attrition

This chapter provides an in-depth overview of L1 attrition, beginning in Section 2.1 with a contextualisation of L1 attrition within bilingualism research. This will be followed in Section 2.2 with a discussion of the terminological debate regarding L1 attrition, as well as its scope within the field. Section 2.3 will then introduce and specify the approach to L1 attrition employed throughout this PhD thesis. Section 2.4 will present and discuss some of the variables that may modulate attrition effects, such as language dominance and length of extensive exposure to the L2, making a distinction between naturalistic and instructed exposure. Section 2.5 will introduce the Activation Threshold hypothesis, a relevant theoretical framework in attrition research. Finally, a summary of the main ideas within this chapter will be provided in Section 2.6. All this will set the basis for the research questions and hypotheses formulated in the following chapter.

2.1. Bilingualism and L1 attrition

The aim of this section is to contextualise the study of L1 attrition within the broader framework of bilingualism research, specifying the bilingual profile typically tested in attrition studies and outlining several ideas associated with this process.

First, the **variety of bilinguals** will be presented to narrow the focus to those examined in L1 attrition research. Bilingualism is a highly complex phenomenon and its complexity is evidenced, for instance, in the wide variety of bilingual speakers. This is so because individuals differ in relation to many factors, being age of onset or exposure to the second language one of the most relevant ones for the purposes of this study. Based on age of L2 onset, individuals can be classified into early and late bilinguals depending on whether they became bilingual during or after childhood, respectively (Butler & Hakuta, 2006; Wei, 2000). More precisely, Vaid (2018) states that while early bilinguals acquire and master their two languages before the age of 6, late bilinguals typically do so after the age of 12. Thus, early bilinguals are typically simultaneous bilinguals, meaning that their different languages have been developed and acquired simultaneously, whereas late bilinguals are sequential learners who acquired their L1 first and, once completely mastered, started acquiring an L2. The present PhD thesis will focus on late sequential bilinguals, in line with most studies on L1 attrition.

Additionally, bilinguals in general, and late sequential bilinguals in particular, may also differ regarding their type of L2 exposure. Individuals may be exposed to their L2 in a variety of contexts, for instance, naturalistic or instructed settings. L2 naturalistic contexts involve bilinguals living in an L2-speaking environment. This has been often referred to as an L2 naturalistic immersion, in which the L2 is the functional language used for communication and therefore, individuals are consistently exposed to it, often leading to a reduction of L1 use and input. In contrast to immersed naturalistic exposure, another type of L2 exposure involves formal instructed settings. L2 instructed exposure is that of bilinguals who have learnt the L2 in a classroom setting, usually attending to classes while living in an L1 environment where the L2 is not the functional language.

Although most bilinguals fall into the latter category, i.e., L2 instructed exposure, L1 attrition research has typically focused on naturalistically immersed bilinguals. This has been so because it was assumed that for L1 changes to occur, bilinguals must experience drastic conditions regarding L1 limited use/exposure and extensive L2 naturalistic input. While immersion has been typically associated with naturalistic contexts, this PhD thesis will expand the concept of *immersion* and apply it to a different L2 context. Immersion entails certain required conditions: extensive L2 exposure and need to use the L2 regularly as the primary means of communication. All these conditions are met by the bilingual population examined in this PhD thesis, even if they do not live in an L2-speaking environment. Bilinguals tested live in Spain, an L1 environment, but are *immersed* in their L2 as they study a degree in which English is the means of instruction (Lasagabaster, 2022) and consequently, all instruction and activities take place in the L2. Thus, instead of examining *naturalistically immersed* bilinguals as previous L1 attrition research, this thesis will explore bilinguals receiving L2 *immersed instruction*.

Despite the diversity in their profiles, all bilinguals share a common characteristic: the **co-existence of different languages** in their minds. It is crucial to first understand the dynamic interaction between the linguistic systems of a bilingual to establish the origins of L1 attrition research. Becoming bilingual entails both the development and subsequent co-existence of at least two distinct linguistic systems within the bilingual mind, which results in a dynamic interplay between these languages. A considerable bulk of research has emphasised the inter-connectedness of all linguistic systems of a bilingual speaker, suggesting that changes in one of the languages within an individual's linguistic repertoire often triggers modifications in the other languages. This constant interaction has been attributed to the inter-connectedness and co-activation of the languages within the bilingual brain (Paradis, 1993, 2004, 2007; Schmid & Köpke, 2017). The fact that, at least, two languages are constantly active results in a mutual influence between these linguistic systems.

Traditionally, most bilingualism and SLA research relied on the assumption that this influence was unidirectional in an L1-to-L2 direction. In fact, an idea underlying much of the initial work on bilingualism was that the L1, once fully acquired, remains stable and resistant to change, in opposition with the L2 system, which is under constant development. Thus, research addressed the influence of the L1 on L2 learning and performance (Ionin & Montrul, 2010). Studies often focused on the development of different language domains during the L2 learning process and whether, or how, L2 development may be modulated by factors such as age of L2 onset, motivation, aptitude, type of instruction, or L1-to-L2 transfer (Leal & Slabakova, 2019; Rivera et al., 2023; Saito, 2019, 2024; Wu & Ionin, 2022). Regarding the latter, bilinguals tend to rely on previous L1 knowledge in the production, interpretation and processing of their L2, particularly at early stages of acquisition. Such transfer or L1-to-L2 influence has been one of the most well-studied phenomena in SLA research (Jarvis & Pavlenko, 2008).

Against the view that it is the L1 which influences the L2, studies have revealed the bidirectional nature of such influence. Not only the L1 may exert an effect on the L2, but also can the L1 system be influenced by the acquisition, use of and exposure to an L2 (Bardovi-Harlig & Stringer, 2010; Gallo et al., 2021; Schmid & Köpke, 2019; Seliger & Vago, 1991b, 1991a; Weltens & Cohen, 1989). This process has typically been referred to as **L1 attrition** and involves changes in L1 production, comprehension, and processing as a result of extensive L2 use and exposure. This has revealed that the preconceived idea of the L1 as a stable system seems to be a misconception, as it can undergo readjustments and be subject to change under the influence of an L2. Despite the growing number of studies examining attrition, the amount of evidence remains limited, especially in comparison to the more traditional field of SLA and studies on L1-to-L2 transfer.

To further contextualise L1 attrition research, the remaining of the section will offer an overview of past literature, outlining ideas associated with the notion of attrition in previous studies. L1 attrition research emerged with Haugen's (1938) study entitled "Language and immigration", which aimed to challenge the idea that once a native speaker reaches adulthood, their L1 remains stable and resistant to change. The study focused on lexical changes in the L1 of Norwegian native speakers living in the United States (US). Subsequent research provided further evidence of the bi-directionality of L1-L2 influence, revealing that a bilingual's L1 is not the fixed system it was assumed to be (Cook, 2003; Jarvis & Pavlenko, 2008; Van Hell & Dijkstra, 2002). Consequently, the interest to account for such L1 modifications fostered considerable research in this field, with subsequent studies attesting attrition effects in a variety of linguistic domains such as phonology, semantics and grammar (Chamorro et al., 2016; de Leeuw et al., 2018; Schmid & Jarvis, 2014) across different L1-L2 combinations such as Spanish-English (Cairncross et al., 2023; de Leeuw et al., 2018; Hicks et al., 2024; Linck et al., 2009; Ribbert & Kuiken, 2010; Tsimpli et al., 2004).

However, L1 attrition has been traditionally associated with a narrow scope and several assumptions. Firstly, a prevailing idea in the field has been the fact that L1 attrition effects occur at the level of **knowledge representation**, rather than online processing, and most importantly, that such influence at a representational level would lead to L1 erosion, or loss (Gürel, 2004; Seliger & Vago, 1991b). This negative connotation attributed to L1 attrition has been recurrent in the literature, especially in the origins of the field. For instance, Lambert and Freed (1982, p. 1) describe L1 attrition as "the loss of any language or any portion of a language by an individual or a speech community. It may refer to the declining use of mother tongue skills by those in bilingual situations". Similarly, Oxford (1982, p. 120) states that "attrition refers to loss of proficiency", while Schmid (2002, p. 5) refers to "gradual loss of a language by an individual". The idea of loss is related to the assumed characteristic of attrition as permanent L1 changes at the level of knowledge representation. The fact that L1 attrition would result in modifications of the underlying representations and structures of the bilingual's L1 fostered the assumption of attrition being permanent, maybe leading to language loss.

These ideas have not been completely overcome, as some scholars still attach a negative connotation to L1 attrition. Gallo et al. (2021, p. 2) refer to this process as a "gradual decrease of native language performance that occurs with time and may be associated with increased use of L2, decreased use of L1 or both". Similarly, Kasparian and Steinhauer (2017, p. 710) claim that L1 attrition should be conceptualised as a "less efficient L1 processing", and Cuza (2010, p. 256) refer to attrition as "the nonpathological erosion of previously acquired L1 properties". References such as decrease of language performance, less efficient process or erosion rely on the idea that certain properties of the L1 will disappear, depicting L1 attrition as a negative consequence of the interaction between the linguistic systems of a bilingual. Following Seliger and Vago (1991b, p. 7), "it is erosion that reaches the level of competence that allows for interesting claims about and meaningful insight into the attrition process". L1 attrition seems to be restricted to changes in comprehension and knowledge representation, while changes at a processing level would remain outside its scope. As summarised by Schmid and Köpke (2017) "'true' attrition effects […] should be permanent, irreversible and affect underlying structure". In contrast, modifications in the online processing of bilinguals' L1 would be placed out of the scope of L1 attrition, as they would correspond to typical crosslinguistic influence that all bilinguals experience.

The view of L1 attrition as permanent and irreversible changes has been questioned by studies examining whether attrition effects are permanent or temporal, providing evidence that re-exposure to the L1 may mitigate previously attested attrition effects (Chamorro et al., 2016; Genevska-Hanke, 2017; Köpke & Genevska-Hanke, 2018). For instance, Genevska-Hanke (2017) studied L1 Bulgarian-L2 German bilinguals living in Germany for 17 years. Findings revealed that bilinguals' proportion of overt pronominal subjects in L1 Bulgarian was significantly higher than that of Bulgarian natives, which was considered evidence of L1 attrition. Most importantly, after a 3-week stay in Bulgaria, the L1 environment, the proportion of overt pronominal subjects in bilinguals dropped to monolingual-like levels. These results were further compared in an investigation by Köpke & Genevska-Hanke (2018) five years later. Unexpectedly, no further attrition effects were found for L1 Bulgarian-L2 German bilinguals after they returned to the L2 environment, i.e., Germany, since the production of overt subjects remained monolingual-like. Based on these results, changes in attrited phenomena does not seem to be permanent and irreversible, but rather temporal and modulated by re-exposure to the L1. Thus, it seems to be problematic to consider L1 attrition as language loss. The present PhD thesis will depart from this perspective and consider L1 attrition as a natural by-product of the process of becoming bilingual.

As a response to this restricted view, Schmid and Köpke (2017) suggest that classifying L2-to-L1 influence into temporary online effects and permanent representational ones, with only the latter being considered L1 attrition, is arbitrary and counterproductive as these two categories simply represent different stages along the same developmental continuum. In this view, attrition would encompass all changes detected in the L1 of a bilingual, with these changes first being observed in online phenomena affecting production and/or processing. In some cases, this process may continue and result in readjustments at the level of knowledge representation. Schmid and Köpke (2017) advocate for a broader, more inclusive concept of L1 attrition, opening its scope to include changes traditionally rejected as L1 attrition. This PhD thesis will rely on this open view of L1 attrition, not making assumptions regarding at which levels attrition may occur. Instead, it will explore both offline interpretation and online processing to examine whether attrition effects are observed in either or both levels.

Together with the association between attrition and language loss, an additional characteristic of attrition research has been the **narrow scope of bilinguals tested**. L1 attrition has not been considered a phenomenon that may apply broadly to any bilingual speaker. Instead, it has been restricted to a specific type of bilinguals who meet certain conditions. The traditional view of attrition assumes that not all bilinguals are susceptible to experiencing it and therefore, has typically regarded attriters as a specific subset within the broader category of L2 learners. Only those with limited L1 use and exposure, together with extensive L2 immersion would be considered potential attriters. In this line, given that the bilinguals examined in this PhD thesis do not meet these criteria, they would be more typically classified as learners rather than potential attriters. However, results will reveal evidence of L1 attrition in this bilingual population.

The constant distinction between L2 learners and attriters is frequent in previous literature, as many studies use these two concepts to refer to fundamentally separate populations. This is easily exemplified in the way participant groups are labelled. For instance, Kasparian and Steinhauer (2016) explored L1 attrition in three groups of speakers, naming these as follows: Italian monolinguals, L1 attriters, and L2 learners[2]. The methodological decision to include a group of attriters and separate group of learners illustrates the spread view of L1 attrition as exclusive of a particular bilingual population. In fact, the attriter group consisted of L1 Italian-L2 English bilinguals (N = 24) who migrated to Canada and had been living there ever since, with a mean length of residence (LoR) of 11 years. These bilinguals also reported limited use of L1 Italian and a predominant use of L2 English, which had become their functional/dominant language. In contrast, the group of L2 learners (N = 20) encompassed L1 English-L2 Italian bilinguals who had learned Italian in a classroom context. Based on their characteristics, the authors assumed these bilinguals could not qualify as attriters.

Based only on their characteristics, the bilingual group examined in this PhD thesis aligns more with the group of L2 learners rather than that of attriters. This is why this bilingual population has not been considered in previous L1 attrition studies, which explains the lack of research addressing attrition in bilinguals with different profiles. The key aspect is that such distinction relies more on assumptions associated with the notion of L1 attrition than actual empirical evidence. It has been presupposed, rather than tested, that bilinguals other than those immersed in the L2 environment with great L1 disuse may also experience attrition. This thesis will offer a novel contribution to the field, challenging the traditional conditions required for attrition.

This lack of data explains why current understanding of this phenomenon remains incomplete. Further research is required to unveil the nature of L1 attrition, particularly regarding the conditions under which it may emerge and the populations susceptible to experiencing it. As Hicks et al. (2024) rightly point out, there is a need to identify the extralinguistic conditions under which attrition may manifest. To date, attrition research has predominantly focused on a specific bilingual population characterised by limited L1 use/exposure and extensive L2 naturalistic immersion. This was so because, assuming the L1 is a stable system, only extreme conditions would lead to attrition. While there is extensive evidence of attrition in these bilinguals, the narrow scope of attrition has resulted in a limited range of bilinguals tested, leaving potential L1 attrition effects in other contexts unexplored. In this regard, this PhD thesis offers a novel contribution by demonstrating that L1 attrition is not restricted to naturalistic settings but can also occur

[2] It is worth specifying that the L1-L2 combination of the two bilingual groups does not coincide: L1 Italian-L2 English for attriters vs. L1 English-L2 Italian for learners.

in other L2 exposure contexts like classroom settings. By investigating L1 attrition in an underexplored population, this study provides valuable insights into the true scope of L1 attrition. Findings will highlight the need to expand research beyond the traditional focus and foster our understanding of attrition across different contexts.

2.2. L1 attrition: multiple definitions

The notion of L1 attrition has been increasingly discussed in recent literature, but there is still considerable disagreement among researchers. Despite the growing body of studies that has explored the processing and interpretation strategies that may vary in the L1 of bilingual speakers (Bergmann et al., 2008; Dussias & Sagarra, 2007; Frenck-Mestre & Pynte, 2000; Linck et al., 2009; Whitford & Titone, 2012), the definitions and terminology used to refer to L1 attrition and its scope are not consistent. Köpke (2004, p. 1331) described this situation as a “terminological jungle”.

The debate on what attrition is originates with the conditions traditionally regarded as necessary for its occurrence, these being the following: (1) considerable L1 disuse and lack of L1 exposure, (2) prolonged naturalistic immersion in an L2 environment and therefore, (3) extensive L2 exposure. Most research on L1 attrition is built on these assumptions, which are directly related to the origins of the field, as attrition research began in migration contexts and focused specifically on bilingual migrant populations. As a result, most studies on L1 attrition that followed investigated a very specific bilingual population, i.e., bilingual speakers who were immersed in an L2 naturalistic context, frequently immigrants. These bilinguals had often been living in an L2-speaking country for an extended period of time, with limited L1 use and input and with their L2 being their dominant language (Dussias & Sagarra, 2007; Kasparian & Steinhauer, 2016, 2017). Based on the extensive research conducted on these bilinguals, L1 attrition effects have been largely attested and reported for this population. However, while there seems to be an agreement that high amount of L2 exposure is a necessary condition for L1 attrition to emerge, both L1 disuse and prolonged naturalistic L2 immersion have been challenged in previous literature as necessary conditions for this process. The present PhD thesis will further challenge these conditions by exploring a bilingual population that does not meet any of them to determine whether they can also experience L1 attrition. Still, results show evidence of L1 attrition in these bilinguals, demonstrating that this phenomenon is not exclusive to naturalistically immersed bilinguals. These findings highlight the need to reconsider the traditional conditions associated with attrition. These conditions will be addressed in more detail in the following paragraphs.

First, regarding **L1 disuse and limited exposure,** the assumption of it being an essential condition for L1 attrition is pervasive in the literature. This is particularly common in the initial literature on L1 attrition, when the scope of this process was more restricted and focused on immigrant populations. As an example, Olshtain (1989, p. 151) states that "the study of language attrition […] focuses on the effects resulting from an individual's reduced use of the attrited language". This claim clearly establishes limited use as a pre-requisite of attrition to occur, implying that it is only when the bilingual speaker considerably reduces their exposure and use of their L1 that attrition may arise. In the same line, but from a more radical perspective, Waas (1996, pp. 29–30) claims that L1 attrition seems to be "prevalent in language contact situations where one language is not maintained by its speakers". Here, first language attrition is not just associated with limited use and exposure, but rather with language loss. Although this is an extreme situation, even more recent literature presents reduced L1 use/exposure as a fundamental factor. Paradis (2007, p. 125), for instance, claims that "attrition is the result of long-term lack of stimulation". The idea of "lack of stimulation" here refers to the lack of input and production of the native language for a prolonged period.

Overall, such reduced amount of use of and exposure to the bilingual's L1 has been a traditional factor in attrition and consequently, a characteristic of most bilinguals tested in previous studies. As an example, Kasparian and Steinhauer (2016) explored lexical-semantic processing in native speakers of Italian with English as their second language (N = 24) who migrated to Canada. These participants self-reported very limited use of their L1 Italian, while they highlighted the predominant use of L2 English. They also reported having noticed changes in terms of fluency of their L1 Italian. In an additional study, Jegerski et al. (2016) collected more in-depth information of the participants' language profile. Focusing on their late sequential bilingual group (N = 21), it encompassed L1 Spanish-L2 English bilinguals who migrated to the United States. Participants also completed self-reported questionnaires about their language profile and based on their responses, their mean exposure at the time of testing was 51.5% of English vs. 43.9% of Spanish[3]. Although the difference does not seem to be large, it is still

[3] The remaining 3.7% corresponds to other languages.

sufficient to illustrate the reduced exposure to their L1 in comparison to their L2, which is the language these participants are most exposed to.

Overall, attrition has been assumed to occur when there is a significant decrease in the use of and exposure to an individual's native language. However, this condition is in fact a consequence of a broader factor: extensive **L2 naturalistic immersion**. It is the fact that bilinguals settle in an L2-speaking country, with an obvious increase of L2 use and exposure, that inevitably leads to a reduction of the L1. Therefore, bilinguals believed to potentially experience L1 attrition were those with prolonged exposure to the second language in an L2-speaking country where this was the functional language. L2 naturalistic immersion has been considered a necessary condition for the development of L1 attrition. Following this view, Schmid (2008, p. 10) describes attrition as the result of "a change in linguistic behavior due to a severance of the contact with the community in which the language is spoken". Such prolonged contact with the L2 community would lead to an unbalanced scenario where bilinguals' L2 use and exposure would overwhelmingly overcome both the use of and exposure to their L1. As a consequence of this assumption, the majority of previous L1 attrition research has explored bilingual speakers who migrated to an L2-speaking country and were naturalistically immersed in such L2-dominant environment ever since (Cazzoli-Goeta & Young-Scholten, 2011; Cuza, 2010; Dussias & Sagarra, 2007; Kasparian & Steinhauer, 2016, 2017).

Most importantly, traditional research emphasised the need for this period to be extensive, as it was assumed that the L1 was a stable linguistic system and that, to cause changes in it, prolonged time would be necessary. Therefore, it is not just naturalistic immersion but **prolonged naturalistic immersion**. Then, the most frequent procedure was to test bilinguals a long time after migration to the L2- speaking country had taken place. The early literature on L1 attrition focused specifically on bilinguals who had been living in the L2 environment for a long period of time, usually for several decades (Bot et al., 1991; De Bot & Clyne, 1994; Gürel, 2004; Tsimpli et al., 2004; Weltens et al., 1987). In words of Schmid (2020, p. 200), researchers have considered attrition to be a slow process, "with years if not decades necessary before any observable changes take place". In this context, studies on L1 attrition have typically investigated individual speakers who have lived in the L2 environment for around 10 years after the onset of immigration, as this timeframe seemed to be sufficient for potential observable changes in their native language to emerge (Gürel, 2004). Schmid (2011a, p. 111), for example, acknowledged the cautious approach in past research to set a minimum length of residence of ten or fifteen years, and recommended to maintain this participation criterion as it would allow researchers identify “relatively stable effects”, avoiding potential interference from the active development of the L2 in the initial years after migration.

Cuza (2010), for instance, explored long-term immigrants (N = 19) with Caribbean Spanish as their L1 and English as their L2 who migrated to either the United States or Canada after puberty. Length of residence was a selection criterion, testing participants who had lived in the L2 context for a minimum of 10 years (mean LoR = 27 years). The study explored L1 attrition in relation to the ongoing value of Spanish present tense, not available in English. Long-immersed L1 Spanish-L2 English bilinguals were expected to exhibit reduced acceptance and use of such ongoing value. As expected, results show low levels of acceptance and use of present-tense forms with an ongoing meaning in favour of significantly higher use of progressive forms among immigrant bilinguals. This was taken as evidence of attrition. Similarly, Schmid and Dusseldorp (2010) conducted a study on L1 German speakers with either English (N = 53) or Dutch (N = 53) as their L2. These participants were living in either Anglophone Canada or the Netherlands, respectively. A minimum length of residence was set to 15 years for both groups, with a mean LoR of 37.09 years for the Canadian group and 34.28 years for those in the Netherlands. The study examined to what extend sociolinguistic and extralinguistic factors account for changes in L1 proficiency, measured via verbal fluency tasks, a grammaticality judgement task and a film retelling task. Overall, results evidence attrition effects as the two bilingual groups did not reach L1 native-like proficiency levels. However, this PhD thesis will demonstrate that a long period of L2 naturalistic immersion is not a necessary condition to observe attrition effects in bilinguals.

This tendency to investigate naturalistically long-immersed bilinguals has not been overcome, as it is still present in more recent L1 attrition studies (Cairncross et al., 2023; Chamorro et al., 2016; Gargiulo & Van De Weijer, 2020; Hicks et al., 2024; Kaltsa et al., 2015). For instance, Cairncross et al. (2023) tested long-immersed bilinguals to explore their attachment interpretative biases. The bilingual group consisted of L1 Italian-L2 English bilinguals (N = 29) living in an English-speaking country for an average of 14.27 years (SD = 7.89). Participants reported using Italian 22.96% of the time, English 76.16%, and other languages 0.87%. Interestingly, the authors argue that these characteristics (extensive L2 immersion, frequent L2 use, reduced L1 exposure) make these bilinguals appropriate candidates for L1 attrition. In fact, results from a sentence interpretation task in their L1 Italian revealed evidence of attrition, as the selection of their L1 preferred disambiguation interpretation, i.e., high attachment, was significantly lower than that of a control group of Italian natives. This adds to the bulk of literature that views prolonged naturalistic immersion and reduced L1 use/exposure as necessary conditions to ensure the presence of attrition in bilinguals.

The above research exemplifies the baseline requirements bilinguals have to meet to be susceptible to experience L1 attrition. Specifically, bilingual speakers who moved to an L2 country after puberty, settled and lived there for an extended period before being investigated. Such participants' profile was the result of how L1 attrition had been operationalised. The narrow scope of its definition prompted research focusing in a highly specific population. Consequently, scarce data is available regarding attrition effects on other bilingual populations in different settings. This PhD thesis will address this gap by examining data from bilinguals in a different L2 exposure context: L1 Spanish-L2 English bilinguals with extensive L2 exposure in a university classroom setting while still living in an L1 environment, Spain, where their L1 remains the functional language.

The preconceived idea that naturalistic immersion had to be extensive for attrition to emerge resulted in a lack of evidence from the initial stages of L2 naturalistic immersion, as pointed out by Martín-Villena (2023). In fact, the need of L2 immersion to be extensive as a necessary condition for L1 attrition has been questioned by researchers like Gallo et al. (2021, p. 3), who suggest that this requisite was call into question by studies where attrition effects are found "in the case of short periods of immersion experience (or length of residency, LoR)". More recent literature on L1 attrition has indeed explored shorter periods of L2 residence in different domains like morphosyntax (Martín-Villena, 2023), phonetics, phonology (Celata, 2019; De Leeuw, 2019) and lexicon (Jarvis, 2019), providing evidence that even bilinguals with shorter periods of immersion may experience readjustments in their L1. Findings suggest that short periods of L2 immersion can also create the ground for attrition effects in bilinguals' L1, which implies that the native language is more permeable, plastic and subject to change than initially thought. This seems to suggest that the definition and framework of L1 attrition is becoming more flexible, broadening its initial scope.

Studies on short-term naturalistic immersion have revealed that naturalistic immersion does not need to be long for observable L1 changes to emerge. This idea has been supported by a recent study that, although focused on long-immersed bilinguals to ensure they were potential attriters, did not find clear attrition effects. Hicks et al. (2024) investigated attrition effects in the aspectual interpretations of L1 Spanish-L2 English adult bilinguals settled in the United Kingdom (UK) for a minimum of 15 years, with a mean length of residence of 21.3 years prior to their participation in the study. However, their findings were unexpected as no clear attrition effects were observed in their results. These findings seem to suggest that extensive L2 naturalistic exposure may not play a determining role, providing support for the fact that prolonged L2 naturalistic immersion may not be a necessary condition for L1 attrition.

However, the underlying implication is that naturalistic L2 immersion, although shorter, is still considered a prerequisite for bilinguals to experience L1 attrition effects. The aforementioned studies do not directly challenge the need of L2 naturalistic immersion, but rather the length of such required naturalistic immersion. They challenge the view that L2 naturalistic immersion and consequently, L1 limited use and exposure, must occur for a prolonged time, providing evidence that naturalistically immersed bilinguals can also experience L1 attrition after short periods. The key aspect here is that L2 naturalistic immersion is not rejected as a requirement, and seems to be a necessary condition, although briefer than earlier. It is still assumed that for L1 attrition to occur, the speaker must move to and settle in an L2 environment.

Against all the restrictions imposed to the concept of attrition from its origins, recent research has advocated the need for a broader scope of this term. Particularly relevant is the definition provided by Schmid & Köpke (2017, p. 638), who describe L1 attrition as "the process by which (a) pre-existing linguistic knowledge becomes less accessible or is modified to some extent as a result of the acquisition of a new language, and (b) L1 production, processing or comprehension are affected by the presence of this other language". This PhD thesis will be built on the need to re-define the notion of L1 attrition. It will question the conditions traditionally assumed to foster attrition, i.e., L1 disuse and limited exposure, as well as extensive L2 naturalistic immersion. The naturalistic-immersion requirement will be questioned by testing a bilingual population who is not living in an L2 environment. The concept of immersion will be expanded from naturalistic contexts to formal classrooms settings, exploring whether L1 attrition can also emerge in bilinguals who are immersed in a university L2 classroom setting but live in an L1-environment. This PhD investigation will also question the L1-disuse requirement, as bilinguals tested in the present study do not experience considerable L1 disuse. Findings obtained will demonstrate that these two conditions are non-essential for L1 attrition since attrition effects will be observed in bilinguals immersed in an L2 instructed setting. The results will provide relevant insights into the true scope of attrition and will highlight the need to redefine its traditional characteristics.

2.3. A working definition of L1 attrition

The previous terminological debate makes it necessary to specify the scope of and approach to L1 attrition that will be used in the present PhD thesis. First, L1 attrition is a non-pathological process, highlighted by Köpke (2004) as one of its main characteristics. In this line, L1 attrition is different from language disorders or language-related problems such as aphasia. Second, the onset of attrition occurs after first language acquisition has been completed. This meaning that L1 attrition involves any changes in a bilingual's first language due to the acquisition, use of and exposure to an L2 after the L1 has been fully acquired. Consequently, and based on the distinction between early and late bilinguals in Section 2.1, L1 attrition will be explored in late sequential bilinguals whose first exposure to their L2 English took place once their L1 Spanish was fully acquired.

Limiting the scope of L1 attrition to late sequential bilinguals will ensure a distinction between L1 attrition and incomplete L1 acquisition, in which the L1 may not have been fully acquired by the individual prior to the first exposure to a second language. This would be the case, for instance, of adopted children (Nicoladis & Grabois, 2002; Ventureyra et al., 2004), and heritage speakers, whose quality and quantity of L1 input is not comparable with those of late bilinguals. As for heritage speakers, their L1 is likely to be different from that of native speakers in the L1 community because their L1 input likely comes from potential attriters and other HSs and may be restricted to specific registers/contexts (Rothman, 2007). Given the complexity of including these bilingual populations, L1 attrition is restricted in this PhD thesis to adult bilinguals who have completed the acquisition of their L1 before learning and being exposed to an L2.

For the purposes on the present PhD thesis, the focus is even more specific as it examines L1 attrition in late sequential bilinguals in a specific environment, which differs from that of most previous studies. While previous research typically involves bilinguals living in L2-speaking contexts where their L2 is the majority language and their L1 the minority language, this study explores the opposite scenario. It focuses on late L1

Spanish-L2 English bilinguals living in an L1-context in which the L2 is not a functional language of both the country and region where they live, i.e., Granada, Spain. All bilinguals tested have been born and raised in a monolingual context, using their L1 Spanish exclusively and on a daily basis with their families and friends. This is important because other Spanish regions such as the Basque Country and Catalonia, for example, are bilingual. In these environments, speakers are more likely to be early simultaneous bilinguals who have been exposed to two languages from an early age, i.e., Spanish and the official language of their region. Recruiting participants in Andalucia, a non-bilingual region, facilitates access to the population of interest for this thesis and offers the ideal conditions for investigating the scope of L1 attrition.

A third relevant aspect in the scope of attrition within the present PhD thesis is the fact that L1 attrition is considered a characteristic of the individual. As stated by Gallo et al. (2021, p. 2), attrition is related to "individual change", specifying that it "indicates changes occurring at the cognitive/psycholinguistic level". L1 attrition is then a direct result of the activation and coexistence of at least two languages in the linguistic repertoire of a bilingual. Consequently, L1 attrition is different from language change that may take place at a societal level (Dorian, 1982; Gardner-Chloros, 2001; Milroy, 2001). Fourth, no assumptions will be made regarding whether attrition occurs at a representational level only, or also at a processing level. This thesis aims at exploring the scope of attrition to gain a better understanding of this process, so different tasks will be conducted to investigate potential attrition effects in both offline comprehension and online processing. This will allow us to identify whether and, if so, to what extent L1 attrition manifests at a representational o processing level.

Fourth, and last, L1 attrition will not be explained in terms of direct transfer of language-specific properties from the L2 to the L1. It is understood as a natural process of change or readjustment in the bilingual's first language due to the interaction and coexistence of two linguistic systems. It is considered a by-product of bilingualism, rather than the result of direct L2 influence or the replication of L2 specific patterns in the L1. To claim that bilinguals replicate L2-specific patterns in their L1, it would be necessary to investigate other language pairs. For instance, if L1 Spanish-L2 English bilinguals exhibit a pattern similar to that of English monolinguals, we could only conclude that they are replicating English-specific tendencies if L1 Spanish-L2 French bilinguals, for example, favour French patterns instead. Conversely, if the same tendencies are observed across different language combinations, these cannot be attributed to the specific L2. The lack of a second bilingual group with a different L1-L2 combinations implies that potential attrition effects observed will be explained as a result of bilingualism.

To summarise, L1 attrition will be explored in late sequential bilinguals who have achieved complete competence in their native language prior to the onset of L1 attrition. In particular, the target bilingual population does not involve naturalistically immersed bilinguals as most L1 attrition studies do, but rather bilinguals living in an L1 environment who are extensively immersed in an instructed setting. In addition, attrition is considered a non-pathological and natural process at the level of the individual, potentially experienced by bilinguals due to the coexistence of distinct linguistic systems in the bilingual mind, and which can potentially manifest at either representational or processing levels. Thus, it will be examined in this thesis using both offline and online measures. Finally, results obtained for bilinguals will not be attributed to direct transfer from the L2 English but will rather be explained as a by-product of the general process of bilingualism.

2.4. Predicting factors in L1 attrition

The previous sections have provided an overview of the debate on what L1 attrition is, together with a specification of its scope in the present PhD thesis. Although a number of necessary conditions have been attached to this concept since the origins of this field, these have been put to question in more recent research. This has evidenced the need to broaden the scope of L1 attrition, as suggested by Schmid & Köpke (2017). Such broader perspective has been implemented in the scope of L1 attrition within the present PhD thesis, as outlined in Section 2.3 above. At this point, this section will address some of the factors discussed in previous studies as potential modulating factors in L1 attrition outcomes. L1 attrition seems to be influenced by multiple variables such as age of bilingualism (Bylund, 2019), proficiency (Kasparian & Steinhauer, 2017), frequency of use and length of residence (Schmid, 2019) and re-immersion in the L1 environment (Chamorro et al., 2016), among others. However, attention will be paid in this section to language dominance and length of extensive L2 exposure.

2.4.1. Language dominance

This section will provide a discussion of the concept of language dominance, along with some measurement approaches employed in previous literature. In particular, attention will be paid to individual language dominance, as opposed to societal language dominance (Fishman, 1972). Individual language dominance refers to variability in bilinguals' dominance across the languages in their linguistic repertoire, i.e., how dominant a bilingual is in each of their languages. Language dominance is a complex phenomenon, whose interest arises from its potential to predict or modulate outcomes in bilinguals at an individual level (Treffers-Daller, 2019; Treffers-Daller & Korybski, 2015). Bilingual speakers are not homogeneous regarding their previous language experience, showing considerable differences in the dimensions that that shape such bilingual background. Among these, language dominance seems to be an essential one as previous research has evidenced the role played by language dominance both in the L1 and L2 of bilingual speakers (Amengual & Chamorro, 2016; Argyri & Sorace, 2007; Puig-Mayenco et al., 2018; Tsui et al., 2019).

Despite its relevance in bilingual development and the increasing interest among scholars, there is still confusion about what language dominance is. Although agreeing on a specific, detailed definition of language dominance remains challenging, there appears to be an agreement in some general characteristics. Language dominance seems to be widely recognised as a multi-faceted and dynamic construct, as it covers a wide range of factors within the bilingual experience and involves change over time.

Regarding its multi-faceted nature, dominance is not a single construct but rather composed of multiple components. Among these, it is worth mentioning the role of proficiency and language use, which are reflected in definitions proposed by researchers. Montrul (2015, p. 16) argues that language dominance includes "a linguistic proficiency component, an external component (input), and a functional component (context and use)". Similarly, Treffers-Daller (2019, p. 378) highlights both language proficiency and language use across different domains (at home, work, school, etc.) as "two key dimensions of language dominance", and Wei (2000, p. 5) defines bilinguals with a dominant language as "someone with greater proficiency in one of his or her languages and [who] uses it significantly more than the other language(s)". Such pivotal role of proficiency and language use in language dominance is agreed by other authors (Luk & Bialystok, 2013; Silva-Corvalán & Treffers-Daller, 2015; Snape & Kupisch, 2016). Additionally, these factors may vary over time. For instance, proficiency may increase, remain stable, or decline. This means that dominance is not always the same but rather dynamic and changing. Bilinguals may exhibit greater proficiency and more frequent use in one language, i.e., their dominant language, compared to the other non-dominant language at different points in time.

In general, dominance has been measured by assessing the constructs that compose it. For instance, it has been measured in terms of self-ratings of proficiency (Tsui et al., 2019) and amount of use of / exposure to each language (Argyri & Sorace, 2007). Other measures such as mean length of utterance (Yip & Matthews, 2006) or lexical richness, (Treffers-Daller, 2011) have also been used. Based on the data collected through these measures, dominance has been operationalised in two different ways: as a categorical variable or along a continuum.

First, attention will be given to studies that have treated language dominance as a **categorical variable**. The studies implement a binary distinction in their analyses, categorising one language as dominant and the other, as non-dominant (Fallah & Jabbari, 2018; Puig-Mayenco et al., 2018; Tsui et al., 2019). As an example, Tsui et al. (2019) explored the effect of language dominance, treated categorically, on phonetic transfer to examine if different language dominance profiles influence the direction of phonetic transfer in bilinguals with the same L1-L2 combination. Participants were Cantonese-English bilingual adults (N = 60), further classified into three dominance groups based on self-reported proficiency ratings: Cantonese dominant (N = 20), English dominant (N = 20), and balanced bilinguals (N = 20). Thus, researchers established a dichotomy between complete dominance in one language or the other, categorising participants into either Cantonese-dominant or English-dominant. Those with similar proficiency in both languages were included in the balanced group. Participants were presented with pictures of objects or scenes (N = 24) and were instructed to name them in either English or Cantonese. The response language was either the same as or different from the preceding trial. Results for Cantonese and English dominant bilinguals reveal phonetic transfer from the non-dominant to dominant language, but not in the opposite direction, whereas balanced bilinguals are unaffected by language switching. When compared to bilinguals with no dominant language, language dominance seems to influence speech production. However, the fact that bilinguals are categorically classified as either Cantonese or English dominant prevents exploring variability among them. It is possible that being more or less dominant in a specific language might better explain the results, but this remains unknown. This will be addressed in this investigation.

In fact, treating language dominance categorically has drawn criticism (Silva-Corvalán and Treffers-Daller 2015). This dichotomy (dominant vs. non-dominant language) oversimplifies the complexity of bilingual experience and consequently, of language dominance, not taking into consideration individual variation in terms of proficiency, use, usage contexts, cultural association with each language, etc.

Against the categorical treatment, and to better capture the dynamic nature of language dominance, some studies have treated it along a **continuum**. Given the complexity and wide variety of bilingual profiles (see Section 2.1), some authors advocate to consider language dominance within a continuum from more L1 dominant to more L2 dominant. Several questionnaires have been used to investigate dominance as a gradient continuous construct, which address a variety of dimensions within the wider construct of language dominance such as language use, language history, proficiency, attitudinal variables, etc. Some examples are the *Bilingual Language Experience Calculator* (Unsworth, 2013), the *Bilingual Dominance Scale* (Dunn & Fox Tree, 2009), the *Language Experience and Proficiency Questionnaire* (Marian et al., 2007), the *Language and Social Background Questionnaire* (Anderson et al., 2018) or the *Bilingual Language Profile* (Birdsong et al., 2012) questionnaire. The former is particularly relevant as it is the questionnaire administered in the present PhD thesis.

These questionnaires provide a gradient score placing bilinguals within a continuum from complete dominance in the L1 to complete dominance in the L2. The advantage of using these questionnaires is that they allow a more detailed exploration of subtle individual differences, which would be overlooked if dominance is treated categorically. For instance, if dominance is treated categorically, the following two types of speakers could be qualified as Spanish dominant: (1) a Spanish monolingual with little knowledge of L2 English and lack of L2 use, and (2) an advanced L1 Spanish-L2 English bilingual living in Spain with higher L2 use. However, their bilingual experience is clearly different, and this may lead to different outcomes in linguistic tasks. Such differences are better captured by questionnaires measuring dominance in a continuum. For example, returning to the previous example, the score of both speakers may indicate that they are dominant in their L1, but the monolingual to a greater degree than the bilingual speaker.

Among the aforementioned questionnaires, the *Bilingual Language Profile* test (Birdsong et al., 2012) has been extensively employed to account for variability in wide range of bilingual populations. For instance, simultaneous bilinguals (Amengual, 2016;

Bonvin et al., 2023), sequential bilinguals (Black et al., 2020; Garraffa et al., 2017; Puig-Mayenco et al., 2020), or heritage speakers (J. Y. Kim, 2019). It has also been demonstrated to be a suitable tool to investigate potential L1 attriters (Gertken et al., 2014; Martín-Villena, 2023), which are the focus of this PhD thesis. The BLP assesses language dominance via a set of four separate modules: language history, language use, language proficiency and language attitudes (see Section 5.3.2 for further details). These aspects have been shown to be relevant for the variability attested in L1 attrition studies (Schmid & Köpke, 2017a, 2019). Based on the information provided within each module, the BLP provides a final score within a continuum that ranges from -218 to +218. Values closer to the negative end (-218) indicate that bilinguals are more L2-dominant, while values closer to the positive end (+218) suggest they are more L1-dominant.

Furthermore, and more closely related to the objectives of this PhD thesis, it is important to highlight the connection between language dominance and L1 attrition. This is relevant since there are two limitations in how language dominance has been considered in L1 attrition research. First, bilinguals tested have been L2 dominant and second, studies have relied on a categorical approach. Regarding the former, attrition studies have assumed that for attrition to occur, the L2 must replace the L1 as the bilingual's dominant language (see Section 2.2). For example, Kasparian and Steinhauer (2016, p. 201) consider that "in contrast to L2 learners who continue to maintain predominant use of their native language and who therefore consider their L1 to be their dominant language, attriters are individuals for whom increasing L2 exposure and proficiency comes at a cost to their L1, exposure to which is reduced or interrupted". Similarly, Cuza (2010, p. 256) argues that L1 attrition is the result of "intense contact with a dominant second language and reduced L1 input and use". This view has prevailed in the field and therefore, bilinguals typically attested in previous literature have been L2-dominant speakers.

As an illustration, Cuza (2010) tested L1 Caribbean Spanish-L2 English bilinguals (N = 19) settled in the US or Canada during adulthood. Cuza (2010, p. 263) specifies that participants "worked or studied in environments where high proficiency in English was a requirement (high school teachers, librarians, nurses, lawyers, students, customer service/retail, university students)". In addition, participants were highly proficient in L2 English and, regarding language use, they indicated that they used both English and Spanish 58% and 53% of the time, respectively, in both work and home settings. Given these characteristics, the dominant role of bilinguals' L2 on their daily life becomes evident. L1 attrition has been mostly limited to bilinguals whose dominant language is their L2. However, little evidence is provided on potential attrition effects on bilinguals whose dominant language remains to be their L1, and this will be tackled in this thesis.

Finally, these studies have mostly treated language dominance categorically. L1 attrition seems to be influenced by the immediate language context, with small differences among bilinguals. These differences, as mentioned earlier, are better captured by measuring dominance as a continuous gradient construct. However, this approach has not been applied in past research, which has favoured a categorical approach (Dussias, 2003; Köpke & Genevska-Hanke, 2018; Schmid & Yılmaz, 2018). The present PhD thesis will address this limitation by measuring language dominance as a continuous variable using the *Bilingual Language Profile* questionnaire.

To summarise, most findings on L1 attrition research come from bilinguals who are dominant in their L2, but little is known about potential attrition effects on bilinguals who remain L1-dominant. In addition, it has been typically addressed in a categorical manner, overlooking variability across participants. In contrast, this PhD thesis will operationalise language dominance as a multidimensional and dynamic construct, measuring it in a continuum. It will also explore dominance as a modulating factor in L1 attrition among a bilingual population who remains dominant in their L1 Spanish, although to a lesser extent than participants in the Spanish monolingual control group. Assessing language dominance in a continuum as a matter of degree will allow us to investigate whether L1 attrition effects, if any, are further modulated by the degree of language dominance.

2.4.2. Length of extensive L2 exposure

In addition to language dominance, other factors have also been explored as potential predictors of L1 attrition in bilinguals. This section will focus on the role of length of extensive exposure to the L2, as bilinguals may differ in this regard to different degrees. L2 exposure seems to be an umbrella term encompassing various types of contact with the second language, mostly naturalistic and instructed exposure. The former, typically referred to as *naturalistic immersion*, occurs when a bilingual moves to and settles in an L2-speaking country where the L2 is the functional language. Conversely, *instructed exposure* occurs in formal, classroom settings. The present PhD thesis will focus on the latter type, and more precisely, on a specific type of instructed exposure: *immersed instruction*. This term refers to a specific context in which bilinguals who live in an L1 environment receive intensive and daily formal instruction in the L2, i.e., are immersed in L2 formal instruction. This is the case of the bilingual population tested in this thesis: bilingual students completing the degree of English Studies, which is taught in English. The approach followed in the degree is English-Medium instruction (EMI) (Lasagabaster, 2022), where the L2 is used as the means of instruction in content courses at a university level, and language learning mostly takes place implicitly. Consequently, these bilinguals receive extensive daily exposure to English, being immersed in an English-speaking environment not only during lectures but also outside of class when completing their assignments and preparing their exams. The term *immersed* is used due to the intensive contact with the L2, distinguishing this type of instructed exposure from that of bilinguals attending L2 courses twice a week, for instance.

The motivation to explore the modulating effect of immersed instruction in L1 attrition is based on previous research. The study of length of L2 exposure relies on the assumption that stronger evidence of L1 attrition will be observed in bilinguals with more extensive L2 contact and therefore, lower L1 use and exposure. In words of Schmid (2019, p. 288), “the speaker with less attrition phenomena will be the ones with a shorter period of residence, more opportunity to use their L1, or both”. As a result, most L1 attrition studies have explored the role of L2 naturalistic environments, limiting its focus to naturalistically immersed bilinguals, often immigrants, who lived in an L2-country for long periods, under the premise that the longer the length of L2 residence, the stronger the evidence of L1 attrition. In fact, as outlined in Section 2.2, previous literature has considered a 10-year gap between arrival in the L2 environment and the moment of testing to be both necessary for L1 attrition effects to emerge (Gürel, 2004). As a result, considerable fewer attention has been paid to the role of instructed exposure in general, and immersed instruction in particular, and even fewer studies have addressed the potential effect of length of such instructed exposure on L1 attrition effects. This section will review findings from the effect of L2 exposure, both naturalistic and instructed, to justify the need to explore the influence of length of *immersed instruction* in L1 attrition.

Focusing first on L2 naturalistic studies, L1 attrition research has extensively focused on long-term bilingual immigrants settled in an L2 country. Thus, one of the most evident predictor variables to be thought as having an impact on L1 attrition effects was the length of such naturalistic immersion. This has been referred to in the literature as length of residence (LoR) or length of stay. For consistency, this variable will be referred to as **length of naturalistic immersion** in this PhD thesis. Previous studies have reported an effect in the expected direction, i.e., an increase in time naturalistically immersed in the L2 country leading to more evident attrition effects. This is the case of Kasparian and Steinhauer (2017)'s event-related-potential (ERP) study on processing of Italian relative clauses. In this study, data were gathered from two groups: L1 Italian-L2 English adult bilinguals (N = 24) and Italian monolinguals (N = 30). Attrition effects are reported in the bilingual group, represented by a greater sensitivity to word-order preferences than Italian monolinguals, following the English pattern, and lower acceptance of grammatical Italian sentences that were ungrammatical in English. When these results were further analysed considering additional modulating factors, the findings revealed that bilingual's response patterns were influenced by length of residence as longer L2 immersion was associated with increased L2-to-L1 influence. An effect of length of residence is observed as those speakers with longer length of residence were shown to be less native-like. These results provide evidence in favour of length of residence as a predictor variable in L1 attrition. The increase in L2-to-L1 influence in bilinguals with longer L2 immersion suggests that amount of exposure to the second language can influence bilinguals' L1.

Additionally, Dussias and Sagarra (2007) explored the effect of length of L2 exposure on L1 relative clause attachment strategies, which is the structure tested in the present PhD thesis. Data were gathered from three groups: Spanish monolinguals (N = 44) and late L1 Spanish-L2 English bilinguals, further divided into an *extensive exposure* group (N = 20) and a *limited exposure* group (N = 28). Although both bilingual groups lived in the US, the extensive exposure group had an average of 7.1 years of L2 immersion, while the limited exposure group had an average of 8.5 months. Participants completed an eye-tracking experiment that addressed their online strategies to resolve ambiguous relative clauses. Findings revealed an effect of length of immersion on RCA processing. bilinguals with limited exposure, exhibited Spanish native-like processing with a preference for HA, the typical strategy in native Spanish. Conversely, bilinguals with extensive exposure showed processing cost in the L1-preferred forcing-HA condition, evidencing attrition effects. Findings suggest that L1 attrition is observed only in bilinguals with longer immersion, supporting the idea that not only naturalistic exposure, but also extensive naturalistic exposure is needed for attrition to emerge.

However, this effect is not consistent in the literature. Contrary to expectations, and challenging the above findings, some studies have revealed a lack of modulating effect

(Schmid, 2019). Although the idea that extensive length of naturalistic immersion may foster L1 attrition is intuitive, a series of studies exploring attrition regarding fluency, lexicon, morphosyntax, and grammatical gender have shown that this is not necessarily the case (Dostert, 2009; Gürel, 2002; Schmid & Jarvis, 2014; Varga, 2012; Yilmaz, 2011; Yilmaz & Schmid, 2012). Focusing first on lexical L1 attrition, Schmid and Jarvis (2014) examined long-immersed bilinguals in an L2 environment, collecting data from three groups: attrited bilinguals of L1 German-L2 English (N = 53), attrited bilinguals of L1 German-L2 Dutch (N = 53), and a control group of German natives (N = 53) living in Germany. Regarding the two bilingual groups, L1 German-L2 English bilinguals lived in Anglophone Canada, while L1 German-L2 Dutch bilinguals were settled in the Netherlands. Thus, all bilinguals were immersed in an L2-speaking environment, with a minimum of 9 years of residency, and an age of arrival of 14 years or older. Participants completed two semantic verbal fluency tasks and produced two speech samples to gather data from both free and elicited speech. L1 lexical diversity was measured regarding the number of different words, and the total number of words per sample, among other measures. Compared with monolinguals, results show that both bilingual groups could retrieve fewer items from a specific lexical category in a limited time, suggesting lower productivity in their L1 and evidencing attrition effects. To further explore these differences, the potential effect of individual external factors such length of L2 residence was also analysed. It was predicted that bilinguals with longer exposure in a naturalistic setting would exhibit greater attrition effects, i.e., lower productivity in their L1. Unexpectedly, results showed no effect of length of residence as bilinguals with longer immersion did not differ from those with shorter exposure. Thus, variability in bilingual data was not accounted for by this variable.

In addition, the fact that extensive residence does not modulate L1 attrition effects is also observed in L1 attrition research on morphosyntax (Gürel, 2002; Scherag et al., 2004; Varga, 2012; Yilmaz, 2011). Gürel (2002) investigated pronominal binding in overt and null subject pronouns in L1 Turkish comparing two groups: a control group of L1 Turkish speakers (N = 30) living in Turkey and an experimental group of L1 Turkish-L2 English bilinguals (N = 24) living in either Canada or the US, i.e., an L2-environment. Participants in the bilingual group had a mean age of immigration of 25.5 years and a minimum of 10-year residence in the L2 country (range: 10 to 43 years), as this was a participation criterion. Compared to Turkish monolinguals, bilinguals were significantly more likely to associate the pronoun *o* (*he/she*) with the previous subject, which is not grammatical in Turkish, revealing L1 attrition effects in long-immersed bilinguals. To further explore whether length of residence may influence these outcomes, bilinguals were grouped according to the number of years they had been living in the L2 country. Contrary to expectations, results evidenced no modulating effect of length of L2 residence, as no differences were found between bilinguals who have lived in the L2 environment for more years compared to those with shorter residence periods. Gürel (2002, p. 170) indicates that "those who stayed in an L2 country longer do not necessarily show more LI attrition than those who stayed less".

In line with the above, research on grammatical gender has also supported the idea that a longer L2 residence does not necessarily lead to greater L1 attrition. Scherag et al. (2004) examined L1 morphosyntactic attrition regarding grammatical gender, collecting data from: (a) short-term German visitors to the US enrolled in an US University for two terms, (b) long-term German immigrants in the US and (c) L1 German natives living in Germany. It is worth noticing the distinction made by the authors between visitors and immigrants. Both visitors and immigrants are immersed in the L2 environment, being length of stay the difference between them. Visitors are temporary residents, while immigrants have settled more permanently. Regarding the first two groups (L1 German-L2 English visitors and L1 German-L2 English immigrants in the US), the mean time since arrival was 1.3 years for visitors and 18.3 years for immigrants. Data were collected via a lexical decision task where grammatical agreement of German adjectives was manipulated. Results showed no effect of length of residence, as visitors, i.e., short-term bilingual (LoR range: 0-2 years), perform identical to immigrant or long-term bilinguals (LoR range: 6-49). Results from a lexical decision task revealed no differences between the three groups of L1 German speakers (visitors vs. immigrants vs. control group) regarding processing patterns. All groups showed similar processing gains when presented with noun-adjective pairs that were semantically and/or morpho-syntactically congruent in their L1. The fact that these two groups exhibit an identical behaviour regardless of the time they had been immersed in the L2 environment seems to suggest that length of L2 residence does not modulate attrition effects.

Overall, results on the effect of length of L2 naturalistic immersion on L1 attrition are inconclusive, with studies providing either a positive or a lack of effect. This issue was addressed by Schmid (2019), who reviewed 41 studies where length of L2 immersion is included as a predictor in L1 attrition. However, only 12 of them report an effect on bilinguals' L1. Schmid (2019, p. 295) points out that "in every case where there is both a significant attrition effect and a significant impact of LOR[4], the minimum LOR represented in the sample is smaller than ten years". In this line, in the study previously reported by Kasparian and Steinhauer (2017), the authors find a positive effect on bilinguals with a range of naturalistic immersion from 1 to 26 years. This is in line with the claim that L1 attrition seems to stabilise after 10 years of L2 immersion. Overall, the initially assumed effect of length of naturalistic immersion does not appear to be so clear. Findings suggest that longer naturalistic immersion does not necessarily lead to stronger L1 attrition. It is only in the first 10 years of naturalistic exposure that it may modulate such effects, but not afterwards. Crucially, this time period coincides with the length of immersed instruction of the bilinguals tested in this PhD thesis, which ranges from 1 to 4 years. Given that naturalistic immersion may modulate attrition within this period, it seems logical to ask whether length of immersed instruction, particularly in its initial stages, may also modulate L1 attrition effects.

While all previous studies have addressed the relationship between longer L2 naturalistic immersion and stronger attrition effects, little is known about L2 instructed settings and even fewer about contexts of immersed instruction. The data on instructed settings is very limited, but few studies on L1 attrition have provided evidence of L2-to-L1 influence among bilinguals in instructed contexts (Cenoz, 2003; Chang, 2012; Cook et al., 2003; Długosz, 2021; Kecskes, 1998; Martín-Villena, 2023; Requena & Berry, 2021). Most of these studies do not focus on immersed instruction, but on general L2 instructed bilinguals attending L2 courses, and most importantly, none of them investigates relative clause attachment ambiguities, which is the structure of interest in this PhD thesis. Thus, it is necessary to address whether L1 attrition is observed regarding RCA ambiguities in bilinguals with L2 immersed instruction, and whether any potential effects are further modulated by the length of such instruction.

Among the studies cited earlier, three are especially relevant for the present PhD thesis as they examine an instructed bilingual population comparable to the one tested in this investigation. Firstly, Martín-Villena (2023) addressed potential changes in the first language of L1 Spanish-L2 English bilinguals not only exposed, but immersed in an

[4] LOR stands for length of residence.

instructed setting. L1 attrition in this population was studied regarding the L1 production, processing and interpretation of subject referring expressions. Results revealed attrition effects in these bilinguals, who differed from Spanish monolingual speakers by producing and accepting more overt pronouns as referring to the previous sentential subject, which is not typical in their native Spanish. Interestingly, the bilingual population tested by Martín-Villena (2023) coincides with the one explored in this thesis. If attrition effects were found regarding subject referring expressions, it seems necessary to address whether such effects emerge in other linguistic phenomena like RCA.

Additionally, Długosz (2021) investigated potential L2 effects on L1 grammar comparing L1 Polish-L2 English/German bilinguals (N = 25) and a control group of Polish monolinguals (N = 16). Bilinguals were university students of linguistics with advanced level of English and German. Given that they were learning both languages at the same time, both were labelled as L2. At the time of testing, bilinguals had received approximately 800 hours of language instruction in both languages, and around 800 hours of courses on linguistics, literature, and culture. Thus, these bilinguals seem to have a similar profile to those tested in this PhD thesis. Results revealed that learners were significantly more likely that their monolingual counterparts to accept overt object pronouns, while no significant differences were observed in their judgements of wh-questions. Although L1 attrition effects were found for object referring expressions only, findings evidence that the L1 of instructed bilinguals can also undergo readjustments.

Finally, Requena and Berry (2021) studied L2-to-L1 influence in the processing of pre and post-verbal clitic pronouns among advanced bilinguals living in an L1 environment. A self-paced reading task was administered to an experimental group of L1 Spanish-L2 English bilinguals (N = 22) and a control group of Spanish monolinguals (N = 20). Interestingly, bilinguals tested were living in Granada, Spain, as the bilinguals examined in this PhD thesis. Most importantly, the authors report that some were undergraduate students of English Studies at the University of Granada, like the bilinguals in this thesis. However, a difference between the two bilingual populations is that bilinguals in Requena and Berry's (2021) study had been living in an English environment for an average of 5 months. This was avoided in the present investigation to control for potential interference of naturalistic exposure in the results. Overall, both bilingual populations are comparable as they have similar profile: same L1 environment (Granada, Spain), advanced L2 proficiency, and immersed instruction in their L2 English. Results revealed differences between monolinguals and bilinguals in L1 processing. When tested in their L1 Spanish, bilinguals were faster than monolinguals reading clitics in the L1 dispreferred condition, i.e., post-verbal position. This increased acceptability of post-verbal clitics in L1 processing seems to evidence L1 attrition effects in instructed bilinguals (being some of them receiving immersed instruction).

The above studies show that instructed bilinguals may also experience L1 attrition. However, given the scarcity of attrition research on instructed contexts in general, and immersed instruction in particular, future studies should further address this population. It is necessary to examine the under-researched L1 vulnerability of these bilinguals. Similarly to studies on the effect of length of L2 naturalistic immersion, it is also necessary to address whether L1 attrition in instructed settings is further modulated by cumulative length of L2 immersed instruction. This is one of the main questions addressed in the present PhD thesis (see Chapter 4), as it aims to disentangle the potential influence of length of intensive L2 exposure in a university classroom setting, i.e., length of immersed instruction, as a modulating factor predicting L1 attrition.

In following analyses, this will be explored as a within-group variable that may account for variability regarding attrition effects in the L1 Spanish-L2 English bilingual group. To achieve this, the data for this group have been carefully collected. All participants are immersed in an instructed setting, as they are undergraduate students completing the degree of English Studies in Granada, Spain, which is a four-year degree taught in their L2 English (see Section 5.1.3 for further details on bilinguals' profile and their specific language context). These bilinguals are immersed in an English environment not only at university during their lectures, but also at home while doing their assignments and preparing for their exams. This is why they are not only exposed, but rather immersed in an L2 instructed context. To explore whether additional years immersed in an instructed setting modulate potential attrition effects, a balanced number of students from the first, second, third, and fourth years were included. This decision will allow us to include the academic year as a modulating variable in the analyses and consequently, determine whether greater L1 attrition effects tend to occur in students in higher academic years, which have received increased L2 immersed instruction.

2.5. Activation Threshold Hypothesis

Before finishing this chapter, it is relevant to introduce a theoretical framework that has been influential in the study of L1 attrition and is relevant for the purposes of this thesis. The Activation Threshold Hypothesis (ATH), proposed by Paradis (Paradis, 1993, 2004, 2007), creates a correlation between frequency of use of a linguistic item and its degree of activation. It builds on the idea that any mental linguistic representation requires certain amount of neural impulses to reach its activation threshold, i.e., to make it active in the speaker/hearer's mind. Such neural impulses occur every time a linguistic item is used, and the speaker/hearer is exposed to it. Thus, frequency of use will determine its degree of activation, which in turn reflect how accessible the specific item is. To put it simply, each time a linguistic item, this being a single form or a structure, is used, its activation threshold gets lowered, meaning that the item becomes more accessible for the speaker. On the contrary, the less a linguistic form is used, the higher its activation threshold will be and, therefore, the less available or accessible that form will be (Paradis, 2007).

Based on these claims, the ATH formulates relevant predictions for L1 attrition. Firstly, it predicts that language disuse leads to language loss. Lack of use of a language results in lower activation and consequently, fewer accessibility to its linguistic elements. This ideas places frequency of use in a central role within L1 attrition. This connects with the following prediction: due to increased use and exposure to the second language, L2 items that are more frequently used (i.e., more active and accessible) will replace L1 counterparts which are less used and active. This introduces the idea of selectivity in L1 attrition, with those L2 elements that have an L1 counterpart being more likely to experience attrition. Thirdly, and finally, the ATH predicts that comprehension will be retained longer than production, meaning that L1 attrition will first influence production and then, comprehension.

Given that the present PhD thesis does not examine L1 attrition in production data, the two first predictions are the most important ones. Regarding language disuse, bilingual speakers tested in the present PhD thesis experience fewer opportunities to use their L1 Spanish compared to monolingual counterparts, for instance, Spanish natives in the monolingual group. This is so because, as already mentioned, bilinguals receive L2 immersed instruction as they are exposed to the L2 in a formal university setting where they are formally immersed in their L2 English. Despite having fewer opportunities to use their L1, they still maintain regular contact with it. However, and importantly for the implications of this thesis, the extent of their L1 disuse is not comparable to that of naturalistically immersed bilinguals with little L1 use and contact, who have been the focus of study of most L1 attrition literature (Cairncross et al., 2023; Dussias & Sagarra, 2007; Gürel, 2004; Kasparian & Steinhauer, 2016, 2017). L1 Attrition has been attested in naturalistically immersed bilinguals with significant L1 disuse, highlighting frequency of use as a key factor in attrition and supporting the ATH. However, in terms of L1 disuse, instructed bilinguals seem to occupy an intermediate position between monolinguals and naturalistically immersed bilinguals. This makes this bilingual group an interesting population to test the predictions of the ATH. Compared to naturalistically immersed bilinguals, if similar attrition effects are observed in instructed bilinguals despite their continuous but reduced L1 contact, findings will further support the claims of the ATH. However, and crucially, they will suggest that more moderate L1 disuse, i.e., lower but not radically reduced L1 contact, may be sufficient to trigger attrition, which would evidence that the L1 is more sensitive to changes that assumed.

Additionally, considering the selective nature of L1 attrition, the ATH predicts that L1 attrition will occur when an L1 linguistic item has an L2 counterpart with a lower activation threshold (Paradis, 2007). Given two "competing" items, the one less-frequently used or with fewer exposure to will get inhibited due to the activation of the more-frequently used counterpart. This inhibition would raise the activation threshold of the linguistic item, making it less accessible. This prediction has been widely tested in the literature, particularly regarding subject referring expressions, i.e., null and overt pronouns (Chamorro et al., 2016; Gürel, 2004; Martín-Villena, 2023). Overall, L1 attrition effects have been predicted and tested mostly for overt pronouns, while null pronouns seem to be more stable. This is so because not all languages allow null pronouns in subject position and therefore, it is less likely they have a competing counterpart. Regarding the structure of interest in this PhD thesis, RCA ambiguities, previous studies have not directly tested the ATH (Paradis, 1993, 2007). When researchers have aimed to interpret RCA differences in bilinguals based on frequency of language use or exposure, they have predominantly relied on the predictions made by the Linguistic Tunning Hypothesis (see Section 3.2.4 for a thorough description of its main claims). This has been so because the Tunning account is a more specific model of sentence parsing, while the ATH provides a more general framework for L1 attrition. However, the similarities between the two are evident and therefore, evidence in favour of the Tuning account can be considered to also support the ATH. The influence of language use in bilinguals' RCA preferences has been attested, particularly regarding Spanish-English bilinguals (Dussias & Sagarra, 2007; Jegerski, VanPatten, et al., 2016), with studies reporting that increased contact with an L2 and consequently, reduced contact with the L1, leads to modification in late bilinguals' L1 biases, i.e., to L1 attrition.

2.6. Chapter summary

The present chapter has aimed to introduce the phenomenon of L1 attrition, providing a thorough overview of the different approaches to attrition, emphasising the lack of agreement on the conditions required for its occurrence, as well as modulating factors, and the Activation Threshold hypothesis. This in-depth overview of L1 attrition began in Section 2.1 with a contextualisation of L1 attrition within bilingualism research. Section 2.2 introduced the terminological debate within the field about the nature and scope of L1 attrition, offering the background to introduce in Section 2.3 the specific approach to L1 attrition employed throughout this PhD thesis. Section 2.4 focused on additional factors that have been discussed as predicting variables for L1 attrition, particularly language dominance and length of L2 immersed instruction. Finally, Section 2.5 introduced the Activation Threshold Hypothesis, which can guide relevant predictions for this investigation.

Despite the increasing interest in L1 attrition over the past decades, an agreement regarding the concept of attrition seems to be far from reached. Such controversy is related to the conditions traditionally assumed to be necessary for attrition effects to emerge in bilinguals. L1 attrited bilinguals were considered a specific type of bilingual speakers who met the following requirements: (a) L1 disuse and limited L1 exposure, (b) extensive L2 naturalistic immersion, i.e., living in an L2-speaking country for a prolonged time, and consequently, (c) extensive exposure to the second language. The majority of studies on L1 attrition are built on these assumptions and therefore, findings on this process are mostly limited to a very specific population, i.e., bilinguals, frequently immigrants, who have been living in an L2-speaking country for many years prior testing, with limited L1 use and exposure, and with their second language often being their dominant language (Dussias & Sagarra, 2007; Kasparian & Steinhauer, 2016).

However, these are not the only assumptions. The distinction between changes at the level of processing and knowledge representation is also relevant. Traditional research has restricted first language attrition to modifications occurring in comprehension and knowledge representation, while changes at a processing level would not be considered as such. True attrition effects are those influencing the underlying structure of a language and therefore, have a permanent nature. Schmid and Köpke (2017) claims that this distinction is arbitrary and highlight the need for a broader definition if this term, where temporary online effects and more permanent representational ones are understood as stages within the same continuum. L1 attrition would then involve all potential changes in a bilingual's first language, ranging from online readjustments, which appear first and influencing then at the level of knowledge representation. This thesis departs from this idea, as no assumption is made regarding where attrition will be observed.

This discussion on the scope of L1 attrition was narrowed down in Section 2.3 to delimit the definition of first language attrition in which the present PhD thesis relies on. L1 attrition is a non-pathological process, restricted to late bilinguals who have completely acquired and mastered their native language by the time they were first exposed to their second language. Attrition is also considered a characteristic of the individual. It involves individual change at a cognitive level resulting from the interaction and coexistence of at least two languages in the bilingual mind. Thus, this definition excludes changes at a societal level. Finally, potential attrition effects observed in this thesis will not be attributed to direct transfer from the second to the first language. L1 attrition constitutes an essential and natural aspect of bilingual development. Further research involving different language pairs would be required to determine whether attrition entails replication of L2 patterns in the L1 or more general tendencies independent of the specific language combination.

Section 2.4 examines the influence of some modulating factors in first language attrition, with a particular focus on language dominance and length of L2 residence. Regarding the former, language dominance is viewed as a complex multi-dimensional concept that encompasses a variety of aspects such as proficiency, language use, cultural association of the language, etc. These variables and their interactions are unique and distinct to each individual bilingual, resulting in great variability across bilinguals in terms of language dominance. This PhD thesis will not operationalise language dominance making a binary distinction between a dominant and non-dominant language.

Instead, bilinguals will be placed on a continuum of dominance ranging from greater L2 dominance to greater L1 dominance, allowing bilinguals to differ in terms of degrees even within the same group. This will be done using the *Bilingual Language Profile* questionnaire (see Section 5.3.2).

Finally, Section 2.5 introduced an influential theoretical framework in L1 attrition research, i.e., Paradis' Activation Threshold Hypothesis (Paradis, 1993, 2004, 2007). This hypothesis considered L1 attrition as the result of increased or decreased frequency of language use, which will lead to higher or lower accessibility of linguistic items, respectively. This account predicts L1 attrition to emerge due to language disuse, particularly influencing words or structures with a competing L2 counterpart that has higher frequency of use and exposure. These claims will help formulate the research questions about L1 attrition effects in bilingual speakers who have fewer opportunities of L1 use than their monolingual counterparts, rather than radical L1 disuse, focusing on an existing structure in their L1 and L2.

To sum up, this PhD thesis explores L1 attrition in a bilingual population that, according to traditional views, would not be susceptible to experience attrition. Unlike previous L1 attrition studies, bilinguals tested are not naturalistically immersed in an L2-speaking country and do not experience limited L1 use or exposure. Instead, this PhD thesis examined late sequential bilinguals who live in an L1 environment and receive extensive exposure to their L2 English in a formal instructed setting. Their daily exposure to L2 English in a university classroom setting ensures that they receive considerable amount of L2 input both in the classroom and at home doing their assignments. Bilinguals tested in the present PhD thesis differ from other bilingual speakers who simply attend L2 English courses a couple of times per week. To make a distinction between naturalistically immersed bilinguals and those who merely attend L2 courses, bilinguals in this thesis are immersed in an instructed setting, i.e., immersed instruction. This distinction emphasises the difference not only from naturalistically immersed bilingual speakers, but also from those occasionally attending L2 courses. This makes them a suitable population to test potential attrition effects. Overall, the specific conditions of the bilinguals examined make them a suitable population to test potential L1 attrition effects, while still challenging the traditional requirements of L1 limited use/exposure and prolonged naturalistic immersion in the L2. First, bilinguals are not detached from their first language, which remains their dominant language but to a lesser extent. Secondly, they received extensive L2 exposure but rather than in a naturalistic L2 environment, they are immersed in an L2 instructed setting. To conclude, L1 attrition will be explored regarding a specific linguistic phenomenon, relative clause attachment ambiguities, which will be addressed in the following chapter. The findings obtained will increase our current understanding of the L1 attrition process, its scope, and the implications of becoming bilingual.

Chapter 3: Relative clause attachment

This chapter will discuss a prominent phenomenon in the psycholinguistics literature and the structure if interest for this PhD thesis: the observed differences across languages regarding relative clause attachment preferences. Although parsing strategies were considered to be universal (Frazier, 1978), research has evidenced language-specificity in the preferences to cope with the same grammatical structure, i.e., the strategies to attach and resolve ambiguous relative clauses. These findings questioned the assumption that parsing strategies relied on universal principles of language economy, and consequently, subsequent theories of language processing have addressed this issue. Thus, various theoretical frameworks have been proposed to account for the cross-linguistic variation found regarding the attachment of relative clauses (see Section 3.2).

Such cross-linguistic variation is relevant since L1 attrition will be explored in relation to this specific syntactic construction, i.e., relative clause attachment ambiguities. The structure, exemplified in (4) below, contains a complex noun phrase *NP1 of NP2* followed by an ambiguous relative clause introduced by the relative pronoun *who*. As will be explained in more detail in Section 3.1, this is an object-modifying RC in subject position. Focusing on (4) below, two interpretations originate depending on who the antecedent of the RC is, as it can be attached to either NP1 (*the servant*) or NP2 (*the actress*). The interest on this syntactic ambiguity is justified due to the cross-linguistic variability observed among native speakers of different languages regarding attachment preferences. In particular, native Spanish and native English, the two languages under study, have been found to differ regarding their default strategy to disambiguate these sentences (Y. Cheng et al., 2021; Cuetos & Mitchell, 1988; Dussias, 2003; Jegerski, Keating, et al., 2016). This creates an ideal ground to explore potential L1 attrition effects on attachment preferences in L1 Spanish-L2 English bilinguals under extensive L2 immersed instruction. These ideas will be further developed in the following sections.

(4) *Someone shot the servant$_i$ of the actress$_j$* ***who***$_{i/j}$ *was on the balcony*[5]

Taking the sentence above as an example, it is worth mentioning that in English there are two ways of expressing possessive relations: the Saxon genitive (e.g., *the scientist's student*) and the Norman genitive (e.g., *the student of the scientist*). It has been shown that when both nouns are human, the Saxon genitive is preferred (Rosenbach, 2014). This PhD thesis will, however, employ the Norman genitive in the English stimuli. The rationale behind this decision is the fact that previous literature on RCA ambiguous has consistently tested sentences including the Norman genitive, as it allows for direct comparison with the same structure in other languages (Carreiras & Clifton, 1993, 1999; Y. Cheng et al., 2021; Cuetos & Mitchell, 1988; Dussias, 2003). To ensure that the findings from this PhD thesis can be reliably compared to those in prior studies, we will only study the Norman genitive construction in the English items.

The aim of this chapter is to present the linguistic phenomenon under analysis, i.e., RCA preferences, together with various theoretical frameworks and previous research. The chapter is divided as follows. First, Section 3.1 outlines the diversity of RC types to contextualise the one explored in this thesis. Section 3.2 introduces some theoretical proposals on sentence parsing, with a focus on Garden-Path theory, Construal Hypothesis, Predicate Proximity principle and Tuning hypothesis. Section 3.3 delves deeper into the crosslinguistic variation associated to RCA ambiguities, while Section 3.4 introduces the main findings reported in previous literature on RCA preferences, focusing on offline and online preferences among Spanish and English natives, as well as bilinguals. Finally, a summary of the main ideas presented throughout this chapter can be found in Section 3.5.

3.1. Introduction to relative clauses

Before discussing any aspect related to the linguistic structure of interest in this PhD thesis or an overview of past research, it is essential to present the variety of relative clause types to contextualise the specific one examined in this investigation. To begin with, and in a general way, relative clauses are those that modify a noun. These are subordinate clauses, meaning that they cannot stand as independent clauses but must be

[5] The example sentence has been taken from the study conducted by Cuetos et al. (1988).

embedded within a main clause. Although linguistic theory has extensively discussed relative clauses over the years (Alexiadou et al., 2000; De Vries, 2018; Presotto, 2024; Salzmann, 2006), offering an in-depth discussion of this debate is beyond the scope of the current PhD thesis. Therefore, only an overview of different RC types will be presented to contextualise the one tested in this study.

Traditionally, RCs have been classified into two main types: restrictive and non-restrictive. The former, restrictive relative clauses, provide essential information for the understanding of the sentence as they specify and limit the meaning of the noun they modify, restricting the identification of its antecedent. For instance, in (5), the restrictive relative clause within brackets (*that Sarah recommended*) specifies that *the book* is the one recommended by Sarah. On the contrary, non-restrictive relative clauses do not alter the meaning of the noun but rather provide additional information. In example (6), the non-restrictive RC (*which won several awards*) does not limit the meaning of the referent *the book*, and can be removed without affecting the overall meaning of the sentence.

(5) *The book [that Sarah recommended] was fascinating*[6]

(6) *The book, [which won several awards], has been translated into Spanish*

This PhD thesis focuses exclusively on restrictive relative clauses. In addition, based on the syntactic function of the entire relative clause within the main clause, RCs can be classified into subject-modifying and object-modifying RCs. The difference between these RCs lies in which constituent of the sentence the relative clause modifies, either the subject as in (7a) or the object of the main clause (7b). This PhD thesis will only examine object-modifying relative clauses.

(7) SUBJECT-MODIFYING VS. OBJECT-MODIFYING RCS

(7a) **Subject-modifying RC**

The woman [who lives next door] is a doctor

(7b) **Object-modifying RC**

I met the assistant [that the manager recommended]

Additionally, based on the syntactic function of the relative pronoun within the relative clause, two major types can be distinguished: subject RCs and object RCs, illustrated in (8). Example (8a) illustrates a subject RC because the relative pronoun *that* is the subject

[6] Square brackets […] are used to indicate the relative clause.

of the subsequent relative clause it introduces. In this case, it is *the student* who met *the teacher*. On the other hand, (8b) exemplifies an object relative clause in which the relative pronoun *that* is the direct object of the RC. Thus, it is now *the teacher* who met *the student*. Importantly, in both case the pronoun that refers to the same antecedent, i.e., *the student*, but the word order of the relative clause determines its syntactic function. This thesis will be concerned with subject RCs.

(8) SUBJECT VS. OBJECT RCS

(8a) **Subject relative clause**

The student [that met the teacher]

(8b) **Object relative clause**

The student [that the teacher met]

Based on the above, the present PhD thesis focuses on restrictive subject RCs which modify the object of the main clause, illustrated in (9) below. A key difference between all previous relative clauses and the one in (9) is the fact that the restrictive RC does not modify an individual noun, but rather a complex NP composed of two nouns [*NP1 of NP2*]. Thus, while the syntactic analysis in previous examples was straightforward, with the relative pronoun easily attached to its antecedent, sentence (9) is structurally ambiguous as two syntactic analyses, and consequently, two semantic interpretations, are possible. The RC *who reads a book carefully* can be attached to either NP1 (*the student*) or NP2 (*the scientist*) via high attachment or low attachment, respectively. Given that two interpretations are possible, the speaker/listener has to decide which syntactic analysis to apply. The final analysis will determine the semantic interpretation of the sentence.

(9) *Observe here the student$_i$ of the scientist$_i$ [who$_{i/j}$ reads a book carefully]*

The interest in this structure is justified for several reasons. Firstly, it has been extensively investigated in previous literature, ensuring reliable comparisons with the results obtained in this thesis. Secondly, it enables to explore L1 attrition in L1 Spanish-L2 English bilinguals due to the cross-linguistic variation attested in native speakers of different languages in general, and Spanish and English in particular, regarding their preference to attach RCs to NP1 or NP2. Such variation challenges general locality principles that would favour attachment to the linguistic element currently being processed, i.e., to NP2, in all languages. The following section will introduce several theoretical frameworks that have aimed at addressing such variability in attachment preferences.

3.2. Theoretical accounts on RCA ambiguities

Research on language processing has extensively tried to explain how humans deal with syntactic ambiguity, with considerable attention devoted to the parsing strategies or mechanisms employed to resolve ambiguous sentences. In this regard, a variety of parsing strategies have been proposed, and attempts have been made to provide a theoretical framework that can account for them. This section will outline some theoretical models that have addressed the crosslinguistic variation in RCA preferences. First, Section 3.2.1 will introduce the Garden-Path Model (Frazier, 1978, 1987), a syntax-first model that emphasises the universality of syntactic principles such as Late Closure and Minimal Attachment. However, the evidence against such universality provided first by Cuetos and Mitchell (1988), and confirmed by subsequent research (Carreiras & Clifton, 1993; Dussias, 2003; Dussias & Sagarra, 2007; Papadopoulou & Clahsen, 2003; Zagar et al., 1997) challenged the claims of the Garden-Path Model.

Construal Hypothesis (Frazier & Clifton, 1996) was formulated as a revised version, and is discussed in Section 3.2.2. Construal Hypothesis incorporates a distinction between primary and non-primary syntactic relations, with the universal strategies of Late Closure and Minimal Attachment being limited to primary phrases. Instead, non-primary phrases such as relative clauses are governed by additional information. This would account for the variation across languages regarding the disambiguation of RCs. Section 3.2.3 will introduce the Predicate Proximity principle, proposed by Gibson et al. (1996) as a competing parsing principle operating with Recency principles such as Late Closure. Therefore, cross-linguistic differences rely on the strength of these principles. Finally, Section 3.2.4 discusses the Linguistic Tuning Hypothesis, a usage-based model which posits that attachment preferences are shaped by exposure and previous language experience. Overall, these theoretical accounts have attempted to offer a comprehensive basis for the variability in RCA patterns across languages.

3.2.1. The Garden-Path Model

The Garden-Path model proposed by Frazier (1978, 1987) has been a dominant theory of sentence comprehension in psycholinguistic research. Frazier discussed the role of the human parsing device, the parser, whose main task is to assign meaning to any given sentence in real time. However, humans may encounter difficulties during processing, as this task is constrained by both working memory capacity and time limitations. This implies that humans must quickly process incoming linguistic material and structure it within the sentence almost immediately, while it is still preserved it in a limited-capacity working memory.

Extensive attention within the Garden-Path model has been devoted to structural ambiguities. The meaning of structurally ambiguous sentences is open to, at least, two interpretations depending on the syntactic analysis made. The parser must resolve these ambiguities and assign meaning by implementing a syntactic analysis. However, the information required to fully interpret these sentences often becomes available after the ambiguity arises, which results in a temporary ambiguity that can only be resolved once subsequent sentential constituents have been processed. In words of Frazier (1978, p. 2), sometimes the "information relevant to the analysis of a single element is often not available when that element is received but only later when subsequent elements have also been received and analysed". In structurally ambiguous sentences, this means that they cannot be resolved the moment the ambiguity arises, but later with additional subsequent linguistic material is received.

Example (10) below illustrates a structurally ambiguous sentence with two possible analyses. In particular, the phrase *that Bill liked* can be analysed as a complement of the NP *the girl* or as an object relative clause. The ambiguity is maintained until the sentence has finished and it is the parser that must decide one analysis or the other. This contrasts with example (11), where the ambiguity is resolved the moment *eggplant* is mentioned. Once the parser receives the word *eggplant*, there is only one possible analysis, i.e., it can only function as direct object within the relative clause, discarding the complement interpretation of *that Bill liked*.

(10) *John told the girl that Bill liked the story*

(11) *John told the girl that Bill liked the eggplant*

The parser must make its decision regarding the final analysis of a given sentence based on parsing strategies, even when the information needed to resolve the ambiguity is not available. The Garden-Path model proposes that these choices occur in a serial order, meaning that one single analysis is implemented at a time, rather than several analyses simultaneously. Initially, humans consider only syntactic information. The parser first makes a syntactic analysis, with meaning not being involved in the initial syntactic interpretation. In this first stage, the parser constructs a solely syntax-based representation of a sentence, and it does so by applying two universal parsing strategies: Late Closure and Minimal Attachment.

According to the Late Closure principle, "when possible, attach incoming material into the phrase or clause currently being parsed" (Frazier, 1978, p. 49). New material must be attached to the material on its left, which has already been received and analysed by the parser. For instance, in (12), *last week* can be attached to either the main clause (the higher verb phrase) or to the subordinate clause (the lower verb phrase). Late Closure predicts that the parser would favour an attachment to the lower verb phrase, as it is the clause currently processed. This strategy allows the parser to easily and immediately integrate new linguistic input with prior constituents, mitigating working memory load as it reduces the chances of exceeding the working memory limits of the parser.

(12) *Hans claimed he went to London last week*

The second parsing strategy, Minimal Attachment, states the following: "attach incoming material into the phrase-maker being constructed using the fewest nodes consistent with the well-formedness rules of the language under analysis" (Frazier, 1978, p. 36). Minimal Attachment predicts that the parser will select the simplest, most straightforward syntactic structure that is possible, avoiding unnecessary nodes and favouring the simplest possible structure which can be retained in memory.

Evidence in favour of Minimal Attachment was provided by Rayner et al. (1983) in sentences like (13) and (14) below. Both are string-identical sentences, but their syntactic analysis differs. In (13), *with a revolver* is attached to the preceding NP (*the cop*) and functions as a modifier, while in (14), *with binoculars* must be attached to the verb phrase (*saw*). The parser is predicted to favour sentences like (14) as they involve fewer nodes and result in a simpler syntactic structure.

(13) *The spy saw the cop with a revolver*
(14) *The spy saw the cop with binoculars*

Late Closure and Minimal Attachment are assumed to be implemented as sentences unfold, constructing the analysis item by item. However, this first analysis may be incorrect and inconsistent with new information. If the parser is misleaded by ambiguous sentences, a processing cost or disruption emerges. This is often called garden-path effect, referring to the idea of being metaphorically led up the garden path toward an incorrect interpretation. If the initial interpretation conflicts with subsequent information, the parser is forced to make a reanalysis of the sentence. This corresponds to the second stage where the parser accesses other types of information to reconstruct the sentence, for instance, lexical information.

Late Closure and Minimal Attachment were assumed to be universal parsing strategies across languages. Minimal Attachment was shown to accurately predict parsing decisions across various languages and syntactic structures. However, this universality was not observed for Late Closure, which predicts the parser to attach new information locally, not maintaining unattached linguistic items in working memory. Regarding the construction of interest in this thesis, i.e., RCA ambiguities, sentences such as (15) contain two potential antecedents *NP1 of NP2* for a subsequent RC. Late Closure would predict local attachment to NP2 (*the actress*) rather than to NP1 (*the servant*).

(15) *Someone shot the servant*$_i$ *of the actress*$_j$ *who*$_{i/j}$ *was on the balcony*

Early research on RCA preferences was conducted on English, and findings confirmed this preference among English speakers. However, Cuetos and Mitchell (1988) reported the opposite strategy in Spanish, as Spanish natives tend to attach the RC to NP1. The literature has revealed that attachment preferences vary across languages, challenging the universality of the Late Closure principle and consequently, questioning the Garden-Path model. RCA ambiguities have received extensive attention due to the variability of parsing strategies observed for the same grammatical structure. This variation is precisely what will allow us to test potential L1 attrition effects on L1 Spanish-L2 English bilinguals, as these two languages seem to favour HA and LA, respectively.

3.2.2. Construal Hypothesis

A variety of new theoretical frameworks emerged to account for the observed cross-linguistic variation. Frazier and Clifton (1996, 1997) proposed the Construal Hypothesis as a revision of the Garden-Path Theory, motivated by research that evidenced the non-universality of the Late Closure principle. Based on principles of sentence parsing, and regarding example (15) above, it would be expected a preference for LA. However, the seminal work by Cuetos and Mitchell (1988) on L1 Spanish found that monolingual speakers of Spanish display a bias for HA in sentences that include these structurally ambiguous RCs. Studies on languages other than English proliferated, confirming that the Late Closure principle does not apply to all languages regarding this construction.

Construal Hypothesis was proposed as a revised version of the Garden-Path theory and therefore, does not discard its main claims. Frazier and Clifton (1996, 1997) argue that the initial view could accurately account for a broad range of syntactic constructions that the human parser rapidly and successfully recovers. However, there exist other constructions that are governed by different mechanisms. In Frazier and Clifton (1996, 1997) revised view, some phrases are not integrated within the sentential structure based on structural information only. Instead, they are analysed and interpreted using both structural and non-structural information (e.g., prosody, semantic or pragmatic information). A central claim of the Construal hypothesis is the distinction between two types of phrases or syntactic relations: primary phrases (arguments) and non-primary phrases (adjuncts). Primary relations refer to those established between the verb and its arguments. On the other hand, non-primary relations involve adjuncts and relative clauses as they are not determined by the syntactic properties of the verb. This distinction is crucial to understand parsing choices.

According to Frazier and Clifton (1996, 1997), both Late Closure and Minimal Attachment are universal parsing strategies, but they apply only to the processing of primary phrases. These phrases are parsed following the processing principles proposed in the Garden-Path model. However, non-primary phrases such as relative clauses are associated with the current thematic domain, which is determined by the last constituent that introduces a thematic role. Regarding the construction of interest for this PhD thesis and to illustrate how syntactic analysis takes place according to Construal hypothesis, let us consider (15) above. Relative clauses are non-primary phrases and therefore, the parser will not analyse them as primary relations. In contrast, it will integrate them within the current thematic domain using pragmatic and discourse principles. In (15), the current thematic domain corresponds with the complex NP *the servant of the actress* and consequently, the parsing of the following relative clause *who is on the balcony* is built in relation to it. Given that the thematic domain involves two NPs, i.e., *the servant* and *the actress*, the relative clause can potentially be attached to either of the two. Non-primary phrases must be attached to some sentential constituent to construct a complete analysis and therefore, the parser must select either NP1 or NP2 as the host of the RC. The final analysis of non-primary phrases will be determined by additional non-syntax-based sources of information such as semantics, prosody or pragmatics. Frazier and Clifton (1996) argue that discourse principles, like the Referentiality Principle, favour

HA, meaning that the host of the relative clause in (15) is predicted to be *the servant* as it is the head of the complex NP and is relevant to the main assertion of the sentence. This means that there is a preference to attach the RC to the focus, i.e., to attach high.

In summary, the Garden-Path Model and its reformulated version, Construal Hypothesis, are two syntax-first models of sentence processing based on the existence of universal parsing strategies: Late Closure and Minimal Attachment. The main difference between them is the scope of these principles. According to Garden-Path theory, these principles apply to all sentential components, including relative clauses, and the parser implements a serial analysis integrating item by item the incoming material following these strategies. In contrast, Construal hypothesis restricts these parsing principles to primary syntactic relations, i.e., those between a head and its arguments, while non-primary phrases like RCs are attached following other discursive principles. This would explain the variability observed across languages in the processing preferences to disambiguate relative clauses.

3.2.3. Predicate Proximity

In addition to the Construal Hypothesis, Gibson et al. (1996) proposed another theoretical account to address the cross-linguistic variation in RCA preferences evidenced by Cuetos and Mitchell (1988). Based on their results, Cuetos and Mitchell (1988) concluded that Late Closure, a recency principle, was not a universal parsing mechanism. To accommodate these findings, Construal hypothesis acknowledges its universality but restricts its implementation to primary syntactic relations. Similarly, Gibson et al. (1996) agree with the universality of Late Closure, but claim that it is modulated by one additional factor, i.e., the principle of Predicate Proximity. This principle predicts that new incoming linguistic material will be attached as close as possible to the head of a predicate phrase. To put it simply, and regarding RCA ambiguities, there is a preference for attachments to structurally occur as close as possible to the head of a predicate phrase.

Taking (15) above as an example, Late Closure predicts attachment of the pronoun *who* to NP2 *the actress* as it is the linguistic form currently being processed. This principle involves a preference for LA. In contrast, the Predicate Proximity principle predicts HA. This is so because the closest predicate phrase to the relative pronoun *who* is the direct object of the main clause, which is realised by a complex NP [*NP1 of NP2*] whose head is NP1 *the servant* and consequently, the pronoun *who* will be attached high to it.

The apparent lack of a LA preference in native Spanish with RCA ambiguities suggests that Late Closure may not apply universally. Interestingly, however, Late Closure seems to apply in native Spanish regarding constructions other than RCA ambiguities with two potential antecedents. This is the case, for instance, of verb phrase attachment ambiguities. This is illustrated in (16), which involves the same LA preference in both native English and native Spanish. Regardless of language, it is likely that the adverb *yesterday* / *ayer* is attached to the most recent element, i.e., to the verb *died* / *murió*, rather than to the verb of the main clause *said* / *dijo*.

(16) *John said Bill died yesterday*
Juan dijo que Bill murió ayer

This evidence in favour of Late Closure in other Spanish constructions raised the question of why Late Closure applies in one syntactic construction but not in the other. To explore whether Late Closure operates in RCA, Gibson et al. (1996) conducted two self-paced reading experiments, one in native Spanish and the other, in native English. The objective was to determine whether Late Closure is the only factor influencing RCA preferences, or whether other factors may interact with it. In the Spanish experiment, participants were native Spanish speakers (N = 26) living in Massachusetts from a variety of Spanish-speaking countries such as Mexico, Puerto Rico, Spain, Argentina, Chile, E1 Salvador, Guatemala, Peru, and Venezuela. Regarding the English experiment, data were collected from native English speakers (N = 30) living in Massachusetts and studying at the Massachusetts Institute of Technology.

Gibson et al. (1996) examined a more complex construction which encompassed three, rather than two, potential antecedents or attachment sites. In (17) below, the underlined RC can be grammatically attached to, and consequently modify, any of the three preceding NPs, i.e., NP1 *lámpara* / *lamp*, NP2 *pintura* / *painting*, and NP3 *casa* / *house*. These NPs can also be labelled as high, middle and low NP, respectively.

(17) *La lampara cerca de la pintura de la casa que fue dañada en la inundación*
The lamp near the painting of the house that was damaged in the flood

Given that Cuetos and Mitchell (1988) proposed one single factor as influencing the interpretation of RCA constructions (either HA or LA), a monotonic attachment pattern is expected. Monotonic preference ordering or ranking means that attachment preferences move consistently in one direction. For instance, if HA is preferred in native Spanish, a monotonic pattern will be evidenced if the RC is predominantly attached to the highest, and therefore farthest, NP1 (*la lámpara* / *the lamp*), followed first by attachment to the middle NP2 (*la pintura / the painting*) and finally, by the lowest NP3 (*la casa / the house*). In English, the expected pattern would be expected. Assuming that Late Closure is the only operating factor, it is predicted that the RC will be mostly attached to NP3 (*the house* / *la casa*), followed by NP2 and finally, NP1. However, if any additional factor interacts with Late Closure, monotonic rankings are not predicted. To be more precise, if a factor promoting LA (such as Late Closure) applies simultaneously with a factor that promotes HA (Predicate Proximity), it is likely that both the highest and lowest NPs are preferred over the intermediate one, which would be the dispreferred option.

Stimuli in the SPRT are exemplified in (18) below, with target items (N = 18) including a RC preceded by three NPs. Sentences were disambiguated via number agreement with the verb within the RC, as it only matched the number of one out of the three preceding NPs. In (18) below, the singular verb form (*fue* / *was*) can only be attached with one of the previous NPs, i.e., the only singular NP. In (18a), the RC is attached to the lowest NP3 (*la casa*), while (18b) forces attachment to the middle NP2 (*la pintura*) and (18c), to the highest NP1 (*la lámpara*).

(18) **TARGET ITEMS**

(18a) *Las lámparas cerca de las pinturas de la casa que* ***fue*** *dañada en la inundación*

(18b) *Las lámparas cerca de la pintura de las casas que* ***fue*** *dañada en la inundación*

(18c) *La lámpara cerca de las pinturas de las casas que* ***fue*** *dañada en la inundación*

The lamp(s) near the painting(s) of the house(s) that **was** damaged in the flood

Reading times were measured and effects, if any, expected at the disambiguating region, i.e., *fue dañada* / *was damaged*. The authors expected processing difficulty to evidence participants' attachment preference ranking. If one single factor determines attachment preferences, a monotonic difficulty ordering was expected. For native Spanish, the preference ordering will be as follows: NP1 > NP2 > NP3. For native English, the ordering will the following: NP3 > NP2 > NP1. On the contrary, if two factors are responsible for such preferences, other (non-monotonic) orderings will be possible. If one of those factors (Late Closure) favours LA and a second factor favours HA, the following ordering may emerge: NP1 > NP3 > NP2 or NP3 > NP1 > NP2.

Results for RTs revealed that native Spanish speakers read low attachments significantly faster than both high and middle attachments, with high attachments being faster than middle ones. Thus, the resulting ranking order for Spanish was: NP3 > NP1 > NP2. These results were taken as evidencing that a LA preference factor (Late Closure) operates in Spanish, as LA was preferred over the other attachments. Focusing on native English, the same pattern is reported. Native speakers of English were significantly faster when reading sentences that forced LA than those forcing high and middle attachments. Additionally, English participants exhibited less difficulty attaching the RC to the highest NP1 than to the middle NP2. Again, the resulting ranking order in English was the following: NP3 > NP1 > NP2.

The implications of these findings are twofold. First, they show that Late Closure also operates in Spanish RCA ambiguities in addition to verb phrase ambiguities as those in (16) and, therefore, may be a universal parsing principle. Secondly, results do not support a one single-factor account of RCA preferences. If it were the only factor influencing attachment preferences, the ranking would follow a consistent monotonic order from the most distant NP1 to the most recent NP3 in native Spanish, and the opposite for native English. However, this is not the case. To account for this, Gibson et al. (1996) proposed a two-factor explanation. Although Late Closure is an operative principle, there must exist a second modulating factor interacting with it and masking its effect. This second factor should favour HA, which would account to the preference for NP1 over NP2 in both Spanish and English.

To define the nature of such HA factor, Gibson et al. (1996) build on Frazier's (1990, p. 321) Relativised Relevance Principle: "other things being equal (e.g., all interpretations are grammatical, informative, and appropriate to discourse), preferentially construe a phrase as being relevant to the main assertion of the current sentence". As Frazier does not specify what "main assertion" refers to, Gibson et al. (1996) suggest it may refer to the root sentence node, i.e., to the entire syntactic structure of the sentence. Regarding RCA ambiguities with two potential hosts, the structure of interest in this thesis, the Relativized Relevance principle predicts HA attachment to NP1. This is so because in complex NPs [*NP1 of NP2*], NP1 is either the subject or the object of the main sentence and consequently, is structurally closer to the main sentence than NP2.

This, however, did not explained VP attachment ambiguities in (16). To also account for them, Gibson et al. (1996) suggested that, instead of favouring closer attachments to *the* root sentence node (main sentence), this could be broaden to *any* sentence node (predicate phrase). The extension of the Relativised Principles was named Predicate Proximity principle and stated the following: “attach as close as possible to the head of a predicate phrase” (Gibson et al., 1996, p. 41).

Predicate Proximity is based on the idea that every grammatical sentence has a predicate, which is the fundamental part of all sentences. Thus, it is proposed that the human parser prioritises attachment of new elements (for instance, a RC) to the core predicate structure, i.e., the verb and its arguments. Given the limited nature of human resources (for instance, memory limitations), it is likely that attachment sites related to predicate phrases remain more active and accessible as these structures provide essential information to fully comprehend the sentence. Thus, new information is more likely to be interpreted as part of a predicate phrase.

To summarise, Late Closure and Predicate Proximity are two competing principles influencing RCA preferences. If the parser follows recency principles such as Late Closure will favour LA. Conversely, if the parser is guided by Predicate Proximity, this will favour HA. Cross-linguistic variation is based on the strength of each principle for each language. In Spanish, Late Closure is an operating parsing principle, but when it comes to RCA ambiguities with two potential antecedents, it is dominated by Predicate Proximity, which favours HA. On the contrary, the recency principle of Late Closure in English is stronger, and therefore, English native tends to favour a LA interpretation of ambiguous RCs. The present PhD thesis explores RCA ambiguities with two potential antecedents (either NP1 or NP2). Results from the two monolingual groups of Spanish and English speakers align with the predictions by Gibson et al. (1996). The Spanish monolingual group favour HA across all experimental tasks, while English monolinguals tend towards LA. However, the LA English preference, although evident, seems to be slightly weaker compared to the Spanish HA preference. This may indicate that the strength of each principle, Predicate Proximity in Spanish and Late Closure in English, varies. Data from the L1 Spanish-L2 English group, tested in Spanish, reveals lack of attachment preferences, suggesting that bilinguals may adopt more flexible processing strategies, with their behaviour not being solely guided by one specific parsing principle.

3.2.4. Linguistic Tuning Hypothesis

An alternative proposal to explain cross-linguistic variability regarding RCA postulates the possibility that the parser is experience-based. Cuetos et al. (1996) and Mitchell et al. (1995) proposed the Linguistic Tuning Hypothesis, an experience-based model where an individual's parsing choices are determined by prior linguistic contact. Parsing mechanisms are not exclusively governed by syntactic information. Structural preferences are determined by the individual's previous linguistic experience, especially by the frequency with which such preferences occur in a particular language. In words of the authors, "parsing decisions may depend in part on the person's history of experience with the structures under scrutiny, in which case there may be a general bias in favor of analyses that occur most frequently in the language" (Mitchell et al., 1995, p. 470). More precisely, "structural ambiguities are initially resolved on the basis of stored records relating to the prevalence of the resolution of comparable ambiguities in the past" (Mitchell et al., 1995, p. 470).

RCA ambiguities can be accounted for within this framework. During sentence processing, the initial analysis of an ambiguous sentence is influenced by the individual's previous encounters with ambiguities of the same type. The parser is predicted to resolve the ambiguity by selecting the interpretation it has been exposed to most often in the past. If the listener/reader has previously encountered this type of ambiguity in natural contexts and in such cases, it has been resolved typically and successfully towards HA, this will be the strategy the parser will employ in future occasions if no disambiguation cues are provided. If, on the other hand, it is LA the resolution most frequently exposed to, the parser will likely favour it on future encounters. This is so because every time an ambiguity is successfully resolved in a specific way, the chosen resolution is stored. Thus, the selection of the most appropriate host for the RC is grounded on the accumulated records regarding frequency of attachment to either NP1 or NP2 in structures of the form complex NP [*NP1 of NP2*] followed by a RC. This was supported by a small-scale corpus study conducted by Mitchell et al. (1992). The authors observed that the most frequent relative clause ambiguous construction [*NP1 of NP2 RC*] in L1 English was resolved toward LA, while HA was found in a corpus of L1 Spanish.

Linguistic Tuning hypothesis attributes cross-linguistic variation to differing frequency distributions in different languages. In the case of L1 Spanish, for example, the preference for the relative clause to modify NP1 would correspond to higher frequency of this disambiguating strategy in Spanish, while the opposite scenario would be expected for English. Dussias and Sagarra (2007) tested the predictions of the Tunning Hypothesis by exploring the potential effect of exposure to L2 input on bilinguals' L1 processing strategies. In words of the authors, "this scenario provides the strongest test of a tuning account of parsing strategies, given that it focuses on the potential effects of L2 exposure on the putatively highly stable L1 parsing mechanism" (Dussias & Sagarra, 2007, p. 102). This study is relevant for this thesis given that both the sentential structure and the population tested coincide with those in the present thesis. First, the syntactic construction involves sentences with a complex NP followed by a structurally ambiguous RC. The sentences were designed for two conditions: one condition forced a HA-interpretation, illustrated in (19a), and a second condition forced a LA-interpretation, as in (19b).

(19) TARGET ITEMS

(19a) **High attachment**

El policía arrestó a la hermana$_i$ del criado$_j$ que$_{i/j}$ estaba enferma desde hacía tiempo[7]

The police arrested the sister$_i$ of the servant$_{j[masc]}$ who$_{i/j}$ had been ill$_{[fem]}$ for a while

(19b) **Low attachment**

El policía arrestó al hermano$_i$ de la niñera$_j$ que$_{i/j}$ estaba enferma desde hacía tiempo

The police arrested the brother$_i$ of the babysitter$_{j[fem]}$ who$_{i/j}$ had been ill$_{[fem]}$ for a while

To explore the influence of L2 exposure on L1 processing, three groups were tested: two groups of L1 Spanish-L2 English bilinguals, and a control Spanish monolingual group. Participants were tested in their L1 Spanish. The two bilingual groups were immersed in an L2-speaking country, as they were living in the US, but differed in the length of L2 exposure. One group had extensive exposure (mean US residency = 7.1 years), while the other had limited exposure (mean US residency = 8.5 months). The authors predicted that, if L2 exposure is to affect L1 parsing preferences, L1 Spanish-L2 English immersed bilinguals are expected to employ L2 strategies when resolving ambiguous RCs in their L1 Spanish. Additionally, and in line with the Tuning Hypothesis, this effect should be more evident in the extensive-exposure bilingual group than in the limited-exposure bilingual group. As predicted, the authors found an effect of length of L2 naturalistic immersion on bilinguals L1 parsing strategies, further modulated by the length of such exposure (extensive vs. limited). Results show that Spanish monolinguals and bilinguals

[7] In subsequent example sentences, grammatical gender will be marked where relevant: magenta indicates *female* gender, whereas green indicates *male* gender.

with limited L2 exposure preferred HA, while bilinguals with extensive exposure favoured LA. The authors argue this is evidence in favour of an exposure/frequency-based model of sentence parsing such as the Tuning hypothesis. It is not just exposure to the L2 which may modulate L1 parsing preferences, but rather the length of such exposure. Prolonged immersion in an L2-environment would ensure more frequency of encounters with the ambiguity under study, allowing the parser to modify the disambiguation strategy employed based on such exposure.

In summary, the Tuning Hypothesis predicts changes in parsing preferences if the reader/listener is exposed to a non-typical dominance of a different attachment resolution. This is so because the parser's initial structural analysis of a given sentence is determined by previous encounters with ambiguities of the same type and the most typical resolution used in such cases. Thus, when the parser encounters the same ambiguity, the listener or reader will favour the dominant or more frequent resolution in the past.

3.3. Cross-linguistic aspects of RCA preferences

This section will focus on the sentential structure tested in the present PhD thesis: relative clause attachment ambiguities. This examination will help contextualise the L1 parsing mechanisms implemented to disambiguate such sentences, together with the cross-linguistic variability regarding attachment preferences. The specific syntactic structure examined is composed of a main and subordinate clause, with the latter containing a complex noun phrase *NP1 of NP2* followed by a RC. This structure allows two potential syntactic analyses that result in two different interpretations. As an illustration, sentence (20) below is ambiguous because there are two potential hosts for the relative pronoun *who* as it may refer to either NP1 (*the servant*) or NP2 (*the actress*). The ambiguity must be resolved by attaching *who* to one of the preceding NPs.

(20) *Someone shot the servant$_i$ of the actress$_j$ **who**$_{i/j}$ was on the balcony*

Alguien disparó contra el criado$_i$ de la actriz$_j$ **que**$_{i/j}$ estaba en el balcón con su marido

The preference to attach the RC to either NP1 or NP2 involves two separate parsing mechanisms. The strategy that involves an association with NP1 (*the servant*) has been referred to as high attachment (HA) or early closure. On the other hand, a preference to attach the relative pronoun to NP2 (*the actress*) is typically known as low attachment (LA) or late closure (Carreiras & Clifton, 1993; Cuetos & Mitchell, 1988; Dussias, 2003;

Papadopoulou & Clahsen, 2003). In this PhD thesis, the terms high attachment and low attachment will be used to refer to these two parsing strategies.

Crucially for this investigation, parsing strategies are language-specific, meaning that native speakers of different languages show cross-linguistic variation in attachment preferences. This challenged the universality of parsing strategies (see Section 3.2). L1 English and L1 Spanish seem to differ in their interpretative preferences to resolve these ambiguities. In native Spanish, there seems to be a strong preference for HA (Carreiras et al., 2004; Carreiras & Clifton, 1993, 1999; Cuetos & Mitchell, 1988; Dussias, 2003). Taking as an example (20) above, a Spanish native would typically interpret as if it was *the servant/el criado* who was on the balcony. By contrast, native English seems to favour low-attachment (Carreiras et al., 2004; Carreiras & Clifton, 1999; Y. Cheng et al., 2021; Dussias, 2003; Fernández, 2002, 2003), meaning that an English native speaker would likely understand that it was *the actress* who was on the balcony.

Cross-linguistic variation in RCA has also been attested for other languages, using a wide range of offline and online tasks. Languages can be classified into two groups according to their attachment preferences: those than tend to favour a HA-interpretation and those that show a tendency for LA. Regarding the former group, and in addition to Spanish, the tendency toward a HA-interpretation has been reported for languages such as French (Frenck-Mestre, 1999; Zagar et al., 1997), Greek (Papadopoulou & Clahsen, 2003), German (Hemforth et al., 1999, 2015) Dutch (Brysbaert & Mitchell, 1996; Mitchell et al., 2000) and Arabic (Bidaoui et al., 2016). On the contrary, a preference for LA has been observed not only for English, but also in other languages like Chinese (Shen, 2006), Basque (Gutierrez-Ziardegi et al., 2004; Leeser & Prieta, 2018) and Brazilian Portuguese (Miyamoto, 2005). A HA or LA preference in all aforementioned languages has been attested through both online and offline measures, except for Brazilian Portuguese, which has only been tested online. Finally, evidence on Italian remains inconclusive as research has provided evidence of HA in offline interpretation and LA in online measures (Baccino et al., 2000; De Vincenzi & Job, 1993, 1995). To better illustrate this variation, Table 1 below includes a classification of the previously mentioned languages based on their preferred strategy to resolve RCA ambiguities.

Table 1:

Classification of languages by preferred RCA strategy

HA-interpretation	LA-interpretation
Spanish	English
French	Chinese
Greek	Basque
German	Brazilian Portuguese (online)
Dutch	Italian (online)
Arabic	
Italian (offline)	

In summary, native speakers of different L1s employ distinct mechanisms to resolve temporarily ambiguous sentences as (20) above. Such cross-linguistic variability provides a good opportunity to explore L1 attrition effects in bilinguals of two languages that favour opposing attachment biases. This PhD thesis will explore L1 Spanish-L2 English bilinguals as these two languages have been consistently shown to favour a HA and a LA interpretation, respectively. The following section will dive deeper into previous RCA research on these two languages, focusing on both natives and bilinguals.

3.4. Previous research on RCA preferences

This section will review findings on RCA biases, focusing first on native speakers of Spanish and English in Section 3.4.1, the languages of interest in this study. Section 3.4.2 will then discuss research on Spanish-English bilinguals, who constitute the experimental group of this PhD thesis. This summary of research findings will lay the ground for the research questions and hypotheses about L1 processing and interpretation of RCA ambiguities in monolingual and bilingual speakers.

3.4.1. RCA preferences in native Spanish and English

This section will focus on RCA preferences in both native Spanish and native English. Extensive research has been conducted on these languages, reporting a tendency toward HA in native Spanish, and a preference for LA in native English (Cuetos & Mitchell, 1988; Dussias, 2003; Dussias & Sagarra, 2007; Hemforth et al., 2015). The summary of findings from native Spanish and English speakers tested in their L1 will serve as a baseline to compare results for the two monolingual groups in this PhD thesis, as well as the L1 Spanish-L2 English bilingual group.

A novelty of this thesis is that a control group of bilinguals' L2 has been included. Previous studies testing bilinguals have often included a control group of bilinguals' L1. However, data from native speakers of their L2 is not frequently collected in the same study, and comments about how the L2 behaves regarding RCA are typically based on previous literature. Adding not only a control group of Spanish monolinguals, but also a second control group of English monolinguals tested in their L1 will provide a better understanding of how each of bilinguals' languages function regarding RCA. The fact that control data have been collected using the same stimuli and tasks ensures reliable comparisons with the experimental bilingual group.

It is relevant to clarify that most studies reported here will be repeated in Section 3.4.2, devoted to previous RCA research on bilinguals. This is so because most studies have not focused exclusively on native RCA preferences but instead, they have examined other groups such as bilinguals. Bilinguals' preferences will be discussed in Section 3.4.2, while the present section will exclusively report results from native Spanish and English groups tested in their L1. Finally, given that studies on RCA have addressed both offline (post-hoc interpretation) an online (real-time processing) preferences, both will be addressed. Offline findings in native Spanish and English will be reported first (see Section 3.4.1.1), followed by online results (see Section 3.4.1.2).

3.4.1.1. Offline preferences in native Spanish and English

A variety of studies have addressed the **offline interpretation** of RCA in native Spanish and English, i.e., post hoc attachment choices once the sentence has ended. Cuetos and Mitchell (1988) compared the L1 strategies of Spanish and English natives. The native Spanish group consisted of undergraduate students (N = 20) at the University of Oviedo, Spain, while participants in the English group were undergraduate students (N = 26) at the University of Exeter, UK[8]. However, no further details are provided on their linguistic profile[9]. Two offline questionnaires were designed to ensure each group was tested in

[8] Although their linguistic variety is not specified, it is assumed that participants were Peninsular Spanish and British English speakers as they studied in Spain and the UK, respectively.
[9] It has been a common practice in past research to provide limited details about participants' linguistic profiles. This PhD thesis has addressed this limitation as extensive information was collected prior to their participation. For example, Spanish monolinguals in this thesis are confirmed to have low L2 proficiency, no L2 exposure, L1 dominance, etc.

their L1: Spanish natives were tested in Spanish, and English natives were tested in English.

The Spanish questionnaire was administered first and contained 24 target sentences that included an ambiguous relative clause, as illustrated in (21) below. The RC (*que tuvo el accidente* / *who had had the accident*) can be attached to either NP1 (*la hija* / *the daughter*) or NP2 (*el coronel* / *the colonel*). Items were followed by a comprehension question that addressed the ambiguity involved, and participants had to write down an answer for each sentence, with responses evidencing their offline attachment preferences.

(21) *El periodista entrevistó a la hija$_i$ del coronel$_j$* ***que***$_{i/j}$ *tuvo el accidente*
The journalist interviewed the daughter$_i$ of the colonel$_j$ **who**$_{i/j}$ had had the accident[10]
¿Quién tuvo el accidente?
Who had the accident?

The English questionnaire was administered as a follow-up to the Spanish study, and therefore, the authors encountered some limitations regarding the original stimuli. Although the English questionnaire contained literal translations of the Spanish sentences, only 11 out of the original 24 target items were included. This was so because, as exemplified in (22) below, some Spanish sentences contained a non-human entity (*the book* / *el libro*) followed by a human entity (*the girl* / *la niña*) in the complex NP. In these cases, the selection of either *who* or *that* as relative pronoun would bias the final interpretation, with *who* resulting in an NP2 bias, and *that* leading to an NP1 bias. The analysis focused on the 11 original sentences where both NPs were human, using the relative pronoun *who* in the English questionnaire, as in (23) below. This PhD thesis will also test sentences with two human entities, given that this factor has been proved to influence attachment preferences (Acuña-Fariña et al., 2009).

(22) *Pedro miraba el libro$_i$ de la chica$_j$ /* ***que***$_{i/j}$ *estaba en el salón / viendo la tele*
Peter was looking at the book$_i$ of the girl$_j$ **who$_i$**/that$_j$ was in the living room

(23) *John met the friend$_i$ of the teacher$_j$* ***who***$_{i/j}$ *was in Germany with her students*

The analysis focused on the number of times participants attached the RC to each NP. For Spanish natives, with a maximum of 24 selections, a HA interpretation was selected an average of 14.96 times, while a LA interpretation was preferred an average of 8.83 times.

[10] The English translation is the original one used by Cuetos and Mitchell (1988).

The number of HA choices was greater than that of LA choices, so the authors conclude that Spanish natives tend to attach ambiguous RCs to NP1, suggesting a HA preference. The authors concluded that Spanish natives exhibit a preference for HA, as the number of HA choices was higher than LA choices. Turning to English results, the mean number of occasions in which the RC was attached high is 4.08 out of 11, while the average for LA is 6.38 out of 11. The authors conclude that English natives exhibit an LA interpretative bias. However, compared to results for native Spanish, findings on L1 English seem to suggest that the bias toward LA in English is not as strong as HA is for Spanish. English natives seem to be less categorical in their attachment preferences when their post hoc interpretation of ambiguous relative clauses is considered.

Similarly, Dussias (2003) tested offline interpretative biases in native Spanish and English. The scope of the study, however, was broader as it included advanced L2 learners of Spanish and English. Results for bilingual groups will be discussed in Section 3.4.2. To address offline comprehension, a questionnaire was administered to all participants in their L1. The Spanish group was composed of native Spanish speakers (N = 14), who reported having less than 1 year of study in an L2 and were recruited and tested in a Spanish-speaking country. The English group was composed of native English speakers[11] (N = 19) who reported less than 1 year of study in an L2. Unfortunately, no further information is provided about their language profile. The procedure was similar to the one implemented by Cuetos and Mitchell (1988), described above. Target sentences (N = 16) contained an ambiguous RC and were followed by a comprehension question with two possible answers, exemplified in (24) below. The question addressed who the host of the RC was, either NP1 (*la hija* / *the daughter*) or NP2 (*el psicólogo* / *the psychologist*), and participants selected the answer they considered to be the most appropriate.

(24) *Pedro se enamoró de la hija$_i$ del psicólogo$_j$ que$_{i/j}$ estudió en California*

Peter fell in love with the daughter$_i$ of the psychologist$_j$ who$_{i/j}$ studied in California

¿Quién estudió en California?

Who studied in California?

a. *La hija estudió en California*

The daughter studied in California

[11] Native speakers' variety is not specified. It is assumed that English natives are American speakers as the study also includes bilinguals living in the US. However, it is not possible to determine Spanish natives' variety as the only reference is that participants were recruited in a Spanish-speaking country.

b. *El psicólogo estudió en California*
The psychologist studied in California

Consistent with Cuetos and Mitchell (1988), the raw data were the number of selections made for the HA and LA forced-choice options. Due to the dependent nature of the responses, only HA responses were reported. While Spanish natives were expected to favour the option forcing HA in their L1 Spanish, English monolinguals were predicted to favour the forcing-LA option in English. Spanish natives provided a HA response approximately 74% of the time (mean HA responses = 11.79 out of 16), suggesting a preference for the NP1 as the host of the relative clause. In contrast, English natives selected a HA response an average of 14% of the time (mean HA responses = 2.26 out of 11), which indicates tendency toward LA in offline comprehension. Overall, results from Dussias' (2003) study show a HA preference in native Spanish and an LA preference in native English, which aligns with the offline findings by Cuetos and Mitchell (1988).

Bergmann et al. (2008) also explored offline disambiguation preferences among Spanish and English natives in their L1. Spanish data were collected from native speakers of Mexican Spanish (N = 10), and most participants reported speaking good to excellent English. The native English group consisted of native speakers of American English (N = 10), with most of them having some knowledge of an L2, ranging from poor to excellent. Unfortunately, no further information is provided about their language profile. As for the procedure, participants were required to read aloud ambiguous sentences like (25) below and afterwards, answer a comprehension question about their attachment preference. For each sentence, three possible answers were provided: NP1 preference (*the servant*), NP2 preference (*the actress*) or *I don't know*.

(25) *Alguien disparó al sirviente$_i$ de la actriz$_j$ que$_{i/j}$ estaba en el balcón*
Somebody shot the servant$_i$ of the actress$_j$ who$_{i/j}$ was on the balcony
¿Quién estaba en el balcón?
Who was on the balcony?

a. *El sirviente* — The servant
b. *La actriz* — The actress
c. *No sé* — I don't know

Results were reported for the proportion of HA, LA and *I don't know* answers to the comprehension questions. Spanish natives tested in their L1 showed a straightforward preference for HA (mean HA responses = 78% vs. mean LA responses = 19%). In contrast, native English speakers resolve ambiguous relative clauses toward LA 49% of the time, while 43% for HA. The remaining percentages corresponds to *I don't know* responses. Results for the English group indicate a slight LA preference, especially in comparison with the straightforward HA bias in Spanish. Such slight preference to attach ambiguous relative clauses to NP2 is in line with findings obtained by Cuetos & Mitchell (1988), which were discussed earlier.

A potential explanation for the mild LA bias can be found in the design of the study. Participants were instructed to read sentences aloud, whereas in previous studies they read silently. Thus, prosodic patterns may have influenced responses to comprehension questions. The authors expected higher number of breaks after NP2 in Spanish natives than English speakers as these breaks tend to favour HA. However, both groups showed similar (and very high) break rates at NP2. This could be because participants read sentences for the first time and did not know what was coming next, so prosody reflects the moment when the ambiguity arises, i.e., at NP2. For English natives, the number of prosodic breaks at NP2, which fosters HA, might have been lower if participants had known the message of the sentence in advance. It is then that prosodic patterns can reflect an individual's interpretative bias.

Finally, Hemforth et al. (2015) conducted an offline study on L1 preferences in English, Spanish, German and French. Only results for native Spanish and English will be discussed here. The Spanish group consisted of native speakers of Peninsular Spanish (N = 48) at the Complutense University of Madrid, Spain, living in an L1 environment. Participants within the English group were native speakers of American English (N = 48) also living in an L1 environment, as they were undergraduate students at the University of Massachusetts, US. No further details are mentioned. Offline preferences were assessed using a written questionnaire in the L1 of each group. Target items (N = 32) are exemplified in (26) below. They were designed in four conditions by manipulating both the position of the RC, i.e. subject vs. object, and its length, i.e., short vs. long RCs. Authors classify RC position based on whether they are embedded within the subject, as in (26a) and (26b), or within the object of the main clause, as (26c) and (26d). Following this distinction, findings will only be commented for object RCs, both long and short, where the relative clause may modify either NP1 (*the son* / *el hijo*) or NP2 (*the colonel* / *el coronel*). Participants were required to read each sentence and indicate what they understood by completing a blank space that addressed the resolution of the ambiguous RC. This is illustrated in the last line of example (26) below.

(26) TARGET ITEMS

(26a) **Subject + short RC**

The son$_i$ of the colonel$_j$ who$_{i/j}$ died had written five books on tropical diseases

El hijo$_i$ del coronel$_j$ que$_{i/j}$ murió escribió cinco libros sobre enfermedades tropicales

(26b) **Subject + long RC**

The son$_i$ of the colonel$_j$ who$_{i/j}$ tragically died of a stroke had written five books on tropical diseases

El hijo$_i$ del coronel$_j$ que$_{i/j}$ trágicamente murió de apoplejía escribió cinco libros sobre enfermedades tropicales

(26c) **Object + short RC**

The doctor met the son$_i$ of the colonel$_j$ who$_{i/j}$ died

El doctor conoció al hijo$_i$ del coronel$_j$ que$_{i/j}$ murió de apoplejía

(26d) **Object + Long RC**

The doctor met the son$_i$ of the colonel$_j$ who$_{i/j}$ tragically died of a stroke

El doctor conoció al hijo$_i$ del coronel$_j$ que$_{i/j}$ trágicamente murió de apoplejía

The ____________ *died*

El ______________ murió

Data were analysed regarding the mean percentage of HA responses. Considering only RCs embedded within the object of the main clause, Spanish natives exhibit an average of 41% of HA choices in short RCs like (26c), and 55% of HA responses in long RCs like (26d). The weak HA tendency, especially in short RCs, contrasts with the strong tendency in previous studies. For English natives, HA responses were provided 33% of the time for short RCs, and 48% of the time for long RCs. Overall, they tend to favour LA, and this preference is particularly strong in short RCs. When results for both groups are compared, a HA preference is only observed for Spanish in long RCs. The authors justify these findings arguing that previous research has focused on object-modifying RCs, as it is the case of this PhD thesis, but neither subject-modifying RCs, as (26a) and (26b), nor the potential influence of RC length have been tested. The authors suggest that the HA Spanish preference may not be a general and stable property, but rather strengthened or weakened by additional factors. Bearing in mind the potential influence of RC length and syntactic position, stimuli for this thesis were designed controlling these variables so that only object-modifying RCs with similar length were tested.

Up to this point, this section has offered an overview of previous findings regarding offline preferences to resolve ambiguous RCs in native Spanish and native English. Overall, while native Spanish seems to favour HA, the opposite tendency holds for native English, which tends to favour LA. To ensure the interpretation of the aforementioned studies, Table 2 summarises of the findings reported above.

Table 2:

Summary of offline studies on RCA preferences in native Spanish and native English

STUDY	TASK	ITEMS	PARTICIPANTS	PROFILE	RESULTS
Cuetos & Mitchell (1988)	L1 questionnaire Items + question	**SPA.** *El periodista entrevistó a la hija del coronel* ***que*** *tuvo el accidente* ¿Quién tuvo el accidente? **ENG.** *The journalist interviewed the daughter of the colonel* ***who*** *had had the accident* Who had the accident?	Spanish natives (peninsular) English natives (British)	Living in L1 environment (Spain and UK)	**Spanish natives:** favour high 14.96 out of 24 → HA preference **English natives:** favour high 4.08 out of 11 → LA preference
Dussias (2003)	L1 questionnaire Items + question	**SPA.** *Pedro se enamoró de la hija del psicólogo* ***que*** *estudió en California* ¿Quién estudió en California? **ENG.** *Peter fell in love with the daughter of the psychologist* ***who*** *studied in California* Who studied in California?	Spanish natives (?) English natives (American)	Living in L1 environment Less than 1 year of study in an L2	**Spanish natives**: favour high 74% (11.8/16) → HA preference **English natives**: favour high 14% (2.3/16) → LA preference
Bergmann et al. (2008)	To read L1 sentences aloud + Question	**SPA**. *Alguien disparó al sirviente de la actriz* ***que*** *estaba en el balcón* ¿Quién estaba en el balcón? **ENG**. *Somebody shot the servant of the actress* ***who*** *was on the balcony* Who was on the balcony?	Spanish natives (Mex) English natives (US)	Spa natives: speak good-to-excellent English Eng natives: L2 knowledge (poor to excellent)	**Spanish natives:** HA (78%) > LA (19%) → HA preference **English natives:** HA (43%) < LA (49%) → LA preference (slightly)
Hemforth et al. (2015)	L1 questionnaire Items + fill in blank space	**Short RC:** *The doctor met the son of the colonel* ***who*** *died* El doctor conoció al hijo del coronel **que** murió **Long RC:** *The doctor met the son of the colonel* ***who*** *tragically died of a stroke* El doctor conoció al hijo del coronel **que** trágicamente murió de apoplejía	Spanish natives (peninsular) English natives (American)	Living in L1 environment (Spain and US)	**Spanish natives:** HA choices = 41% short RCs vs. 55% long RCs → HA preference in long RCs **English natives:** HA choices = 33% short RCs vs. 48% long RCs → LA preference

3.4.1.2. *Online preferences in native Spanish and English*

In addition to offline RCA preferences, a great bulk of studies have addressed the **online processing strategies** employed in native Spanish and native English. However, online data from these two languages have not typically been collected in the same study. To my knowledge, one study has simultaneously addressed both languages online (Carreiras & Clifton, 1993), and this study will be reviewed first. This section will then review online findings for native Spanish first, followed by online native English data.

Carreiras and Clifton (1993) explored native English and native Spanish attachment preferences using a self-paced reading task. The Spanish group consisted of native Spanish speakers (N = 48) enrolled at the University of La Laguna, Spain. Additionally, the English group encompassed native English speakers (N = 48) enrolled at the University of Massachusetts, US. Unfortunately, no further details are specified regarding their language profile. Target items (N = 16) had two conditions (forcing-HA and forcing-LA) using gender information to disambiguate RCs. Given that NP1 and NP2 always had different gender, disambiguation was accomplished by reverting their gender. For instance, (27a) below forces HA, while (27b) forces LA. However, a review of the stimuli used in the SPRT has revealed limitations regarding how sentences were disambiguated. The authors use the term "gender information" as an umbrella term because target items were disambiguated in different ways but always in relation to gender: morphological agreement, semantic information or world knowledge. In the words of Carreiras and Clifton (1993, p. 358), "gender was morphologically marked in three of the Spanish relative clauses and one of the English relative clauses (via a pronoun), while it was conveyed only through semantic information in the remaining items". Although disambiguation always relies on gender, this is not a concise approach to test attachment resolution and variability in the way of resolving ambiguous RCs could influence results. This has been properly addressed in this PhD thesis, which relies exclusively on grammatical gender agreement.

(27) TARGET ITEMS

(27a) **Forcing-HA**

*La policía arrestó a la hermana$_i$ del criado$_j$ / **que**$_{i/j}$ dio a luz recientemente dos gemelos*

The police arrested the sister$_i$ of the handyman$_j$ / **who**$_{i/j}$ recently gave birth to twins

(27b) **Forcing-LA**

*La policía arrestó al hermano$_i$ de la niñera$_j$ / **que**$_{i/j}$ <u>dio a luz</u> recientemente dos gemelos*

The police arrested the brother$_i$ of the nursemaid$_j$ / **who**$_{i/j}$ recently <u>gave birth</u> to twins

Sentences were divided into two segments, marked in (27) above, with the second segment containing the RC. While no significant differences were found in the first segment, mean RTs for the second region show that Spanish natives read temporarily ambiguous sentences significantly faster when the RC is forced to modify NP1 (mean RTs = 2456 ms) rather than NP2 (mean RTs = 2886 ms), evidencing a HA preference in their online strategies. Focusing on English natives, there seems to be a slight preference for sentences forcing LA (HA: mean RTs = 1961; LA: mean RTs = 1920), but differences were non-significant. The authors conclude that native English does not exhibit a processing preference for either HA or LA, while native Spanish shows a clear HA preference, which was confirmed in two follow up experiments on Spanish natives only.

From this point on, the following **online studies** only investigated attachment preferences in **native Spanish,** so only findings from these speakers will be reported. Continuing with Carreiras and Clifton (1993), they administered two additional SPRTs to examine online **processing in native Spanish only**. They replicated the design described earlier (see example (27) above) and used the same stimuli. The only difference was the introduction of true/false comprehension questions to ensure participants' understanding of the sentences. Participants were native Spanish speakers (N = 48) enrolled at the University of La Laguna, Spain. Results for mean RTs were very similar to those reported above: the second display, which included the RC, was read significantly faster when a HA-interpretation was forced (HA: mean RTs = 2565; LA: mean RTs = 3084), suggesting a tendency to attach high. This was supported by the responses to the comprehension questions, whose accuracy was higher in the forcing-HA than in the forcing-LA condition (91.7% vs. 81.5%, respectively). These findings indicate a strong preference for HA in Spanish natives.

A third SPRT testing native Spanish was conducted by Carreiras and Clifton (1993) to address whether disambiguation type (grammatical vs. pragmatic) had an effect in the observed HA preference in native Spanish. Participants were Spanish natives (N = 56) studying at the University of La Laguna, Spain. These participants were different to those in previous experiments. Stimuli were also different as new set of target sentences (N =

24) were created in four conditions: half of the sentences were disambiguated via morphological information[12], while the other half was disambiguated via pragmatic information. Within each disambiguation type, half of the sentences forced HA and the other half, LA. As an illustration, (28) below exemplifies these conditions.

(28) TARGET ITEMS

(28a) **HA + grammar**

La policía detuvo a la hermana$_i$ del portero$_j$ / que$_{i/j}$ estuvo acusada de hurto

The police arrested the sister$_i$ of the male porter$_j$ who$_{i/j}$ was accused$_{[fem]}$ of robbery

(28b) **HA + pragmatics**

La policía detuvo a la hermana$_i$ del portero$_j$ / que$_{i/j}$ acababa de dar a luz

The police arrested the sister$_i$ of the male porter$_j$ who$_{i/j}$ just gave birth

(28c) **LA + grammar**

La policía detuvo al hermano$_i$ de la portera$_j$ / que$_{i/j}$ estuvo acusada de hurto

The police arrested the brother$_i$ of the female porter$_j$ who$_{i/j}$ was accused$_{[fem]}$ of robbery

(28d) **LA + pragmatics**

La policía detuvo al hermano$_i$ de la portera$_j$ / que$_{i/j}$ acababa de dar a luz

The police arrested the brother$_i$ of the female porter$_j$ who$_{i/j}$ just gave birth

Mean RTs for the relative clause were analysed via 2x2 ANOVA (disambiguation type by attachment). Only attachment had an effect, as higher RTs were reported for the forcing-LA condition regardless of disambiguation type (Grammar: mean RTs HA = 2309, mean RTs LA = 2555; Pragmatics: mean RTs HA = 2218, mean RTs LA = 2513). RCs were read faster when they were disambiguated toward HA, independently of whether the attachment was forced using morphological information or pragmatics. The effect of disambiguation type was non-significant. Results evidence a tendency in Spanish natives to attach the RC to the first-mentioned antecedent regardless of disambiguation type, and are in line with the findings reported above

[12] Mostly using adjective gender agreement with one of the preceding NPs, as in (28a) and (28c). However, there are there a few cases where disambiguation was achieved using a noun with the same gender as one of the two antecedents. For example: *Ayer me encontré con la amiga del concejal que fue asesora de nuestra empresa.* This lack of consistency will be addressed in the present PhD thesis.

Similarly, Cuetos and Mitchell (1988) collected online data to explore the moment when offline structural choices were made. Offline results, reported in Section 3.4.1.1, evidenced a HA preference for Spanish natives, and a SPRT was implemented to investigate whether these choices were made the sentence unfolded or once it had ended. Participants were native speakers of Peninsular Spanish (N = 15) at the University of Oviedo, Spain. Stimuli were presented clause by clause and designed for two conditions via pragmatic bias: a forcing-LA condition as in (29a), and a neutral condition (29b) where the two NPs were equal candidates to be the host of the relative clause.

(29) TARGET ITEMS

(29a) **Forcing-LA condition**

Alguien disparó al criado$_i$ de la actriz$_j$ / que$_{i/j}$ estaba en el balcón / con su marido[13]

Someone shot the servant$_{i[mas]}$ of the actress$_j$ / who$_{i/j}$ was on the balcony / with her husband

(29b) **Neutral condition**

Alguien disparó a la criada$_i$ de la actriz$_j$ / que$_{i/j}$ estaba en el balcón / con su marido

Someone shot the servant$_{i[fem]}$ of the actress$_j$ / who$_{i/j}$ was on the balcony / with her husband

The authors argue that in the forcing-LA condition, the gender mismatch between the masculine noun *marido* / *husband* and the masculine NP1 (*criado* / *servant*) would create a processing cost in the final display, which is underlined in (29). To put it simply, in the forcing-LA condition, if Spanish natives initially attach the relative pronoun *que* / *who* to NP1 (*criado* / *servant*), the gender mismatch in the final display (*con su marido* / *with her husband*) would foster a reanalysis of the sentence. However, this presents some limitations, as disambiguating the RC through world knowledge complicates processing considerably. The authors assume that just because *marido* / *husband* is mentioned at the end of the sentence, only a female antecedent can be associated with it (i.e., only NP2 is an optimal host for the RC because if refers to a female person). Such attachment resolution relies on assumptions about how participants perceive the world and is not an efficient approach. This has been avoided in the present PhD thesis, where the resolution was achieved in a more straightforward manner via grammatical gender agreement

[13] The oblique lines (/) mark the end of each display.

Going back to a review of the study, the authors claim that such processing difficulty in native Spanish would be represented by higher RTs in the forcing-LA condition compared to the neutral condition. Online results confirmed the HA preference observed offline. As expected, the authors report no differences in the mean RTs for the first two displays, whereas significant differences were observed for the final display. This critical segment took significantly longer to read in target sentences forcing LA (mean RTs = 1689 ms), which included the gender mismatch, than in control sentences (mean RTs = 1480 ms) where NP1 and NP2 were equal candidates to be hosts of the RC. These findings suggest a processing cost among Spanish natives in ambiguous RCs that force a LA-interpretation, which was taken as evidence of a HA preference. In summary, the online results for native Spanish align with the offline findings and demonstrate a strong tendency to attach ambiguous RCs to NP1 both online and in offline interpretation.

Continuing with research on online RCA preferences in native Spanish, Dussias (2003) tested Spanish natives and Spanish-English bilinguals. Here, only results for Spanish natives will be reported, while bilingual findings will be discussed in Section 3.4.2.2[14]. A SPRT was completed by 32 Spanish natives in their L1 Spanish. Participants were recruited in a Spanish-speaking country and had studied an L2 for less than 1 year. Target items, illustrated in (30) below, were manipulated to create four conditions based on the attachment of the RC.

(30) TARGET ITEMS

(30a) **Forcing-LA**

El perro mordió al cuñado$_i$ de la maestra$_j$ / que$_{i/j}$ vivió en Chile / <u>*con su esposo*</u>

The dog bit the brother-in-law$_i$ of the teacher$_{j[fem]}$ who$_{i/j}$ lived in Chile with <u>her husband</u>

(30b) **Forcing-HA**

El perro mordió a la cuñada$_i$ del maestro$_j$ / que$_{i/j}$ vivió en Chile / <u>*con su esposo*</u>

The dog bit the sister-in-law$_i$ of the teacher$_{j[masc]}$ who$_{i/j}$ lived in Chile with <u>her husband</u>

(30c) **Control 1**

El perro mordió a la cuñada$_i$ de la maestra$_j$ / que$_{i/j}$ vivió en Chile / <u>*con su esposo*</u>

The dog bit the sister-in-law$_i$ of the teacher$_{j[fem]}$ who$_{i/j}$ lived in Chile with <u>her husband</u>

[14] In contrast to the offline study, which included two control groups (Spanish and English monolinguals), the online SPRT only included a control group of Spanish monolinguals. Thus, although the offline data from English natives in Dussias (2003) was reported in Section 3.4.1.1, online results cannot be offered.

(30d) **Control 2**

El perro mordió a la maestra$_i$ / que$_i$ vivió en Chile / con su esposo

The dog bit the teacher$_{i[fem]}$ who$_i$ lived in Chile with his/her husband

According to Dussias (2003), in the LA-biased condition, the final phrase *con su esposo / with his/her husband* forces LA since NP1 (*cuñado / brother in law*) is masculine. In the forcing-HA condition, the gender of NP1 and NP2 was switched to force HA. Two control conditions were added for comparison. Items were segmented into three displays, being the third display the crucial segment since it included the bias of the RC. Spanish natives were predicted to take longer to read the final display in the LA-biased condition. Results for the mean RTs in the third display evidence, as expected, lower RTs in the HA-biased condition than in the LA-biased condition (HA-bias: mean RTs = 1407; LA-bias: mean RTs = 1603). This suggests that Spanish natives are faster processing relative clauses attached to NP1. This is in line with all previous studies reporting that the default processing strategy among Spanish monolinguals is HA.

Also using a SPRT, Jegerski et al. (2016) explored online preferences among Spanish natives and Spanish heritage speakers. However, results for heritage bilinguals will not be discussed here. The group of Spanish natives (N = 46) included participants who were born and raised in Mexico, an L1-environment. Target items, exemplified in (31) below, contained temporarily ambiguous sentences that were gender-biased toward either HA or LA.

(31) TARGET ITEMS

(31a) **Forcing-HA**

Miguel discutió con el jefe$_i$ de la vendedora$_j$ / que$_{i/j}$ tenía un bigote muy largo

Miguel argued with the boss$_{i[masc]}$ of the clerk$_{j[fem]}$ / that$_{i/j}$ had a very long mustache

(31b) **Forcing-LA**

Miguel discutió con la jefa$_i$ del vendedor$_j$ / que$_{i/j}$ tenía un bigote muy largo

Miguel argued with the boss$_{i[fem]}$ of the clerk$_{j[masc]}$ / that$_{i/j}$ had a very long mustache

Each sentence was fragmented into two segments, with the first segment containing the main clause and the second, the RC, as in (31) above. For the analysis, mean reading times of the RC were considered. Overall, Spanish natives show longer RTs in the LA-biased condition (mean RTs = 3022 ms) than in the HA-biased condition (mean RTs = 2762 ms). This indicates that Spanish monolinguals might show evidence of a high attachment preference. Participants needed more time to read sentences that forced a LA interpretation, suggesting a processing cost in this condition, and a preference for HA.

Online preferences in native Spanish have also been accounted for via eye-tracking data. Dussias and Sagarra (2007) investigated the effect of L2 exposure on L1 parsing strategies in a reading eye-tracking study with two groups: native speakers of Peninsular Spanish (N = 44) and late L1 Spanish-L2 English bilinguals (N = 48) with extensive or limited L2 exposure. Focusing on the Spanish native group[15], participants were born and raised in Spain, and were students of the degree in Translation and Interpreting at the University of Granada, Spain. L2 proficiency was assessed through self-reports and only candidates who indicated a proficiency level of 2 or lower in a 10-point scale were considered for participation. This group is relevant for the present PhD thesis because its characteristics are similar to those of the Spanish monolinguals included in this thesis. Participants in both studies were born and raised in the same Spanish city, Granada, sharing the same L1 environment. They were also undergraduate university students, ensuring a similar age range and educational background, and had low L2 proficiency.

Target items contained temporarily ambiguous RCs resolved via morphological gender, creating two conditions illustrated in (32) below. The relative clause included a gender-marked adjective, and disambiguation was achieved by changing the gender of the preceding NPs. One condition, exemplified in (32a), forced HA (*hermana* / *sister*) since the female adjective *enferma* / *ill* can only refer to a female antecedent in Spanish, which appears in NP1. In contrast, a second condition forced LA. In (32b), the relative clause must be attached to a female antecedent, which appears in the NP2 (*niñera* / *babysitter*).

(32) TARGET ITEMS

(32a) **Forcing-HA**

El policía arrestó a la hermana$_i$ *del criado*$_j$ *que*$_{i/j}$ *estaba enferma desde hacía tiempo*

The police arrested the sister$_i$ of the servant$_{j[masc]}$ who$_{i/j}$ had been ill$_{j[fem]}$ for a while

[15] Results for the bilingual group in Dussias and Sagarra (2007) will be reported in Section 3.4.2.

(32b) **Forcing-LA**

El policía arrestó al hermano$_i$ de la niñera$_j$ que$_{i/j}$ estaba enferma desde hacía tiempo

The police arrested the brother$_i$ of the babysitter$_{j[fem]}$ who$_{i/j}$ had been ill$_{[fem]}$ for a while

The critical region was defined as the adjective within the RC (*enferma* / *ill*), given that it disambiguates the RC toward NP1 or NP2. Data from a reading eye-tracking experiment revealed a preference for HA among Spanish natives. Total reading times at the critical region were significantly longer for sentences disambiguated towards LA (mean RTs = 613 ms) when compared to items forced to HA (mean RTs = 497 ms). The authors then conclude that, in line with previous literature, native Spanish speakers tend to attach the relative clause to the first of the two potential hosts within the complex NP.

Table 3:

Summary of online studies on RCA preferences in native Spanish

STUDY	TASK	ITEMS	PARTICIPANTS	PROFILE	RESULTS
Carreiras & Clifton (1993)	SPRT	**Forcing-HA** *La policía arrestó a la hermana del criado / **que** <u>dio a luz</u> recientemente dos gemelos* The police arrested the sister of the handyman / **who** recently <u>gave birth</u> to twins **Forcing-LA** *La policía arrestó al hermano de la niñera / **que** <u>dio a luz</u> recientemente dos gemelos* The police arrested the brother of the nursemaid / **who** recently <u>gave birth</u> to twins	Spanish natives (Canary Islands, Spain) English natives (US)	Living in an L1 environment	Mean RTs. **Spanish natives**: forcing-HA (2456 ms) < forcing-LA 2886 ms) → Preference for HA **English natives**: forcing-HA (1961 ms) > forcing-LA (1920 ms) → Preference for LA
Carreiras & Clifton (1993) (study on native Spanish)	SPRT	Same items described above + Comprehension question	Spanish natives (Canary Islands, Spain)	Living in an L1 environment	Mean RTs. Forcing-HA (2565 ms) < forcing-LA (3084 ms) →Preference for HA
Carreiras & Clifton (1993)	SPRT Effect of bias	**HA + grammar:** *La policía detuvo a la hermana del portero / que estuvo <u>acusada</u> de hurto* **HA + pragmatics:** *La policía detuvo a la hermana del portero / que acababa de <u>dar a luz</u>* **LA + grammar:** *La policía detuvo al hermano de la portera / que estuvo <u>acusada</u> de hurto* **LA + pragmatics:** *La policía detuvo al hermano de la portera / que acababa de <u>dar a luz</u>*	Spanish natives (Canary Islands, Spain)	Living in an L1 environment	Faster RTs in forcing-HA regardless of disambiguation Grammar: HA = 2309 ms < LA = 2555 ms Pragmatics: HA = 2218 ms < LA = 2513 → Preference for HA

STUDY	TASK	ITEMS	PARTICIPANTS	PROFILE	RESULTS
Cuetos & Mitchell (1988)	SPRT	**Forcing-LA** *Alguien disparó al criado de la actriz / que estaba en el balcón / con su marido* Someone shot the servant$_{[mas]}$ of the actress / who was on the balcony / with her husband **Neutral** *Alguien disparó a la criada de la actriz / que estaba en el balcón / con su marido* Someone shot the servant$_{[fem]}$ of the actress / who was on the balcony / with her husband	Spanish natives (Peninsular)	Living in an L1 environment	Mean RTs. Neutral condition (1480ms) < forcing-LA (1689 ms) Processing cost if LA is forced → Preference for HA
Dussias (2003)	SPRT	**Forcing-HA:** *El perro mordió a la cuñada del maestro / que vivió en Chile / con su esposo* **Forcing-LA:** *El perro mordió al cuñado de la maestra / que vivió en Chile / con su esposo*	Spanish natives (?)	Living in an L1 environment	Mean RTs HA is forced (1407 ms) < LA is forced (1603 ms) →HA is faster; preference for HA
Jegerski et al. (2016)	SPRT	**Forcing-HA:** *Miguel discutió con el jefe de la vendedora / que tenía un bigote muy largo* **Forcing-LA:** *Miguel discutió con la jefa del vendedor / que tenía un bigote muy largo*	Spanish natives (Mex)	Born and raised in Mexico, L1 environment	Mean RTs: Forcing HA (2762 ms) < forcing LA (3022 ms) → Preference for HA
Dussias & Sagarra (2007)	Reading ET	**Forcing-HA:** *El policía$_i$ arrestó a la hermana$_j$ del criado$_k$ que$_{j/k}$ estaba enferma$_j$ desde hacía tiempo* **Forcing-LA:** *El policía$_i$ arrestó al hermano$_j$ de la niñera$_k$ que$_{j/k}$ estaba enferma$_k$ desde hacía tiempo*	Spanish natives (Peninsular)	Living in an L1 environment	Mean RTs: Forcing HA (497 ms) < forcing LA (613 ms) Spa natives high is faster → Preference for HA

After reviewing online studies on native Spanish, the following studies will exclusively focus on **online strategies** employed by **English natives** in their L1. For instance, Cheng et al. (2021) investigated attachment resolution among English natives and learners, examining whether their preferences were modulated by RC syntactic position and individual differences. Participants were native English speakers (N = 66), being all of them university students at the University of Reading, UK. Data were collected using a reading eye-tracking experiment, where participants' eye movements were monitored as they read a series of sentences on a screen. An eye-tracking methodology has also been implemented in this PhD, so results from this study on native English are particularly relevant. Cheng et al. (2021) tested RCs in both subject and object position, but only results for object-modifying RCs in subject position will be reported as this is the construction explored in this PhD thesis. Stimuli encompassed globally ambiguous sentences and sentences forcing either LA or HA, illustrated in (33). The two latter conditions were disambiguated via a gender-marked reflexive pronoun (*himself*). Importantly, in the ambiguous condition, NP1 and NP2 had the same gender (both *brother* and *man* are masculine), while they differed in the HA and LA conditions (*brother* vs. *woman* and *sister* vs. *man*, respectively) to force a disambiguation towards NP1 or NP2.

(33) TARGET ITEMS

(33a) **Ambiguous**

We saw the brother$_i$ of the man$_j$ who$_{i/j}$ accidentally hurt himself$_{i/j}$ yesterday afternoon

(33b) **Forcing-HA**

We saw the brother$_i$ of the woman$_j$ who$_{i/j}$ accidentally hurt himself$_i$ yesterday afternoon

(33c) **Forcing-LA**

We saw the sister$_i$ of the man$_j$ who$_{i/j}$ accidentally hurt himself$_j$ yesterday afternoon

For the eye-tracking data, RTs were calculated at two regions: the reflexive pronoun (*himself*) and the consecutive spillover region (*yesterday afternoon*). In online processing, English natives exhibited a LA preference across various measures, i.e., total reading times, first-pass reading times and regression path times. Table 4 below summarises the mean RTs for object-modifying RCs across conditions and reading measures.

Significantly longer RTs were found in the forcing-HA condition compared to the ambiguous condition, but the latter did not have significantly longer RTs than the LA condition. Findings align with those of the present PhD thesis (see Section 8.4.2), as English monolinguals favour LA when processing ambiguous sentences.

Table 4:

Summary of mean RTs in milliseconds for object-modifying RCs from Cheng et al. (2021)

Reflexive pronoun region			
	First pass RTs	Regression path RTs	Total RTs
Ambiguous	235	327	380
LA	239	382	406
HA	251	379	523
Spillover region			
	First pass RTs	Regression path RTs	Total RTs
Ambiguous	428	990	654
LA	412	997	612
HA	418	1628	753

Similarly, Solaimani and Marefat (2024) investigated online English RCA preferences and whether these are modulated by syntactic and discourse-based parsing principles. The study compared two groups: L1 Persian-L2-English learners and English native speakers. However, only results for the latter group will be discussed. Participants in the English native group (N = 36) consisted of undergraduate students who reported to be living in the UK, an L1-environment, and lack of L2 fluency. They completed SPRT in their L1 English. Target items, in (34) below, were designed in four conditions depending on the interpretative bias (HA vs. LA) and definiteness of the article (definitive vs. indefinite). All target sentences involved RC ambiguities that were semantically biased toward HA (*injecting penicillin* is more likely to be associated to *a nurse* than *a patient*) or LA (*coughing severely* is more likely to be associated to *a patient* than *a nurse*). The authors predict an LA preference in sentences that bias this interpretation (see (34c) and (34d)), which will be fostered when NP2 is preceded by a definite article (34d).

(34) TARGET ITEMS

(34a) **HA + indefinite antecedent**

*The resident called **a** nurse$_i$ of the patient$_j$ / who$_{i/j}$ was <u>injecting penicillin</u>*

(34b) **HA + definite antecedent**

The resident called ***the*** *nurse$_i$ of a patient$_j$ / who$_{i/j}$ was* <u>*injecting penicillin*</u>

(34c) **LA + indefinite antecedent**

The resident called the nurse$_i$ of ***a*** *patient$_j$ / who$_{i/j}$ was* <u>*coughing severely*</u>

(34d) **LA + definite antecedent**

The resident called a nurse$_i$ of ***the*** *patient$_j$ / who$_{i/j}$ was* <u>*coughing severely*</u>

The dependent variable was the RTs of the relative clause. For English natives, sentences (34c) and (34d), that forced LA (mean RTs = 1174 and 914 ms, respectively) were read faster than conditions (34a) and (34b), which forced HA (mean RTs = 1813 and 1161 ms, respectively). These preferences were influenced by the definiteness of the article. In the forcing-LA conditions, significant differences are found when NP2 is introduced by a definite antecedent as English natives significantly increase their LA tendency, while no strong preference is observed with an indefinite antecedent. In other words, a general tendency toward LA is found among English natives, being this tendency particularly strong when NP2 includes a definite article. This online LA preference attested with self-paced reading data will also be observed in the eye-tracking results from this PhD thesis. To better illustrate findings on English natives' online preferences, a summary can be found in Table 5.

To sum up, this section has reviewed both offline and online studies on RCA preferences among Spanish and English natives. Spanish natives have been found to consistently exhibit a HA preference in both offline comprehension tasks and online tasks such as SPRTs and eye-tracking experiments (Carreiras et al., 2004; Carreiras & Clifton, 1993; Cuetos & Mitchell, 1988; Dussias, 2003; Dussias & Sagarra, 2007). In contrast, native English tends to display a LA preference, attested using both offline (Bergmann et al., 2008; Cuetos & Mitchell, 1988; Dussias, 2003; Hemforth et al., 2015) and online measures (Y. Cheng et al., 2021; Solaimani & Marefat, 2024). However, the LA preference in English seems to be to some extent less pronounced than the HA-preference in Spanish. These findings will contribute to the formulation of the research questions and hypotheses that address RCA preferences in the two native control groups of Spanish and English. Additionally, they also confirm the cross-linguistic differences reported for these two languages regarding their preferred strategy to resolve ambiguous RCs.

Table 5:

Summary of online studies on RCA preferences in native English

STUDY	TASK	ITEMS	PARTICIPANTS	PROFILE	RESULTS
Cheng et al. (2021)	Reading ET	**Ambiguous:** *We saw the brother of the man* ***who*** *accidentally hurt himself yesterday afternoon* **Forcing-HA:** *We saw the brother of the woman* ***who*** *accidentally hurt himself yesterday afternoon* **Forcing-LA:** *We saw the sister of the man* ***who*** *accidentally hurt himself yesterday afternoon*	English natives (UK)	Living in an L1 environment	Different RTs measures. At reflexive region: English natives: longer RTs when forcing HA than in the other conditions. RTs in HA > ambiguous (sig) and LA → Processing cost in HA
Solaimani & Marefat (2024)	SPRT	**HA + indefinite antecedent:** *The resident called* ***a*** *nurse of the patient / who was injecting penicillin* **HA + definite antecedent:** *The resident called* ***the*** *nurse of a patient / who was injecting penicillin* **LA + indefinite antecedent:** *The resident called the nurse of* ***a*** *patient / who was coughing severely* **LA + definite antecedent:** *The resident called a nurse of* ***the*** *patient / who was coughing severely*	English natives (UK)	Living in an L1 environment and lack of fluency in an L2	Mean RTs at RC. Sentences forcing HA (1813 and 1161 ms) were read slower than sentences forcing LA (1174 and 914 ms) → Overall LA preference, being particularly strong when NP2 includes a definite article

3.4.2. RCA preferences in bilinguals: a focus on Spanish-English

The study of RCA preferences has not been limited to native speakers, but has also been examined in bilingual speakers (Cairncross et al., 2023; Dussias, 2003; Papadopoulou & Clahsen, 2003; Valenzuela et al., 2020). Of particular interest are findings on Spanish-English bilinguals as this is the language combination of the experimental group tested in this PhD thesis. The present section will offer an overview of findings on RCA preferences in Spanish-English bilinguals, focusing first on offline studies (see Section 3.4.2.1), followed by a review of online studies (see Section 3.4.2.2).

3.4.2.1. Offline preferences in bilinguals

Regarding offline RCA preferences in bilinguals, Dussias (2003), tested whether bilinguals exhibited the same interpretative biases than their native counterparts[16]. Two bilingual groups were recruited: L1 Spanish-L2 English (N = 31) and L1 English-L2 Spanish (N = 32) speakers. The former is the most relevant one because it has the same L1-L2 combination than the bilingual group in this PhD thesis. Participants were naturalistically immersed in an L2 environment, although length of immersion was not balanced across groups. L1 Spanish-L2 English bilinguals lived in the US for an average of 7.5 years, while L1 English-L2 Spanish bilinguals lived in a Spanish-speaking country for an average of 2 years before returning to the US, where they were tested. This is crucial because not only did the two groups differ in length of residency by approximately 5 years, but also the L1 English-L2 Spanish group was re-exposed to their L1, which has been reported to attenuate attrition effects (Chamorro et al., 2016). Participants' L2 proficiency was superior in an oral interview. Additionally, L1 Spanish-L2 English bilinguals reported being almost equally proficient in their two languages, while L1 English-L2 Spanish bilinguals reported being proficient in their L2 but to a lower extent that the other group. Regarding language dominance, measured via self-reports, all bilinguals were English dominant based on exposure as they were living in an English environment. However, based on proficiency, they identified as L1 dominant.

Participants completed an questionnaire containing globally ambiguous sentences followed by a comprehension question, as in (35) below (this example was provided in Section 3.4.1.1, but reintroduced here for the reader's convenience).

[16] Natives' results have been discussed earlier in Section 3.4.1.

(35) *Pedro se enamoró de la hija$_i$ del psicólogo$_j$ que$_{i/j}$ estudió en California*

Peter fell in love with the daughter$_i$ of the psychologist$_j$ who$_{i/j}$ studied in California

¿Quién estudió en California?

Who studied in California?

a. La hija estudió en California

The daughter studied in California

b. El psicólogo estudió en California

The psychologist studied in California

Participants were tested in their L1 and L2, but only L1 results will be provided as that is the focus of the thesis. L1 Spanish-L2 English bilinguals tested in their L1 Spanish favour HA 44% of the time, significantly differing from Spanish natives reported in Section 3.4.1.1. Conversely, L1 English-L2 Spanish bilinguals tested in L1 English prefer HA 28% of the time, pattering with their native English counterparts in a bias toward LA. Thus, only the L1 Spanish-L2 English group seems to depart from native behaviour, as they tend to attach ambiguous RCs low, their L2-preferred strategy. Results are relevant because L1 attrition effects are found in the bilingual group with longer length of L2 immersion (mean = 7.5 years). The mean length of residency of L1 English-L2 Spanish bilinguals was considerably shorter (mean = 2 years) and were tested back in an L1 environment, meaning that their L2 exposure had been reduced compared to the other bilingual group. Although both groups are not comparable in terms of length of immersion, results provide interesting insights into bilinguals' interpretative biases and evidence the influence of L2 immersion. However, it remains unclear whether other exposure contexts, like instructed settings, may play a similar role.

Additionally, Dussias (2003) measured language dominance through self-reports, which can be problematic due to its subjective nature. Despite this limitation, it is worth noting that attrition is observed in bilinguals who identified as dominant in L1 Spanish, contrasting with the traditional tendency to test attrition in L2 dominant bilinguals. To provide a more objective measure of language dominance and avoid categorical classifications of L1 vs. L2 dominance, the present PhD thesis will administer the *Bilingual Language Profile* questionnaire (Birdsong et al., 2012), that places participants on a continuum from more L1-dominant to more L2-dominant (see Section 5.3.2). Interestingly, our results also evidence attrition in L1 dominant bilinguals.

Similarly, Jegerski, VanPatten, et al. (2016) investigated offline attachment strategies in heritage L1 Spanish-L2 English speakers (N = 23) and late L1 Spanish-L2 English bilinguals (N = 21). Given that heritage speakers are outside of the scope of this PhD thesis, only findings for the late bilingual group will be discussed. These L1 Spanish-L2 English bilinguals acquired L2 English after the age of 12 and migrated to the US in adulthood, with a mean residency of 4.8 years (SD = 4.3). Based on self-reported proficiency, they identified as Spanish dominant. Interestingly, although again measured by self-reports, bilinguals were also L1 dominant. Language exposure was 51.5% English, 43.9 % Spanish, and 3.7% other. Participants completed an offline sentence interpretation task in their two languages. Target items (N = 10) contained a globally ambiguous RC followed by a question as in (36) below, in which the RC can be attached high to NP1 (*la hermana* / *the sister*) or low to NP2 (*la amiga* / *the friend*).

(36) *El ratón mordió a la hermana$_i$ de mi amiga$_j$ que$_{i/j}$ ganó la lotería grande*

The hamster bit the sister$_i$ of my friend$_j$ who$_{i/j}$ won the big lottery

¿Quién ganó la lotería?

Who won the lottery?

a. La hermana

The sister

b. La amiga

The friend

Late bilinguals show similar attachment preferences in their L1 and L2. The average of HA responses was 57.1% in L1 Spanish and 50.5% in L2 English, with no significant differences between languages. Late bilinguals show neutral preferences, implementing a single strategy in both Spanish and English. Relevant for this study in the percentage of HA choices in bilinguals' L1 (57.1%) which suggests an attenuated HA preference, departing from the strong HA tendency in Spanish natives and evidencing attrition effects. These findings align with the results of this study. It is worth noting that these bilinguals reported being dominant in their L1 Spanish and having relatively short L2 naturalistic immersion compared to early studies on attrition (mean residency = 4.8 years). Thus, findings by Jegerski, VanPatten, et al. (2016) indicate that L1 attrition of offline RCA biases can occur even in short periods of naturalistic immersion. However, it is also crucial to examine if other exposure contexts may trigger similar effects.

Table 6:

Summary of offline RCA in Spanish-English bilinguals

STUDY	TASK	ITEMS	PARTICIPANTS	PROFILE	RESULTS
Dussias (2003)	L1 questionnaire Items + Q	**SPA.** *Pedro se enamoró de la hija del psicólogo* ***que*** *estudió en California* ¿Quién estudió en California? **ENG.** *Peter fell in love with the daughter of the psychologist* ***who*** *studied in California* Who studied in California?	L1 Spa-L2 Eng (immersed living in US) L1 Eng-L2 Spa (late L2ers)	Advanced L2 **proficiency** **Dominance** (self-reports): L2 Eng: almost equally prof in Spa and Eng L2 Spa: proficient but less than Eng L2ers **Immersion** L1 Spa-L2 Eng: 7.5 years in US L1 Eng – L2 Spa: 2 years in Spa-speaking country (back US)	**L1 Spanish-L2 English:** LA, LA → attrition due to immersion **L1 English-L2 Spanish:** LA, mid-to-HA → slight attrition
Jegerski, VanPatten, et al. (2016)	L1 questionnaire Items + Q	*El ratón mordió a la hermana de mi amiga* ***que*** *ganó la lotería grande* The hamster bit the sister of my friend **who** won the big lottery *¿Quién ganó la lotería?* Who won the lottery? a. *La hermana* / The sister b. *La amiga* / The friend	L1 Spa-L2 Eng (late L2ers)	**Proficient** (self-rated) **Dominance**. Based on self-rated Spa and Eng proficiency Late L2ers: Spa dominant **Naturalistic immersion**: living in US for 4.8 years	**L1 Spanish-L2 English:** neutral attach preferences when tested in Spanish (57.1% for HA) and Eng (50.5% for HA) → L1 attrition

3.4.2.2. Online preferences in bilinguals

Bilingual RCA preferences have not only been examined in offline interpretation, but also in online processing (Dussias, 2003; Dussias & Sagarra, 2007). For instance, Dussias (2003) tested Spanish-English bilinguals, together with a group of Spanish natives. While natives' results were discussed in Section 3.4.1.2, this section will bilinguals' findings. Two bilingual groups were recruited: L1 Spanish-L2 English (N = 28) and L1 English-L2 Spanish (N = 28). All participants were tested in Spanish, meaning that the L1 Spanish-L2 English group was tested in their L1, while the L1 English-L2 Spanish group was tested in their L2. These participants had already participated in the offline study reported in Section 3.4.2.1 and consequently, their language profiles are the same. Bilinguals in both groups were proficient in their L2. However, L1 Spanish-L2 English bilinguals reported almost equal proficiency in their two languages, whereas L1 English-L2 Spanish bilinguals reported being proficient in their L2 but to a lower extent that the other group. In terms of language dominance, all bilinguals identified as English dominant based on exposure, based L1 dominant based on proficiency.

Additionally, participants lived in an L2 environment, but length of immersion across groups was not balanced. As mentioned earlier, the online study included a subset of bilinguals in the offline study and therefore, their language profile remains the same. However, the author does not provide updated data regarding mean length of L2 naturalistic immersion. Thus, relying on data from the broader offline study, L1 Spanish-L2 English bilinguals lived in the US for an average of 7.5 years, while L1 English-L2 Spanish bilinguals lived in a Spanish-speaking country for an average of 2 years before returning to the US, where they were tested. This is crucial because not only did the two groups differ in length of residency by approximately 5 years, but also the L1 English-L2 Spanish group was re-exposed to their L1, which has been reported to attenuate attrition effects (Chamorro et al., 2016).

Target items (N = 32) in the SPRT, exemplified in (37) below, were designed for four conditions manipulating the attachment of the RC. The example has been introduced earlier but is reintroduced for the reader's convenience.

(37) TARGET ITEMS

(37a) **LA-bias**

El perro mordió al cuñado$_i$ de la maestra$_j$ / que$_{i/j}$ vivió en Chile / con su esposo

The dog bit the brother-in-law$_i$ of the teacher$_{j[fem]}$ who$_{i/j}$ lived in Chile with her husband

(37b) **HA-bias**

El perro mordió a la cuñada$_i$ del maestro$_j$ / que$_{i/j}$ vivió en Chile / con su esposo

The dog bit the sister-in-law$_i$ of the teacher$_{j[masc]}$ who$_{i/j}$ lived in Chile with her husband

(37c) **Control 1**

El perro mordió a la cuñada$_i$ de la maestra$_j$ / que$_{i/j}$ vivió en Chile / con su esposo

The dog bit the sister-in-law$_i$ of the teacher$_{j[fem]}$ who$_{i/j}$ lived in Chile with her husband

(37d) **Control 2**

El perro mordió a la maestra$_i$ / que$_i$ vivió en Chile / con su esposo

The dog bit the teacher$_{i[fem]}$ who$_i$ lived in Chile with her husband

Recall that bilinguals were tested in Spanish. Thus, L1 Spanish-L2 English participants were expected to show a native-like HA preference. In contrast, if L1 English-L2 Spanish transfer their L1-English preferred strategy (LA) to L2 Spanish, the forcing-HA condition should take longer to read. Results for mean RTs in the final display are unexpected for L1 Spanish-L2 English, as bilinguals took significantly more time to read forcing-HA sentences (mean RTs = 1660 ms) than forcing-LA sentences (mean RTs = 1534 ms). This indicates that bilinguals have lost the strong HA preference observed for Spanish natives in online data, suggesting evidence of L1 attrition. In contrast, L1 English-L2 Spanish bilinguals display similar RTs when forcing either HA or LA (HA mean RTs = 1592 ms, LA mean RTs = 1538 ms). There is a numerical advantage for the forcing-LA condition, typical of their L1 English, but is non-significant. In line with results from the offline study, significant differences were only observed in L1 Spanish-L2 English bilinguals, which is the group who have been immersed for longer period, remains in the L2 environment at the time of testing and reported higher L2 proficiency. However, it is also worth noting these bilinguals identified as Spanish dominant based on proficiency, which suggests that L2 dominance may not be a requirement to experience attrition effects.

To further explore the role of L2 naturalistic immersion in L1 RCA preferences, Dussias (2004) conducted a follow-up study to examine whether bilinguals with fewer years of L2 immersion than those in Dussias (2003) may also undergo changes in their

L1. Eye-movement data were collected from proficient L1 Spanish-L2 English bilinguals (N = 20) while they read ambiguous sentences in their L1. Participants lived in an L2 environment at the time of testing. They reported using Spanish and English in their daily lives, but specified that English was the language most frequently read. Additionally, all bilinguals felt integrated and acculturated in the L2 environment. However, a crucial difference with the L1 Spanish-L2 English group in Dussias (2003) was the length of L2 naturalistic immersion. Participants in Dussias (2004) had been immersed in the L2 context for a considerably shorter period (mean residency = 3.7 years), contrasting with the average of 7.5 years in Dussias (2003). Target items (N = 16), exemplified in (38) below, contain a temporarily ambiguous relative clause resolved via gender morphology. The Spanish adjective *enferma* / *ill* must refer to a female entity, which appears in NP1 in (38a) forcing HA, but in NP2 in sentence (38b), forcing LA.

(38) TARGET ITEMS

(38a) **Forcing HA**

El policía arrestó a la hermana$_i$ del criado$_j$ que$_{i/j}$ estaba enferma desde hacía tiempo

The police arrested the sister$_i$ of the servant$_{j[masc]}$ who$_{i/j}$ had been ill$_{[fem]}$ for a while

(38b) **Forcing LA**

El policía arrestó al hermano$_i$ de la niñera$_j$ que$_{i/j}$ estaba enferma desde hacía tiempo

The police arrested the brother$_i$ of the babysitter$_{j[fem]}$ who$_{i/j}$ had been ill$_{[fem]}$ for a while

Analyses revealed significant differences for both first-pass and total RTs at the critical region, i.e., the disambiguating adjective. L1 Spanish-L2 English bilinguals exhibited longer RTs in the forcing-HA condition across both measures. Regarding first-pass RTs, participants fixated their eyes in the critical adjective for longer time when forcing HA (mean RTs = 334 ms) than when forcing LA (mean RTs = 268 ms). Similarly, the total RTs, mean RTs were higher in the forcing-HA condition (mean RTs = 548 ms) than in the forcing-LA condition (mean RTs = 404 ms). The LA reading advantage was significant in both measures, indicating that LA, typical of L2 English, seems to be the preferred attachment strategy in the L1 Spanish of L1 Spanish-L2 English bilinguals. The preference of LA over HA when reading in their L1 aligns with the results obtained by Dussias (2003) for the same group. The key difference is that bilinguals in Dussias (2004) have been naturalistically immersed for considerable shorter time, meaning that L1 changes are susceptible to occur even after short periods of immersion.

Similarly, Dussias and Sagarra (2007) explored a similar bilingual population to the one in this investigation, the only difference being the type of L2 exposure received (naturalistic vs. instructed). The authors conducted a reading eye-tracking experiment to address the effect of length of L2 exposure on L1 RCA attachment strategies. Two groups were recruited: Spanish monolinguals (N = 44) and late L1 Spanish-L2 English bilinguals, further divided into an *extensive exposure* group (N = 20) and a *limited exposure* group (N = 28). All bilinguals lived in the US: the extensive exposure group had an average of 7.1 years of L2 immersion, while the limited exposure group had an average of 8.5 months. Importantly, the latter not only had shorter immersion, but had also returned to an L1 environment at the time of testing, which may influence results (Chamorro et al., 2016). Participants were tested in Spanish, and target items contained RCA ambiguities resolved using morphological gender, creating two conditions illustrated in (39) below. (39a) forced HA to NP1 (*hermana* / *sister*) since the adjective *enferma* / *ill* can only refer to a female antecedent in Spanish. Conversely, in (39b), the female character appears in NP2 (*niñera* / *babysitter*), forcing the RC to be attached low.

(39) TARGET ITEMS

(39a) **High attachment**

El policía arrestó a la hermana$_i$ del criado$_j$ que$_{i/j}$ estaba enferma$_j$ desde hacía tiempo

The police arrested the sister$_i$ of the servant$_{j[masc]}$ who$_{i/j}$ had been ill$_{[fem]}$ for a while

(39b) **Low attachment**

El policía arrestó al hermano$_i$ de la niñera$_j$ que$_{i/j}$ estaba enferma desde hacía tiempo

The police arrested the brother$_i$ of the babysitter$_{j[fem]}$ who$_{i/j}$ had been ill$_{[fem]}$ for a while

The critical disambiguating region was defined as the adjective within the RC (*enferma* / *ill*). Findings revealed an effect of length of immersion on RCA processing. For bilinguals with limited exposure, total RTs at the critical region were shorter in sentences forcing HA (mean RTs = 406 ms) than LA (mean RTs = 660 ms), which indicates Spanish native-like processing with a HA preference. Conversely, bilinguals with extensive exposure exhibited shorter RTs when LA is forced (mean RTs = 454 ms), compared to forcing-HA (mean RTs = 537 ms). The processing cost in the L1-preferred forcing-HA condition is considered evidence of attrition, concluding that length of L2 exposure influences bilinguals' L1 parsing strategies.

This aligns with Dussias (2003), who observed attrition in bilinguals naturalistically immersed for an average of 7 years, but not in those immersed for around 2 years. Similarly, Jegerski et al. (2016) demonstrated that even short immersion may lead to attrition effects, which may contrast with the lack of attrition effects in the *limited exposure* group in Dussias and Sagarra (2007). The difference is due to how short immersion has been defined: it is operationalised as a mean of 8.5 months in Dussias and Sagarra (2007), compared to 4.8 years in Jegerski et al. (2016). The important aspect is that long naturalistic immersion does not seem to be a necessary condition to experience attrition. Attrition may emerge after relatively short periods of immersion, although an L2 residency of less than 2 years (approximately) may be insufficient to trigger noticeable L1 changes, particularly if followed by a L1 re-exposure period, as in Dussias (2003) and Dussias and Sagarra (2007).

In addition, Valenzuela et al. (2020) examined online attachment preferences in three groups of bilingual speakers: simultaneous bilinguals of L1 Spanish-L2 English (N = 22) and two late sequential bilingual groups, L1 Spanish-L2 English (N = 18) and L1 English-L2 Spanish (N = 15). Findings will be reported only for the two late bilingual groups. Importantly, all participants lived in an English-speaking environment, which involves an L2 context for L1 Spanish-L2 English bilinguals and an L1 context for L1 English-L2 Spanish bilinguals. The mean length of residency in the L2 environment for the former group was 5.4 years. The latter group a mean length of residency in an L2 environment of 0.9 years, which is assumed to correspond to trips or short stays abroad. Additionally, language dominance was assessed via proficiency tests in Spanish and English, together with a language background questionnaire. All bilinguals tested were L1 dominant: L1 Spanish-L2 English bilinguals identified as Spanish dominant, whereas L1 English-L2 Spanish bilinguals were English dominant.

Online RCA preferences were accounted for using a reading eye-tracking task. A difference of this study with those previously reported is the fact that it examines attachment preferences in code-switched RCs. Target items (N = 20) were divided into code-switched sentences and single-language sentences written in one language only, either Spanish or English. Only findings for single-language sentences will be reported, as code-switching patterns are beyond the scope of this PhD thesis. Target items (N = 20) are exemplified in (40). They forced either a HA or a LA reading via pragmatics or grammatical gender. All participants read 10 sentences in Spanish and 10 in English.

(40) ENGLISH TARGET ITEMS

(40a) **HA + pragmatics**

Lynn talked to the granddaughter$_i$ *of the old man*$_j$ *that*$_{i/j}$ *has Alzheimer's disease*

(40b) **HA + grammatical gender**

Robert saw the sister$_i$ *of the fireman*$_j$ *that*$_{i/j}$ *was the first female engineer in the city*

(40c) **LA + pragmatics**

Scott dined with the son$_i$ *of the ballerina*$_j$ *that*$_{i/j}$ *has danced in many shows*

(40d) **LA + grammatical gender**

Doug cheated with the wife$_i$ *of the man*$_j$ *that*$_{i/j}$ *was chairman of a large foundation*

(41) SPANISH TARGET ITEMS

(41a) **HA + pragmatics**

Manuel se casó con la hermana$_i$ *del compañero*$_j$ *que*$_{i/j}$ *siempre lleva vestidos caros*

Manuel married the sister$_i$ of his male classmate$_j$ that$_{i/j}$ always wears expensive dresses

(41b) **HA + grammatical gender**

Alicia vio a la amiga$_i$ *del ciudadano*$_j$ *que*$_{i/j}$ *es conocida por sus obras de caridad*

Alicia saw the girlfriend$_i$ of the male citizen$_j$ that$_{i/j}$ is known$_{[fem]}$ for her charity work

(41c) **LA + pragmatics**

Esteban busca a la mujer$_i$ *del viejito*$_j$ *que*$_{i/j}$ *vive en una casa de ancianos ahora*

Esteban is looking for the wife$_i$ of the old man$_j$ that$_{i/j}$ now lives in a senior's residence

(41d) **LA + grammatical gender**

Beatriz entrevistó a la hija$_i$ *del actor*$_j$ *que*$_{i/j}$ *fue muy famoso en los años 80*

Beatriz interviewed the daughter$_i$ of the actor$_j$ that$_{i/j}$ had been famous$_{[mas]}$ in the 80s

The region of interest was defined as the word containing the disambiguating information within the RC (underlined in examples above). The analysis focused on three measures: total duration, first-pass duration and right bounded reading time[17]. Among L1 Spanish-

[17] Defined as: "Total duration of all fixations and refixations in a target region until the eyes fixate a region of text that is progressive to the target region" (Valenzuela et al., 2020, p. 149).

L2 English bilinguals tested in their L1 Spanish, no differences were observed between forcing-HA and forcing-LA sentences, with both conditions read at a similar speed. The same pattern was observed in their L2: when reading English sentences, RTs for forcing-HA and forcing-LA were similar. In contrast, turning to L1 English-L2 Spanish speakers, RTs in their L1 English were longer when forcing HA than LA, indicating an LA online preference. However, when reading in Spanish, no differences were observed between forcing-HA and forcing-LA conditions.

Taking these findings together, while L1 English-L2 Spanish bilinguals seem to retain their L1 preferred strategy (LA), L1 Spanish-L2 English bilinguals do not exhibit the typical HA preference of their native Spanish. Interestingly, it is this latter group the one with higher L2 proficiency, longer naturalistic immersion (5.3 years vs. 0.9), and L2 residency at the time of testing, although dominant in Spanish. This pattern suggests that increased language experience in the L2 plays a determining role in potential L1 changes. The absence of attachment biases among L1-dominant Spanish-English bilinguals aligns with findings in this PhD thesis. However, Valenzuela et al. (2020) measured dominance categorically, so they did not examine potential variability in attachment preferences at the group level. This will be addressed in this PhD thesis by measuring dominance in a continuum.

Table 7:

Summary of online RCA preferences in Spanish-English bilinguals

STUDY	TASK	ITEMS	PARTICIPANTS	PROFILE	RESULTS
Dussias (2003)	SPRT	**Forcing-HA:** *El perro mordió a la cuñada del maestro / que vivió en Chile / con su esposo* **Forcing-LA:** *El perro mordió al cuñado de la maestra / que vivió en Chile / con su esposo*	L1 Spa-L2 Eng (immersed living in US) L1 Eng-L2 Spa (late L2ers)	Advanced L2 **proficiency** **Dominance** (self-reports): L2 Eng: almost equally prof in Spa and Eng L2 Spa: proficient but less than Eng L2ers **Immersion** L1 Spa-L2 Eng: 7.5 years in US L1 Eng – L2 Spa: 2 years in Spa-speaking country (back US)	Mean RTs. **L1 Eng-L2 Spa:** forcing HA (1592 ms) ≈ forcing LA (1538 ms) No sig differences between HA and LA **L1 Spa-L2 Eng:** forcing HA (1660 ms) > forcing LA (1534 ms) L1 attrition
Dussias (2004)	SPRT	**Forcing-HA:** *El policía arrestó a la hermana del criado que estaba enferma desde hacía tiempo* The police arrested the sister of the servant[masc] who had been ill[fem] for a while **Forcing-LA:** *El policía arrestó al hermano de la niñera que estaba enferma desde hacía tiempo* The police arrested the brother of the babysitter[fem] who had been ill[fem] for a while	L1 Spa-L2 Eng	Living in L2 environment (US, mean = 3.7 years) Use of Spa and Eng in daily lives, but English most frequently read Integrated in L2 environment	First-pass RTs: RTs forcing HA (334 ms) > forcing LA (268 ms). Total RTs: RTs forcing HA (548 ms) > forcing LA (404 ms) LA reading advantage significant in both measures → Preference for LA

STUDY	TASK	ITEMS	PARTICIPANTS	PROFILE	RESULTS
Dussias & Sagarra (2007)	Reading ET	**Forcing-HA:** *El policía arrestó a la hermana del criado que estaba enferma desde hacía tiempo* The police arrested the sister of the servant[masc] who had been ill[fem] for a while **Forcing-LA:** *El policía arrestó al hermano de la niñera que estaba enferma desde hacía tiempo* The police arrested the brother of the babysitter[fem] who had been ill[fem] for a while	L1 Spa-L2 Eng (late L2ers) Extensive exposure: living in US Limited exposure: US and back Spain	L2 **proficiency**: low **Dominance**. Based on prof, Spanish dominant **Naturalistic exposure** (living in US) Extensive (7.1 years) vs. limited exposure (8.5 months)	**Limited exposure:** forcing HA (406 ms) < forcing LA (660 ms) → Spa native-like processing (HA preference) **Extensive exposure:** forcing HA (537 ms) > forcing LA (454 ms) → attrition due to extensive L2 naturalistic exposure
Valenzuela et al. (2020)	Reading ET	**HA + pragmatics:** *Lynn talked to the granddaughter of the old man that has Alzheimer's disease* **HA + grammatical gender:** *Robert saw the sister of the fireman that was the first female engineer in the city* **LA + pragmatics:** *Scott dined with the son of the ballerina that has danced in many shows* **LA + grammatical gender:** *Doug cheated with the wife of the man that was chairman of a large foundation*	L1 Spa-L2 Eng L1 Eng-L2 Spa	All bilinguals in Eng-speaking environment L1 Spa-L2 Eng in L2 context (mean = 5.4 years) L1 Eng-L2 Spa L1 context	**L1 Spanish-L2 English**: Reading in either Spanish or English, no differences between HA and LA **L1 English-L2 Spanish:** Reading in L1 English, RTs in HA > LA → LA online preference Reading in Spanish, no diff between HA and LA

3.5. Chapter summary

This chapter has introduced the linguistic construction under study, i.e., relative clause attachment ambiguities, and its cross-linguistic variation. The structure contains a complex noun phrase *NP1 of NP2* followed by an ambiguous RC. For the purposes of this thesis, i.e., to investigate potential attrition effects on bilinguals' L1 processing and comprehension, the interest on this syntactic ambiguity is justified due to the cross-linguistic variation observed regarding attachment preferences among native speakers of different languages (Y. Cheng et al., 2021; Cuetos & Mitchell, 1988; Dussias, 2003; Hemforth et al., 2015; Papadopoulou & Clahsen, 2003; Shen, 2006; Zagar et al., 1997).

Firstly, Section 3.1 briefly reviewed the variety of RC types to contextualise the specific structure under study, i.e., object-modifying RCs in subject position. Then, Section 3.2 provided an overview of theoretical frameworks that attempt to account for the cross-linguistic variation in RCA strategies. This section particularly focused on the Garden-Path model, Construal Hypothesis, Predicate Proximity and Linguistic Tuning hypothesis. The Garden-Path model (Frazier, 1978, 1987) is a syntax-first account that which claims that the human parser structures incoming linguistic input based on universal syntactic principles such as Late Closure and Minimal Attachment. Regarding RCA ambiguities, Garden-Path theory predicts attachment to NP2 (LA), as this is the closest referent and the one currently active when the relative pronoun is received. However, evidence of cross-linguistic variation in RCA preferences challenged the universality of these principles. To account for such variability, Construal hypothesis (Frazier & Clifton, 1996, 1997) distinguished between primary and secondary syntactic relations. In this view, universal principles only govern primary relations, whereas non-primary relations such as RCs are also analysed using non-structural information (e.g., prosody, semantic or pragmatic information). This would explain the variability observed in RCA, as it depends on additional, non-syntax-only principles. Another explanation is offered by the principle of Predicate Proximity (Gibson et al., 1996), which claims that new linguistic material will be attached as close as possible to the head of a predicate phrase. Thus, considering RCA ambiguities, there is a preference for attachments to structurally occur as close as possible to the head of the preceding complex NP, consequently favouring HA. The strength of Predicate Proximity principle and other recency ones such as Late Closure will determine the parsing strategy of each language. Finally, the Linguistic Tuning hypothesis (Cuetos et al., 1996; Mitchell et al., 1995) highlights the role of prior language contact. Structural preferences are determined by the individual's experience with a given construction, resulting in a preference for the analysis that occurs most frequently in a language. Regarding RCA preferences, the parser is predicted to select the ambiguity resolution most typically exposed to in previous encounters, being it either HA or LA.

Crucially for this PhD thesis, parsing strategies are language-specific, with native speakers of different languages differing in their preferences to attach ambiguous RCs. Such variation was illustrated in more detail in Section 3.3, which presented a broad classification of languages that favour HA and those favouring LA. The former group includes languages like Spanish, French, German, Dutch and Arabic, whereas the second involves English, Chines, Basque and Brazilian Portuguese, among others (Bidaoui et al., 2016; Cuetos & Mitchell, 1988; Dussias, 2003; Hemforth et al., 2015; Leeser & Prieta, 2018; Shen, 2006; Zagar et al., 1997). Section 3.4 focused on Spanish and English, offering an overview of previous online and offline research in native and bilingual speakers. Research on native Spanish has evidenced a strong bias for HA using both offline measures such as questionnaires (Cuetos & Mitchell, 1988; Dussias, 2003), and online tasks addressing early stages of processing (Carreiras & Clifton, 1993; Dussias, 2003; Dussias & Sagarra, 2007; Jegerski, Keating, et al., 2016). In contrast, native English seems to attach the RC to NP2, exhibiting a tendency towards LA in offline and online studies (Y. Cheng et al., 2021; Dussias, 2003; Solaimani & Marefat, 2024).

Regarding Spanish-English bilinguals, the language combination of interest for this PhD thesis, findings from both offline and online measures point in a similar direction: bilinguals exhibit an attenuated tendency to their L1-preferred strategy when tested in their L1. This is more pronounced when bilinguals have considerable L2 experience. Studies have reported changes in the L1 processing and interpretation of ambiguous RCs among bilinguals with high L2 proficiency and L2 naturalistic immersion (at least 2 years approximately), although not necessarily dominance in the L2. Language dominance needs to be further explored since it has been typically examined based on self-reports and in a categorical dichotomous way, with bilinguals been classified as either L1 or L2 dominant. This PhD thesis will address this by assessing dominance with an objective measure, the *Bilingual Language Profile* questionnaire, and accounting for individual variability as participants will be placed in a continuum from higher L2 dominance to higher L1 dominance. Additionally, while the modulating effect of length of naturalistic immersion has been discussed in prior literature, other L2 exposure contexts like university instructed settings and the length of such exposure has been underexplored. This thesis will tackle this issue by examining the potential modulating effect of L2 immersed instruction on L1 attrition. It is expected that longer exposure in a formal, instructed setting will be associated with stronger attrition effects.

To sum up, this chapter has introduced the syntactic construction under study, RCA ambiguities, and outlined some theories relevant in sentence parsing. It has also addressed the cross-linguistic variation observed for this structure and reviewed findings for Spanish and English natives as well as Spanish-English bilinguals. The following chapter will present the main research questions that motivate this investigation, along with their corresponding hypotheses.

Chapter 4: Research questions

This chapter aims to present the research questions (RQs) and hypotheses (Hs) that guide the present PhD thesis. These have been motivated by literature on both L1 attrition and relative clause attachment preferences, together with theoretical accounts discussed in previous sections. Given that the present study encompasses data from three main tasks to address both offline and online attachment preferences, this chapter is structured into three sections, each presenting the specific research questions and hypotheses formulated for each task. Section 4.1 will introduce the RQs and Hs for the picture selection task, while those for the picture verification and eye-tracking tasks will be introduced in Section 4.2 and Section 4.3, respectively. A general overview of the RQs addressed in each task is presented in Table 8, although they will be discussed in detail in their corresponding section.

In addition, the present PhD thesis will attempt to combine the findings of all the tasks, including offline and online data, and discuss them together rather than just individually. This will allow us to get a more complete understanding of the phenomenon explored, i.e., L1 attrition in instructed settings, and the factors that may modulate it. Findings from this PhD thesis will offer relevant insights into the actual scope of L1 attrition, helping to determine whether L1 attrition effects are limited to bilinguals who meet specific requirements regarding L1 disuse, extensive L2 naturalistic immersion and L2 dominance. Thus, the general and starting question is the following:

RQ_0 Does immersed instructed exposure to a second language influence L1 Spanish-L2 English bilinguals' interpretation and/or processing of RCA ambiguities in their L1 Spanish?

Table 8:

Summary of task-specific research questions addressed in this PhD thesis

Picture selection task	
RQ_1	Offline attachment strategies across groups in ambiguous RCs
RQ_2	Effect of language dominance on attachment strategies
RQ_3	Effect of length of L2 immersed instruction on bilinguals' strategies
RQ_4	L1 attrition effects in the RTs of instructed bilinguals
Picture verification task	
RQ_{5a}	Attachment strategies across groups in ambiguous RCs
RQ_{5b}	Relation between PVT and PST results from attachment preferences
RQ_6	Garden-path effects in RTs across groups
RQ_7	Effect of language dominance on bilinguals' RTs
RQ_8	Effect of length of L2 immersed instruction on bilinguals' RTs
Eye-tracking experiment	
RQ_9	Time course of processing ambiguous RCs
RQ_{10}	Proportion of fixations across groups in ambiguous RCs
RQ_{11}	Effect of language dominance on fixation patterns in bilinguals
RQ_{12}	Effect of length of L2 instructed exposure on fixation patterns in bilinguals

If extensive L2 exposure in a classroom setting has an influence in the interpretation and/or processing preferences in bilinguals' L1 Spanish, it is predicted that instructed bilinguals show a departure from the L1-preferred disambiguation strategy, i.e., high attachment, in favour of an increased tendency to the L2-preferred mechanism, i.e., low attachment. The fact that bilinguals demonstrate interpretative biases or parsing preferences associated to their L2 when resolving ambiguous relative clauses in their first language will be considered evidence of L1 attrition. This will be manifested differently in each task and therefore, the general hypotheses for each separate task are as follows:

H_{0a} For the **picture selection task**, this tendency will emerge as higher selection rates of the image that represents a low-attachment interpretation as this is the L1-dispreferred attachment strategy.

H_{0b} Regarding the **picture verification task**, an advantage in response times is expected for the low-attachment condition, while increased processing cost will be associated with the high-attachment condition.

H_{0c} Finally, in the **eye-tracking task**, it is expected (1) that in the time course of ambiguous sentences, bilinguals will look more quickly at the image representing a low-attachment interpretation and consequently, (2) that there will be a higher proportion of fixations on this image compared to that representing high attachment.

It is worth emphasising that bilinguals tested in the present PhD thesis have never lived in an environment where their L2 English is the dominant language. Instead, they have been born and raised in an L1 environment where their L1 Spanish is the functional language. Their contact with L2 English, although extensive and daily, is restricted to an instructed classroom setting since they are enrolled in a degree on English Studies, which is taught in English. Such intense instructed exposure to the L1 is expected to result in a tendency to favour interpretative and parsing strategies associated with the L2 when resolving ambiguous relative clauses in their L1. Recall that previous literature on L1 attrition has extensively focused on bilinguals immersed in an L2-speaking country, i.e., naturalistic immersion, for a prolonged time. Consequently, most data available evidencing attrition effects come from this specific population, confirming the existence of readjustments in the first language of these bilinguals. However, this does not exclude the possibility of L1 attrition effects being found in other under-researched bilingual populations. The lack of data from other types of bilinguals is the result of the definition and scope traditionally associated with the notion of L1 attrition (see Section 2.2).

The main novelty of this PhD thesis lies in investigating potential L1 attrition effects in a bilingual population that does not meet traditionally assumed criteria to be considered potential attriters. By exploring L1 attrition beyond the typical bilingual profiles studied in previous research, this PhD thesis aims to address a gap in the current literature. Bilinguals tested in this thesis live in an L1 environment where their first language, Spanish, is the functional language and therefore, do not experience significant L1 disuse and lack of exposure. As will be shown in later sections, these bilinguals remain L1-dominant speakers, although to a lesser extent than native Spanish speakers with low L2 proficiency and use, and have never been naturalistically immersed in an L2-speaking country. Instead, they have been extensively exposed to their second language, English, in an instructed, university classroom context.

4.1. RQs: offline picture selection task

Offline RCA preferences have been widely investigated in previous literature (Bergmann et al., 2008; Cuetos & Mitchell, 1988; Dussias & Sagarra, 2007; Hemforth et al., 2015), typically using questionnaires that directly address the preferred final interpretation of ambiguous sentences (see Section 3.4.1.1 for native Spanish and English, and Section 3.4.2.1 for bilinguals). Findings evidence cross-linguistic variation in offline attachment preferences, with native Spanish showing a straightforward HA preference and native English favouring LA (Bergmann et al., 2008; Cuetos & Mitchell, 1988; Dussias, 2003; Hemforth et al., 2015). Such opposite preferences provide an ideal ground to test potential L1 attrition effects, which will be observed if L1 Spanish-L2 English bilinguals' depart from their L1-preferred strategy (HA) in favour of increased LA bias, typical of their L2 English. Based on this, the following research questions and hypotheses were formulated.

RQ$_1$ What **attachment strategies** (HA vs. LA) do Spanish monolinguals, instructed bilinguals, and English monolinguals employ in their L1 offline interpretation of ambiguous relative clauses?

H$_1$. It is predicted that the two control monolingual groups show clear preferences in their L1 offline interpretation of ambiguous relative clauses. Spanish monolinguals are expected to display a straightforward tendency towards HA in their L1 Spanish. On the other hand, the English monolingual group is predicted to favour a LA interpretation of ambiguous RCs in their L1 English. This will be manifested by higher selection of the image that represents the L1-preferred interpretation for each group, i.e., increased HA responses for the Spanish group, while higher LA responses will be found in the English group. Regarding the experimental group of L1 Spanish-L2 English instructed bilinguals, it is predicted that their L1 preferred strategy will be mitigated, showing higher tendency toward the L2 preferred disambiguation mechanism, i.e., low attachment.

The present PhD thesis also attempts to investigate the role of individual differences to account for potential variation within attachment preferences.

RQ$_2$ Does **language dominance** modulate the L1 offline interpretation of ambiguous relative clauses across the three groups investigated?

H$_2$. Language dominance is explored in the present PhD thesis as a multi-faceted and gradient factor. This means that language dominance is understood as a construct composed of several variables such as proficiency, language use and attitudes, which is not stable and common to all bilinguals. Dominance is a continuum where bilinguals may differ in terms of degrees depending on their language background. Studies exploring the role of dominance as a gradient, multi-faceted construct have evidenced it can modulate linguistic outcomes (Amengual, 2016; Garraffa et al., 2017; Martín-Villena, 2023; Onnis et al., 2018). Thus, language dominance may also account for variability regarding offline attachment preferences. If language dominance is to exert an effect, this effect is expected to be significant for the bilingual group only.

Given that participants in the monolingual groups also have knowledge of an L2. It may be the case that Spanish monolinguals with higher English dominance, are more likely to show attachment patterns that are not L1 preferred. The same hold for participants in the English group. However, given the low dominance in the L2 of these participants, no significant effect of language dominance is expected in these groups. Conversely, significant effects may be found for bilinguals, compared to the other groups. Higher dominance in Spanish is predicted to correlate with increased HA-responses, while bilinguals who are more English-dominant are expected to favour LA-responses.

RQ$_3$ Does **length of L2 immersed instruction** modulate the L1 offline interpretation of ambiguous relative clauses in L1 Spanish-L2 English bilinguals, leading to L1 attrition effects?

H$_3$. It is predicted that, if L1 attrition effects are evidenced in the offline interpretation of ambiguous relative clauses, these effects will be further modulated by cumulative exposure to the second language in an instructed, classroom setting. Focusing on the bilingual group, more evident L1 attrition effects, i.e., higher selection of the image depicting an LA interpretation, will be found in bilinguals with longer immersed instructed exposure to their L2 English. In other words, longer exposure to the L2 in an instructed setting is expected to correlate with increased preference for low attachment among bilinguals.

RQ$_4$ Are L1 attrition effects observed in the **response times** of instructed L1 Spanish-L2 English bilinguals compared to Spanish and English monolinguals?

H$_4$. If L1 attrition effects are found in bilinguals, these will be observed in ambiguous sentences, manifested as higher RTs. Based on the offline PST data, monolinguals show clear interpretative biases (HA preference in Spanish natives and LA preference in

English natives) and therefore, lower RTs (i.e., faster responses) are predicted for the two monolingual groups, who will need less time to provide a final interpretation of the sentence. In contrast, bilinguals are expected to exhibit higher RTs (i.e., slower responses) in ambiguous sentences compared to Spanish and English monolinguals due to the greater optionality observed in the offline data.

Regarding the two control conditions (i.e., forcing-HA and forcing-LA), no differences are expected. Spanish monolinguals and bilinguals will exhibit similar RTs when they encounter non-ambiguous sentences in their L1.

4.2. RQs: sentence-picture verification task

While the PST mostly assessed offline attachment preferences, this task was designed to explore attachment strategies measuring processing cost. It has been observed that in online processing, the initial choice of Spanish parser is to attach ambiguous relative clauses to NP1 (Dussias, 2003; Dussias & Sagarra, 2007). On the contrary, the initial preference of the English parser is to attach the RC to NP2, favouring LA (Y. Cheng et al., 2021; Solaimani & Marefat, 2024). However, most data on these initial online preferences have been gathered from self-paced reading tasks (Carreiras & Clifton, 1993; Cuetos & Mitchell, 1988; Dussias, 2003; Fernández, 2002; Jegerski, Keating, et al., 2016; Rodríguez, 2004). These studies measure potential difficulty when speakers process temporary ambiguous RCs that are eventually resolved in favour of the presumably dispreferred attachment strategy, i.e. HA for English natives and LA for Spanish natives.

The present PhD thesis aims to investigate L1 attrition in attachment preferences gathering data from the same participants in different tasks. This triangulation will allow to compare their behaviour from different angles and obtain comparable results. Given that SPRTs do not involve a visual component, it could not be used to address processing cost. An alternative was an auditory sentence-picture verification task, since it includes visual and auditory stimuli, ensuring the nature of the data would be similar to the PST and eye-tracking data. To contextualise the following RQs, in the PVT participants first listened to a sentence containing a globally ambiguous RC with no visual stimuli on the screen, allowing them to create a mental representation based on a specific attachment strategy (HA or LA). Once the sentence ended, either a HA-biased or a LA-biased image was displayed. A parser that initially attaches high will be forced to reanalyse if a LA-biased image is presented, resulting in increased processing cost, whereas no disruption is expected if a HA-biased picture is presented. The opposite scenario is expected if the parser initially attaches low. Based on this, the following research questions and hypotheses were formulated.

RQ_{5a} What **attachment strategies** (HA vs. LA) do Spanish monolinguals, instructed bilinguals, and English monolinguals employ to resolve ambiguous RCs?

RQ_{5b} Are the offline results of the PVT in line with those of the PST regarding relative clause attachment preferences for each group?

H_{5a}. This research question will be explored based on the acceptance rates for each experimental condition (HA vs. LA). When a HA-biased image is displayed following an ambiguous sentence, the acceptance rates will be highest for Spanish monolinguals because it depicts the preferred strategy in their L1 Spanish, followed by instructed bilinguals, and then, English monolinguals. Conversely, in the LA condition, the highest percentage of *accept* responses is hypothesised for English monolinguals, reflecting their L1 preference to attach low, followed by bilinguals and finally, Spanish monolinguals.

H_{5b}. It is expected that the offline responses in the picture verification trials will be in line with those in the PST data. Spanish monolinguals will more frequently accept the HA than the LA condition, while the opposite holds for English monolinguals. Bilinguals are expected to show similar acceptance rates across conditions.

RQ_6 Are **garden-path effects** observed in the response times of L1 Spanish-L2 English instructed bilinguals compared to Spanish and English monolinguals?

H_6. If garden-path effects are observed in instructed L1 Spanish-L2 English bilinguals, these will be reflected as higher response times in the HA condition compared to those of Spanish monolinguals. In addition, in the LA condition, bilinguals' RTs are predicted to be longer than in the HA condition, and most importantly, considerable shorter than those of Spanish monolinguals in the same condition.

This RQ will allow to explore whether bilinguals initially use a LA parsing strategy, typical of their L2 English, instead of the HA strategy associated with their L1 Spanish. The HA condition depicts bilinguals' L1 preferred disambiguation strategy and therefore, additional time to provide a response will indicate reanalysis of the sentence, suggesting that HA was not implemented in the initial analysis. The fact that longer RTs are observed in the HA condition of bilinguals compared to Spanish monolinguals indicate that instructed bilinguals may have experienced a disruption between their initial representation created as the sentence unfolded and the HA representation depicted in the image. This would be evidence of L1 attrition. On the other hand, regarding the LA condition, shorter RTs in bilinguals compared to Spanish monolinguals will reflect bilinguals' increased tolerance of the L1-dispreferred mechanism, low attachment.

Garden-path effects are not predicted for Spanish or English monolinguals in their corresponding preferred strategy since previous literature, together with the data from the picture selection task, has evidenced clear attachment preferences for L1 Spanish and L1 English. Additional processing cost may surface when the image biases the ambiguous sentence towards the L1 dispreferred attachment mechanism, i.e., the low-attachment condition for Spanish monolinguals and bilinguals, and the high-attachment condition for English monolinguals.

Similarly to the RQs for the picture selection task, specific RQs and Hs have been formulated for the picture verification data focusing on the role of individual differences. These questions further examine how individual factors may account for variability in response times. The RQs and Hs are presented below.

RQ_7 Does **language dominance** modulate instructed L1 Spanish-L2 English bilinguals' response times when confronted with ambiguous relative clauses?

H_7. If a language dominance effect is observed in instructed L1 Spanish-L2 English bilinguals, such effect will differ across conditions. In the HA condition, the expected language dominance effect will be represented by higher RTs (i.e., slower responses) for bilinguals with increased English dominance. Conversely, in the LA condition, more English-dominant bilinguals will exhibit lower RTs (i.e., faster responses), indicating higher acceptance of their L2 preferred strategy.

RQ_8 Does **length of L2 immersed instruction** modulate instructed L1 Spanish-L2 English bilinguals' response times when confronted with ambiguous relative clauses?

H_8. If such effect is found, it will be represented by stronger attrition evidence among bilinguals who have been intensively exposed to L2 instruction for higher number of years. In the HA condition, higher response times (i.e., slower responses) are predicted for long-exposed bilinguals, evidencing a more pronounced departure from the L1-

prefered strategy. On the contrary, in the LA condition lower RTs (i.e., faster responses) are expected for bilinguals with increased exposure, displaying increased preference for the L1-dispreferred mechanism.

4.3. RQs: eye-tracking experiment

Finally, in addition to data on offline interpretative preferences and processing costs, online data were also collected using an eye-tracking experiment. The primary goal of gathering online eye-tracking data was to address real-time processing of ambiguous RCs for all groups, i.e., Spanish monolinguals, instructed bilinguals and English monolinguals. A visual world eye-tracking task was conducted as it would offer relevant insights into processing patterns. A visual-world rather than a reading eye-tracking task was chosen for several reasons. Firstly, it allowed to maintain consistency with the sentence-picture verification task. Recall that the picture selection data was integrated within the eye-tracking task, meaning that two types of data were collected using the same experimental in-situ experiment. As a result, all tasks administered contain a visual and auditory component. This ensures comparability across tasks, allowing to reliably compare the results obtained from them. In addition to this, an eye-tracking methodology has been extensively used to test the processing of RCA ambiguities. However, most previous eye-tracking research has relied on while-reading data (Carreiras & Clifton, 1999; Dussias & Sagarra, 2007; Valenzuela et al., 2020). The findings obtained will contribute to the understanding of this phenomenon via a new methodological approach.

In psycholinguistic research, eye-tracking data have been used to explore the time course of RCs processing to determine at what specific moment during sentence processing the parser attaches the relative clause to either NP1 or NP2.

Based on the above, the following research questions and hypotheses were formulated.

RQ$_9$ Does the **time course** of processing ambiguous relative clauses reveal evidence of L1 attrition effects among instructed bilinguals compared to Spanish and English monolinguals?

H$_9$. This RQ specifically addresses when disambiguation occurs during sentence processing, i.e., as the sentence unfolds. This will be investigated comparing the time course of processing relative clauses across the three groups: Spanish monolinguals, instructed bilinguals and English monolinguals. The analysis conducted to answer this research question will only consider data from the ambiguous condition. If time course processing reveals L1 attrition effects on bilinguals, these effects will manifest as delayed looks at the target image compared to the monolingual groups. The two monolingual groups, Spanish and English natives, are expected to resolve ambiguous sentences more quickly and therefore, they will be faster than bilinguals in directing their looks at their corresponding target image. The target image for each group is the one that represents the default parsing strategy based on previous literature: high attachment for the Spanish group, and low attachment for the English group.

RQ_{10} Does **the proportion of fixations** on the HA vs. LA-biased image differ between instructed bilinguals, Spanish monolinguals and English monolinguals for ambiguous relative clauses?

H_{10}. Similarly to RQ_9, the analysis to address this research question will only focus on the ambiguous condition, comparing the performance of the three groups involved: Spanish and English natives, together with instructed bilinguals. If differences in the proportion of fixations emerge across groups, it is predicted that the Spanish monolingual group will exhibit the highest proportion of fixations on the HA-biased image, followed by bilinguals and then, by English monolinguals. On the other hand, the reverse pattern is expected for the LA-biased image. The English group is expected to show the highest proportion of fixations, followed by bilinguals first and then, by Spanish monolinguals, who are predicted to have the lowest proportion.

Additional RQs on the potential effect of individual differences were also formulated.

RQ_{11} Does **language dominance** modulate fixation patterns in instructed bilinguals when they are confronted with ambiguous relative clauses in their first language?

H_{11}. A relevant question in this investigation is whether language dominance may further account for attrition effects in the L1 processing of ambiguous relative clause among L1 Spanish-L2 English bilinguals. A dominance effect is expected in the eye-tracking data for the bilingual group. If such effect is observed, it will be reflected in increased proportion of fixations to the LA-biased image among bilinguals with higher dominance in L2 English. On the other hand, instructed bilinguals who are more Spanish dominant will reveal stronger preference for the HA-biased image. To put it simply, instructed bilinguals who have more dominance in English are expected to show stronger evidence of using parsing strategies associated with their L2 when they resolve ambiguous relative clauses in their L1 Spanish.

RQ12 Does **length of L2 immersed instruction** modulate fixation patterns in instructed bilinguals when they are confronted with ambiguous relative clauses in their first language?

H12. Previous eye-tracking research has evidenced that not only naturalistic immersion in an L2 environment, but also the length of such immersion influences the L1 processing of ambiguous relative clauses among L1 Spanish-L2 English bilinguals (Dussias & Sagarra, 2007). Bilingual speakers with limited L2 immersion patterned with Spanish monolinguals in their L1 processing of relative clauses, significantly differing from those with extensive exposure, who favoured low attachment. Therefore, an effect of length of exposure to the L2 in an instructed context is also expected. If such effect emerges, it will be manifested in higher proportion of fixations in the image depicting the L1-dispreferred parsing strategy, i.e., the image depicting a low attachment interpretation, among bilinguals with increased exposure to the L2. Conversely, those bilinguals who have received fewer exposure to their L2 English in a classroom setting will behave more similarly to Spanish monolinguals, showing higher preference for the HA-biased image.

Overall, RQ12 will be particularly discussed regarding the study by Dussias and Sagarra (2007) for several reasons. Firstly, it aims to examine whether the L2 immersion effect reported may be replicated in a different population, i.e., bilinguals with extensive instructed L2 exposure. Secondly, the analysis implemented in their study involves some methodological concerns and it would be necessary to investigate the issue using more updated statistical methods. In particular, in their analysis they include an effect of attachment as the dependent variable, which is not recommended. It would be better to include it as a predictor in the model rather than as the dependent variable. Doing so may bias the results and result in significant effects that may not be real. Their study presents a highly relevant issue, the potential influence of length of L2 exposure in L1 parsing strategies, but it is necessary to account for this using current statistical recommendations for psycholinguistic research.

Chapter 5: Methodology

The main aim of this PhD thesis is to investigate L1 attrition in the interpretation and processing of ambiguous relative clauses among L1 Spanish-L2 English bilinguals, compared to a Spanish monolingual and an English monolingual control group. This is explored in relation to the effect that L2 exposure in a university instructed setting may have on bilinguals' L1 preferences. To address both their interpretation and processing, three types of data were gathered: (1) an offline picture selection task, (2) a picture verification task and (3) a visual world eye-tracking experiment. Each task was designed to measure specific aspects. The picture selection task focuses on offline interpretation, assessing participants' post hoc RCA preferences. The picture verification task provides information regarding processing cost when ambiguous RCs are encountered. Lastly, the eye-tracking experiment captures online processing by monitoring eye movements in real time, offering insights into how participants interpret visual and linguistic stimuli. This will ensure a complete understanding of the phenomenon under analysis. In addition, data from several background tasks were also collected: L2 proficiency tests, the Bilingual Language Profile (BLP) questionnaire to measure language dominance, and a working memory task. A crucial novelty of this PhD thesis is the fact that all experiments were completed by the same participants, unlike most current literature where each language task is administered to different participants.

This chapter aims at offering an in-depth description of the methodology employed in this PhD thesis and is organised as follows. Section 5.1 presents a comprehensive summary of the participants' profile, detailing the selection criteria for each group, as well as their main characteristics. In Section 5.2, procedure of data collection is described, presenting the chronological order of the tasks administered and providing a general overview of each individual task. Section 5.3 provides and in-depth description of the three background tasks included in this study, i.e., L2 proficiency test, BLP questionnaire to measure language dominance and a working memory task. Finally, Section 5.4 focuses on the design of the stimuli (linguistic, visual and auditory) used in the experimental tasks. A summary will be introduced in Section 5.5.

5.1. Participants

A description of the participants' profile will be provided in this section. Three groups were sampled for this investigation: (1) an experimental group of L1 Spanish-L2 English late sequential bilinguals (N = 47), (2) a control group of Spanish functional monolinguals (N = 50) and (3) a control group of English functional monolinguals (N = 49). A total of 146 participants was recruited. Regardless of group, they all had normal or corrected-to-normal vision, which was particularly relevant for the eye-tracking experiment, as well as no previous history of language disorders. Each participant gave informed consent before taking part in this investigation and received a monetary compensation upon completion of their participation[18]. Table 9 offers a general summary of the participants' profile for each group.

Table 9:

General profile of each group of participants

	Spanish monolinguals	**English monolinguals**	**Instructed bilinguals**
L1	Spanish	English	Spanish
L2	English	Spanish or French	English
Country of residence	Spain	United Kingdom	Spain
L2 proficiency	Low (A1 – A2)	Low (A1 – A2)	High (C1 – C2)
L2 dominance	163.08	175.95	67.64
L2 exposure	Limited	Limited	Extensive; instructed setting

Data for the Spanish monolingual and the bilingual groups were collected in Granada, Spain, where these participants lived at the time of testing, whereas the data collection for the English monolingual group was conducted in Cambridge, United Kingdom. Additionally, both monolingual groups differed from the bilingual group regarding L2

[18] Participants in the Spanish monolingual and bilingual groups received a compensation of 15 euros for their participation, while participants in the English monolingual group were compensated with 15 pounds.

proficiency and exposure. Spanish and English monolinguals had low L2 proficiency and were not exposed to an L2 at the time of testing, while bilinguals were highly proficiency in their L2 English and received extensive L2 exposure in a classroom setting. The following sections will provide a more detailed description of each group.

5.1.1. Spanish functional monolinguals

The aim of this PhD thesis is to address the potential influence of extensive instructed L2 exposure on the interpretation and processing of bilinguals' L1 Spanish. Therefore, it was necessary to collect data from a control group of Spanish functional monolinguals (N = 50) that served as a benchmark for comparison. Their data were collected between March and June 2023 in Granada, Spain. To do so, a call for participation was launched, which included the criteria participants had to meet to be accepted in the present study (see Table 10 for a summary and Appendix A: Participation requirements). The requirements were as follows. All participants had to be native speakers of Peninsular Spanish between 18 and 30 years of age to control for potential differences between Spanish varieties (Ayelén Stetie & Mariel Zunino, 2023) and working memory effects, respectively. They could not be bilingual from birth, and in fact, all participants reported growing up monolingually. Additionally, they could neither study a language-related degree nor attend English classes at the time of testing to avoid potential exposure to a second language in a formal instructed setting. In line with this, they could never have attended a bilingual school or high school. Their proficiency in L2 English had to be low (A1 – A2 level) and could not be proficient in any additional language. All participants reported low or even a lack of proficiency in a third language. Finally, potential candidates who had spent more than one month in a foreign country were not eligible to participate. This was so to avoid potential exposure to an additional language in a naturalistic setting, which could influence the results obtained for this group.

Table 10:

Participation requirements for Spanish monolinguals

Participation requirements	
Spanish monolinguals	
Native speakers of peninsular Spanish	Never attended a bilingual (high)school
Between 18-30 years of age	Not proficient in an L3
Not bilingual from birth	Not have spent a month living abroad
Low L2 English proficiency (A1-A2)	

As a result, the Spanish monolingual group was very homogeneous (see Table 11). All selected participants in this group were adult Spanish native speakers ranging from 18 to 29 years of age (mean = 22.3, SD = 2.53) who had lived in Spain from birth until the moment of testing. Out of the 50 participants, 43 were undergraduate students, 3 were doing their master's degree, 3 were already working and one was a PhD candidate of geography. All participants reported Spanish to be their dominant language and very low proficiency in L2 English. Additionally, L2 proficiency was objectively measured using the CEFR-based *Oxford Quick Placement Test* (OQPT) (Oxford University Press, 2003), being 20.54 (SD = 3.03) out of 60 their mean L2 proficiency, which corresponds to an A2 level. Given the fact that English as an L2 is a compulsory subject in primary and secondary education in Spain, all participants had previous exposure to the language with a mean age of onset to L2 English of 6.26 years (SD = 1.86) and 11.92 years of length of instruction (SD = 1.80). However, none of them used English in their daily life when the study was conducted.

Table 11:

Profile of Spanish functional monolinguals

Spanish monolinguals' profile			
Variables	**mean**	**SD**	**range**
Age	22.3	2.53	18 – 29
Age of onset to L2 English	6.26	1.86	3 – 10
Length of L2 instruction (nº of years)	11.92	1.80	
L2 English proficiency (scale 0-60)	20.54	3.03	13 – 26
BLP	163.08	11.28	141 – 190
Working memory (scale 0-1)	0.73	0.08	0.50 – 0.92

Regarding the additional background measures of language dominance and working memory, these were measured by means of the *Bilingual Language Profile* (BLP) questionnaire (Birdsong et al., 2012) and a verbal working memory test (Elosúa et al., 1996). All participant groups were administered these tasks in their first language, so Spanish monolinguals completed them in Spanish. Spanish monolingual speakers were dominant in their L1 Spanish with a mean of 163.08 (SD = 11.27). The BLP (Birdsong et al., 2012) offers a score ranging from -218 to +218 where a score closer to the end of the positive pole (as it is the case for Spanish monolinguals) indicate higher L1 dominance. Finally, they have a mean working memory span of 0.73 (SD = 0.08; range = 0-1).

5.1.2. English functional monolinguals

To investigate the disambiguation strategies employed by L1 Spanish-L2 English instructed bilinguals in their L1 processing and interpretation of ambiguous relative clauses, a second control group was required, i.e., a control group of English monolingual speakers. Data from this group will provide evidence of the preferred disambiguation strategy in native English, as opposed to native Spanish. This group consisted of 49 adult English monolingual speakers, with ages ranging from 18 to 29 years of age (mean age 20.71, SD = 2.80), and their data were collected in Cambridge, United Kingdom, from October to December 2023.

As mentioned earlier for the Spanish monolingual group, a call for participation was distributed (see Appendix B: Calls for participation), which included the list of requirements participants had to meet to be accepted in the study (see **Table 12** for a summary). The criteria were as follows. All participants had to be native speakers of

English between 18 and 30 years of age to control for potential working memory effects and to establish reliable comparisons between groups. They could not be bilingual from birth, and all participants indeed reported being raised in a monolingual environment. Additionally, they could neither study a language-related degree nor attend L2 courses at the time of testing to avoid potential exposure to any additional language as well as to reduce the possibility of metalinguistic awareness while doing the tasks. Similarly, they could never have attended a bilingual school or high school, their proficiency in an L2 had to be low (A1 – A2 level) and could not be proficient in any third language.

Table 12:

Participation requirements for English monolinguals

Participation requirements	
English monolinguals	
Native speakers of English	Never attended a bilingual (high)school
Between 18-30 years of age	Not dominant in an L3
Not bilingual from birth	Not have spent a month living abroad
Low L2 English proficiency (A1-A2)	

Regarding the general characteristics of the English monolingual group, **Table 13** provides a summary. Given the fact that the British education system makes it compulsory to study a second language, most of the population between 18 and 30 years of age have done so and therefore, all participants in this group had previous contact with an additional language. Initially, participation was planned to be restricted only to English natives who had studied Spanish as an L2 in an attempt to ensure the homogeneity of the group. However, while it is common in Spain to find individuals with English as their L2, the mirror scenario, i.e., L1 English-L2 Spanish, is less frequent in the UK. Due to the difficulty of finding sufficient participants with this language profile, i.e., L1 English-L2 Spanish bilinguals, it was decided to open participation also for L2 French learners. The rationale behind this decision was twofold. First, French is a popular language studied in the UK, and more importantly, native French behaves in a similar way to Spanish regarding RCA preferences, with previous studies reporting a preference for high attachment in French, as discussed in Section 3.4.2 (Frenck-Mestre & Pynte, 2000; Zagar et al., 1997). Thus, if the L2 exerted any influence, the effect should be the same across all participants in this group, being English natives who have learnt Spanish or French.

Out of the 49 participants within the English monolingual group, 28 had studied Spanish as an L2, while 21 had studied French.

Table 13:

Profile of English functional monolinguals

English monolinguals' profile			
Variables	**mean**	**SD**	**range**
Age	20.71	2.80	18 – 29
Age of onset to the L2 (Spanish or French)	10.87	1.23	9 – 14
Length of L2 instruction (nº of years)	4.75	1.89	2 – 10
Overall L2 proficiency	17.34	2.71	11 – 23
L2 Spanish proficiency	18.28	2.22	14 – 23
L2 French proficiency	16.09	2.93	11 – 20
BLP	175.95	15.91	128 – 200
Working memory (scale 0-1)	0.74	0.09	0.5 – 0.9

Participants have a mean age of onset to the L2, either Spanish or French, of 10.87 years old (SD = 1.23) and a mean length of L2 instruction of 4.75 years (SD = 1.89). L2 proficiency mas measured via two placements tests (see Appendix E: University of Wisconsin Placement Test and Appendix F: ESL French placement test), administered depending on the second language of each participant (see Section 5.3.1 for a detailed description of each placement test). When combining all participants, the mean L2 proficiency is 17.34 (SD = 2.71), which corresponds to an A2 level. If only L2 Spanish learners are considered, their mean is 18.28 (SD = 2.14), while it is 16.09 (SD = 2.93) for L2 French learners. In addition, all participants reported low or even a lack of proficiency in a third language and could not have spent more than one month living in a foreign country. This was so to avoid potential exposure to an additional language in a naturalistic setting, which could influence the results obtained.

The same tests introduced earlier were administered to the English monolingual group to measure language dominance and working memory. Both the BLP and the working memory task were completed in their L1 English. In line with the Spanish monolingual group, English monolinguals are clearly L1-dominant as measured by the BLP, with a mean score of 175.95 (SD = 15.91; range = ±218). Finally, their mean working memory span is 0.74 (SD = 0.09; range = 0-1).

5.1.3. Instructed L1 Spanish-L2 English bilinguals

The experimental group consisted of advanced L1 Spanish-L2 English learners (N = 47) who live in an L1-speaking country, Spain, and more precisely, in a non-bilingual region where their L1 Spanish is the functional language. Additionally, they are extensively exposed to their L2 English in an instructed setting, i.e., in a university classroom setting, as these participants were all undergraduate students at the University of Granada, Spain, completing the degree of English Studies. The aim of this PhD thesis is to explore potential attrition effects on L1 Spanish-L2 English learners due to extensive L2 exposure in an instructed setting. Therefore, this group includes an ideal population to explore such influence given the extensive and daily exposure these students have to their L2 English.

The data from this group were collected between March and June 2023 in Granada, Spain, together with the data from the Spanish monolingual group. Following the same procedure, a call for participation (see Appendix B: Calls for participation) was distributed with the criteria that participants had to meet to be accepted for participation (see Table 14 for a summary). The specific requirements were as follows. Similarly to the Spanish monolingual group, all participants had to be native speakers of Peninsular Spanish between 18 and 30 years of age who had been born and raised in Spain to control for potential differences between Spanish varieties (Ayelén Stetie & Mariel Zunino, 2023) and working memory effects, respectively. They could not be simultaneous bilinguals from birth and in this regard, all participants reported growing up monolingually. Additional criteria were related to their language history. All participants had to be L1 Spanish-L2 English learners with very high proficiency in the L2 (C1 – C2 level), although they could not be proficient in any additional language. Only participants who reported very low knowledge of a third language and no use were included in the study. Finally, and to avoid potential exposure in a naturalistic setting as it could influence the results obtained, participants could not have lived in an English-speaking country for more than one month. In an ideal situation, only participants who had never travelled to such countries would be eligible candidates. However, given the difficulty to find participants to had never made a trip to United Kingdom or Ireland, for example, an emphasis was made on the idea of living, rather than temporal trips, and a one-month limit was set.

Table 14:

Participation requirements for L1 Spanish-L2 English instructed bilinguals

Participation requirements	
L1 Spanish-L2 English instructed bilinguals	
Native speakers of Spanish	Never attended a bilingual (high)school
Between 18-30 years of age	Not dominant in an L3
Not bilingual from birth	Not have lived in an English-speaking country for more than a month
High L2 English proficiency (C1-C2)	

As mentioned earlier, all those who completed their participation in the bilingual group were students in the degree of English Studies at the University of Granada, Spain. The degree of English Studies is a four-year degree whose contents cover a variety of courses such as English literature, linguistics, history, English as a second language, etc. It is relevant to mention that the vast majority of these courses are delivered in English, except for some courses in the first year of the degree, which has a more introductory character and are therefore taught in Spanish (see Appendix C: Syllabus for the degree of English Studies). The university system in Spain requires an average of 20 weekly hours of attendance to lectures and additional hours of autonomous work at home. Therefore, students in the degree of English Studies not only receive an average of 20 hours of intensive exposure to L2 English per week, but also use their L2 English outside the classroom. All the materials provided are in English, and they are required to study and do their assignments and readings in their L2 English. Students are indeed expected to complete the degree with a C1 level of English. All participants in this group reported attending lectures regularly, which ensured they receive enough L2 exposure daily. As a result, these participants are extensively exposed to the L2 in an instructed context.

In addition to this, these university students ranged from 18 to 26 years of age (mean = 20.30; SD = 1.83) and all of them reported being raised monolingually in Spain (see Table 15, which summarises the profile of the bilingual group). As explained for the Spanish monolingual group, all these participants had previous knowledge of L2 English because it is a compulsory course in primary and secondary education in Spain. Their mean age of onset to L2 English is 5.60 years of age (SD = 1.37) and an average length of instruction of 14.47 years (SD = 2.19).

Table 15:

Profile of L1 Spanish-L2 English instructed bilinguals

Bilinguals' profile			
Variables	**mean**	**SD**	**range**
Age	20.27	1.82	18 – 26
Age of onset to L2 English	5.60	1.36	3 – 10
Length of L2 instruction (nº of years)	14.49	2.17	8 – 19
L2 English proficiency (scale 0-60)	53.27	3.51	48 – 60
BLP	67.64	13.54	30.1 – 90.4
Working memory (scale 0-1)	0.77	0.09	0.58 – 0.93

Regarding their L2 proficiency level, all participants were advanced L2 English learners, with a mean score of 53.26 out of 60 (SD = 3.54) according to the CEFR-based OQPT, which corresponds to a C1-C2 level of English. The bilingual group also completed the BLP questionnaire, which offers a score from -218 to +218 in such a way that the closer this score is to the negative pole, the more L2-dominant bilinguals are. As illustrated in Table 15, bilinguals obtained a mean score of 68.23 (SD = 13.07). When compared with the scores of the Spanish (mean = 163.08) and English functional monolingual (mean = 175.95) groups, the mean score of bilinguals indicates lower L1 dominance in favour of their L2 English. Finally, their mean working memory span is 0.76 (SD = 0.09). Bilinguals were tested both in the BLP and working memory task in their L1 Spanish.

5.2. Procedure

This section offers an in-depth description of the general procedure followed in the data collection as well as a brief account of both the main and background tasks administered to all groups. Data were collected between March and December 2023 both in situ and in an online format. Participants completed online both the corresponding L2 proficiency test and the picture verification task, while the other tasks were administered in a face-to-face session. Regarding the bilingual group, it is relevant to mention that their data were gathered in spring 2023. The motivation of this decision is related to the aim of the investigation, i.e., to explore potential differences in L1 interpretation and processing as a result of daily L2 exposure in an instructed setting. In particular, we aimed at analysing whether the number of years exposed in an instructed setting modulated potential attrition effects. Therefore, data collection had to be conducted towards the end of the academic year so that, by the time they were tested for this study, all participants in the bilingual group had received a considerable amount of instructed input over the academic year by means of lectures, courses, academic readings, etc. In line with this, it was decided not to collect data in the months immediately following the summer, i.e., September, October, and Christmas breaks, i.e., January, February, since there are no classes during these periods. The consequent reduced exposure to the L2 during summer and Christmas may result in more subtle L1 changes or even a lack of them since it has been demonstrated that detachment from the L2 environment, i.e., the classroom setting, may revert potential L1 attrition effects (Chamorro et al., 2016). Additionally, and for the same reasons, examination periods in January-February, as well as June-July were also not ideal moments for data collection.

As for the tasks, the sequencing was as follows for all participants:

1. L2 proficiency test
2. Bilingual Language Profile test
3. Picture verification task
4. Eye-tracking experiment and picture selection task
5. Working memory task

For all groups, the data collection began with the distribution of calls for participation, which included the requirements to participate, the financial compensation participants would get upon completion of their participation (15 euros for the Spanish monolingual and the bilingual groups; 15 pounds for the English monolingual group)[19], and either a link or a QR code to a Google Forms questionnaire. This questionnaire allowed candidates to register as potential participants in the study and it was structured as follows. First, a brief description of the aim of the investigation was provided, together with the requirements to participate, monetary compensation, list of tasks to complete and information about the ethical approval of the study (see Appendix A: Participation requirements). Right afterwards, participants were asked to fill in several questions to make sure they met the participation criteria. Such questions gathered information about candidates' initials, email address, age, native language, degree and academic year. They

[19] The funding for participants' payment was made possible thanks to the ANACOREX research project (PID2020-113818GB-I00), a Language Learning Dissertation Grant and a British Spanish Society scholarship.

were also asked whether they (1) were bilingual from birth, (2) had lived in a foreign country, (3) had attended a bilingual school or high school and the number of years, if applicable, as well as (4) whether they had knowledge of a third language and which one that would be. Once participants had filled in all the questions, they gave informed consent of their participation and submitted their response to the registration questionnaire. The researcher received all submitted responses and checked them individually so that only eligible candidates would be taken into consideration. Candidates were excluded from the study if they (1) were bilingual from birth, (2) had lived in a foreign country for more than one month, (3) had attended a bilingual school or high school or (4) had knowledge of a third language.

Each potential participant was contacted by email individually. The researcher informed them that to participate, they must meet an additional requirement, i.e., a specific L2 proficiency level. Thus, the first background task all potential candidates completed was a proficiency test, although the specific test depended on the L2 of each candidate. The L2 of both the Spanish monolingual group and the bilingual group was English and therefore, a link to an English proficiency test was provided. Both the Spanish monolingual group and the bilingual group were administered the *Oxford Quick Placement Test* (Oxford University Press, 2003) to test their L2 English. On the other hand, candidates in the English monolingual group had two possible L2s, i.e., Spanish or French, so they were administered either the *University of Wisconsin Placement Test* (University of Wisconsin, 1998) or the *ESL French Placement Test* (ESL Free French Level Test, 2023) depending on whether their L2 was Spanish or French, respectively. All tests were administered online via Google Forms, took approximately 15 minutes to complete, and addressed L2 vocabulary and grammar. Upon submitting their response, each candidate automatically obtained a score. Based on it, they were either allowed to continue participating or excluded from the study. The L2 proficiency requirements were, as mentioned earlier, A1-A2 level for both Spanish and English functional monolinguals, and C1-C2 level for bilinguals. The researcher checked all submitted responses and contacted candidates individually, either confirming their participation if they had the required proficiency level or rejecting them if they did not. It is worth mentioning that neither the specific L2 level nor the score range they had to obtain in the corresponding placement test were specified in the email to prevent candidates from manipulating or adjusting their responses to meet the proficiency level requirement. The email for those candidates accepted in the study also included the instructions and links to the two following tasks: the Bilingual Language Profile test (BLP) (Birdsong et al., 2012) and the picture verification task.

The BLP was administered to all participants using its online version, which can be accessed and downloaded from their webpage[20]. All participants that met the proficiency requirement received a link to the language profile questionnaire, which was implemented in Google Forms. There are several versions of the BLP available with various L1-L2 combinations to ensure that the test can be administered to different bilingual populations. Thus, for both the Spanish monolingual group and the bilingual group, the L1 Spanish-L2 English version was administered. For the English monolingual group, the L1 English-L2 Spanish or L1 English-L2 French versions were administered, depending on the second language of each participant. All participants completed the BLP in their L1, being this Spanish for the Spanish monolingual and the bilingual groups, and English for the English monolingual group. Regardless of the BLP version, all tests were structured as follows. First, participants were presented with a brief description of the questionnaire. Afterwards, they were presented with the informed consent, which they had to agree with to continue participating. Once they voluntarily agreed to participate, they completed the language background questionnaire and submitted their response.

The same email that included the BLP, also provided the link and instructions for the first main task of this study: the auditory sentence-picture verification task. The task was programmed and developed with *OpenSesame* (Mathôt et al., 2012; Mathôt & March, 2022), and subsequently deployed online via the OSWeb extension using the JATOS server[21] (Lange et al., 2015). To ensure that data were collected in the appropriate conditions, participants received detailed instructions. They were asked to do the task in a quiet place when they could spare the required time to avoid being interrupted. They were also asked to use either a laptop or desktop because they would need the keyboard, as well as to use headphones and adjust the volume before beginning since the task contained audio. They were encouraged to avoid Safari as their browser and use Google Chrome instead because Safari might cause more issues when opening and running the task. Participants were informed that the estimate time to complete the task was 15 minutes and that, since the task was designed to be only taken once, they could not start

[20] BLP webpage: https://sites.la.utexas.edu/bilingual/
[21] Webpage: https://mindprobe.eu/

over. Their data would be considered fraudulent and excluded from the study if they did so. The task was administered in the L1 of each group, i.e., Spanish for the Spanish monolingual and bilingual groups, and English for the English monolingual group.

Once participants completed both the BLP and the picture verification task, the researcher checked their two responses were stored correctly and contacted each individual participant to schedule an appointment for the in-person session. In this session, they completed the eye-tracking experiment, which included a picture selection task, as well as the working memory task. In the email, participants received a calendar with the available time slots and selected the date and hour that best suited them. A time-gap of two weeks had to occur between the day participants completed the two aforementioned online tasks and the in-person session. This ensured that participants did not fully remember the tasks they had already done, especially the picture verification task. A few days before the face-to-face session, the researcher sent an email to remind each participant of the appointment. In the email, participants were also asked to wear no or as little make-up as possible, especially on their eyes (mascara, eyeliner, etc.) for the eye-tracking task. They were also informed that sometimes contact lenses and glasses with blue light filters may cause problems, so in case they had corrected eyesight, they were encouraged to bring normal glasses.

Finally, the in-person session took place in a lab setting and consisted of two tasks, i.e., the eye-tracking experiment (including the picture selection component) and the working memory task. Data collection was conducted in person in two labs: *BilinguaLab* at the University of Granada[22] for Spanish monolinguals and bilinguals, and the *Cambridge Processing and Acquisition of Language Lab* (CAMPAL) at the University of Cambridge[23] for English monolinguals. Each session took approximately one hour. When participants arrived, they were asked to turn off their phones and leave all personal devices. The researcher first provided the instructions of the eye-tracking experiment verbally, so ensure everything had been understood. Then, the calibration was conducted, followed by a presentation of the instructions of the experiment on the screen so that each participant could read them at their own pace and afterwards, participants completed the actual eye-tracking experiment. It was necessary to recalibrate during the experiment for some participants, and one participant in the bilingual group had to be excluded from the

[22] Lab webpage: https://bilingualab.ugr.es/
[23] Lab webpage: https://www.mmll.cam.ac.uk/campal

study given the impossibility of calibrating the eye-tracker. Upon completion, the researcher made sure the data had been stored correctly and if so, the instructions for the working memory task were provided verbally. All participants gave verbal informed consent to record the task, which would allow the researcher to check their responses afterwards. A laptop was provided to do this task. First, the instructions appeared again on the screen to ensure they could read them at their own pace and fully understand the procedure, this was followed by a practice part after which, the actual task started. The in-person session finalised with the end of the working memory task.

The order in which the PVT and eye-tracking experiment was administered was not counterbalanced. For all groups and participants, the PVT was completed before the eye-tracking task. This was so because both tasks used the same stimuli (see Section 5.4), but in the PVT, participants were only exposed to a subset of the total stimuli, whereas the eye-tracking experiment contained all of them. For instance, in the PVT, participants only heard ambiguous sentences and saw one image per sentence, while in the eye-tracking experiment, they saw two images per sentence and, in the case of Spanish monolinguals and bilinguals, they heard sentences in three different conditions (forcing-HA, forcing-LA and ambiguous)[24]. If the eye-tracking task had been administered first, exposure to a larger number of stimuli might affect participants' performance in the PVT. To prevent this, the PVT was always administered first.

5.3. Background tasks

This section will provide more detailed information about the three background tasks included in the study, i.e., (1) the L2 proficiency tests (Oxford Quick Placement Test, University of Wisconsin Placement Test and ESL French Placement Test), (2) the Bilingual Language Profile questionnaire and (3) the verbal working memory task. These variables will offer relevant information as modulators of attachment preferences in the interpretation and processing of participants' first language.

[24] A more thorough description of the task design and stimuli used can be found in Section 7.2 for the PVT and Section 8.2 for the eye-tracking experiment.

5.3.1. L2 proficiency tests

5.3.1.1. English placement test

The *Oxford Quick Placement Test* (OQPT) (Oxford University Press, 2003) measured the L2 English proficiency of Spanish functional monolinguals and L1 Spanish-L2 English instructed bilinguals (see Appendix D: Oxford Quick Placement Test). The scores obtained by each participant allowed to only include in each group participants with either low or highly advanced L2 proficiency, respectively. The OQPT consists of 60 multiple-choice questions that address learners' L2 competence regarding grammatical and vocabulary knowledge. Once each participant has responded to all questions and submitted their response, a score is automatically provided. Such score rage from 0 to 60 points, divided into six intervals that correspond to specific proficiency levels following the *Common European Framework of Reference for Languages* (CEFR) (see Table 16).

Table 16:

OQPT scores and their CEFR correspondences

	Test score	CEFR level
Lower beginner	0 – 17	A1
Upper beginner	18 – 29	A2
Lower intermediate	30 – 39	B1
Upper intermediate	40 – 47	B2
Lower advanced	48 – 54	C1
Upper advanced	55 – 60	C2

To meet the participation requirements, participants in the Spanish functional monolingual group were required to be L2 English learners with a low proficiency level, i.e., lower or upper beginners, corresponding to levels A1 to A2 of the CEFR. Thus, participants who scored between 0 to 29 points in the OQPT were eligible candidates. Similarly, participants in the L1 Spanish-L2 English bilingual group were required to be advanced learners, either lower or upper advanced, which coincides with a C1 to C2 proficiency level according to the CEFR. As a result, participants in the bilingual group had to score between 48 to 60 points (see Section 5.1.3).

5.3.1.2. Spanish placement test

Out of the total of 49 English monolinguals tested in this study, 28 reported to have studied Spanish as an L2 at some point. Their proficiency in L2 Spanish was assessed via the *University of Wisconsin Placement Test* (University of Wisconsin, 1998). In other words, this test was administered to all potential candidates in the English functional monolingual group whose L2 was Spanish to assess their competence in Spanish and use their scores as participation criterion in the study. As the control group of English natives had to consist of native speakers of English with low proficiency of an L2, only those with very low competence of L2 Spanish (A1-A2) were considered for participation.

The *Wisconsin Placement Test* is a 43-point standardised placement test which measures L2 Spanish proficiency level. Based on the score obtained, participants are classified from lower beginner to upper advanced. It comprises a total of 43 questions that address vocabulary and grammatical knowledge, similarly to the OQPT, and its structure can be checked in Appendix E: University of Wisconsin Placement Test. The test was administered online via Google Forms. Once candidates filled it in and submitted their response, a score from 0 to 43 was automatically assigned. They received one point per accurate answer for a maximum possible score of 43 points. Each score corresponds to a proficiency level of the *Common European Framework of Reference* (see Table 17), allowing the researcher to filter candidates and only accept those English natives who had scored between 0 and 20 points, as this represented a low level of Spanish (A1-A2).

Table 17:

Wisconsin Placement Test scores and CEFR correspondences

	Test score	**Proficiency level**
Lower beginner	0 – 12	A1
Upper beginner	13 – 20	A2
Lower intermediate	21 – 28	B1
Upper intermediate	29 – 35	B2
Lower advanced	36 – 40	C1
Upper advanced	41 – 43	C2

5.3.1.3. French placement test

Within the English monolingual group (N = 49), 21 participants reported having studied French and therefore, it was necessary to assess their L2 proficiency in French. To do so, the *ESL French placement test* (ESL Free French Level Test, 2023) was administered and implemented via Google Forms, the same as the other two proficiency tests (see Sections 5.3.1.1 and 5.3.1.2).

The *ESL French placement test* is a 40-point test composed of 40 multiple-choice questions that address L2 competence regarding both grammatical and vocabulary knowledge in French (see Appendix F: ESL French placement test). It takes 15 minutes to complete, approximately, and all questions appear in order within a single section. Following the same procedure as the two previous L2 proficiency tests, once all questions had been answered, participants submitted their response, and a score from 0 to 40 was automatically provided based on their answers. They received one point per accurate answer for a maximum possible score of 40. Such scores are divided into six intervals that correspond to specific proficiency levels following the CEFR (see Table 18).

Table 18:

ESL French Placement Test and CEFR correspondences

	Test score	**CEFR level**
Lower beginner	0 – 8	A1
Upper beginner	9 – 18	A2
Lower intermediate	19 – 28	B1
Upper intermediate	29 – 34	B2
Lower advanced	35 – 38	C1
Upper advanced	39 – 40	C2

In order to meet the participation requirements, candidates in the English functional monolingual group must had a low proficiency in French, i.e., lower or upper beginners, corresponding to levels A1 to A2 of the CEFR. Thus, they had to score between 0 and 18 points in the ESL French placement test to be considered eligible candidates.

5.3.2. Bilingual Language Profile

A second background task was used to gather information regarding participants' language profile, i.e., the *Bilingual Language Profile* test (Birdsong et al., 2012). This questionnaire was completed by all groups, i.e., Spanish monolinguals, English monolinguals and instructed bilinguals. The rationale behind this decision is the fact that, according to Gertken et al. (2014), bilingual speakers may have the same proficiency level but still differ in terms of language dominance in their L1 and L2. Given the gradient nature of language dominance, administering the BLP would allow us to control for potential variability among participants as well as to include this variable in the analyses and modulate the results obtained for the main tasks based on participants' language dominance.

The BLP is a standardised questionnaire for assessing language dominance based on self-reports, which encompass several linguistic variables such as age of onset, length of instruction, self-proficiency, etc. The test can be freely downloaded from their webpage[25] and it has been translated into different languages, so that the BLP is designed for assessing language dominance in a variety of language pairs. In this dissertation, the versions of the BLP employed were the following: (1) Spanish-English version for both the Spanish monolingual group and the L1 Spanish-L2 English bilingual group, as well as (2) the English-Spanish and (3) the English-French versions for the English monolingual group, depending on whether their L2 was Spanish or French, respectively.

The BLP is structured as follows. It is divided into four components, which correspond to four dimensions of language experience (language history, language use, language proficiency and language attitude) and consists of a total of 19 multiple-choice items (see Appendix G: Bilingual Language Profile test). Participants are requested to provide a response for each individual item and based on their responses, being the four components of the test equally weighted by factorising the score of each module, a final score is automatically assigned. To calculate this final score, participants first obtain two specific scores within each component, one score for their L1 and one score for their L2. Then, the scores in the L1 four all four components are added, as well as the scores in the L2. The maximum score that can be obtained per component within each language is 54.5 points, being 218 the maximum total score per language. The final language dominance score is the result of subtracting the L2 score from the L1 score. Such score ranges from -218 to +218. A score near 0 indicates balanced dominance in the two languages. In this line, the closer the score is to +218, the more L1-dominant the participant is. A score closer to the negative pole (-218) indicates higher L2 dominance. Table 19 below provides a summary of the language dominance scores by group.

[25] Webpage to BLP: https://sites.la.utexas.edu/bilingual/

Table 19:

BLP mean scores per component by group

	Spanish monolinguals		Bilinguals		English monolinguals	
	L1	**L2**	**L1**	**L2**	**L1**	**L2**
History	53.23	11.26	50.66	18.98	47.29	7.33
Use	48.39	0.58	35.09	15.35	53.98	0.40
Proficiency	54.16	17.43	53.59	46.33	54.01	14.54
Attitudes	52.84	16.29	52.60	43.03	53.55	10.60
Overall	208.64	45.58	191.95	123.71	208.84	32.89
Final score	163.08		67.64		175.95	

As observed, instructed bilinguals are closer to the negative side of the scale. This indicates that they are more L2-dominant than both Spanish and English functional monolinguals, who tend towards the positive side of the scale, corresponding to an L1-dominant profile. These BLP scores were included in the analysis to explore the potential effect of language dominance on participants' attachment preferences.

5.3.3. Working memory task

Together with the L2 proficiency tests and the BLP questionnaire, participants completed a third and final background task: a verbal working memory task, particularly a reading span test. It was administered to control for potential differences in working memory capacity, as it has been shown to be a factor influencing attachment preferences. Differences in working memory may influence sentence processing and comprehension (Cunnings, 2017, 2022), with a number of studies addressing the effect of working memory on attachment preferences (Y. Cheng et al., 2021; Hopp, 2014; J. H. Kim & Christianson, 2017). It would be expected that speakers with higher working memory capacity favour HA more frequently, due to their ability to retain more in working memory. Although most data on RCA and working memory comes from L2 studies, predictions are not confirmed, with low-capacity speakers tending towards LA. Although participants in this thesis are tested in their L1, the WM task allowed us to control for potential differences. However, given that it is a control measure, it will not be included as a variable in future analyses.

The task was administered in the L1 of each participants' group and therefore, two versions were implemented (see Appendix H: Working memory task. Spanish version and Appendix I: Working memory task. English version). The English monolingual group completed the original English working memory test proposed by Daneman and Carpenter (1980), while the Spanish monolingual and the L1 Spanish-L2 English bilingual groups did the Spanish adaptation developed by Elosúa et al. (1996). Both versions follow the same structure, being the language of the task the only difference.

The original task was implemented using cards, but for this study, the two working memory tests, i.e., the original English version and the Spanish adaptation, were implemented in *OpenSesame* and administered during the in-person session for all groups. Table 20 summarises the specific structure of the task, which comprises a total of 60 unrelated sentences that participants are required to read aloud. These sentences are divided into five blocks, with each block containing three sets of sentences. The number of sentences within each set varies across blocks as it increases by one sentence from one block to the following. The number ranges from 2 sentences in the first block to 6 sentences in the final one. As a result, the task complexity increases progressively as participants conduct the task.

Table 20:

Working memory task structure

	Block 1	
Set 1	Set 2	Set 3
2 sentences	2 sentences	2 sentences
	Block 2	
Set 1	Set 2	Set 3
3 sentences	3 sentences	3 sentences
	Block 3	
Set 1	Set 2	Set 3
4 sentences	4 sentences	4 sentences
	Block 4	
Set 1	Set 2	Set 3
5 sentences	5 sentences	5 sentences
	Block 5	
Set 1	Set 2	Set 3
6 sentences	6 sentences	6 sentences

Regarding the procedure, participants first read the instructions on the screen and completed a practice part to get familiarised with the procedure before conducting the actual task. During the task, participants were first presented with a fixation point in the centre of the screen to address their attention to that point, given that all sentences were typed on a single line and in centred position. The first sentence appeared automatically, and participants had to read it aloud. Immediately after, participants had to press the space bar for the next sentence to appear. This was so to ensure that all participants read aloud the sentence completely and at their own pace without time pressure. After reading all sentences within a set, a question mark (?) was displayed on the screen, indicating that that was the moment to recall aloud the last word of each sentence. In case they could not recall the correct order, they were requested to verbalise the words in the order they remembered. The only condition was not to begin with the last word of the last sentence since it was the most recent sentence and the easiest to remember. Once they did so, they pressed the space bar again to continue with the following trial until the end of the task.

Regarding the analysis, a partial-credit scoring was implemented (see Table 21) following Conway et al. (2005). This means that it was necessary neither to recall all words neither to do it in the correct order to receive some credit. Credit was assigned even if participants did not recall all words, or they did so but the order was incorrect. This would provide a higher sensitivity measure of participants' working memory span. As a result, the scoring was done as follows. The total number of words recalled was added together, and then divided by 60, i.e., the maximum number of words to be recalled. The result was scaled between 0 and 1 to obtain the final score for each participant. Table 21 below illustrates the scoring procedure, where each cell represents the number of correctly recalled words within each set of sentences.

Table 21:

Working memory task scoring

Block 1 (2 sentences)			**Block 2** (3 sentences)			**Block 3** (4 sentences)			**Block 4** (5 sentences)			**Block 5** (6 sentences)			**Score**
2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	60/60 = **1**
2	2	2	3	1	3	4	3	2	4	5	2	4	4	3	44/60 = **0.7**

The first row represents an ideal participant that had recalled all words in the correct order and therefore, had obtained a maximum score of 1. On the opposite, the second row illustrates the scoring of a real participant, who correctly recalled a total of 44 out of 60 words and obtained a final score of 0.7 points.

5.4. Materials and stimuli design

A variety of linguistic, visual, and auditory stimuli were specifically designed for this study. These stimuli were the same in all main tasks to control for potential differences across tasks given the nature of the stimuli themselves. In this section, a detailed description of the stimuli used in the experimental tasks will be provided. First, the linguistic stimuli (sentences) will be presented, followed by the visual stimuli (images), and finally, the auditory stimuli (recordings).

5.4.1. Linguistic stimuli

The linguistic stimuli of this study consisted of three types: target sentences, filler items, and practice items (full list of items in Appendix J: Target sentences and Appendix K: Practice and filler items). To explore disambiguation preferences in ambiguous relative clauses, all **target sentences** (N = 18) present the same syntactic configuration, which is as follows. All target sentences consist of a main clause followed by a subordinate clause, which is realised by a relative clause. More precisely, the main clause contains an imperative verb, an adjunct, and a direct object comprised of a complex NP of the form *NP1 of NP2* followed by the subordinate RC. Each syntactic element will be explained in detail below, but an example of the general structure is illustrated in (42).

(42) *Observa aquí al alumno*$_i$ *de la científica*$_j$ *que*$_{i/j}$ *lee un libro atentamente*
Observe here the student$_i$ of the scientist$_j$ who$_{i/j}$ reads a book carefully

First, the main clause of all target sentences is introduced by a verb of perception (e.g., *mirar/look*, *observar/observe*, *prestar atención/pay attention*, etc.) in the imperative mode to direct participants' attention to the images presented during the tasks. Given the fact that some verbs were very short, an adjunct *aquí/here* was included after the verb to lengthen the beginning of the sentence before introducing the two characters and the region of interest. The adjunct is followed by a direct object realised by a complex noun phrase of the form *[NP1 of NP2]* (*al alumno de la científica que lee un libro atentamente / the student (masc) of the scientist (fem) who reads a book carefully*). The two NPs (NP1 and NP2) preceding the RC are always realised by a definite article and an animate human entity. These two human entities always coincide with the characters of the images displayed. One of the NPs always refers to a male character (*alumno/student (masc))*, while the other one always refers to a female one *(científica/scientist (fem))*. The rationale behind this decision is the fact that previous studies have evidenced an animacy effect on attachment preferences (Acuña-Fariña et al., 2009).

As mentioned in previous sections, all participants completed the tasks in their L1: Spanish for Spanish monolinguals and bilinguals, and English for the English monolingual group. Thus, all linguistic items have a Spanish and an English version. Examples can be found in (43) and (44) below. In each set of stimuli, the number of conditions of the target sentences differed. For the Spanish version of the tasks, target sentences (N = 18) were built in three conditions each, i.e., forcing HA interpretation vs. forcing LA vs. ambiguous condition (full list of items available in Appendix J: Target sentences) and implemented in a Latin square design. Three different lists were obtained and randomly assigned to participants so that each individual participant only saw one condition of each experimental sentence. This was different for the English version of the tasks, administered to the English monolingual group, where all target sentences presented one single condition, i.e., ambiguous condition. This was so because the disambiguation of experimental items in Spanish was accomplished via gender match between the relative pronouns (*el cual/la cual*) and one of the preceding NPs, which is not possible in English. To be more precise, in Spanish, the relative pronouns *el cual*, *la cual* and *que* have the same meaning, the only difference being that the first two mark the grammatical gender of the entity they refer to (*el cual* refers to a male entity vs. *la cual* refers to a female entity), whereas *que* is ambiguous as it is not marked for gender. It may refer to either a male or female antecedent. Thus, sentences with *el cual*/*la cual* were used in unambiguous target items to force either a HA or LA interpretation of the sentence, while the relative pronoun *que,* which may refer to either a female or male referent, was used in ambiguous target items.

(43) **Item set 1**

Forcing-HA: *Observa aquí al alumno$_i$ de la científica$_j$ el cual$_i$ lee un libro atentamente*
Forcing-LA: *Observa aquí al alumno$_i$ de la científica$_j$ la cual$_j$ lee un libro atentamente*
Ambiguous: *Observa aquí al alumno$_i$ de la científica$_j$ que$_{i/j}$ lee un libro atentamente*
Observe here the student$_i$ of the scientist$_j$ who$_{i/j}$ reads a book carefully

(44) **Item set 2**

Forcing-HA: *Presta atención a la amiga$_i$ del policía$_j$ la cual$_i$ fuma un cigarro lentamente*
Forcing-LA: *Presta atención a la amiga$_i$ del policía$_j$ el cual$_j$ fuma un cigarro lentamente*

Ambiguous: *Presta atención a la amiga$_i$ del policía$_j$ que$_{i/j}$ fuma un cigarro lentamente*
Pay attention to the friend$_i$ of the policeman$_j$ who$_{i/j}$ smokes a cigarette slowly

Based on this, each item set presents three conditions: forcing-HA, forcing-LA and ambiguous. The ambiguous condition was always realised by the relative pronoun *que*, while the HA and LA conditions were accomplished via the pronouns *el cual*/*la cual*. It is worth mentioning that for the forcing-HA condition, half of the sentences forced a HA interpretation via *el cual* and the other half, via *la cual*. The same for the forcing-LA condition. This was so to avoid each condition being marked by a single relative pronoun and to prevent any potential effect of the relative pronoun used. This was fulfilled by interchanging the grammatical gender of the two NPs that precede the RC: male + female for half of the sentences vs. female + male for the other half. Example (43) above illustrates an item set where the first mentioned entity is a male character (*el alumno / the student*), followed by a female character (*la científica / the scientist*). Thus, the forcing-HA condition is accomplished via the pronoun *el cual*, while the forcing-LA condition is accomplished via the pronoun *la cual*. The opposite scenario is found in (44), where the forcing-HA condition is achieved using *la cual* referring to the female character (*la peluquera / the hairdresser*), and the forcing-LA condition is marked via *el cual*, which refers to the male antecedent (*el jardinero / the gardener*).

As illustrated above, all RCs are subject RCs and function as object-modifiers since the literature has suggested that the syntactic position of the RC may influence attachment preferences (Hemforth et al., 2015; J. H. Kim & Christianson, 2017). The relative pronoun is followed by a transitive verb, an animate or inanimate direct object realised by a NP and finally, a manner adjunct that could take one of the following forms: either an adverb phrase (AdvP), e.g., *atentamente/carefully*, or a prepositional phrase (PP), e.g., *con preocupación/with concern*. The transitive verb of the RC was always in present simple tense to avoid a possible effect of tense and to make the sentences more natural for the participant as the sentence would sound like a description of the images themselves. Additionally, this also ensures that the temporality of the experiment was not broken (*consecution temporum*). Since participants were asked to look at the pictures displayed on the screen, which depicted several characters doing something, the present simple tense is the most natural tense to describe what is going on in a picture. This was so to facilitate processing and reduce potential difficulties.

Some additional factors that were also controlled were the following: prosody, length of the RC and preposition type. Regarding the former, prosody seems to have an effect in the processing and final interpretation of RCA ambiguities in both Spanish and English (Bergmann et al., 2008; Fromont et al., 2017; Gilboy & Sopena, 1996). Particularly, a pause or a comma after NP1 seems to foster an LA interpretation while the opposite holds for a pause or coma after NP2, which tends to promote a HA interpretation. For instance, in (45) below, a pause after *servant* may suggest that it was the *actress* who was on the balcony. On the other hand, a pause following *actress* may indicate that the person who was on the balcony was the *servant*. Thus, an effort was made in this study to avoid pauses in the target sentences, especially when these were recorded.

(45) *Someone shot the servant [,] of the actress [,] who was on the balcony*

Additionally, the influence of prosodic breaks has also been examined concerning the length of the RC and, as a consequence, its phonological weight across different languages like English, Spanish, German and Basque (de la Cruz-Pavía & Elordieta, 2015; Hemforth et al., 2015). Given that longer RCs tend to induce prosodic breaks, specially following NP2, efforts were made during the design of the target sentences to standardise the length of all RCs. This was so to make them comparable and to minimise the occurrence of pauses. Finally, preposition type may also modulate attachment preferences, as it has been evidenced that thematic prepositions like *with* tend to favour LA interpretations of ambiguous RCs in English (Crocker, 1996; Pritchett, 1992). Thus, all target sentences contain RCs with the preposition *de/of*, for Spanish and English sentences respectively, as it fosters more neutral attachment preferences.

In addition to target sentences, **filler items** (N = 36) were also created and included in the experimental tasks. For the design of the fillers, six sentential structures were designed with six sentences each (full list of items available in Appendix K: Practice and filler items). Some of these structures were completely unambiguous, whereas others contained a variety of syntactic ambiguities different to the one studied in this investigation. An example of each structure is illustrated in (46) to (51).

(46) **Sentences with RCs**

Aquí tienes al bombero$_i$ que$_i$ saluda a la dentista$_j$ de camino al trabajo

Here you have the firefighter$_i$ who$_i$ greets the dentist$_j$ on his way to work

(47) **Unambiguous object**

Aquí está la periodista$_i$ que entrevista al atleta$_j$ que está calentando$_j$

Here is the journalist$_i$ who interviews the athlete$_j$ who is warming up$_j$

(48) **Subject anaphora**

Contempla al mago$_i$ que sorprende al anciano$_j$ mientras él$_{i/j}$ baraja las cartas

Look at the magician$_i$ who surprises the old man$_j$ while he$_{i/j}$ shuffles the cards

(49) **DO complement**

La panadera$_i$ le cuenta a su amigo$_j$ que ha encontrado$_i$ un monedero

The baker$_i$ tells her friend$_j$ that she$_i$ has found a purse

(50) **Preposition *with***

La niña$_i$ espía a un hombre$_j$ con unos prismáticos en el parque

The girl$_i$ spies on a man$_j$ with binoculars in the park

(51) **Object anaphora**

La vaca$_i$ y la oveja$_j$ descansaban cuando una hoja la$_{i/j}$ asustó

The cow$_i$ and the sheep$_j$ were resting when a leaf scared it$_{i/j}$

Filler items such as the one in (46) include subject RCs as target items do. However, these fillers differ from target sentences because the relative pronoun has one possible referent only, rather than two. This referent is always the first-mentioned human NP (*bomber/firefighter*) and therefore, this structure is always unambiguous in both Spanish and English. The first NP is followed by a RC which refers to this character and contains a second NP corresponding to the second character of the images. The second structure used for filler items is illustrated in (47) above. It contains two RCs with one possible referent each, i.e., the character mentioned right before each relative pronoun. These sentences are not ambiguous. The third structure in (48) involves syntactic ambiguity related to anaphora resolution. These items present two same-gender characters via explicit NPs. This is followed by a pronoun in subject position that could potentially refer to either of the previously mentioned characters, creating then an ambiguity that must be resolved. Additionally, (49) is an example of filler items that include a subordinate clause functioning as direct object of the main clause. No ambiguity is created in these cases, neither in Spanish nor in English. Regarding filler items like (50), the structure is always as follows: someone does something to someone + *with* prepositional phrase. (50) may be ambiguous as it can be either *la niña/the girl* or *el hombre/the man* who has the binoculars. However, the semantics of the verb always biases the interpretation to the first-mentioned character, i.e., the subject of the main clause. Finally, the last structure is illustrated in (51) and contains contexts of object anaphora, i.e., pronouns used in object position. These items are mostly ambiguous, as they include two same-gender characters. However, when a human character and an animal are mentioned, there is no ambiguity in English. This is so because the pronoun *it* is used in English to refer to non-human entities, while Spanish refers to them using gender-marked pronouns (*lo/la*).

To avoid priming effects on target items regarding attachment biases, fillers present a balanced bias towards the subject and the object as the character who did the action. In the Spanish version of the tasks, the division is as follows: ambiguous sentences (N = 6 out of 36), subject bias (N = 15 out of 36) and object bias (N = 15 out of 36). In the English version of the tasks, the division is the following: ambiguous sentences (N = 5 out of 36), subject bias (N = 18 out of 36) and object bias (N = 13 out of 36). Filler items were included for two main reasons. Firstly, they allow us to dilute the prominence of the target sentences. In fact, target sentences only account for 25% of the total in the Spanish version of the tasks, and a 33% in the English version. Additionally, fillers, particularly unambiguous fillers, also served as an attentional control. In both the picture verification task and picture selection task, unambiguous fillers become a reliable measure for attentional accuracy. The fact that participants provided an incorrect response to an unambiguous trial is considered the result of lack of attention during task performance. Then, if they did not achieve a sufficiently high accuracy rate on these filler items (implemented as 80% accuracy), the researcher interpreted participants had not paid sufficient attention and their data were removed in the analyses.

Finally, **practice items** (N = 4) were also designed for the tasks. These items are presented at the beginning of each experiment as a warm-up to help participants familiarise with the task procedure and ensure they understand what to do during the actual task. Although the data from the practice trials are saved, they are not analysed. Regarding the sentential structures used in the practice, four different structures were used (see (52) to (55) below), using both ambiguous and unambiguous sentences. This approach was taken so that participants would encounter a variety of scenarios similar to those they would face during the task.

(52) *Aquí tienes al padre$_i$ que$_i$ besa a la novia$_j$ durante la boda*

Here you have the father$_i$ who$_i$ kisses the bride$_j$ at the wedding

(53) *Atiende al chico$_i$ que$_i$ saluda a la mujer$_j$ mientras monta$_{i/j}$ en bicicleta*

Observe the boy$_i$ who$_i$ greets the woman$_j$ while she$_j$ rides a bike

(54) *El lobo$_i$ muerde al conejo$_j$ con manchas grises en la pata*

The wolf$_i$ bites the rabbit$_j$ with grey spots on its paw

(55) *Presta atención al intérprete$_i$ de la ministra$_j$ que$_{i/j}$ lleva una mochila con desgana*

Pay attention to the interpreter$_i$ of the minister$_j$ who$_{i/j}$ carries a bag unwillingly

Finally, it is important to highlight that during the design of all linguistic stimuli, i.e., target sentences, as well as filler and practice items, a constant premise was that all sentences had to be depictable since they would be visually represented in pictures for the main tasks of this study.

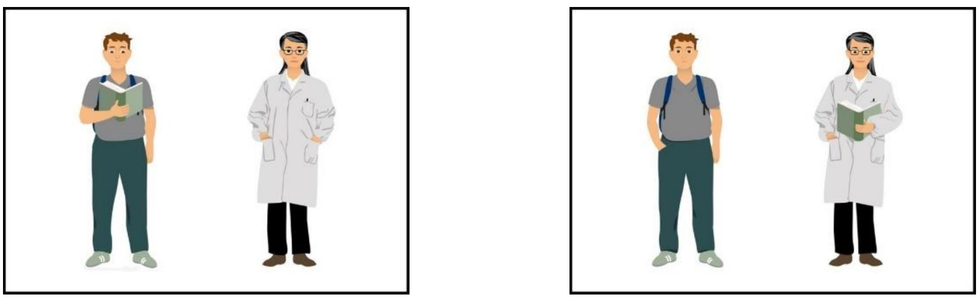
5.4.2. Visual stimuli

Once all sentences had been designed and double checked, the next step was to design the visual stimuli that would be part of the main tasks. This section will provide a thorough description of their design process together with the design criteria. It is important to mention that each individual sentence had two corresponding visual items, i.e., one picture would be the target picture and the other, the distractor, as observed in example (56) below. The design of the images was undertaken by a human graphic designer from the company *Adecua* to ensure the maximum quality and homogeneity of the images[26]. The final images were the result of many sessions in which the researchers provided guidelines and feedback on the specific characteristics each image should have to ensure that all illustrations aligned with the requirements of the experiments.

(56) **Item sample:**

*Observa aquí al alumno$_i$ de la científica$_j$ **que$_{i/j}$** lee un libro atentamente*

Observe now the student$_i$ of the scientist$_j$ **who$_{i/j}$** reads a book carefully



[26] Webpage: https://adecua.es/

For the design of the images, several requirements were carefully followed, ranging from the general and common guidelines applied to all images to the more specific details for both the characters and objects depicted. Regarding the overall guidelines, all images had to adhere to a consistent pattern. For each individual sentence, two pictures had to be created, where each image had two characters with the only difference being which character was doing the action mentioned. Thus, this made them two mirror images, as (56) above. Additionally, to maintain the **visual complexity** of the images low, two key decisions were made. Firstly, it was agreed that no background elements would be depicted. Images had a plain white background to integrate them with the screen of the computer during the tasks and a black border to distinguish the edge of the images from the background. Secondly, no shadows were included below the characters or objects in the pictures since they do not provide relevant information and may be distracting for participants. The main objective was to design as simple images as possible to prevent them from being overloaded.

Apart from the requirements that systematically applied to all images, several guidelines were also followed in relation to the **characters**. First, all the characters were to be drawn with the same height. This means that the two characters within the same picture should have the same size to ensure that their size is balanced within and across pictures and to avoid one character attracting more attention than the other. In the case of target items, the two characters had the exact same size. However, in the practice and filler items, some stimuli contained characters that differed in this regard. For instance, if a boy/girl or any other young character was mentioned, it was unavoidable to graphically capture a height difference. In these cases, an attempt was made to maintain the difference as moderate as possible. Second, the facial expressions of the characters received special attention. We believed it was important for the characters to have facial expressions, but to prevent them from being caricatured and to ensure that their expressions were balanced between the two characters. Therefore, their facial expressions should be lightly or subtly marked. Finally, as for their clothes, characters should wear prototypical clothing so that they are quickly associated with their profession or the type of character they are (a doctor, a teacher, a policeman, a scientist, a grandparent, a child, etc.).

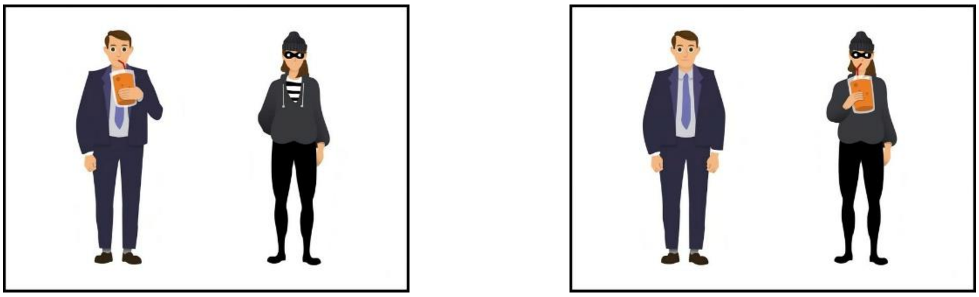
Together with the characters, **objects** were also depicted following specific criteria. Given that most pictures included additional objects, we made a distinction between two types: objects of interest, which are explicitly mentioned in the sentence and are part of the action itself, such as *the book* in (56) above, and other additional objects, which were usually those that characters wear or carry and serve to identify them with specific professions. Regarding the former, they had to be easily and quickly identifiable to avoid any visual delay when scanning the images and therefore, more eye-catching than any other object the characters may wear or hold. Another relevant aspect was their size. In the case of very small objects such as a cigarette, a cup or a juice, it was decided not to be completely faithful to reality in terms of proportion. Thus, these objects could be depicted as larger than normal to ensure that they did not go unnoticed by the participants. In contrast, the size of potentially large objects was also controlled and sometimes reduced in size. For instance, when a dog is mentioned, it was preferred to depict a small dog and not a big one, like a labrador. The aim was that the objects of interest in all images were balanced, and that there were no significant differences in proportion. In addition, objects of interest must appear attached to or as close as possible to the character carrying them. For instance, in sentences where a rubbish bag or an umbrella is mentioned, or a book as it is the case in (56), these should be depicted attached to the character. The motivation was to visually identify two compact units, i.e., the two characters, where one holds an additional element because he or she is the one performing the action.

Regarding other additional objects carried by the characters, their only purpose was to identify the characters themselves. Also, in contrast with the previous objects of interest, which were explicitly mentioned in the sentence, these additional objects were not. An example could be the bag of the student and the glasses of the scientist in (56) above, as well as the wool cap and the mask of the thief in (57) below. These objects were depicted following two main guidelines. First, if possible, they should be avoided to maintain low visual complexity. The was so to design the cleanest and simplest possible images that were not overloaded with dispensable elements. If they were necessary, they should be visually unobtrusive and small so that they did not stand out or attract attention.

(57) **Item sample:**

Observa aquí al abogado$_i$ de la ladrona$_j$ ***que***$_{i/j}$ *bebe un zumo tranquilamente*

Observe here the lawyer$_i$ of the thief$_j$ **who**$_{i/j}$ drinks a juice calmly



Finally, the colour palette of the images was also discussed, and some criteria were established. After seeing several initial sketches by the graphic designer, it was decided to use pastel colours that were not disruptive. Bright colours such as red or yellow were avoided in the characters' clothes and on the objects they carry, as they tend to attract more attention and consequently, could interfere in participants' gaze patterns (Berends et al., 2016), which might interfere with the aim of the tasks, i.e., to focus on the characters themselves and on the action performed.

5.4.3. Auditory stimuli

Together with the linguistic and visual stimuli, auditory stimuli were also part of this study, and this section will provide a description of them. Each individual sentence, i.e., practice items, filler items and target sentences in all conditions, was recorded. Given that all tasks were conducted in the participants' L1, Spanish for the Spanish monolingual and bilingual groups and English for the English monolingual group, auditory recordings were made by two native speakers of these languages.

First, a female native speaker of Spanish with typical prosody and a southern variety of the language recorded the Spanish version of the sentences. These recordings were implemented in the tasks administered to Spanish monolinguals and L1 Spanish-L2 English bilinguals, whose Spanish variety was also southern. Similarly, a female English native speaker with normal prosody recorded the English sentences for the tasks conducted by the English monolingual group. Her variety was British English, which corresponds with the variety of the English participants collected in Cambridge, United Kingdom, and with the English variety they are exposed to on a daily basis.

All sentences were recorded in a quiet lab[27] in the Arts and Humanities Faculty at the University of Granada using special equipment to ensure that no background noise affected the quality of the recordings. Each sentence was recorded multiple times, which allowed the selection of the best exemplar of each stimulus sentence. The selection criteria were based on normal speaking rate and naturalistic prosody in terms of intonation, stress, and rhythm. For instance, as mentioned earlier, pauses that could bias towards either a high or low attachment interpretation were avoided. The program used was *Audacity*®. All auditory recordings were normalised to a consistent sound level. These carefully selected recordings were then implemented in the tasks, providing participants with high-quality auditory stimuli.

5.5. Chapter summary

This section has provided a thorough description of the general method used in this study. This section has provided a thorough description of the general method used in this study. Firstly, a detailed summary of the participants' profile was offered in Section 5.1. The present PhD thesis has been conducted collecting data from three groups, i.e., two control groups of Spanish functional monolinguals (N = 50) and English functional monolinguals (N = 49), as well as an experimental group of advanced L1 Spanish-L2 English adult bilinguals (N = 47). This section also included the selection criteria for each group as well as their main characteristics to justify their suitability to take part in the study. In this regard, two aspects are of special relevance.

Firstly, in relation to the bilingual group, all participants are university students enrolled in the degree of English Studies in Granada, Spain. This was so because the present PhD thesis aims to explore potential attrition effects in a specific and unexplored context by previous literature, i.e., in university instructed settings where students are extensively exposed to their L2 on a daily basis. The high amount of L2 input these students receive and their active involvement in the L2 both in written discourse via essays, notes taken in the class, exams, etc. and oral discourse in the classroom create the perfect population to explore attrition effects. It is essential here to highlight that this L2 exposure takes place in an L1-environment, as these L1 Spanish-L2 English bilinguals live in Spain, being Spanish their functional language. The fact that attrition evidence is found in this population would challenge the assumption that attrition is only experienced

[27] Lab webpage: https://bilingualab.ugr.es/

by bilinguals with great disuse of their L1 and naturalistic exposure to the L2. Additionally, a second relevant aspect concerns proficiency in the L2, which was a criterion to participate in the study. All bilinguals had advanced proficiency in their L2 English (C1 – C2), whereas the two monolingual groups had low proficiency (A1 – A2). The rationale for this decision was to mitigate potential influence of the L2 in the functional monolingual groups.

The description of each group was followed by a description of the data collection procedure. Therefore, Section 5.2 provided an overview of the temporal sequence of the data collection process, including a general outline of the tasks administered. All participants first completed the corresponding L2 proficiency test as the score obtained served as a filter for participation: only candidates with low L2 proficiency were accepted in the Spanish and English monolingual groups, whereas only advanced bilinguals were included in the bilingual group. Then, eligible candidates completed online both the BLP questionnaire and the picture verification task. Once responded were submitted, an in-person session was appointed, where the two remaining tasks were administered, i.e., the eye-tracking experiment (which included the picture selection element) as well as the verbal working memory task.

Section 5.3 provided a more thorough explanation of each individual background task. Focusing first on the L2 proficiency tests, three different tests were administered depending on the second language of the participants. The Spanish monolingual group, along with the L1 Spanish-L2 English bilingual group, were administered the *Oxford Quick Placement Test* (Oxford University Press, 2003) to measure their proficiency in their L2 English. Regarding the English monolingual group, two tests were administered as participants within this group has either Spanish or French as their second language. Their proficiency in L2 Spanish and L2 French was assessed via the *University of Wisconsin Placement Test* (University of Wisconsin, 1998) and the *ESL French placement test* (ESL Free French Level Test, 2023), respectively. Candidates eligible to participant, completed a second background task: the *Bilingual Language Profile* questionnaire (Birdsong et al., 2012) to measure their language dominance. This test was included because, according to Gertken et al. (2014), bilinguals may have the same proficiency level but differ regarding their L1-L2 dominance. The BLP allowed us to address potential individual variability to include this variable in the analyses and modulate the results for the main tasks. Finally, all participant completed a verbal working memory task in the first language. Differences in working memory capacity may influence sentence processing and comprehension regarding attachment preferences (Y. Cheng et al., 2021; Hopp, 2014; J. H. Kim & Christianson, 2017). Thus, measuring these potential differences allowed us to control for potential variation in the results obtained.

Lastly, Section 5.4 focused on the design of the linguistic, visual and auditory stimuli employed in the experimental tasks. A thorough description and justification of the methodological decisions involved in the design process were provided. This explanation was further supported by multiple examples, particularly regarding sentences and images, which were carefully presented and discussed to ensure a clear understanding of the stimuli employed in the study.

Chapter 6: Picture selection task

This chapter presents the results of a picture selection task (PST), which was designed and administered to explore interpretation preferences in ambiguous relative clauses among an experimental group of instructed L1 Spanish-L2 English bilinguals compared to two control groups of Spanish monolingual and English monolingual speakers. It is important to specify that the PST was not a separate task, but rather integrated within the eye-tracking experiment. Since this experiment provided two different types of data, this chapter will focus on the offline results from the picture selection component.

Studies testing offline interpretation preferences regarding relative clauses have mostly employed other methodologies different from a PST. In particular, most data on interpretative biases have been collected using comprehension questionnaires in which ambiguous sentences were presented in written format, followed by several answers indicating who the host of the RC is (Y. Cheng et al., 2021; Dussias, 2003; Jegerski, VanPatten, et al., 2016; Shabani, 2018). For instance, Cheng et al. (2021) tested offline attachment preferences in ambiguous RCs such as (58). Participants were required to answer a comprehension question (*Who bought himself some books?*) followed by two possible answers (*The brother* / *The man*). In this case, selecting *the brother* would reflect a HA preference, while selecting *the man* would manifest a LA preference.

(58) *We met the brother*$_i$ *of the man*$_j$ ***who***$_{i/j}$ *often bought himself*$_{i/j}$ *some books*
Question: Who bought himself some books?
Answer options: The brother / The man

Other studies have investigated offline RCA preferences using the scores assigned to biased sentences in an acceptability judgement task (Papadopoulou & Clahsen, 2003) and participants' responses to comprehension questions included within other experimental tasks like self-paced reading tasks (Jegerski, Keating, et al., 2016). For example, Papadopoulou and Clahsen (2003) tested attachment preferences via an AJT where participants read sentences like those in (59) below and judged their acceptability on a five-point scale: 1 = not at all acceptable, 5 = completely acceptable. The authors predicted participants' scores to be affected by their attachment preferences. If the disambiguating adjective (*disappointed*) confirmed the initial, preferred strategy, those sentences should receive higher scores.

(59) TARGET ITEMS[28]

(59a) **High attachment**

*A man called the student$_{i[masc]}$ of the teacher$_{j[fem]}$ **who**$_{i/j}$ was disappointed$_{[masc]}$ by the new educational system*

(59b) **Low attachment**

*A man called the student$_{i[masc]}$ of the teacher$_{j[fem]}$ **who**$_{i/j}$ was disappointed$_{[fem]}$ by the new educational system*

Although these methodological approaches, i.e., offline questionnaires and AJTs, directly address offline attachment preferences, little is known about attachment biases with visual stimuli. Thus, data gathered from a PST will provide insights into offline interpretation strategies using a different approach, adding evidence to the existing literature.

The present chapter is structured as follows. Section 6.1 will revisit the research questions to be answered with data from the picture selection task. The methodology of the PST will be described in Section 6.2, focusing on the procedure and experimental conditions of the task. Section 6.3 will focus on the process of data cleaning and pre-processing prior to data analysis, while the results will be provided in Section 6.4. A final discussion of the results obtained will be presented in Section 6.5.

6.1. Research questions

This chapter presents the results of the PST and address the research questions formulated specifically for this task. The complete set of research questions and hypotheses were presented and discussed in Chapter 4, but the specific RQs for the picture selection task,

[28] In Papadopoulou and Clahsen's (2003), the original experimental sentences were in Greek as they tested L1 and L2 Greek speakers. For simplification purposes, only the literal translations into English provided by the authors themselves are shown here.

together with an abbreviated version of their corresponding hypotheses are reintroduced. The rationale behind this decision is to contextualise the results provided in the following sections and to facilitate readers' interpretation of those findings. Therefore, the present chapter aims to answer the following research questions:

RQ1 What **attachment strategies** (HA vs. LA) do Spanish monolinguals, instructed bilinguals, and English monolinguals employ in their L1 offline interpretation of ambiguous relative clauses?

H1. Spanish monolinguals are expected to display a straightforward tendency toward HA in their L1 Spanish, while English monolinguals are predicted to favour LA in their L1 English. This will be represented by higher selection of the image that represents the L1-preferred interpretation for each group: HA-biased image for the Spanish group, and LA-biased image for the English group. Regarding L1 Spanish-L2 English instructed bilinguals, it is predicted that their L1 preferred strategy will be mitigated, showing higher tendency toward the L2 preferred disambiguation mechanism, i.e., low attachment.

RQ2 Does **language dominance** modulate the L1 offline interpretation of ambiguous relative clauses across the three groups investigated?

H2. If language dominance is to exert an effect on offline RCA preferences, this effect is expected to be significant for the bilingual group only. Given the low dominance in the L2 control monolingual participants, no significant effect of language dominance is expected in these groups. Conversely, significant effects may be found for instructed bilinguals, compared to the other groups. Higher dominance in Spanish is predicted to correlate with increased HA-responses, while bilinguals who are more English-dominant are expected to favour LA-responses.

RQ3 Does length of **L2 immersed instruction** modulate the L1 offline interpretation of ambiguous relative clauses in L1 Spanish-L2 English bilinguals, leading to L1 attrition effects?

H3. It is predicted that, if L1 attrition effects are evidenced in the offline interpretation of ambiguous relative clauses, these effects may be further modulated by cumulative L2 exposure in an instructed, classroom setting. Focusing on the bilingual group, more evident L1 attrition effects, i.e., higher selection of the image depicting an LA interpretation, will be found in instructed bilinguals with longer exposure to their L2

English. In other words, longer exposure to the L2 in an instructed setting is expected to correlate with increased preference for LA among bilinguals.

RQ4 Are L1 attrition effects observed in the **response times** of instructed L1 Spanish-L2 English bilinguals compared to Spanish and English monolinguals?

H4. If L1 attrition effects are found in bilinguals, these will be observed in ambiguous sentences only, manifested as higher RTs. This is so because, based on the offline PST data, monolinguals show clear interpretative biases (HA preference in Spanish natives and LA preference in English natives). Thus, lower RTs (i.e., faster responses) are predicted for the two monolingual groups, who will need less time to provide a final interpretation of the sentence. Conversely, bilinguals are expected to exhibit higher RTs (i.e., slower responses) compared to Spanish and English monolinguals due to the greater optionality in their attachment preferences found in the offline data. No differences are expected in the two control conditions (i.e., forcing-HA and forcing-LA).

6.2. Methodology

This section will outline all methodological aspects specifically related to the PST. While Chapter 5 presented the general method of the entire PhD thesis, including participant details, overall procedure and task sequencing, stimuli design, etc., this section will revisit and expand all methodological aspects specific to the PST. This will ensure that readers have the necessary context to successfully interpret the following results.

The experiment was conducted in person. First, the researcher explained the procedure of the task verbally and asked for any questions or doubts. Then, participants sat in front of the computer screen and were required to place their hands on the keyboard. The researcher started the task, which began automatically for the participant. The first display thanked their participation, and this was followed by the written instructions, which covered a couple of displays (see Appendix L: Written instructions for eye-tracking task and PST). While the first screen appeared automatically, participants pressed the spacebar to proceed to the next instructions window. Written instructions were provided to ensure all participants could read at their own pace and fully understand them. Once the instructions were read, the actual task started, beginning with some practice sentences. The procedure was identical in both the practice part and throughout the actual task.

Each trial began with a blank screen displaying a fixation cross in the centre. Recall that although we present data from the picture selection task as an independent task, it was integrated in the visual world eye-tracking experiment. If participants looked at the cross for the required minimum time, the trial started. Two images appeared on the screen simultaneously, with each image being displayed on one side of the screen: one picture on the left and the other, on the right. At the same time, participants listened to a sentence in their native language. The stimuli used in this task have been described in Section 5.4. Example (60) below is an illustration of a trial. In this trial, participants would be presented with the two images below and simultaneously listen to one of the sentences. The Spanish version of the task, as explained in Section 5.4.1, contains three experimental conditions, i.e., forcing-HA, forcing-LA and ambiguous condition, while the English task only included the ambiguous condition. Thus, for the trial displaying the two images below, Spanish monolinguals and L1 Spanish-L2 English bilinguals listened to one of the conditions exemplified in (60). The same applies to the English monolingual group, but they were only exposed to the ambiguous condition.

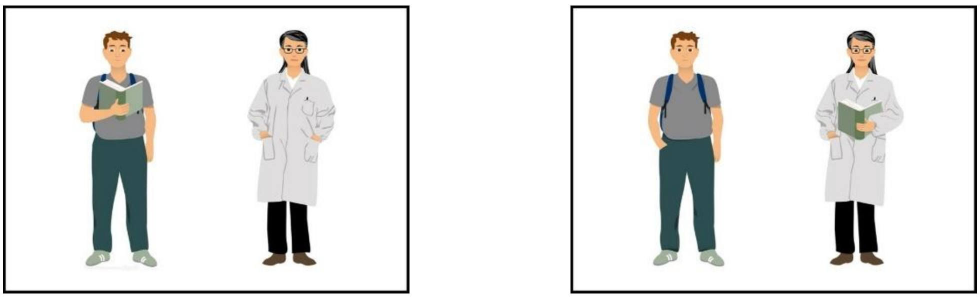
(60) **Trial sample:**

Forcing-HA: *Observa aquí al alumno*$_i$ *de la científica*$_j$ ***el cual***$_i$ *lee un libro atentamente*

Forcing-LA: *Observa aquí al alumno*$_i$ *de la científica*$_j$ ***la cual***$_j$ *lee un libro atentamente*

Ambiguous: *Observa aquí al alumno*$_i$ *de la científica*$_j$ ***que***$_{i/j}$ *lee un libro atentamente*

Observe here the student$_i$ of the scientist$_j$ **who**$_{i/j}$ reads a book carefully



Participants were instructed to listen carefully to the sentence while looking at the images. It is worth mentioning that one image always represented a high-attachment interpretation of the sentence, while the other represented a low-attachment interpretation. In example (60) above, the image on the left depicts a HA-interpretation and the image on the right, a LA- interpretation of the relative clause *que lee un libro atentamente / who reads a book carefully*. At the end of each recording, a sound marked the conclusion of the sentence and participants selected an image using the keyboard. The sound was included for two reasons. First, we believed it was necessary to explicitly mark the end of the sentence, as there were no comprehension questions. Second, the task was designed so that participants could not select any image until the sentence had finished. Even if they pressed a button during the trial, this was not recorded. This was so to ensure that participants had listened to the whole sentence before providing a response. Therefore, the sound signalled the moment from which they were allowed to respond. After the sound, participants had to choose which image best represented the sentence they just had heard. They did so by pressing either the F or J keys in the keyboard, depending on whether they wanted to select the image on the left or the image on the right, respectively. Once a button was pressed, both images disappeared, and the next trial began.

The forced-choice nature of the task, i.e., participants could only select one of the two possible interpretations, would provide insights into participants' offline preferred interpretation. Taking (60) above as an illustration, the fact that participants selected the image on the right would evidence a HA preference in the interpretation of the sentence. The opposite would hold if the image on the right would be chosen. In the L1 Spanish task, the forcing-HA and forcing-LA conditions were two control conditions because these sentences are not ambiguous and only one interpretation is possible. Selecting the incorrect attachment option would be considered the result of lack of attention.

6.3. Data cleaning and pre-processing

Prior to analysing data from the PST, data were cleaned and pre-processed. Experiment Builder provides a separate file for each participant in long format, where each row corresponds to each trial or observation, and all relevant variables are included in separate columns. The files with experimental data were first merged to include the demographic information for the participants, which included, for example, variables such as L2 proficiency, BLP and working memory scores, etc. Adding these variables allowed us to include them as predictors in the statistical models, providing further insights into whether and how they may modulate the main results obtained. As a result, both the experimental and demographic data were combined into one single long-format dataset

The Bilingual Language Profile (BLP) variable required special attention to ensure consistency across all groups. As described in Section 5.3.2, the BLP questionnaire measures language dominance along a continuum. It provides an index of dominance ranging from -218 to +218, where positive values indicate that a participant is more L1 dominant and negative values indicate that they are more L2 dominant. The final mean score is obtained by subtracting the overall L2 dominance score from the overall L1 dominance score. The scoring procedure is exemplified in Table 22, where each row represents a real participant from each group. For all of them, the mean BLP score is the result of subtracting the L2 score from the L1 score.

Table 22:

Example scoring of BLP variable with raw data

	Overall L1	Overall L2	Mean BLP score
Spanish monolingual	208.64	45.58	163.08
Bilingual	191.95	123.71	67.64
English monolingual	208.84	32.89	175.95

Not all groups were administered the same version of the BLP questionnaire. Instead, three versions were administered based on the participants' L1-L2 combination. The only difference between these versions was the language in which questions were formulated, while the range of scores remained consistent across all versions (from -218 to + 218). As explained in Section 5.3.2, the two groups with L1 Spanish and L2 English, i.e., the Spanish monolingual group and the bilingual group, completed the L1 Spanish-L2 English version of the BLP. In contrast, the English monolingual group completed either the L1 English-L2 Spanish or the L1 English-L2 French versions. Thus, the L1-L2 combination do not coincide for all groups and participants cannot be placed within the same continuum of dominance as the poles of the continuum differ. For Spanish monolinguals and bilinguals, scores closer to the positive pole (+218) indicate higher dominance in Spanish. For instance, in Table 22, the mean score for the Spanish monolingual speaker (163.08) is higher than that of the bilingual one (67.64), meaning that the former is more Spanish-dominant. However, a higher score for the native English participant (175.95) does not indicate higher dominance in Spanish, but in English.

The issue arises because the subtraction of L2 from L1 involves different languages for different groups. To place all scores within the same continuum, with the same poles, it is necessary to specify which language is on the left-side of the continuum (-218) and which language is on the right-side (+218). To do so, it was avoided to subtract the L2 score, regardless of what specific language the L2 is, from the L1. Instead, the overall score for Spanish (or French) was always subtracted to the overall English score. This was done by creating a new variable in the dataset, whose value was calculated by subtracting the overall dominance in Spanish (or French in the English native group) from the overall dominance in English. This is illustrated in Table 23, where the mean BLP score for each participant, regardless of group, is the result of subtracting the Spanish score from the English score. As a result, the values for both the Spanish monolingual (-163.08) and the bilingual speakers (-67.64) are negative. Being closer to the negative pole no longer indicates higher L2 dominance, but rather higher Spanish dominance. On the contrary, scores closer to the positive pole represent higher dominance in English, as it is the case for the English monolingual participant (175.95).

Table 23:

Example scoring of transformed BLP variable

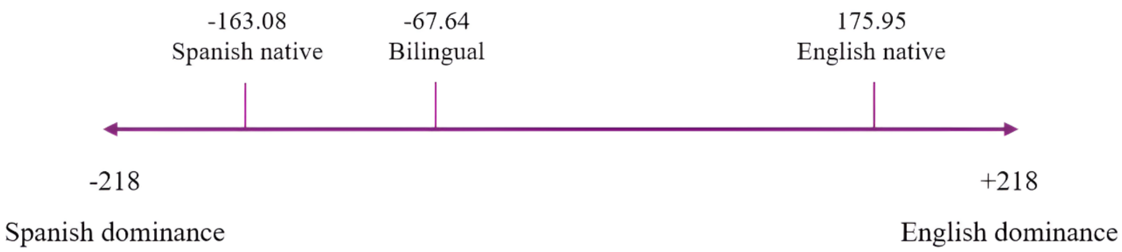
	Overall English	Overall Spanish[29]	Mean BLP score
Spanish monolinguals	45.58	208.64	-163.08
Bilinguals	123.71	191.95	-67.64
English monolinguals	208.84	32.89	175.95

Consequently, the mean BLP scores for all participants can be placed within the same Spanish-English continuum. By recalculating the scores in this way, the resulting means can be consistently compared across groups and the new BLP variable can be added to the statistical models as a predicting variable. Figure 1 below illustrates the final BLP continuum, indicating the mean scores for participants in Table 23.

[29] A most accurate label would be "Overall Spanish/French" as participants in the English group had either Spanish or French as their L2. However, we prefer the label provided for simplification purposes.

Figure 1:

BLP continuum after transformation



An additional step before data analysis was to check comprehension accuracy in the filler items as a measure of participants' attention. Following standard practices in previous research (Marsden et al., 2018), the threshold was set at 80% per participant. A percentage above this threshold would indicate that the participant accurately completed the task and were engaged in it. A total of 7 participants were excluded because they did not reach the 80% threshold. These excluded participants belonged to the Spanish monolingual group (N = 5) and the English monolingual group (N = 2). No participants from the bilingual group were excluded from the analysis. For the remaining participants (N = 138), mean comprehension accuracy to fillers was 89%, 99% and 97% for Spanish monolinguals, instructed bilinguals and English monolinguals, respectively.

The analysis will also consider the response times of each experimental trial, i.e., the time participants needed to select the image that best represented the sentence they just heard and to provide a response. To identify and remove potential outliers in the response time data, the first step was to create a plot to visualise the distribution of RTs for each group. Then, the interquartile range (IQR) for each group was calculated, and a separate upper cutoff value was provided for Spanish monolinguals (2314 ms), bilinguals (2838 ms) and English monolinguals (4822 ms). Values with RTs exceeding the upper cutoff for each participants group were coded as missing and removed. In the experimental items, this led to the removal of 7.11% of the data. The specific percentage of RTs exclusion for each group was as follows: Spanish monolingual group = 8.27%, bilingual group = 8.52%, English monolingual group = 4.73%).

6.4. Results

This section will provide the results obtained from the picture selection task. The following statistical analyses will consider two types of data: offline attachment preferences (see Section 6.4.1), which corresponds to the image selected by participants, together with the response times to make such decision (see Section 6.4.2).

6.4.1. Results for offline attachment preferences

First, it is relevant to specify the dependent and independent variables for the analyses. Regarding the former, the dependent variable is participants' offline attachment preferences (HA vs. LA). This is a two-alternative forced choice response, as participants must select either the image that represents a HA interpretation of the RC, or the image that represents a LA interpretation. Given that attachment preferences are a categorical response variable, these will be examined using logistic regression. Generalised linear mixed-effects models were applied to the data using the *glmer* function of the *lme4* package (Bates et al., 2015) in the R environment (R Core Team, 2024). In addition, the independent variables or predictors will be the following: experimental *condition* (forcing-HA, forcing-LA and ambiguous), *group* (Spanish monolinguals, bilinguals and English monolinguals), together with demographic variables such as *language dominance* (BLP score) and *length of L2 immersed instruction*. Finally, as mentioned earlier, the outcome variable, i.e., attachment preferences, was binary (HA vs. LA) and coded as follows: HA-choices were coded as 1, while LA-choices were coded as 0. Consequently, the output of the following statistical models, reported in *log odds*, will show the probability of selecting a HA-representation versus the probability of not selecting it.

Prior to providing the output of the inferential models, the descriptive results will be offered. Figure 2 presents the percentage (%) of HA responses by group and experimental condition. Importantly, all groups in Figure 2 were tested in their L1, i.e., Spanish for Spanish monolinguals and instructed bilinguals, and English for English monolinguals. This means that results illustrate participants' preferences in their corresponding L1. Data for the English monolingual group is only available for the ambiguous condition as this was the only experimental condition tested in the English version of the PST (see Section 5.4.1). The means and standard deviations (SDs) of HA responses can be found in Table 24 below.

Figure 2:

Proportion of HA responses by condition and group

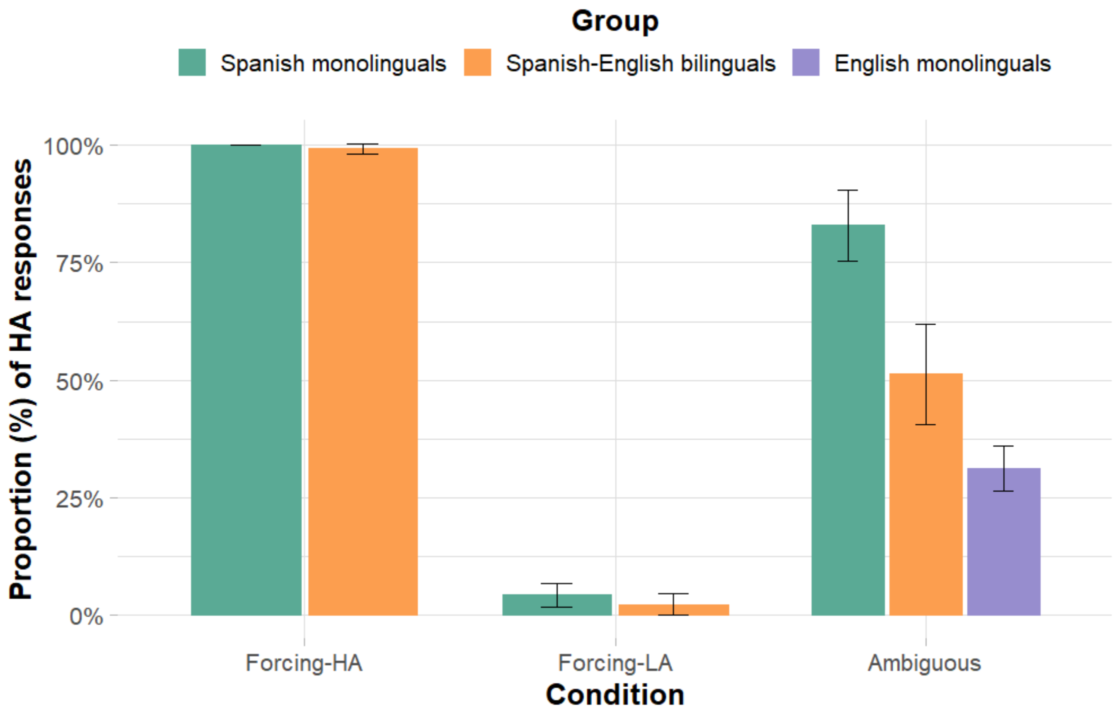


Table 24:

Mean percentages (%) and standard deviation of HA responses by condition and group

	Spanish group		**Bilingual group**		**English group**	
	mean	*SD*	*mean*	*SD*	*mean*	*SD*
Forcing-HA	100	0	99.3	3.47	—	—
Forcing-LA	4.26	8.21	2.22	7.62	—	—
Ambiguous	82.9	24.3	51.3	34.9	31.2	16.5

Considering Figure 2, in the forcing-HA condition, both the Spanish monolingual group and the bilingual group show a strong tendency to select a HA-interpretation of the sentence (Spanish: mean = 100%, *SD* = 0; Bilinguals: mean = 99.3%, *SD* = 3.47). This was predicted as sentences in the forcing-HA condition were not ambiguous but rather forced high attachment to NP1. These mean percentages, together with the low variability reflected in their standard deviations, confirm that participants in these two groups accurately understood the sentences. Regarding the forcing-LA condition, they show the opposite pattern. Spanish monolinguals and bilinguals do not select a HA interpretation, being the percentages for HA very low in the two groups (Spanish: mean = 4.26%, SD =

8.21; Bilinguals: mean = 2.22%, SD = 7.62). This pattern was also expected, as forcing-LA sentences are not ambiguous, and the RC can only be interpreted as modifying NP2. The low rate of HA responses in the forcing-LA condition confirms that participants in both groups correctly understood the sentences they heard. However, considering the percentages for the forcing-LA condition, it seems surprising the number of HA-choices participants made, even when attaching the RC to NP1 was not grammatically correct. This tendency is more pronounced for the Spanish monolingual group (4.26% of HA-choices). Considering these findings with those of the forcing-HA condition, Spanish monolinguals and instructed bilinguals seem to pattern together, clearly favouring HA when this attachment was forced. On the contrary, there is a slight HA bias in the forcing-LA condition for the Spanish group, especially in comparison with the bilingual group.

As for the ambiguous condition, which is the condition of interest for this PhD thesis, data for the three groups can be compared. In fact, group differences are more noticeable than in the previous control conditions. When confronted with ambiguous relative clauses in their L1, the Spanish group clearly prefers a HA interpretation (mean = 82.9%, SD = 24.3), while the native English group prefers an LA interpretation (mean HA-choices: 31.2%, SD = 16.5). Instructed bilinguals seem to be at chance levels (mean = 51.3%, SD = 34.9), which indicates that their L1-preferred strategy, i.e., high attachment, seems to be mitigated. Bilinguals do not pattern neither with Spanish nor with English monolinguals. The results for standard deviations reveal increased variability in the ambiguous condition compared to the two forcing conditions. In both the forcing-HA and forcing-LA conditions, standard deviations are rather small for both Spanish monolinguals and instructed bilinguals, suggesting low variability in participants' responses. This is especially true for the former group. Conversely, the ambiguous condition involves higher standard deviations, which indicates higher variability in attachment choices. Overall, when participants are exposed to unambiguous sentences, their responses are consistent, evidencing a correct interpretation. However, ambiguous RCs result in higher variability regardless of group, although such variation is particularly high in the instructed bilingual group (SD = 34.9).

The output of the regression models predicting attachment preferences is presented in Table 25 and Table 27. As already mentioned, the PST included three conditions for Spanish monolinguals and instructed bilinguals (forcing-HA, forcing-LA and ambiguous conditions), and one condition for English monolinguals (ambiguous condition).

Therefore, two models were run. A first model included all three participant groups in the shared ambiguous condition to explore potential group effects on attachment preferences. Then, a second model included Spanish monolinguals and instructed bilinguals only to investigate both group and condition effects. If group differences are found in the first analysis across all groups for the ambiguous condition, this second analysis will help investigate if such differences represent an actual condition effect, with variability being specific to the shared condition, or if they are arbitrary and found in all conditions. When comparing Spanish monolinguals and bilinguals in all conditions, differences are only expected in the ambiguous condition.

The R code for the **first model** is provided in (61) below. It predicts HA responses comparing data from all participants in the ambiguous condition only, with the Spanish monolingual group set as the reference level. This will allow us to compare bilinguals and English monolinguals with Spanish monolinguals. The best fitting model that converged predicts attachment as a function of one predictor, *group* (Spanish monolinguals, instructed bilinguals and English monolinguals). The random-effects structure includes random intercepts for both participant and item to model variability across participants and items. A random slope for group by item had to be removed due to a singularity issue to reduce complexity in the random-effects structure[30]. The model output is provided in Table 25.

(61) **Model attachment by group:**[31]

```
model ← glmer(attachment ~ group + (1 | participant) + (1 | item),
                    family = binomial)
```

[30] When running mixed-effects models in R, sometimes the *lme4* function cannot properly estimate the correlation between random effects. This may happen, for instance, if the random-effects structure is too complex for the amount of data or collinearity, leading to estimation problems.

[31] When the R code for the models is reported, only the fixed and random-effects structure will be provided.

Table 25:

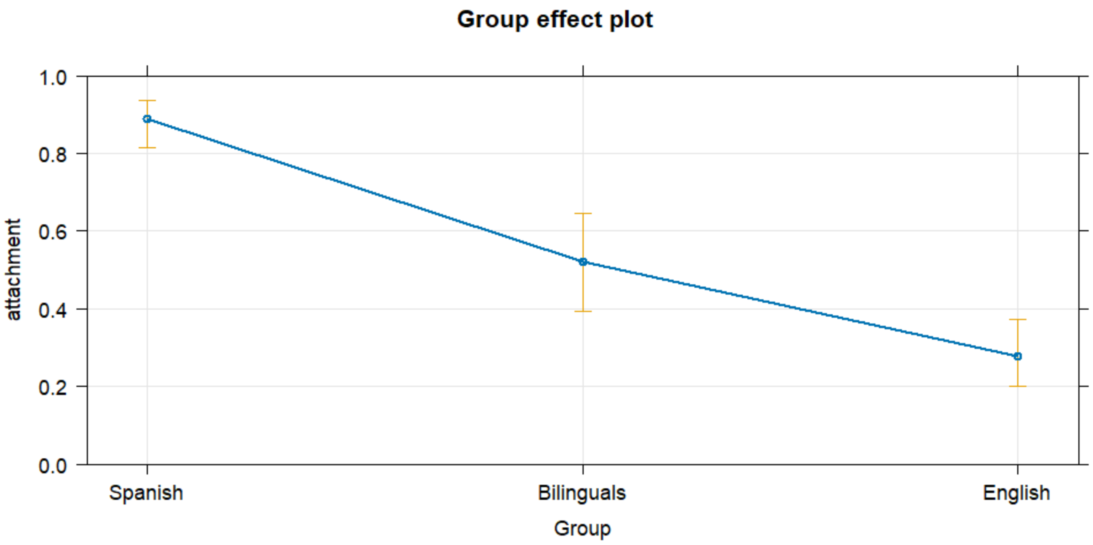
Model output for attachment by group in sentences containing ambiguous relative clauses

	Estimate	**Std. error**	**z-value**	***p*-value**	
Intercept	2.093	0.312	6.701	< 0.001	***
Group Bilinguals	-2.012	0.363	-5.538	< 0.001	***
Group English	-3.044	0.339	-8.977	< 0.001	***

To interpret the above results, recall that negative values indicate lower probability of selecting the HA-biased image (i.e., selecting a HA interpretation) and therefore, higher preference for LA. The model indicates significant differences across groups in the ambiguous condition. When compared with Spanish monolinguals, significantly fewer HA responses are predicted for instructed bilinguals in ambiguous sentences ($\beta = -2.012$, $p < 0.001$). As for native English monolinguals, and relative to the reference Spanish group, English speakers have even lower probability to select a HA response ($\beta = -3.044$, $p < 0.001$), indicating higher preference for low attachment. Overall, these results evidence clear group differences in attachment preferences for ambiguous RCs. The predictions of the model are shown in Figure 3.

Figure 3:

Predicted HA-responses for all groups in ambiguous sentences



To follow up on the significant results obtained, pairwise comparisons were conducted using the *emmeans* package (Lenth, 2024). The contrasts between groups reveal differences are significant for all pairwise comparisons. The Spanish monolingual group shows significantly higher likelihood of selecting a HA-biased image than both bilinguals and English monolinguals. Similarly, the bilingual group is significantly more likely to select a HA-biased image than the English group (β = 1.03, p = 0.001), although the difference is smaller compared to that of Spanish monolinguals vs. bilinguals. Instructed bilinguals do not behave like either Spanish monolingual or like English monolingual speakers, exhibiting an intermediate, more moderate position regarding attachment preferences than the two control groups.

Table 26:

Pairwise comparisons of HA responses across groups

Contrast	Estimate	Std. error	z-value	*p*-value	
Spanish - Bilinguals	2.01	0.363	5.538	< 0.001	***
Spanish - English	3.04	0.339	8.977	< 0.001	***
Bilinguals - English	1.03	0.289	3.566	0.001	**

An additional **second model** was ran including two groups only: Spanish monolingual speakers and instructed L1 Spanish-L2 English bilinguals. The R code is provided in (62) below. The structure of the model of maximum fit for the data is as follows. Fixed effects included *group* (Spanish monolingual and bilingual groups), *condition* (forcing-HA, forcing-LA and ambiguous), and their interaction *group*condition*. For the *group* variable, the reference level was set to Spanish monolinguals, while for the *condition* variable, the reference level was the forcing-HA condition. Therefore, the intercept represents the baseline attachment preference for Spanish monolinguals in the forcing-HA condition. Additionally, random intercepts were included for both participant and item to account for participant-level and item-level variability. The model output is provided in Table 27.

(62) **Model attachment by condition (Spanish monolinguals vs. bilinguals):**

model 🡐 glmer(attachment ~ group * condition + (1 | participant) + (1 | item),
family = binomial)

Table 27:

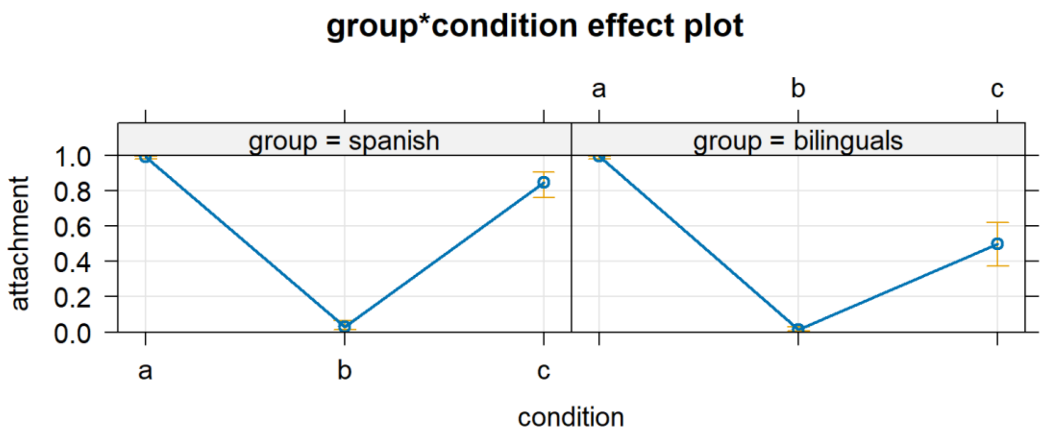
Model output for attachment by group and condition (Spanish monolinguals vs. bilinguals)

	Estimate	**Std. error**	**z-value**	***p*-value**	
Intercept	5.190	0.652	7.951	< 0.001	***
Group bilinguals	0.071	0.880	0.082	0.9350	
Condition forcing-LA	-8.632	0.723	-11.930	< 0.001	***
Condition ambiguous	-3.458	0.622	-5.555	< 0.001	***
Bilinguals: forcing-LA	-0.994	0.999	-0.996	0.319	
Bilinguals: ambiguous	-1.808	0.873	-2.070	0.038	*

To interpret the output in Table 27, recall that higher estimates indicate higher probability of selecting a HA interpretation. The model indicates non-significant *group* effects (Spanish monolinguals vs. bilinguals) in the forcing-HA condition (bilinguals: $\beta = 0.071$, $p = 0.9350$). This means that, as expected, these two groups do not significantly differ in their attachment preferences for this condition. In contrast, *condition* effects are significant for both forcing-LA and ambiguous conditions when compared to the reference forcing-HA condition (Forcing-LA: $\beta = 8.632$, $p = < 0.001$; Ambiguous: $\beta = -3.458$, $p = < 0.001$), although this only involves Spanish monolinguals. When comparing HA choices among Spanish natives in the forcing-HA vs. forcing-LA conditions, these significantly decrease in the forcing-LA condition as the only plausible disambiguation of these sentences is via LA. Similarly, HA-choices in the ambiguous condition also decrease, although this tendency does not reach forcing-LA levels.

Figure 4:

Predicted HA-responses by group and condition (Spanish and bilinguals)



The most relevant findings for this PhD thesis are to be found in the interaction effects (*group*condition*) as both groups are compared. Here, we are comparing the difference between bilinguals' forcing-LA and forcing-HA conditions vs. the difference between Spanish monolinguals' forcing-LA and forcing-HA conditions. The same holds for the ambiguous condition. As expected, significant differences between Spanish monolinguals and bilinguals are only observed for the ambiguous condition (β = -1.808, p = 0.038). This indicates that L1 Spanish-L2 English instructed bilinguals show significantly fewer HA-responses in the ambiguous condition that Spanish monolingual speakers. This is in line with expectations, assuming that L1 attrition effects are manifested. No significant interaction is found between groups and forcing-LA condition. Considering these results together with those obtained in the general model for all participants (see Table 25), it is confirmed that the *group* effects observed earlier are not arbitrary and present across all experimental conditions. Differences are restricted to the ambiguous condition, where instructed bilinguals significantly differ from both Spanish and English natives. This is further confirmed by additional pairwise comparisons using the *emmeans* function (Lenth, 2024). For the ambiguous condition, the contrast between the Spanish monolingual and bilingual groups reveals a highly significant differences, with Spanish monolinguals displaying significantly higher likelihood of selecting a HA representation compared to instructed bilinguals. In other words, Spanish natives are more likely to resolve ambiguous relative clauses via a HA interpretation. The preference for HA in bilinguals is weaker, as they seem to rely more often on an LA interpretation. This tendency may suggest evidence of L1 attrition effects among instructed L1 Spanish-L2 English bilinguals. Such intermediate position will also be observed for response times in the PST (see Section 6.4.2) and will be a general tendency across all experimental tasks. These findings will be further discussed in Section 6.5.

6.4.1.1. Attachment preferences and language dominance

The present PhD thesis also aims to explore whether offline attachment preferences may be modulated by additional factors, focusing on the role of individual differences. According to results from Section 6.4.1, and considering ambiguous sentences only, instructed L1 Spanish-L2 English bilinguals significantly differ from the two control groups of Spanish and English monolinguals, with instructed bilinguals showing higher optionality in their attachment preferences. They do not exhibit a strong tendency to attach the relative clause to NP1, as Spanish monolinguals do, but they do not pattern with English monolinguals either in a preference towards low attachment.

This section will address whether these offline attachment preferences are further modulated by **language dominance**, was assessed using the Bilingual Language Profile (BLP) questionnaire. To include BLP scores as a predictor variable in the statistical models, the raw mean scores obtained for each participant were transformed so that they were all placed within the same language continuum (see Section 6.3 for a more thorough description of this procedure). The resulting mean scores are interpreted as follows for all groups: values closer to the negative end of the continuum (-218) indicate higher Spanish dominance, while values closer to the positive end of the continuum (+218) indicate higher English dominance. Before including this continuous variable as a predictor in the models, it was standardised but not centred. This was so because in the original scale (±218), the value 0 has a specific and meaningful interpretation, i.e., balanced bilingualism. Centring the variable would shift its scale and alter the interpretation. However, not centring the variable helps preserve the original meaning of the scale.

To address potential dominance effects, two regression models were used. First, one model analysed data from all participants in the ambiguous condition. Then, a second model predicted variability in attachment choices for the bilingual group only. Regarding the former, it predicts attachment preferences in the ambiguous condition based on group and language dominance, measured by the BLP questionnaire. The specific code in R for this model is provided in (63). The fixed-effects structure includes simple effects for *group* (Spanish monolinguals, bilinguals and English monolinguals), *language dominance* (BLP score), and their interaction (*group*BLP*). As for the *group* variable, bilinguals were set as reference level to examine the main effect of language dominance (BLP) on this specific group. Finally, the random-effects structure includes random intercepts for participant and item to account for variability in attachment preferences due to individual differences across participants and items. The model output is presented in Table 28.

(63) **Model BLP all groups:**

```
model_BLP ← glmer(attachment ~ group * BLP_scaled +
                  (1 | participant) + (1 | item),
                  family = binomial)
```

Table 28:

Model output for attachment by group and BLP

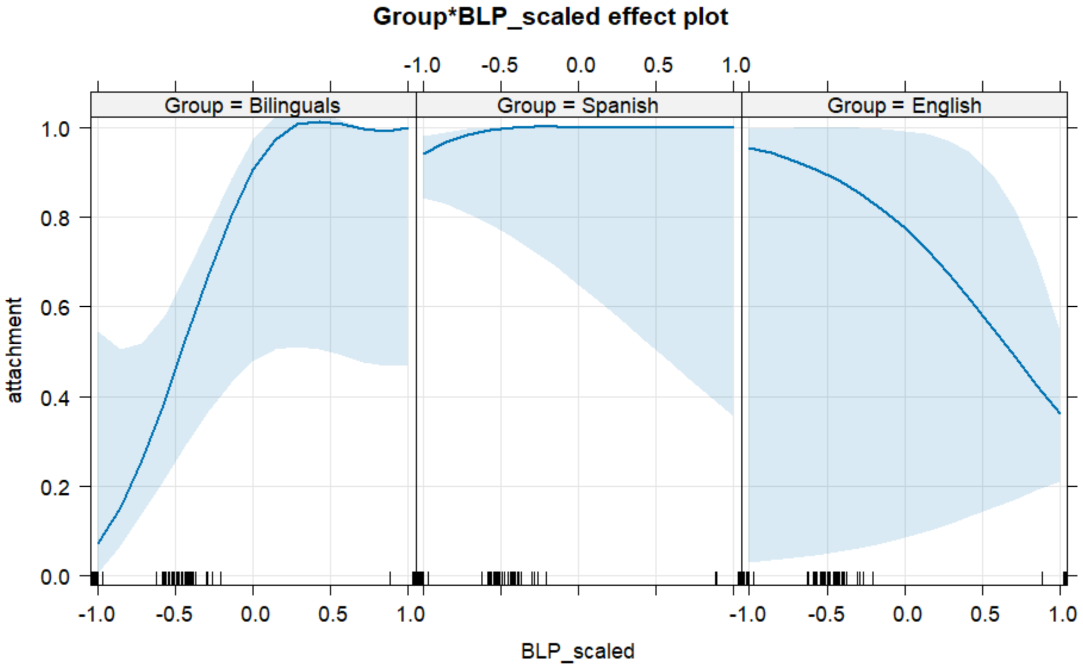
	Estimate	**Std. error**	**z-value**	***p*-value**	
Intercept	2.420	1.253	1.931	0.053	.
Group Spanish	5.946	4.133	1.439	0.150	
Group English	-1.178	2.219	-0.531	0.595	
BLP	4.977	2.599	1.914	0.055	.
Spanish: BLP	0.602	4.325	0.139	0.889	
English: BLP	-6.784	3.009	-2.254	0.024	*

The intercept represents the baseline log-odds of attachment choices when the other predictors (group and BLP score) are at their reference levels, i.e., bilinguals and value 0 for the BLP, respectively. Overall, no significant effects are found. The plot that illustrates the model predictions is provided in Figure 5. Regarding the *group* variable, the estimates indicate that Spanish monolinguals are more likely to select a HA response that bilinguals (β = -5.946, p = 0.150) at the average dominance level. Conversely, English monolinguals are less likely to select a HA response than bilingual speakers (β = -1.178, p = 0.595). None of these differences is statistically significant (p > 0.05).

The most relevant results are to be found in the main effect of language dominance (BLP) on instructed L1 Spanish-L2 English bilinguals. The positive estimate indicates that increased dominance correlates with higher selection of a HA interpretation (β = -4.977, p > 0.05). To put it simply, those bilinguals who are more English-dominant (those with higher positive BLP scores) tend to favour more frequently a HA interpretation. This effect is non-significant but is still contrary to expectations. Bilinguals with higher English dominance were expected to show stronger preference for LA. Given that the main effect of language dominance, measured by the BLP, is non-significant, these findings suggest that dominance does not significantly modulate attachment preferences across groups. These non-significant results may be due to the lack of sufficient data to draw conclusive results. There is great variability across groups regarding language dominance, but the variability within each group may not be enough to predict attachment preferences. A more thorough discussion on this issue will be found in Section 6.5.

Figure 5:

Predicted HA responses by group and language dominance (BLP)



To further explore the potential modulating effect of language dominance, we will analyse only the L1 Spanish-L2 English group. This will allow us to explore whether language dominance may influence RCA preferences within bilinguals. To do so, an additional model was run, using a subset with data from the bilingual group only. The R code for this linear mixed-effects model is provided in (64) below. Attachment preferences were explored based on the BLP predictor, which represents language dominance. Recall that lower BLP scores indicate higher dominance in Spanish, whereas higher BLP scores indicate higher dominance in English. In the random-effects structure, the model includes random intercepts for participant and item. The model output can be found in Table 29.

(64) **Model BLP for bilinguals:**

```
model_BLP_biling ← glmer(attachment ~ condition * BLP_scaled +
                         (1 | participant) + (1 | item),
                         family = binomial)
```

Table 29:

Model output for attachment by BLP and condition in bilinguals

	Estimate	**Std. error**	**z-value**	***p*-value**	
Intercept	5.968	4.074	1.465	0.142	
Ambiguous	-3.836	4.092	-0.937	0.348	
Forcing-LA	-10.011	4.517	-2.216	0.026	*
BLP	0.337	8.617	0.039	0.968	
Ambiguous: BLP	4.033	8.661	0.466	0.641	
Forcing-LA: BLP	0.863	9.547	0.090	0.928	

The intercept represents the log-odds of HA responses in the forcing-HA when the BLP variable is 0 for instructed bilinguals. Compared to the reference level, the log-odds for the forcing-LA and ambiguous conditions are negative (Forcing-LA: β = -10.011, p = 0.026; Ambiguous: β = -3.836, p = 0.348), indicating lower likelihood of selecting a HA response in these conditions. This tendency is however significantly more pronounced in the forcing-LA than in the ambiguous condition, as expected. Crucially, regarding language dominance, the model shows no significant BLP effect on attachment preferences (β = 0.337, p = 0.968) for the reference level, i.e. forcing-HA condition. The most relevant results are found in the interaction effects, particularly in the *ambiguous condition*BLP* interaction. The positive estimate (β = 4.033, p = 0.641) indicates a non-significant tendency to high attachment with increased BLP scores. Against expectations, and confirming the pattern observed earlier (see model output for BLP effect across groups in Table 28) L1 Spanish-L2 English bilinguals with higher BLP scores, i.e., with higher dominance in English, seem to select more HA responses in the ambiguous condition. The fact that this effect is non-significant suggests that language dominance is no predictor of attachment preferences within the bilingual group. This will be further discussed in Section 6.5.

6.4.1.2. Attachment preferences and length of L2 immersed instruction

In addition to language dominance, a second variable explored in this PhD thesis is length of exposure to the second language in a classroom, instructed setting. The motivation to examine this comes from previous L1 attrition research on naturalistically immersed bilinguals and the length of such immersion. To make a distinction, the specific L2-exposure context explored in this thesis will be referred to as *L2 immersed instruction*.

This distinction is necessary because bilinguals in this study neither live in an L2 environment (naturalistic immersion) nor attend L2 English courses for a few hours per week (L2 instruction). Instead, they receive daily and intensive exposure to their L2 English in university setting attending to lectures but also while completing assignments and preparing exams at home.

Length of L2 immersed instruction (LoII) has been operationalised in terms of the number of years participants in the bilingual group have been exposed to the second language in an instructed, classroom university setting. To put it simply, this variable represents the academic year bilingual students were enrolled in the degree of English studies at the time of testing, ranging from 1 to 4 years. This will allow to explore the potential effect of extensive L2 immersed instruction on offline attachment preferences. To do so, only data from the L1 Spanish-L2 English bilingual group across all experimental conditions will be considered in the analysis.

A linear mixed-effects model was implemented to predict attachment preferences (HA vs. LA), which is illustrated in (65) below. The model structure of maximum fit included fixed effects of *condition* (forcing-HA, forcing-LA and ambiguous), *LoII* (number of years exposed to the L2 in a university classroom setting) and their interaction (*condition*LoII*). For the *condition* variable, the reference level was the ambiguous condition to explore differences in this critical condition based on length of instructed immersion. Random intercepts are included for both participant and item. The model output is provided in Table 30.

(65) **Model length of L2 immersed instruction:**

```
model ← glmer(attachment ~ condition * LoII +
              (1 | participant) + (1 | item),
              family = binomial)
```

Table 30:

Model output for attachment by condition and LoII among bilinguals

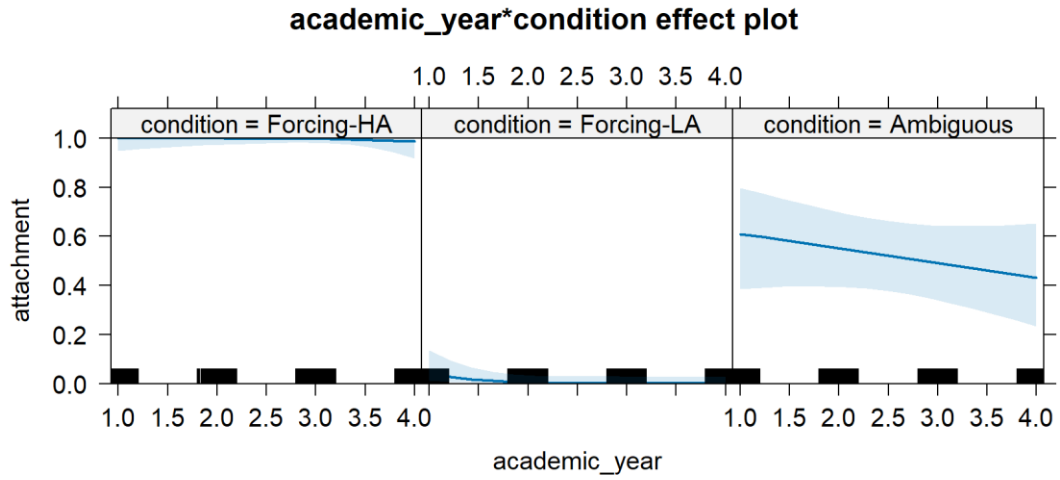
	Estimate	Std. error	z-value	*p*-value	
Intercept	0.084	0.299	0.282	0.777	
Condition Forcing-HA	6.507	1.390	4.679	< 0.001	***
Condition Forcing-LA	-6.455	1.474	-4.378	< 0.001	***
LoII	-0.265	0.261	-1.015	0.310	
Forcing-HA: LoII	-1.350	1.271	-1.062	0.288	
Forcing-LA: LoII	-2.072	1.187	-1.745	0.080	.

The intercept of the model represents the baseline attachment preference for bilinguals in the ambiguous condition when length of L2 immersed instruction is at its reference level. The *condition* effect reported in previous models is observed again here. Compared to the ambiguous condition, bilinguals are more likely to select a HA interpretation in the forcing-HA condition (β = 6.507, p = < 0.001) but significantly fewer HA responses in the forcing-LA (β = -6.455, p = < 0.001). Focusing on the role of *length of L2 immersed instruction*, no significant effect is reported (β = -6.455, p = 0.310). However, it is worth noting that the negative estimate indicates a tendency to provide fewer HA responses as the number of years exposed to their L2 English increases. Despite not reaching statistical significance, the negative main effect of LoII suggests that longer L2 immersed instruction, i.e., being in the final years of the degree, decreases the preference for HA.

Taking into consideration the interaction effects, these show how length of L2 instruction modulates attachment preferences across conditions. Interaction effects, as expected, do not reach statistical significance (Forcing-HA*LoII: β = -1.350, p = 0.288; Forcing-LA*LoII: β = -2.072, p = 0.080), meaning that condition effects in the forcing-HA and forcing-LA conditions are relatively stable with increased length of instructed immersion, i.e., across academic years. This was expected as the two forcing conditions were unambiguous, and it was predicted that bilinguals respond similarly to non-ambiguous sentences in their L1 regardless of length of instructed immersion. To summarise, while longer immersed instruction in the second language generally reduces the probability of selecting a HA interpretation among instructed bilinguals, its effect is non-significant. To better illustrate this, the plot provided in Figure 6 represents the model output described here.

Figure 6:

Predicted HA-responses by condition and LoII for bilinguals



Overall, despite its effects being non-significant, a tendency is observed among instructed bilinguals to select fewer HA interpretations as instructed exposure increases. Those bilinguals in the final years of the English Studies degree seem to be less likely to select the image depicting a HA representation of an ambiguous relative clause, i.e., they seem to reduce the HA preference. As the number of years formally exposed to the L2 increases, bilinguals are more likely to depart from their L1-preferred strategy, i.e., high attachment, in the offline comprehension of ambiguous relative clauses. The lack of a significant effect may also be due to the lack of sufficient data to make more solid predictions. These findings will be further discussed in Section 6.5.

6.4.2. Results for response times (RTs)

Up to this point, previous sections have reported offline results from the PST, focusing on participants' final attachment choices (HA responses vs. LA responses). This section will now investigate an indirect measure of attachment preferences: response times. These were recorded during task performance, reflecting the time taken by participants to provide a response, i.e., to select an image. It is important to clarify that RTs do not include the duration of the recordings themselves, i.e., RTs do not reflect the whole duration of a trial. Instead, the timing for response times begins at the end of the recorded sentence and continues until participants pressed a key to select the image that best represented the recording they just heard (see Section 6.2 for further details on task procedure). Therefore, RTs capture the process of consciously thinking about the sentence, including any potential reanalysis made after listening to the complete sentence.

In the following analyses, the dependent variable is participants' RTs to select the image that best represents the sentence they just heard. Recall that in the PST, participants listened to a sentence while two images were displayed in the screen: one image always represented a HA interpretation, while the other represented a LA interpretation. Response times are therefore a continuous variable, and will be analysed using linear mixed-effect models using the *lmer* function of the *lme4* package (Bates et al., 2015) in the R environment (R Core Team, 2024). The reported model includes the maximal random-effects structure that converged (Barr et al., 2013). However, the statistical models will not include the raw response times as the dependent variable. Instead, these will be log-transformed to normalise model residuals (Vasishth & Nicenboim, 2016). Consequently, and in contrast with the models for offline attachment preferences (see Section 6.4.1), the output of the models in this section will not be reported in *log-odds*. The output will be reported in the scale of the log-transformed response times because the dependent variable is not only RTs, but the logarithm of those RTs. The coefficients for the fixed effects will describe how independent variables or predictors modulate log-transformed response times. In this line, higher estimates will represent longer RTs and consequently, slower speed in the responses. Finally, regarding the predictors or independent variables included in the models to predict participants' RTs, these were the following: *group* (Spanish monolinguals, bilinguals and English monolinguals) and experimental *condition* (forcing-HA, forcing-LA and ambiguous).

As anticipated in Section 6.1, predictions for RTs are as follows. It is expected that sentences disambiguated using the participant's L1-preferred strategy will be answered faster that those which are not. For Spanish and bilinguals, the two control conditions will be responded equally fast. Differences are expected in the ambiguous condition. For ambiguous relative clauses, it is expected that both Spanish monolinguals and English monolinguals will respond faster than instructed bilinguals, who will exhibit higher RTs (i.e., slower responses) given the optionality observed in their offline attachment choices.

Before presenting the data analysis for response times, descriptive results for the raw RTs will be illustrated. It is worth noting that for the descriptive analyses, the raw RTs will be presented (see Table 31), whereas the inferential analyses will include log-transformed RTs (see Table 32). Figure 7 below presents participants' response times in milliseconds (ms) by condition (forcing-HA, forcing-LA and ambiguous) across all groups (Spanish monolinguals, instructed bilinguals and English monolinguals). Recall that all groups were tested in their L1, and the RTs represent the time taken by participants from the end of the sentence until they selected one image. Regarding the English group, data is only available for the ambiguous condition as this was the only condition tested (see Section 5.4.1). The mean RTs and standard deviations are provided in Table 31.

Figure 7:

Mean response times (ms) by condition and group

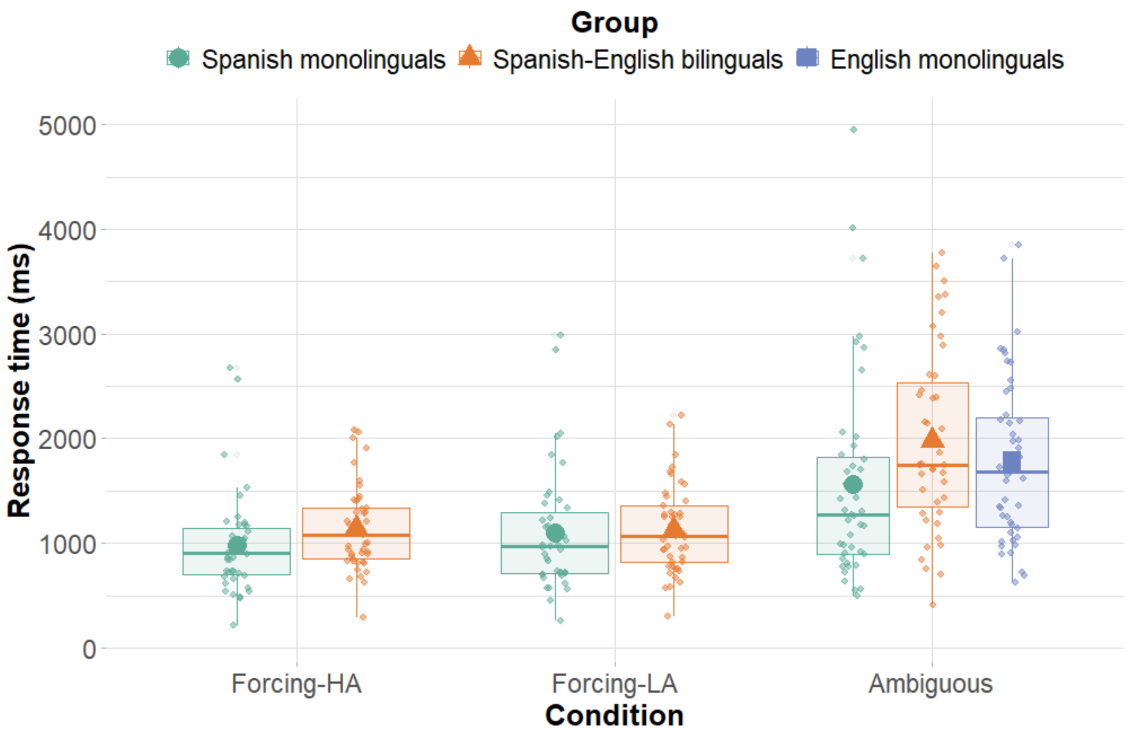


Table 31:

Mean RTs and standard deviation by condition and group

	Spanish group		Bilingual group		English group	
	mean	*SD*	*mean*	*SD*	*mean*	*SD*
Forcing-HA	991	798	1143	568	—	—
Forcing-LA	1105	938	1128	589	—	—
Ambiguous	1555	1351	2064	1670	1797	1421

Considering the findings in Figure 7 and Table 31, the following patterns are observed. First, in the two control conditions, Spanish monolinguals and L1 Spanish-L2 English bilinguals show similar response times, although bilingual speakers seem to be slightly slower overall. Focusing on the forcing-HA condition, the two groups seem to take similar time to provide a response (Spanish: mean = 991, SD = 798; Bilinguals: mean = 1143 ms, SD = 568). Although both groups display similar behaviour, it can be observed that, on average, Spanish monolinguals tend to respond a bit faster than bilinguals in non-ambiguous sentences that force a HA interpretation. Standard deviation for the Spanish group is slightly higher, indicating greater variability among participants in this group. Regarding the forcing-LA condition, recall that these sentences did not involve any ambiguity and forced attachment to NP2, i.e., low attachment. Similarly to the findings for the forcing-HA condition, both Spanish monolinguals and instructed bilinguals show similar response times (mean RTs = 1105 ms and 1128 ms, respectively). This indicates that the bilingual group takes a bit longer to respond than the Spanish group, which appears to be slightly faster in their final decision. However, the difference is minimal and smaller than in the forcing-HA condition.

Finally, the most relevant findings for this PhD thesis are found in the ambiguous condition, where a comparison can be made across all groups. Group differences are more clearly observed in this condition, with Spanish monolinguals being the fastest in providing a response (mean = 1555 ms, SD = 1351), followed first by English monolinguals (mean = 1797 ms, SD = 1421) and then, by instructed bilinguals (mean = 2064, SD = 1670). Compared to the two forcing control conditions, mean RTs clearly increase for both Spanish natives and bilinguals, suggesting higher cognitive load in this condition as a result of the ambiguity. Standard deviations also increase in this condition, evidencing greater variability and reduced consistency in response patters. Overall, these results reveal that the ambiguous condition elicits longer response times, potentially reflecting higher processing cost or the need for more extensive post hoc interpretation. In addition, response patterns differ across groups, with bilinguals generally exhibiting longer RTs in all conditions, but particularly in the ambiguous condition, compared to the Spanish monolingual group.

For the data analysis, and given that the two versions of the PST (Spanish version and English version) did not include the same experimental conditions, a subset of the data was created including only observations for the ambiguous condition as this was the condition common to all participants. To obtain the best fitting model for the data, several models were implemented increasing the number of predictors and random effects. The first, simplest mixed-model predicted log-transformed response times as a function of *group*. The R code of the model can be found in (66). Random intercepts were included for participant and item to account for variability at a participant and item level. Then, additional models included a random slope for group and the *attachment* variable (selection of HA-biased or LA-biased image) in the fixed-effects structure. The best fitting model was selected by comparing these models using the *anova* function of the *stats* package. The results showed that, while models adding random slopes and the *attachment* variable increased the complexity of the model, none significantly improved model fit[32]. Therefore, the model selected was the first one, including fixed effect of *group* and random intercepts for participant and item.

(66) **Model RTs by group:**

model_RTs ← lmer(log(response_times) ~ group +
(1 | participant) + (1 | item))

Table 32 presents the output of the regression model predicting RTs for the ambiguous condition only in all groups. The *group* variable is categorical and has three values (Spanish monolinguals, bilinguals and English monolinguals). It was dummy coded, setting the Spanish monolingual group as the reference level to compare bilinguals and English natives' response patterns with those of Spanish monolinguals.

Table 32:

Model output for log-transformed RTs by group in ambiguous sentences

	Estimate	**Std. error**	**df**	**t-value**	***p*-value**	
Intercept	6.825	0.081	205.969	83.477	< 0.001	***
Group Bilinguals	0.346	0.114	235.280	3.025	0.002	**
Group English	0.138	0.100	161.540	1.375	0.171	

Recall that the estimates above are reported in the log-transformed RTs scale. Positive estimates indicate higher response times and therefore, slower speed in the final decision. The model suggests a *group* effect on response times. L1 Spanish-L2 English bilinguals show significantly higher RTs (on the log scale) compared to the reference Spanish monolingual group (β = 0.346, p = 0.002). Conversely, results for English monolinguals indicate a smaller and non-significant increase in log-transformed RTs (β = 0.095, p = 0.361) compared to Spanish monolinguals, meaning that these two groups do not differ. Thus, significant differences are observed between instructed bilinguals and Spanish

[32] Regarding the *attachment* variable, the fact that participants selected the image representing either a HA or a LA representation had no significant effect on RTs when running the statistical models. Given that it did not modulate RTs nor improve the initial model's fit, it was not included in the main analysis.

monolinguals, while no differences are found for English natives, as expected. These results suggest that, when participants are confronted with ambiguous RCs, the two control monolingual groups take less time than bilinguals to provide a final interpretation of the sentence. This may suggest that monolingual speakers may be more likely to maintain their initial interpretation of an ambiguous sentence, with reduced consideration of potential alternative interpretations. On the other hand, instructed bilinguals may be more sensitive to the ambiguity, leading to potential reanalysis of the sentence and increased response times. These results, together with bilinguals' higher optionality in their offline attachment preferences shown in Section 6.4.1, seem to illustrate a clear pattern for instructed bilinguals, characterised by no clear attachment preference and increased response times, which is considered evidence of attrition effects. All these findings will be discussed in the following section.

6.5. Discussion of findings from picture selection task

This section will provide a thorough discussion of the findings obtained from the picture selection task administered to all participant groups in their first language. To do so, it will reintroduce the research questions formulated for the interpretation of relative clause attachment ambiguities in Section 4.1, addressing each individual question separately.

First, **RQ$_1$** addressed the **offline attachment strategies** (HA vs. LA) employed by L1 Spanish-L2 instructed bilinguals compared to Spanish and English monolinguals in the L1 interpretation of ambiguous relative clauses. Offline results from the PST revealed significant group effects on attachment preferences. As predicted in Section 4.1, while clear interpretative biases were observed for the two monolingual groups, Spanish and English monolinguals, considerable optionality was evidenced in the bilingual group. Attachment preferences were analysed based on the image participants selected as the best representation of the ambiguous sentence they just heard. This was so because one image always represented a HA interpretation, while the other depicted an LA interpretation. Focusing on the Spanish monolingual group, participants selected a greater amount of HA images than LA images as the best visual representation of sentences containing an ambiguous RC. In contrast, when English monolinguals encounter these ambiguities, they tend to select a LA image, evidencing a tendency to attach the RC to NP2, i.e., a tendency towards LA. These findings align with previous studies on L1 offline

RCA interpretation preferences in Spanish (Cuetos & Mitchell, 1988; Dussias, 2003) and English (Bergmann et al., 2008; Cuetos & Mitchell, 1988).

However, it is worth noting that while the Spanish tendency for HA is quite strong, the preference for LA in the English group, although evident, is less pronounced. This is observed in Figure 2, and is in line with previous research. The straightforward preference for HA in native Spanish is illustrated in Dussias' (2003) study, who reports that Spanish natives tested in their L1 preferred NP1 as the host of ambiguous relative clauses approximately 74% of the time. Conversely, in an offline study testing English monolinguals, Bergmann et al. (2008) illustrate that English natives resolve ambiguous RCs using low attachment 49% of the time, while 43% for high attachment. Hemforth et al. (2015) also find a preference for LA among English monolinguals, further modulated by the length of the RC. The authors report their findings in terms of HA responses: HA choices were observed in 33% of short object RCs, while they occurred 48% on the times for long object RCs. Given the dichotomous nature of these findings, it can be inferred that English natives favoured low attachment 67% of the time for short RCs, and 52% for long RCs. Overall, these offline findings reveal a mild LA preference in native English. This is consistent with the results from English monolinguals in the present PST, as their rate of LA choices is comparable with those in previous studies. As observed in Figure 2, the proportion of HA choices in English monolinguals is 31.2%, which corresponds to a LA selection rate of 68.8%. Interestingly, while the LA preference in native English is evident, it is not as robust or strong as the HA preference found in native Spanish both in this PhD thesis (HA selection rate = 82.9%) and in previous literature.

Finally, considering RQ_1 again, results from L1 Spanish-L2 English bilinguals suggest no clear attachment preference. Bilinguals neither favour their L1-preferred strategy, high attachment, nor the L2 mechanism, low attachment. This means that when bilinguals listened to an ambiguous sentence, it appears to be equally likely for them to choose the HA-biased image or the LA-biased one, confirming our predictions for this group. Instructed bilinguals do not pattern with Spanish monolinguals, but more importantly, results indicate that they do not align with the L2 pattern either. While their offline attachment preferences differ from those of Spanish monolinguals, showing a mitigated preference for HA, bilinguals do not fully adopt the LA bias observed in English monolinguals. In other words, their L1 preference for HA has not been entirely replaced by a LA preference, as there is no complete shift in bilinguals' offline RCA choices. Their L1-preferred strategy (HA) seems to be mitigated but has not completely vanished.

Such intermediate position in bilinguals pattern with previous findings from L1 Spanish-L2 English bilinguals, which also reported neutral attachment preferences (Jegerski, VanPatten, et al., 2016). A potential explanation for this lack of preference may lie in the cognitive demands placed on bilingual's language processor. According to theoretical frameworks such as the Garden-Path model, low attachment, i.e., late closure, is a general principle favoured by the parser because it immediately and efficiently integrates new linguistic input, i.e., the relative clause, with the material currently being processed, i.e., NP2 (Frazier, 1978, 1987; Frazier & Clifton, 1996). In fact, instructed bilinguals have been found to exhibit longer RTs in the resolution of ambiguous RCs compared to monolingual speakers, which evidence the additional processing cost of these bilinguals (see Section 6.4.2). The reduced likelihood of HA responses in the L1 of Spanish-English bilinguals directly involves increased preference for LA, maybe to mitigate the additional cost of having two coactivated languages with opposing attachment strategies. To counterbalance this potential additional cost, bilinguals may start implementing more economical strategies such as LA, which enable more simple and straightforward analyses. Bilinguals in this PhD thesis do not consistently favour either HA or LA, but most importantly, exhibit a significantly mitigated L1-preferred HA strategy. This implies that they have increase the preference for LA, although still not reaching native English levels. Previous studies on offline RCA in the L1 of Spanish-English bilinguals have evidenced a preference for LA (Dussias, 2003), but a key difference is that these bilinguals were naturalistically immersed in an L2 environment. Given the influence of naturalistic immersion revealed by research on L1 attrition (see Section 2.4.2), it seems logical that bilinguals in such context exhibit stronger attrition effects than those in the present PhD thesis, who were exposed to their L2 in an instructed setting. Still, it is evident in the offline data from the PST that instructed bilinguals are experiencing L1 attrition is their offline interpretation of ambiguous RCs.

Given that the English PST only contained the ambiguous condition, no condition effects can be explored if the three participant groups are compared. To explore whether the significant group effects observed are indeed a condition effect or whether they generalise to all conditions. Results from an analysis comparing offline attachment preferences for Spanish monolinguals and instructed bilinguals, where both group and condition effects were investigated, demonstrated that significant differences between groups were restricted to the critical ambiguous condition. In the other two conditions, both groups show similar patterns. They select a HA interpretation of unambiguous sentences forced to attach high, meaning that they correctly understood the sentences. The same occurs in the forcing-LA condition, where both Spanish monolinguals and bilinguals clearly select a LA response. This evidences that instructed bilinguals only differ in their offline interpretation of ambiguous relative clauses, where they depart from their L1-preferred attachment mechanism.

To further explore these post hoc interpretative biases, two additional research questions were formulated to account for the potential effect of individual differences. **RQ$_2$** asked whether **language dominance** may modulate the L1 offline interpretation of ambiguous relative clauses across the three groups involved. It is relevant to emphasise that all participants tested in this study are L1-dominant (see Section 5.1). The English monolingual group is highly dominant in English, while the Spanish monolingual and the bilingual group are dominant in Spanish. The difference between the latter two is their degree of L1 dominance, with the former being more dominant in Spanish than the latter. RQ$_2$ is interesting for two reasons. First, it challenges the traditional view that potential attriters are L2-dominant bilinguals. Second, if language dominance effects are observed between Spanish monolinguals and L1-Spanish-L2 English bilinguals, this would suggest that bilinguals do not need to be dominant in their second language to experience attrition effects. The fact of having significantly fewer dominance in their L1 might be sufficient to modulate attachment preferences.

Language dominance effects were expected in the bilingual group only, and the results for the PST confirmed our predictions. No effect of language dominance was expected for either Spanish monolinguals or English monolinguals because, although both groups had some knowledge of an L2, their low L2 dominance would not be enough as to determine attachment preferences. However, the reduced L1 dominance among instructed bilinguals, particularly compared to Spanish monolinguals, may predict offline interpretative biases with those participants who have higher dominance in Spanish, providing more HA-responses. The opposite would hold for less Spanish dominant bilinguals. Against expectations, an initial analysis comparing the three participant groups in ambiguous sentences evidenced no effect of language dominance (see Section 6.4.1.1). To dig deeper into the role of language dominance, an additional analysis focused exclusively on the L1 Spanish-L2 English group, exploring if language dominance may influence RCA preferences within bilinguals.

None of the analyses conducted reported an effect of language dominance, measured by the BLP questionnaire, on attachment preferences. Language dominance was first explored across groups in the ambiguous condition only. When compared to Spanish natives, instructed bilinguals seem to display more likelihood for selecting a HA response with increased BLP scores, which indicate higher dominance in English. However, this tendency did not reach significance. Additionally, the potential effect of language dominance was tested within the bilingual group only, across experimental conditions. Once more, no language dominance effect was reported. In line with the results provided for all groups, bilinguals who tend to be more dominant in their L2 English appear to favour a HA interpretation of ambiguous RCs, but this is not significant either. Overall, and against initial predictions, language dominance does not seem to modulate offline attachment preferences and cannot account for variability in attachment responses. The lack of a significant effect may be associated with the amount of available data, which may have been insufficient for the statistical models to provide more conclusive results. The lack of data may be addressed gathering more participants from each group and particularly, gathering participants with a wider range of language profiles. Given that the current variability in terms of language dominance across and within groups may not be enough to successfully predict attachment preferences, including participants with a wider range of BLP scores would ensure more balanced representation of different language dominance scores along the continuum. This may help to obtain more conclusive results.

Finally, a third research question was formulated to address the potential influence of another individual variable, i.e., length of immersed instruction in the second language. **RQ$_3$** explored whether **length of L2 immersed instruction** may modulate the L1 offline interpretation of ambiguous RCs in instructed L1 Spanish-L2 English bilinguals, leading to more evident attrition effects. Cumulative L2 exposure in an instructed, classroom setting was predicted to modulate attachment preferences. In bilinguals, longer L2 exposure in an instructed context was expected to correlate with increased preference for the L1-dispreferred LA strategy. Results partially confirmed this prediction, as a tendency was observed for longer instruction reducing the selection of HA responses, but it did not reach statistical significance. Length of instruction was operationalised in number of years bilingual students had been exposed to their second language in an instructed university setting, i.e., it represents the academic year they were in at the time of testing. The results obtained reveal that although those bilinguals in the final years of the English Studies degree seem to less frequently select a HA interpretation than those who just started the degree, which would evidence a modulating effect of LoII, such effect is non-significant.

Overall, results for RQ_2 and RQ_3 are relevant as they evidence the need to broaden the scope of L1 attrition. Traditional research on L1 attrition assumed certain conditions had to be met for bilinguals to experience attrition effects. One of these was naturalistic L2 exposure for an extensive period. Consequently, as discussed in Section 2.4.2, most attrition studies examined bilinguals living in an L2-speaking country and established a minimum length of residency in the L2 environment as participation criterion (Bot et al., 1991; Cuza, 2010; De Bot & Clyne, 1994; Gürel, 2004; Schmid, 2011b; Tsimpli et al., 2004; Weltens et al., 1987). Such minimum length of residency, usually of ten or fifteen years, was considered necessary to allow enough time for attrition effects to emerge in bilinguals' L1. Against this view, the present PhD thesis has provided evidence that L2 naturalistic exposure is not a necessary condition to experience L1 attrition. Exposure in an instructed, classroom setting is sufficient to trigger such effects on the offline interpretation of ambiguous RCs. Additionally, and given that traditional literature assumed that naturalistic exposure had to be extensive, this PhD thesis also addressed whether length of exposure to the L2 in a classroom setting would further modulate attachment preferences. It was expected that stronger L1 attrition effects, represented as higher selection rates of the image depicting the L1-dispreferred interpretation (i.e., LA), would be associated with bilinguals in the final years of the degree in English Studies. The findings obtained revealed that, although a tendency is observed in this direction, it did not reach significance.

Finally, **RQ_4** addressed whether potential L1 attrition effects in the **response times** of instructed L1 Spanish-L2 English bilinguals compared to those of Spanish and English monolinguals. As anticipated in Section 6.1, if L1 attrition effects were to be found in bilinguals, these will be observed in ambiguous sentences, manifested as higher RTs (i.e., slower responses). Given the clear interpretative biases found in monolingual groups (HA preference in Spanish natives and LA preference in English natives), these were predicted to need less time to provide a final interpretation of the sentence. In contrast, bilinguals would take longer to respond in ambiguous sentences.

Results confirmed our predictions for L1 attrition effects on response times (see Section 6.4.2). Recall that response times were measured from the end of the recorded sentence until participants selected one of the two images (HA-biased image or LA-biased image). Thus, RTs reflect the time participants needed to process the whole sentence, integrate all syntactic and semantic information, and consciously select a final post hoc interpretation. Instructed L1 Spanish-L2 English exhibit significantly higher RTs (i.e., slower responses) in ambiguous sentences compared to both monolingual groups, who were faster in selecting a final interpretation. These PST findings align with those reported by previous studies on RCA and response time data. They also correlate with those obtained from the picture-verification task, which will be presented in the following chapter, and which also evidence processing cost among bilinguals with ambiguous sentences. A potential explanation for this additional time to resolve ambiguous RCs may be related to the fact that bilinguals, unlike monolinguals, have to active linguistic systems with opposing default attachment strategies. The coactivation of these two languages may result in greater feasibility of both attachment mechanisms, which is supported by the previously discussed optionality in bilinguals' attachment choices for the PST. Such increased optionality may lead to greater hesitation, which in turn results in longer response times and processing cost, as results for RTs and attachment resolution illustrate in Section 6.4.2.

Taken together, results from the PST offer relevant insights. They evidence attrition in instructed bilinguals regarding their L1 preferences to resolve ambiguous RCs. L1 attrition is reflected by greater optionality in attachment preferences, i.e., their L1-preferred strategy for HA is significantly attenuated, which involves an increased preference for the L2-preferred LA. Such neutral preference occurs with an increasing processing cost in their final responses. These findings are particularly relevant given the profile of the bilinguals tested. The bilingual group in this thesis is under L2 immersed instruction, rather than naturalistically immersed in an L2 country. This context leads to fewer opportunities for L1 use, but this remains their dominant language and the functional language of the place they live in, so it still has a predominant role. Still, the results obtained are in line with those reported in L1 attrition studies with naturalistically immersed bilinguals, suggesting that the traditional conditions associated with attrition may not be necessary for it to emerge. In fact, PST results are in line with those in the following tasks: the sentence-picture verification task in Chapter 7 and the eye-tracking experiment in Chapter 8. This will contribute to the understanding of the nature of L1 attrition, evidencing the need to broaden its scope.

Chapter 7: Picture verification task

This chapter will present and discuss the results obtained from the second experimental task: an auditory sentence-picture verification task (PVT). The previous chapter has provided relevant data regarding offline attachment preferences to explore whether L1 attrition effects can be observed in bilinguals' offline interpretation. This chapter will shift focus to processing data. Picture verification tasks have been found to be a sensitive measure of processing cost, and have been used in a variety of studies exploring semantic and phonological auditory comprehension (Breese & Hillis, 2004; Suh et al., 2023), or the role of mental simulations in language comprehension (Van Zuijlen et al., 2024). While the picture selection task in the previous chapter was part of the eye-tracking experiment, the present auditory sentence-picture verification task is an independent task. Participants first listened to an ambiguous sentence and afterwards, were presented with an image depicting it. Then, they were asked to verify whether the picture was congruent with the sentence they just heard. A processing cost was expected when the image represented the L1 dispreferred attachment strategy, i.e., LA for Spanish monolinguals and L1 Spanish-L2 English bilinguals, and HA for English monolinguals.

Most previous studies on processing and relative clause attachment preferences have collected data using two tasks. Self-paced reading tasks have been extensively administered (Dussias, 2003; Jegerski, Keating, et al., 2016; Papadopoulou & Clahsen, 2003), together with eye-tracking tasks which provide more detailed information of time-course processing (Dussias & Sagarra, 2007; Valenzuela et al., 2020). To the best of our knowledge, no study has addressed disambiguation strategies using a picture verification task. This task was implemented for several reasons. First, it addressed processing cost while maintaining an auditory and visual component, similarly to the picture selection task discussed in Chapter 6 and the visual world eye-tracking experiment (see Chapter 8).

This ensured that the results from all tasks within this PhD thesis could be comparable. Second, the sentences tested in this task are garden-path sentences (see Section 3.2.1). This task will create an ideal context to test garden-path effects. Participants listened to an ambiguous sentence like the one in example (67) below, while encouraged to create a visual representation of it. They will go down the path and will be forced, or not, to reanalyse the sentence when the image is depicted. Such reanalysis will be reflected in their response times. Thus, the data collected from the picture verification task will provide relevant information regarding potential processing cost and reanalysis of sentences containing an ambiguous relative clause.

(67) *Observa aquí al alumno$_i$ de la científica$_j$* ***que$_{i/j}$*** *lee un libro atentamente*

Observe here the student$_i$ of the scientist$_j$ **who$_{i/j}$** reads a book carefully

The present chapter is structured as follows. First, the research questions specifically formulated for the auditory picture verification task will be reintroduced in Section 7.1. This will be followed in Section 7.2 with the methodology of the PVT, outlining both the procedure and experimental conditions of this task. Section 7.3 will focus on the data cleaning process conducted prior to data analysis. Finally, the results obtained will be provided in Section 7.4, together with a discussion of the main findings in Section 7.5.

7.1. Research questions

The general research questions and hypotheses formulated for the present PhD thesis, together with the task-specific ones were presented in Chapter 4 (see Section 4.2). However, to facilitate readers' interpretation of the results from the online sentence-picture verification task, the RQs formulated for this task along with their hypotheses are revisited below.

RQ$_{5a}$ What **attachment strategies** (HA vs. LA) do Spanish monolinguals, instructed bilinguals, and English monolinguals employ to resolve ambiguous RCs?

RQ$_{5b}$ Are the offline results of the PVT in line with those of the PST regarding relative clause attachment preferences for each group?

H$_{5a}$. This will be explored based on the acceptance rates for each condition. In the HA condition, Spanish monolinguals will exhibit the highest acceptance rate as it depicts the preferred strategy in their L1 Spanish, followed by instructed bilinguals, and then, English monolinguals. Conversely, in the LA condition, the highest percentage of *accept* responses is hypothesised for English monolinguals, reflecting their L1 preference to attach low, followed by bilinguals and finally, Spanish monolinguals.

H_{5b}. It is expected that the offline responses in the picture verification trials will be in line with those in the PST data. Spanish monolinguals will more frequently accept the HA than the LA condition, while the opposite holds for English monolinguals. Bilinguals are expected to show similar acceptance rates across conditions.

RQ_6 Are **garden-path effects** observed in the response times of L1 Spanish-L2 English instructed bilinguals compared to Spanish and English monolinguals?

H_6. If garden-path effects are observed in bilinguals, these will be reflected as higher RTs in the HA condition compared to those of Spanish monolinguals. The HA condition depicts bilinguals' L1-preferred strategy and therefore, additional time to respond will indicate reanalysis, suggesting that HA was not implemented in the initial analysis and evidencing L1 attrition. Conversely, in the LA condition, bilinguals' RTs are predicted to be longer than in the HA condition, and most importantly, shorter than those of Spanish monolinguals in the LA condition, reflecting increased tolerance of the L1-dispreferred LA mechanism.

Garden-path effects are not predicted for Spanish or English monolinguals in the HA and LA conditions, respectively. Processing cost may surface when there is a bias towards their L1-dispreferred mechanism, i.e., LA condition for Spanish monolinguals and bilinguals, and HA condition for English monolinguals.

RQ_7 Does **language dominance** modulate instructed L1 Spanish-L2 English bilinguals' response times when confronted with ambiguous relative clauses?

H_7. If a language dominance effect is observed in bilinguals, such effect will differ across conditions. In the HA condition, a language dominance effect will be represented by higher RTs (i.e., slower responses) for bilinguals with increased English dominance. Conversely, in the LA condition, more English-dominant bilinguals will exhibit lower RTs (i.e., faster responses), indicating higher acceptance of their L2 preferred strategy.

RQ_8 Does **length of L2 immersed instruction** modulate instructed L1 Spanish-L2 English bilinguals' response times when confronted with ambiguous relative clauses?

H8. Such effect will be manifested as stronger attrition evidence among bilinguals who have been intensively exposed to L2 instruction for higher number of years. In the HA condition, higher RTs (i.e., slower responses) are predicted for long-exposed bilinguals, evidencing a more pronounced departure from the L1-prefered strategy. On the contrary, in the LA condition, lower RTs (i.e., faster responses) are expected for bilinguals with increased exposure, exhibiting increased preference for the L1-dispreferred mechanism

7.2. Methodology

The auditory sentence-picture verification task was the first experimental task completed by all participant groups (see the timeline of tasks in Section 5.2). The PVT was designed using the same stimuli than those in the eye-tracking experiment, and consequently, also in the PST. Data were collected online, with all participant groups completing the task remotely. It was programmed in OpenSesame (Mathôt et al., 2012; Mathôt & March, 2022), an open-source program designed for creating and running behavioural experiments. Once the task was created, it was uploaded to JATOS (Lange et al., 2015) using the MindProbe server[33]. JATOS is an open-source platform for researchers who need to create, run and manage experiments conducted remotely. Hosting the experiment in a JATOS web server allowed to distribute the link to the task to each individual participant, who could complete it using their own computer.

Similarly to the PST, all participant groups completed the picture verification task in their first language, i.e., Spanish for the Spanish monolingual and bilingual groups, and English for the English monolingual group. The PVT was designed using the same stimulus materials than those in the other tasks (see Section 5.4 for a detailed description of linguistic, visual and auditory stimuli). The critical items used in the PVT consisted of 18 target sentences. Although the 18 target sentences were designed for three conditions, i.e., forcing-HA, forcing-LA and ambiguous conditions, the picture verification task only included ambiguous sentences. This was so because, to test potential garden-path effects, sentences must involve an ambiguity to ensure that participants build an initial interpretation that will be confirmed or disconfirmed by the subsequent image, requiring reanalysis or not. The two forcing conditions were not included in this task because no ambiguity is created and therefore, no garden paths will be observed. This rationale applies to both the Spanish version of the PVT, completed by Spanish monolinguals and

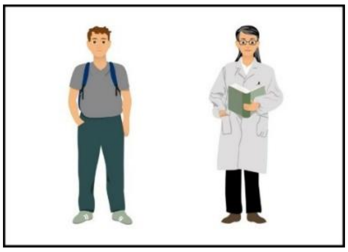
[33] Webpage: https://mindprobe.eu/

instructed bilinguals, and the English version, administered to English monolinguals. Thus, the two versions of the PVT contained ambiguous sentences only, with the only difference being the language in which it was administered.

Originally, as explained in Section 5.4.2, each target sentence was accompanied by a pair of images: an image depicting a HA representation and an image illustrating a LA representation. On the contrary, in the picture verification task, each trial displayed one image only, meaning that participants listened to one ambiguous sentence and saw one single image, as illustrated in Table 33 below. Half of the target sentences were followed by a HA image, whereas the other half were followed by a LA image. Consequently, two experimental conditions were created based on the image that was presented after the sentence: high attachment and low attachment conditions. Table 33 presents these two experimental conditions. In the high-attachment condition, participants first listened to an ambiguous sentence and afterwards, an image that represented a HA interpretation was displayed. Alternatively, in the low attachment condition, participants listened to an ambiguous sentence, which was followed by a picture depicting an LA interpretation. This way, two counterbalanced lists were created, and participants were randomly assigned to one or the other. Additionally, trials were also presented in a random order.

Table 33:

Example of experimental conditions in PVT

Condition	Sentence	Image	Response
High attachment	*Observa aquí al alumno$_i$ de la científica$_j$* ***que$_{i/j}$*** *lee un libro atentamente* *Observe here the student$_i$ of the scientist$_j$* ***who$_{i/j}$*** *reads a book carefully*		Accept / Reject
Low attachment	*Observa aquí al alumno$_i$ de la científica$_j$* ***que$_{i/j}$*** *lee un libro atentamente* *Observe here the student$_i$ of the scientist$_j$* ***who$_{i/j}$*** *reads a book carefully*		Accept / Reject

Regarding the procedure, the task was conducted online and administered after the L2 placement test to all groups. An email was sent to those candidates who met the proficiency level requirement, accepting them for participation. The email included a link to the picture verification task and detailed instructions about the conditions under which the task had to be completed. These were provided to ensure that the data were collected in appropriate conditions. Participants were informed of the estimate duration of the task, 15 minutes approximately, and asked to complete it only when they had sufficient time to do it entirely and without interruptions. Additionally, they were asked to complete the task in a quiet place to avoid being distracted. The instructions indicated that it was necessary to use a laptop or desktop since the keyboard would be required and, given that the task contained audio, it was also necessary to use headphones so that participants could adjust the volume before the actual task performance. The PVT was designed to be taken only once to ensure that participants did not stop and start over. If, for some reason, the task was aborted before it ended, data were excluded from the study.

Once participants clicked on the link and started the PVT from their computer, the full-screen mode was activated during the whole task to block other tabs and ensure they only had access to the task itself. First, participants read a welcome text, followed by instructions explaining what the task consisted of (see Appendix M: Written instructions for PVT). Each trial started with a blank screen. Afterwards, and automatically, a recording was played and simultaneously, the icon  was displayed on the middle of the screen. The icon remained on the screen until the end of the sentence. The recording was played only once, so participants were instructed to listen carefully to the recording and pay attention. For target items, the recording always corresponded to a sentence containing an ambiguous relative clause. After the sentence was fully played, the icon disappeared, and an image was displayed in its place. Participants had to indicate whether the picture represented or not the meaning of the preceding sentence. To do so, they pressed the F or J keys on the keyboard. They pressed the F key when the image corresponded to the content of the sentence, while pressing the J key indicated that the image did not represent the meaning of the sentence. Thus, participants were instructed to place their hands on the keyboard during the whole task. They were also encouraged to visualise what they heard as the sentence unfolded. By encouraging them to mentally simulate the content of the sentence, the subsequent verification of the image would be faster when the picture matched the mental representation participants had created. Such representation would correspond to the disambiguating attachment strategy employed.

Given that all groups were tested in their first language, either Spanish or English, no deficits were expected when depicting a mental representation of the sentences.

Written instructions were presented on several windows and participants had to press the spacebar to proceed from one instructions window to the next. This ensured that all participants could read them at their own pace. After this, the actual task begun, preceded by some practice trials. Experimental trials proceeded automatically, meaning that after pressing a key to respond whether the image represented or not the sentence just played, the picture automatically disappeared from the screen moving on to the next trial.

Crucially, the PVT was the first experimental task participants completed. As explained in Section 5.4, all experimental tasks included the same stimuli to allow reliable comparison between them. Each experimental sentence was paired with two images and, in the Spanish version of the tasks, each sentence was built for three conditions (forcing-HA, forcing-LA and ambiguous). While all tasks included the same stimuli, a key difference between them was the number of stimuli presented out of the total. In the picture selection and eye-tracking task, all visual stimuli (images) were presented and participants in the Spanish monolingual and bilingual groups were exposed to all conditions. However, the PVT involved only a subset of these stimuli: participants saw one image per sentence and only heard ambiguous sentences, meaning they were exposed to 50% of the images and only the ambiguous condition. Thus, the PVT was always administered first to minimise potential priming and task effects. If the eye-tracking experiment (containing the PST component) were completed first, participants would have seen all images before doing the PVT, potentially influencing their responses.

For the PVT, match effects were expected in participants' response times. If the image matched the expected syntactic analysis implemented while the sentence unfolded, faster response times were predicted. On the other hand, if the image illustrated the opposite representation, slower response times were expected as a result of processing costs derived from the reanalysis of the sentence. This matching effect is group dependent. For both the Spanish monolingual and the L1 Spanish-L2 English bilingual groups, higher RTs are expected in the low attachment condition as this is the dispreferred attachment strategy in their L1 Spanish. On the contrary, in the English monolingual group, higher RTs are expected in the high attachment condition because it corresponds to the dispreferred parsing mechanisms in their L1 English.

Finally, a relevant aspect of the auditory sentence-picture verification task is that there are no right or wrong responses. Participants' responses were gathered, but they simply represent preferences. All target items involve grammatical sentences that contain an ambiguity, resulting in two potential interpretations depending on the syntactic analysis implemented. Therefore, no feedback message such as "correct" or "incorrect" was presented after participants provided a response.

7.3. Data cleaning and pre-processing

OpenSesame (Mathôt et al., 2012; Mathôt & March, 2022), the software used to implement and conduct the picture verification task, generates one document with the task results for each individual participant. Therefore, I combined in one single document the data collected from all participants across the three groups, Spanish monolinguals, instructed bilinguals and English monolinguals. These task results were additionally merged with a second dataset that included participants' biodata regarding, for instance, language dominance, length of instruction, working memory, etc. This procedure ensured that these demographic variables could be included as predictors in the statistical models. Consequently, the final document contained both the task results and the demographic information for each participant.

A total of 146 participants were included in the initial dataset. These constitute the same pool of participants analysed in Chapters 6 and 8 for offline attachment preferences and eye-tracking data, respectively. However, a process of data cleaning was conducted on the original dataset based on participants' accuracy responses and response times, in line with the procedure used in the picture selection task (see Section 6.3). Firstly, comprehension accuracy was checked for non-ambiguous filler items as a measure of participants' attention. The threshold for accuracy responses was set at 80%, meaning that only data of those participants who responded correctly to at least 80% of the sentence-picture verification trials were maintained. On the contrary, the data of those below the 80% accuracy threshold were discarded. This led to the exclusion of 4 participants from the Spanish monolingual group, 2 from the bilingual group, and 4 from the English monolingual group. The final sample comprised a total of 136 participants.

In addition, given that the following analyses will explore participants' response times, these were also addressed. Response times represent the time taken by participants to indicate, by pressing a key in the keyboard, whether the image corresponded or not with the ambiguous sentence they just heard. To clean these response time data and remove potential outliers, a plot was first created to visualise the overall distribution of RTs for each group. Then, the interquartile range (IQR) for each group was calculated, providing a separate upper cutoff value for Spanish monolinguals (6501 ms), bilinguals (9609 ms) and English monolinguals (8680 ms). RTs with values exceeding the upper cutoff for each group were coded as missing and removed. In the experimental items, this led to the removal of 7.14% of the data. The specific percentage of RTs exclusion for each individual group was the following: Spanish monolingual group = 6.16%, bilingual group = 8.77%, English monolingual group = 6.54%).

Finally, it is also relevant to specify the modifications implemented to two specific variables. Originally, the experiment was designed so that the *condition* variable had two levels named *match* and *mismatch* condition. However, once the data were collected, it was evident that these labels were not appropriate. The two conditions reflected whether the image displayed corresponded, or matched, with the L1-preferred strategy for each group. Thus, the *match* condition for the Spanish monolingual and bilingual groups involved a HA image, whereas the match condition for the English monolingual group involved a LA image. Conversely, the *mismatch* condition represented the opposite pattern for each group. Given that the term match and mismatch meant different things for the three groups, the labels of the *condition* variable were renamed to *high attachment* and *low attachment* for all groups, based on whether the image depicted a HA or LA representation, respectively. Finally, the dominance variable containing BLP scores was also pre-processed following the procedure described in Section 6.3. A new BLP column was created whose values were recalculated to place all participants within the same Spanish-English continuum and ensure this variable could be accurately used as predictor.

7.4. Results

This section will present the results from the auditory sentence-picture verification task. Although this task was primarily designed and implemented to test potential processing costs, data from participants' responses (accept vs. reject) will also be explored to compare them with the findings from the PST (see Section 6.4.1 in the previous Chapter). Thus, the present section is organised as follows. Section 7.4.1 will present results from trial verification responses, which indicate whether participants accepted or rejected the image displayed as corresponding with the preceding ambiguous sentence. Then, Section

7.4.2 will report the results from response times, i.e., the time taken by participants to provide a verification response, which will reflect potential processing costs.

7.4.1. Results for offline acceptance responses in the PVT

This section will address RQ_5, which examined the attachment strategies (HA vs. LA) employed by instructed bilinguals, compared to Spanish English monolinguals, to resolve ambiguous RCs. Additionally, it also wondered whether the offline results from the PVT will be in line with those of the PST. To answer these questions, participants' responses to each target trial will be examined. The *response* variable has two levels (accept or reject) and indicates whether participants accepted or rejected the image displayed as an appropriate representation of the ambiguous sentence they just heard. Results from these data will offer relevant insights regarding their attachment preferences. However, this is a more indirect measure of participants' attachment preferences compared to the data gathered from the offline picture selection task. The PST directly addressed offline preferences to resolve ambiguous relative clauses, as the two potential interpretations were presented visually, and participants could select the one they considered most appropriate. In contrast, the picture verification task presents one image only, which may create a bias in responses as only one potential interpretation is visually activated. Despite this, it seems relevant to explore participants' responses in the PVT to investigate whether the attachment patterns observed in the PST are maintained.

Prior to providing the output of the inferential models, descriptive results will be presented. Figure 8 illustrates the percentage (%) of accept responses by experimental condition (HA and LA) across groups (Spanish monolinguals, instructed bilinguals and English monolinguals). It is worth noting that, while in the PST not all groups were exposed to the three experimental conditions, forcing-HA, forcing-LA and ambiguous; this is not the case for the picture-verification task. As observed in Figure 8 below, the three participant groups were presented with the two conditions, allowing for comparison across groups. The plot shows the percentage of times participants accepted the either a HA-biased or a LA-biased image (HA or LA condition) as a correct representation of an ambiguous sentence in their L1. The mean percentages and standard deviations of accept responses can be found in Table 34.

Figure 8:

Percentage (%) of "accept" responses by condition and group

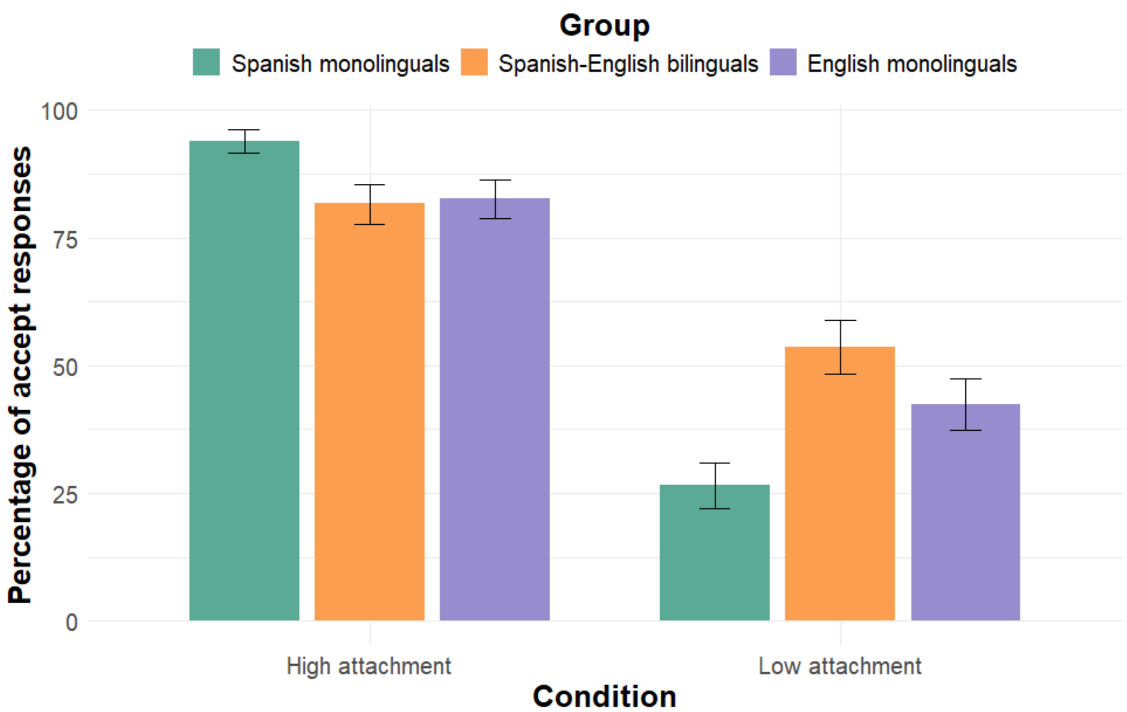


Table 34:

Mean percentages (%) and standard deviation of "accept" responses by condition and group

	Spanish monolinguals		Bilinguals		English monolinguals	
	mean	*SD*	*mean*	*SD*	*mean*	*SD*
High attachment	94	0.23	81.7	0.38	82.6	0.37
Low attachment	26.5	0.44	53.6	0.49	42.4	0.49

Considering the results in Figure 8 and Table 34, the three groups seem to tolerate more the HA condition than the LA condition. Higher acceptance rates are observed across groups when the image following an ambiguous relative clause represents a HA representation, meaning that participants are more likely to accept the image when it depicts a HA interpretation. As expected, this tendency is particularly strong in the Spanish monolingual group, as it shows the highest percentage of *accept* responses and little variation (mean = 94%, SD = 0.23). Lower acceptance percentages are observed for both the bilingual and English groups, whose response patterns appear to be very similar (Bilinguals: mean = 81.7%, SD = 0.38; English: mean = 82.6%, SD = 0.37). Overall, the values for standard deviations in the HA condition are smaller than in the LA condition, reflecting greater consistency in the responses across groups. In contrast, the standard deviations in the LA condition reveal higher variability, suggesting that this condition leads to more diverse responses.

Focusing on the LA condition, a common tendency is observed: all groups are less likely to accept an image when it depicts an LA interpretation than a HA interpretation. However, the bilingual group exhibits the highest percentage of *accept* responses in the LA condition (mean = 53.6%, SD = 0.49), followed closely by English monolinguals (mean = 42.4%, SD = 0.49) and then, by the Spanish monolingual group mean = 26.5%, SD = 0.44). These results were unexpected. Based on previous literature and on the picture selection data (see Section 6.4.1), English monolinguals were predicted to exhibit the highest acceptance rates for the LA condition. When encountered with an ambiguous relative clause, a LA strategy was expected in their initial analysis, coinciding with the representation displayed afterwards in the LA-image. Thus, there would be a correlation between initial analysis and image bias, increasing the number of *accept* responses for this group in this condition. However, more than half of the time, English natives rejected the LA-biased image as an appropriate representation of the ambiguous sentence. This may be because their initial analysis did not consider LA or because their LA preference for LA is weak and easily modified if they are presented with a HA-biased image. The idea that the LA preference reported for native English is not very strong aligns with the conclusions derived from the offline PST results (see Section 6.4.1). A tendency to attach low was observed in the English offline data, but was milder when compared to the Spanish HA preference.

Regarding Spanish monolinguals, results are in line with those from the PST. This group has the lowest rate of *accept* responses in the LA condition (mean = 26.5%, SD = 0.44), meaning that in most cases, when a LA image was displayed, Spanish natives rejected it as an appropriate representation of the preceding ambiguous relative clause. This may indicate that their initial interpretation did not coincide with that in the image, suggesting a preference for HA in initial stages. Additionally, the fact that displaying the image did not make participants change their opinion may imply that Spanish monolinguals remain more faithful to their initial HA interpretation. The strong tendency to attach high reported for the picture selection task aligns with these data.

To summarise, the HA condition consistently yields higher acceptance rates across groups, with Spanish monolinguals showing the strongest HA preference, as expected.

On the other hand, *accept* responses are considerably lower across all groups in the low-attachment condition, which also involves higher variability in the responses, with the instructed bilingual group showing the highest rates of LA acceptance and the Spanish monolingual group, the lowest.

After presenting the descriptive raw data, results from the inferential statistical analyses will be reported. Given that the *response* variable is a categorical variable, generalised linear mixed-effects models were conducted using the *glmer* function of the *lme4* package (Bates et al., 2015) in the R environment (R Core Team, 2024). The DV, accept or reject responses, will be explored in relation to the following IVs or predictors: *condition* (high attachment and low attachment) and *group* (Spanish monolinguals, bilinguals and English monolinguals), together with their interaction (*condition*group*). The *response* variable was binary and coded as follows: *accept* responses = 1, whereas *reject* responses = 0. This means that the output of the statistical models, reported in log odds, will present the probability of participants providing an *accept* response versus the probability of not providing it. Additionally, random intercepts were included in the random-effects structure for both participant and item, accounting for variability in response patterns across participants and items. The R code of the model is introduced in (68) below, and the output is presented in Table 35.

(68) **Model for *accept* responses:**

```
model_responses ← glmer(response ~ condition * group +
                         (1 | participant) + (1 | item))
```

Table 35:

Output model for responses by group and condition

	Estimate	**Std. error**	**z-value**	***p*-value**	
Intercept	3.057	0.264	11.581	< 0.001	***
Condition LA	-4.218	0.267	-15.797	< 0.001	***
Group Bilinguals	-1.335	0.308	-4.333	< 0.001	***
Group English	-1.305	0.309	-4.224	< 0.001	***
LA: Bilinguals	2.676	0.317	8.422	< 0.001	***
LA: English	2.142	0.318	6.732	< 0.001	***

The intercept represents the baseline log-odds of providing an *accept* response for the Spanish monolingual group in the HA condition. As observed, the model output reports significant effects of *condition*, *group* and their interaction. Compared to the reference level, the likelihood of *accept* responses significantly decreases in the LA condition (β = -4.218, p < 0.001), revealing a significant *condition* effect. There is also a significant main effect of *group*, since instructed bilinguals and English monolinguals exhibit fewer *accept* responses (Bilinguals: β = -1.335, p < 0.001; English: β = -1.305, p < 0.001) than the Spanish monolingual group in the HA condition. This suggests that, as expected, the Spanish monolinguals are the ones with the strongest HA preference. Finally, regarding the interaction effects, these reveal that the reduced acceptance from the HA to the LA condition is less pronounced for both the bilingual and the English groups compared to Spanish monolinguals (Bilinguals: β = 2.676, p < 0.001; English: β = 2.142, p < 0.001). The general tendency is that the LA condition is accepted less often than the HA condition, but this is modulated by group, with Spanish monolinguals showing the greatest contrast (high acceptance in HA vs. low acceptance in LA), while the reduced acceptance in the LA condition is more moderate in bilinguals and English monolinguals.

To follow up on these findings, pairwise comparisons were conducted using the *emmeans* package (Lenth, 2024). The results for these contrasts are provided in Table 36. As anticipated in Figure 8, results reveal significant differences in response patterns between groups (Spanish monolinguals, instructed bilinguals and English monolinguals). Focusing on the HA condition, as expected, Spanish monolinguals show the highest likelihood of providing an *accept* response, being significantly greater than both the bilingual and the English groups (Spanish vs. Bilinguals: β = 1.335, $p =$ < 0.001; Spanish vs. English: β = 1.305, $p =$ < 0.001). However, instructed bilinguals and English monolinguals do not differ from each other (β = -0.029, $p =$ 0.992). To put it simply, bilinguals are significantly less likely to accept a HA-biased image, their L1-preferred strategy, compared to Spanish monolinguals. Conversely, no significant differences are found between bilinguals and English monolinguals in the HA condition, suggesting similar response patterns between both groups.

Table 36:

Pairwise comparisons of "accept" responses across conditions and groups

HA condition					
Contrast	**Estimate**	**Std. error**	**z-ratio**	***p*-value**	
Spanish - Bilinguals	1.335	0.308	4.333	< 0.001	***
Spanish - English	1.305	0.309	4.224	< 0.001	***
Bilinguals - English	-0.029	0.259	-0.114	0.992	
LA condition					
Contrast	**Estimate**	**Std. error**	**z-ratio**	***p*-value**	
Spanish - Bilinguals	-1.341	0.238	-5.645	< 0.001	***
Spanish - English	-0.837	0.235	-3.555	0.001	***
Bilinguals - English	0.504	0.228	2.206	0.070	

Additionally, in the LA condition, the Spanish group displays lower likelihood of accepting a LA-biased image than the other groups, as expected. Spanish monolinguals significantly differ from both bilinguals (β = -1.341, p = < 0.001) and English monolinguals (β = - 0.837, p = < 0.001), who are more likely to accept a LA-biased image. Although it does not reach statistical significance, it worth noting that the probability of accepting a LA-biased image is higher for bilinguals than for English monolinguals. Although non-significant, these results are unexpected, as they suggest that instructed bilinguals show increased tendency than English natives to accept an LA interpretation of an ambiguous sentence in their L1. To put it simply, bilinguals significantly differ from Spanish monolinguals, exhibiting higher likelihood of accepting a LA-biased image. When compared with English monolinguals, the difference between bilinguals and English natives is non-significant, although a tendency is found in bilinguals to exhibit higher acceptance rates in the LA condition.

Overall, these findings suggest that Spanish monolinguals show the most polarised responses, frequently accepting the image when it depicts a HA representation, while this acceptance is considerably reduced if the image depicts a LA representation. This aligns with the strong HA preference reported in previous literature for L1 Spanish (see Section 3.4.1). In contrast, the bilingual and English groups display more moderate differences in their responses, i.e., their responses show less pronounced contrasts between the HA and LA conditions. The bilingual group appears to occupy an intermediate position as they have the most balanced response patterns across conditions. This pattern implies that they are less influenced by condition (high vs. low attachment) than the other two groups, with a tendency to accept the image regardless of experimental condition. L1 Spanish-L2 English bilinguals align with the English monolingual group in the HA condition as they do not reach Spanish levels. In the LA condition, instructed bilinguals are significantly different from Spanish monolinguals, increasing their acceptance of the L1-dispreferred LA interpretation, but do not significantly differ from English monolinguals.

Finally, English monolinguals show high number of *accept* responses in the HA condition. This suggests acceptance of a HA interpretation, their dispreferred L1 strategy, although the percentage remains significantly lower than the one of the Spanish monolingual group. The LA condition reveals that, as expected, they are significantly more likely to accept an LA interpretation than Spanish natives. However, compared to bilinguals, no significant differences are found. This lack of difference between English monolinguals and bilinguals, as observed in Figure 8, seems to be due to the unexpected response patterns in native English speakers. While bilinguals behave according to expectations (reduced acceptance of HA in favour of increased acceptance of LA), the expected LA bias in English monolinguals is not evidenced in the results, leading to lack of differences with bilinguals. These surprising findings regarding the English monolingual group will be further discussed in Section 7.5.

7.4.2. Results for response times (RTs)

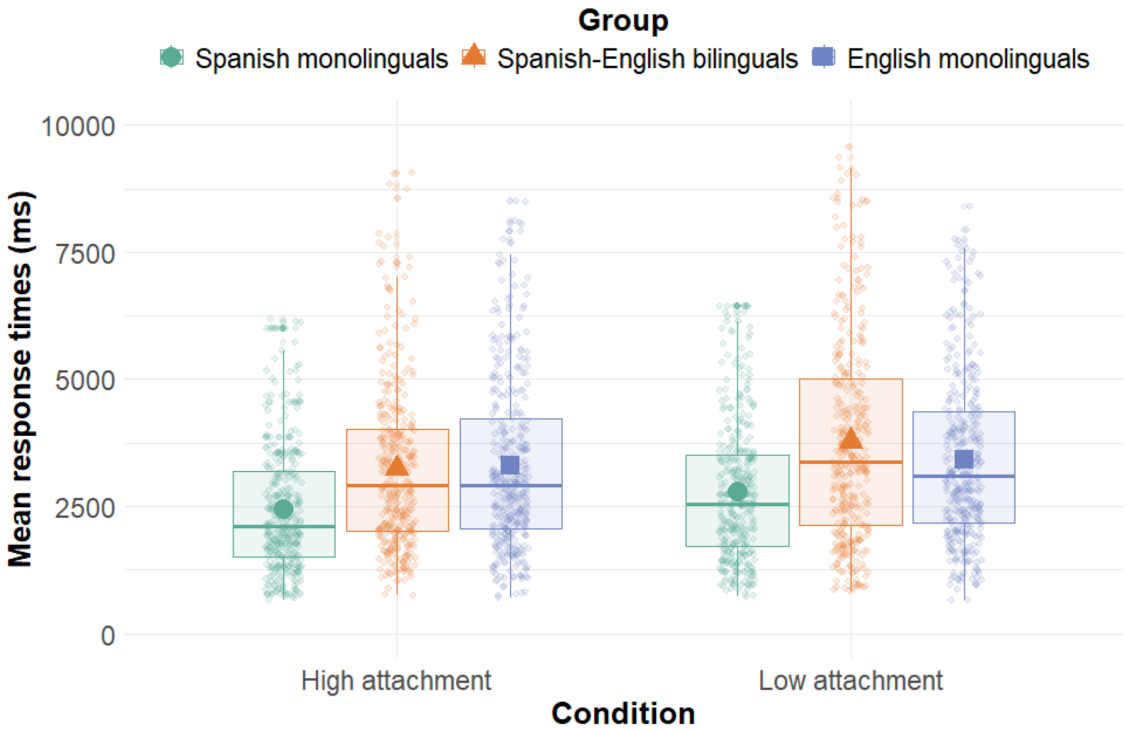
The PVT was designed to account for potential processing costs that may emerge when a sentence containing an ambiguous relative clause is followed by an image that illustrates the L1-disprefered attachment strategy: LA for the two L1 Spanish groups (Spanish monolinguals and L1 Spanish-L2 English bilinguals) and HA for the English monolingual group. Processing delays would be the result of reanalysis of the sentence, evidencing garden-path effects. These processing costs will be addressed examining participants' response times. RTs will be the dependent variable examined in the following analyses, representing the time needed by participants to press a key indicating whether the image displayed corresponds or not to the ambiguous sentence they just heard.

Before presenting the results of the statistical analysis, the descriptive results of the raw data will be presented. Response time data will be plotted in two ways. First, considering only the RTs of each group by condition (see Figure 9). Second, a more detailed plot will present the RTs of each group by condition and response (see Figure 10). These two plots will be complementary. While Figure 9 provides a general overview to quickly identify overall tendencies across groups and conditions, Figure 10 will offer a more complete understanding of response time patterns, illustrating how specific responses interact with conditions and groups.

Regarding the former, Figure 9 illustrates the mean RTs by condition (HA vs. LA) and group (Spanish monolinguals, bilinguals and English monolinguals). Overall, higher response times are observed for the LA condition across groups. Focusing first on Spanish monolinguals, there seems to be a difference between the two experimental conditions, with faster responses in the HA condition (mean RTs = 2452 ms) compared to the LA condition (mean RTs = 2806 ms). This seems to suggest that greater reanalysis was required for the Spanish group in the LA condition. The bilingual group patterns with Spanish monolinguals as they also demonstrate faster RTs in the HA condition (mean RTs = 3249 ms) than in the LA condition (mean RTs = 3784 ms). However, in addition to these differences between conditions, it is important to highlight the general trend that bilinguals' RTs in both experimental conditions are higher than those of Spanish monolinguals. This is a key difference between the two groups. In contrast, the English monolingual group barely shows variability between the two conditions (HA condition: mean RTs = 3304 ms; LA condition: mean RTs = 3419 ms), which suggests more consistent performance and less influence of condition.

Figure 9:

Mean raw RTs by condition and group



Overall, Figure 9 reveals that while Spanish monolinguals and instructed bilinguals are influenced by the type of experimental condition, with the HA condition eliciting faster responses; the English monolingual group appears to be less affected by this manipulation as a similar response time pattern is observed. However, the plot is not completely informative as it does not consider participants' responses (accept or reject) for each condition. Regardless of experimental condition, participants were instructed to indicate whether the image corresponded or not to the preceding ambiguous sentence. In Figure 9 above it remains unclear whether faster response times may be associated to a specific response or whether they reflect general response patterns. To address this issue, Figure 10 below presents a more refined representation of the data, showing participants' mean RTs by condition (HA and LA), group (Spanish monolinguals, instructed bilinguals and English monolinguals) and response (accept and reject).

Figure 10:

Mean RTs by condition, group and response

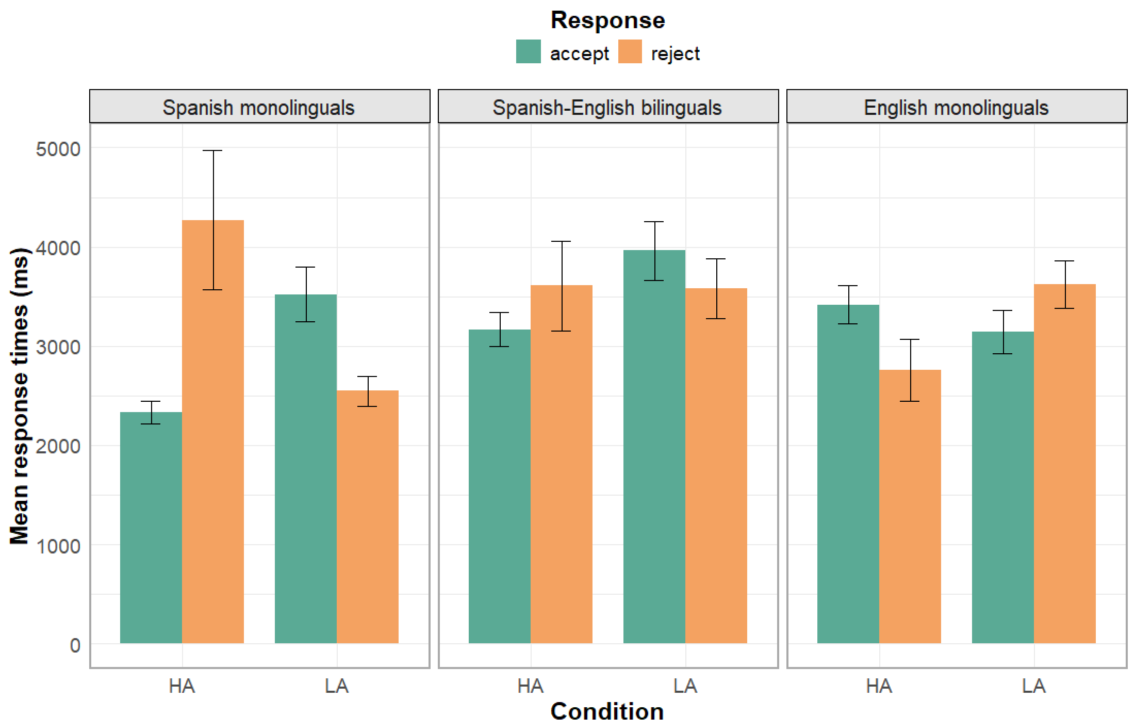


Figure 10 above reveals differences regarding processing patterns, with longer response times suggesting greater processing cost, likely due to reanalysis of the preceding ambiguous sentence. First, considering Spanish monolinguals in the HA condition, they respond faster when accepting the image (mean RTs = 2336 ms) compared to rejecting it (mean RTs = 4271 ms), which suggests that rejecting a HA interpretation may require reanalysis. The opposite pattern is observed in the LA condition since rejecting the LA-biased image is faster (mean RTs = 2548 ms) than accepting it (mean RTs = 3521 ms). This indicates that Spanish natives face processing difficulties when rejecting high attachment and accepting low attachment, in line with the HA preference reported in previous research and also, following the HA tendency reported on the PST.

Table 37:

Means and standard deviations of raw RTs by condition, group and response

Spanish monolinguals			
Condition	**Response**	***mean***	***SD***
HA	accept	2336	1145
	reject	4271	1752
LA	accept	3521	1422
	reject	2548	1288.924
Bilinguals			
Condition	**Response**	***mean***	***SD***
HA	accept	3168	1562
	reject	3607	1935
LA	accept	3963	2094
	reject	3577	199
English monolinguals			
Condition	**Response**	***mean***	***SD***
HA	accept	3419	1761
	reject	2752	1291
LA	accept	3146	1398
	reject	3620	1799

Secondly, instructed bilinguals show a similar pattern, although with reduced differences across conditions and responses. In the HA condition, their RTs are similar for *accept* (mean RTs = 3168 ms) and *reject* (mean RTs = 3607 ms) responses, with slightly increased processing cost for rejection. In the LA condition, accepting a LA-biased image involves higher RTs (mean RTs = 3963 ms) than rejecting it (mean RTs = 3577 ms). While bilinguals seem to maintain the Spanish pattern as they show a mild HA bias, the differences are mitigated compared to the Spanish group, depicting a more balanced pattern. Attachment preferences in bilinguals appear to be less straightforward compared to those of Spanish natives.

Finally, the reverse scenario is observed for the English monolingual group. In the HA condition, they are faster when they reject the HA-biased image (mean RTs = 2762 ms) than when they accept it (mean RTs = 3419 ms). Conversely, in the LA condition, acceptance (mean RTs = 3146 ms) is faster than rejection (mean RTs = 3620 ms). Taken these descriptive data together, as expected, findings reveal that an LA interpretation of an ambiguous relative clause seems to be the default, more natural strategy for English natives, while HA may require more cognitive effort.

These tendencies were further investigated using linear mixed-effect models. RTs represent participants' needed time to either accept or reject the image displayed as an appropriate representation of the preceding ambiguous sentence. In the following analyses, the dependent variable, participants' response times, will be log-transformed to normalise model residuals (Vasishth & Nicenboim, 2016). This continuous variable analysed using linear mixed-effect models with the *lmer* function of the *lme4* package (Bates et al., 2015) in the R environment (R Core Team, 2024). The following models reported throughout this section contain the maximal random-effects structure that converged (Barr et al., 2013). It is also relevant to clarify that the output of the models will be reported in the scale of the log-transformed response times, meaning that higher coefficients will reflect longer RTs and consequently, slower responses.

The R code of the regression model predicting participants' RTs is illustrated in (69), while the output obtained is presented in Table 38 below. The model predicts log-transformed response times as a function of the following fixed effects: *group* (Spanish monolinguals, instructed bilinguals and English monolinguals), *condition* (high vs. low attachment) and *response* (accept vs. reject), along with their interactions. Regarding the random-effects structure, it includes random intercepts and random slopes for *condition* and *response* within each participant and item. In Table 38, the intercept represents log-transformed RTs for the Spanish monolingual group in the HA condition when they provide an *accept* response.

(69) **Model for log-transformed RTs:**

```
model_RTs ← lmer(log(response_time) ~ condition * group * response +
                 (1 + condition + response | participant) +
                 (1 + condition + response | item))
```

Table 38:

Output model log-transformed RTs by group, condition and response

	Estimate	Std. error	df	t-value	*p*-value	
Intercept	7.653	0.049	126.32	153.343	< 0.001	***
Condition LA	0.453	0.059	136.31	7.577	< 0.001	***
Group Bilinguals	0.300	0.069	132.66	4.303	< 0.001	***
Group English	0.349	0.069	131.73	5.016	< 0.001	***
Response reject	0.511	0.109	377.91	4.677	< 0.001	***
LA: bilinguals	-0.271	0.073	208.77	-3.711	< 0.001	***
LA: English	-0.465	0.074	223.90	-6.265	< 0.001	***
LA: reject	-0.871	0.116	1048.94	-7.467	< 0.001	***
Bilinguals: reject	-0.354	0.127	393.44	-2.776	0.005	**
English: reject	-0.602	0.129	424.05	-4.670	< 0.001	***
LA: bilinguals: reject	0.666	0.142	1269.02	4.662	< 0.001	***
LA: English: reject	1.042	0.142	1213.50	7.313	< 0.001	***

Results show significant main effects of *condition*, *group* and *response*, with their interactions also being significant. Regarding the former, Spanish participants responded slower in the LA condition (β = 0.453, p < 0.001) compared to the HA condition. Additionally, significant *group* differences are also reported, with L1 Spanish-L2 English bilinguals and English monolinguals showing longer RTs compared to the Spanish monolingual group (Bilinguals: β = 0.300, p < 0.001; English: β = 0.349, p < 0.001). The type of response provided, either *accept* or *reject*, also significantly influences response times. Slower responses are predicted for *reject* responses compared to *accept* responses (β = 0.511, p < 0.001). However, given that these results only consider Spanish monolinguals, the most relevant findings involve interaction effects.

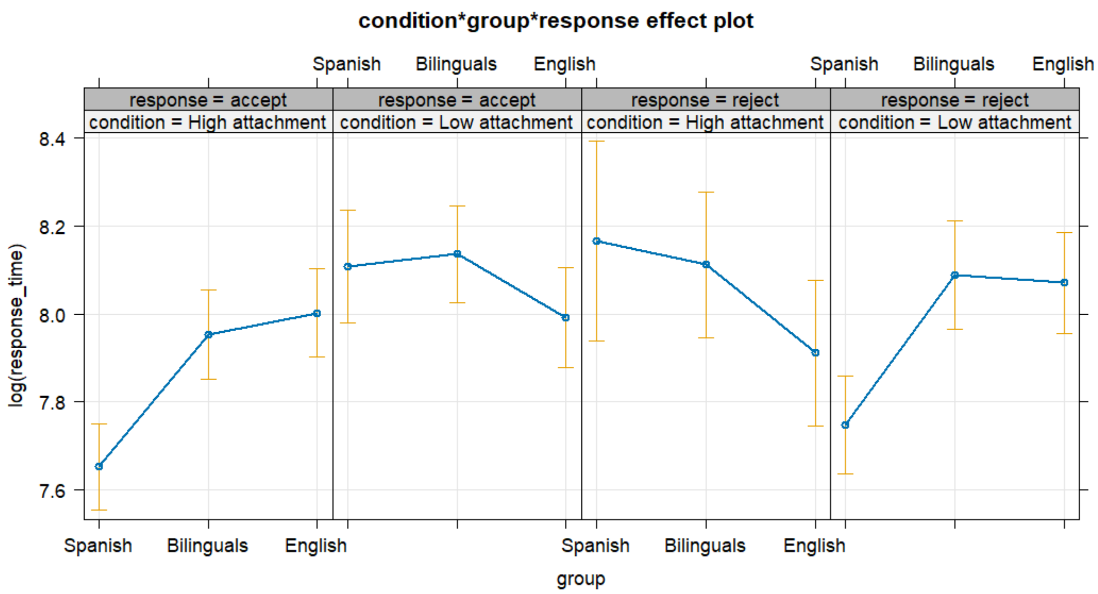
The two-way interaction *condition*group* reveals that the effect of condition varies based on group. When compared to the baseline condition (Spanish natives in the HA condition with an *accept* response), the negative coefficients for the bilingual and English groups reveal that these participants are more affected by the LA condition than Spanish monolinguals (Bilinguals: β = -0.271, p < 0.001; English: β = -0.465, p < 0.001). Bilinguals and English natives respond faster (lower RTs) than Spanish natives in the LA condition, which indicates greater acceptance of a LA interpretation in these two groups.

Additionally, this effect is stronger in English monolinguals, which is in line with the LA preference reported in previous literature. These findings suggest that instructed bilinguals significantly differ from Spanish monolinguals in their response patterns, following the English tendency. Similarly, the interaction *group*response* also reveal significant differences between Spanish monolinguals vs. bilinguals and English natives. In the HA condition, the two latter groups are faster than the Spanish group when rejecting the HA-biased image (Bilinguals: β = -0.354, p = 0.002; English: β = -0.602, p < 0.001). This difference is highly significant between the English and Spanish group, indicating that the former is particularly faster in providing a *reject* response when a HA-biased image is displayed. This again suggests greater HA preference for Spanish monolinguals speakers, followed first by instructed bilinguals and then, by English natives.

Finally, positive coefficients are reported in the output model for the three-way interaction *condition*group*response*. The effect of the LA condition combined with reject responses is stronger for both bilinguals and English monolinguals, being especially stronger in the latter group. Overall, clear group and condition differences are observed in response times and *reject* responses are consistently slower across all groups, but this influence is accentuated by LA, particularly for bilinguals and English speakers. To ensure a better interpretation of these findings, the plot in Figure 11 represents the predictions of the model described here.

Figure 11:

Predicted log-transformed RTs by condition, group and response



Pairwise comparisons were conducted using the *emmeans* package (Lenth, 2024) to follow up on how RTs differ between participants' groups across conditions and response types. In the **HA condition**, Spanish monolinguals are reported to accept a HA-biased image significantly faster than both instructed bilinguals and English monolinguals (Spanish vs. bilinguals: β = -0.300, p < 0.001; Spanish vs. English: β = -0.349, p < 0.001). No significant differences were observed between bilinguals and English monolinguals (Bilinguals vs. English: β = -0.048, p = 0.770). As expected, bilinguals take more time than Spanish natives to accept a HA interpretation, evidencing attrition effects. Turning to *reject* responses in the HA condition, there were no significant differences between any of the three groups. When rejecting a HA-biased image, Spanish natives are slightly slower than bilinguals and English monolinguals (Spanish vs. bilinguals: β = 0.053, p = 0.917; Spanish vs. English: β = 0.253, p = 0.157). Although the difference is more pronounced between Spanish and English monolinguals, it does not reach statistical significance. Additionally, bilinguals are in turn slightly slower than English natives in rejecting a HA-biased image (β = 0.200, p = 0.166), but the difference is non-significant. Overall, when the HA condition is compared across groups, group effects are specific to *accept* responses only.

Regarding the **LA condition**, a different pattern emerges. Spanish natives were significantly faster to *reject* a LA-biased image than both the bilingual and the English groups (Spanish vs. bilinguals: β = -0.340, p < 0.001; Spanish vs. English: β = -0.323, p < 0.001), as predicted. The fact that bilinguals take more time to reject a LA-biased image than Spanish monolinguals reveals higher processing cost, maybe as a result of increased acceptance of the L1-dispreferred LA strategy in bilinguals. Conversely, bilinguals and English speakers showed no significant differences (β = 0.017, p = 0.974). For *accept* responses in the LA condition, no significant differences were observed between groups. This was unexpected, particularly regarding the English group, since Figure 10 shows that English monolinguals are approximately 900 milliseconds faster than the other groups in accepting a LA-biased image. Although Spanish monolinguals and bilinguals respond slower than English natives (Spanish vs. English: β = 0.116, p = 0.371; Bilinguals vs. English: β = 0.144, p = 0.165). Differences between Spanish monolinguals and instructed bilinguals are also non-significant (β = -0.028, p = 0.940).

These results partially confirm predictions for RQ_6 on garden-path effects. As predicted, instructed L1 Spanish-L2 English bilinguals show higher RTs in the HA condition than the Spanish monolinguals. This tendency suggests that some disruption and potential reanalysis has occurred for bilinguals, but not for Spanish monolinguals, indicating a weaker preference for HA in L1 Spanish-L2 English bilinguals. The strong HA tendency typical of L1 Spanish seems to be mitigated in the L1 of bilingual speakers. Otherwise, both groups would show similar times in their responses. In the LA condition, bilinguals' response times were expected to be longer than in the HA condition, which aligns with the results obtained. In fact, compared with Spanish monolinguals in the LA condition, instructed bilinguals show longer RTs.

As expected, no garden-path effects are found for the Spanish monolingual group, who displays a straightforward pattern. Short response times are found in the HA condition, whereas significantly longer RTs are associated with their L1-dispreferred, LA condition. Regarding the English monolingual group, results were unexpected as they display similar response time patterns in the two experimental conditions. While, as expected, English natives respond slower than the other groups in their dispreferred HA condition, no significantly shorter RTs (faster responses) were observed for the LA condition, which represents their default L1 strategy.

7.4.2.1. Results for RTs and language dominance

The previous section has addressed potential processing costs among Spanish monolinguals, instructed bilinguals and English monolinguals in relation to RCA biases. Bilinguals, compared to Spanish monolinguals, seem to provide slower responses when accepting the L1-preferred HA condition and rejecting the L1-dispreferred LA condition. To further investigate these differences, the present PhD thesis aims to explore the potential influence of individual factors in these response patterns. This section will focus on the role of language dominance, investigating whether the RTs of L1 Spanish-L2 English bilinguals may be additionally modulated by language dominance.

A linear mixed-effects model was used to explore log-transformed response times based on the following fixed effects or predictors: *condition* (high attachment vs. low attachment), *response* (accept vs. reject), and the continuous *BLP* variable which measures language dominance, together with their interactions. The specific model is reported in (70) below. It is relevant to emphasise that the BLP variable was pre-processed in advance to ensure that all participant groups were placed along the same Spanish-English dominance continuum (see Section 6.3 for further details). The resulting values for the BLP variable range from -218 to +218 and are interpreted as follows for all groups. Values closer to the negative, left-hand side of the continuum indicate higher dominance in Spanish, whereas values closer to the positive, right-hand side are associated with higher English dominance. Additionally, before including it as a predictor in the model, the BLP variable was standardised but not centred, given that in the original BLP scale the value 0 has a specific meaning, i.e., balanced bilingualism. Finally, and regarding the random-effects structure, random intercepts were included for both participant and item, as well as random slopes for condition. The model output is provided in Table 39.

(70) **Model RTs and BLP:**

model ← lmer(log(response_time) ~ condition * response * BLP_scaled +
(1 + condition | participant) + (1 + condition | item))

Table 39:

Output model for log-transformed RTs by condition, response and BLP in bilinguals

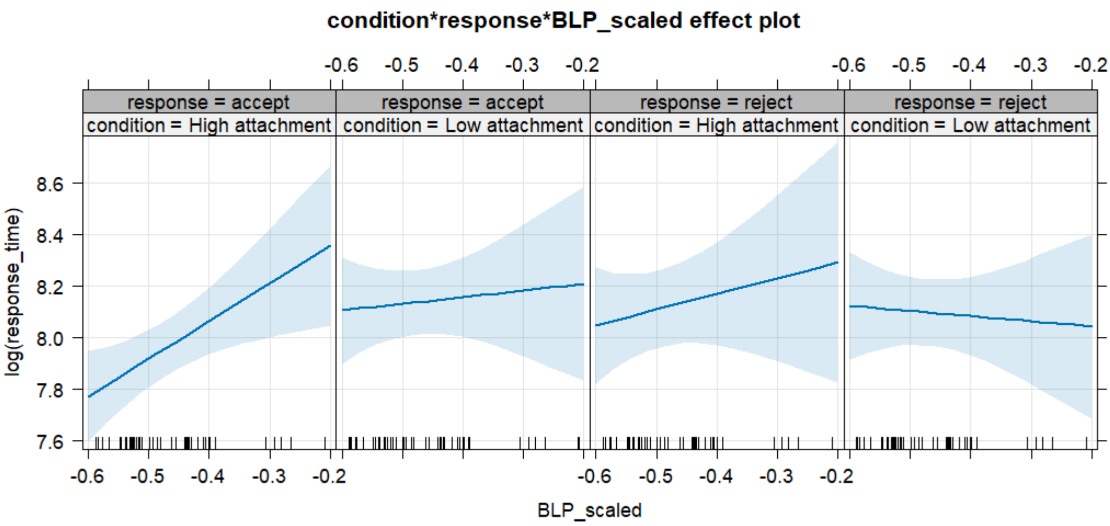
	Estimate	**Std. error**	**df**	**t-value**	***p*-value**	
Intercept	8.629	0.253	44.826	34.021	< 0.001	***
Condition LA	-0.588	0.265	113.229	-2.215	0.028	*
Response reject	-0.208	0.349	367.061	-0.596	0.551	
BLP	1.460	0.533	45.156	2.736	0.008	**
LA: reject	0.195	0.469	589.971	0.416	0.677	
LA: BLP	-1.631	0.555	110.908	-2.939	0.004	**
Reject: BLP	-0.821	0.704	388.607	-1.165	0.244	
LA: reject: BLP	0.850	0.964	600.062	0.882	0.378	

The intercept represents the baseline log-transformed RTs when the other variables (*condition*, *response* and *BLP*) are at their reference levels, i.e., high attachment, accept response and value 0 for the BLP, respectively. As observed, a significant effect of language dominance, measured by the BLP questionnaire, is reported (β = 1.460, p = 0.008). Higher BLP scores among instructed bilinguals, which indicate greater English dominance, are associated with higher response times, i.e., slower responses. This suggests that instructed L1 Spanish-L2 English bilinguals with increased dominance in their L2 English took significantly more time to provide an *accept* response in the HA condition. This seems to indicate that when a HA-biased image is displayed, acceptance of the image is significantly slower for those bilinguals who are more English dominant.

Additionally, the interaction effect between low attachment condition and BLP is also significant (β = -1.631, p = 0.004), which indicates that the BLP effect varies depending on the specific experimental condition, i.e., high attachment vs. low attachment. Compared to the baseline high attachment condition, the negative coefficient (β = -1.631, p = 0.004) reveals that the difference between providing an *accept* response in the HA vs. the LA condition for bilinguals is significant, with *accept* responses in the LA condition being significantly slower than in the HA condition. To put it simply, instructed bilinguals who are more English dominant are predicted to accept faster a LA-biased image than a HA-biased, as expected. The output of the model is illustrated in Figure 12 to facilitate interpretation of the results obtained.

Figure 12:

Predicted log-transformed RTs for bilinguals by condition, response and language dominance



These findings seem to evidence that language dominance modulates response times among instructed L1 Spanish-L2 English bilinguals. However, this effect is not balanced across both conditions (HA vs. LA). A stronger language dominance effect is observed when bilinguals accept a LA-biased image following an ambiguous relative clause, which results in faster RTs compared to accepting a HA-biased image. More English-dominant bilinguals seem to have a processing advantage when accepting the LA condition, typical of their L2 English, compared to the HA condition, typical of their L2 Spanish. This may imply an increased processing preference of their L2 English preferred low attachment condition, revealing that language dominance may modulate L1 attrition effects.

7.4.2.2. Results for RTs and length of L2 immersed instruction

Together with language dominance, an additional individual difference was explored as potentially modulating attachment preferences in instructed L1 Spanish-L2 English bilinguals, i.e., length of immersed instruction in the second language. This variable represents the academic year in which bilinguals were enrolled in the degree of English Studies, and consequently, reflects the number of years bilingual students have been exposed to their L2 English in a formal university classroom setting. To explore the potential modulating effect of length of L2 immersed instruction, a linear mixed-effects model was implemented to predict log-transformed response times for the bilingual group only, illustrated in (71). Regarding the fixed-effects structure, it includes the main effects of *condition* (high attachment vs. low attachment), *response* (accept vs. reject) and *length of L2 instruction*, along with their interaction. Prior to its inclusion as a predictor in the statistical model, the *LoII* variable was scaled, improving model convergence. In addition, the random-effects structure contains random intercepts for participant and item, as well as random slopes for condition. The output of the model is provided in Table 40.

(71) **Model RTs and LoII:**

model ← lmer(log(response_time) ~ condition * response * LoII +
(1 + condition | participant) + (1 + condition | item))

Table 40:

Output model logged RTs by condition, response and length of L2 immersed instruction

	Estimate	Std. error	df	t-value	*p*-value	
Intercept	7.952	0.055	43.874	142.468	< 0.001	***
Condition LA	0.176	0.055	39.48	3.198	0.002	**
Response reject	0.180	0.067	564.059	2.690	0.007	**
LoII	-0.023	0.054	45.891	-0.441	0.661	
LA: reject	-0.226	0.087	682.605	-2.583	0.010	*
LA: LoII	0.047	0.051	82.968	0.925	0.357	
Reject: LoII	0.038	0.063	564.838	0.603	0.546	
LA: reject: LoII	0.011	0.087	676.200	0.136	0.891	

The intercept of the model represents the average log-transformed RTs in bilinguals when all predictors are at their reference level, i.e., high attachment condition, accept response and 0 LoII. As observed, no significant effects are found for length of L2 immersed instruction in bilinguals (β = -0.023, p = 0.661). The negative estimate suggests that bilinguals' response times slightly decrease in the HA condition as the number of years exposed to the L2 increases. Considering the interaction effects, only the two-way interactions between condition and LoII reaches significance (β = -0.226, p = 0.010), meaning that the increase in RTs for *reject* responses is smaller in the LA condition. Neither the interaction between response and LoII (β = 0.038, p = 0.546), nor the three-way interaction between condition, response and LoII (β = 0.011, p = 0.891) is significant.

These results were unexpected as they suggest that length of instruction in the L2 does not modulate response times among instructed bilinguals. No differences are observed based on the academic year they are enrolled in. These findings disconfirm the predictions outlined in Section 4.2, as an effect of length of immersed instruction was expected. These results are in line with those from the PST reported in Section 6.4.1.2, where a tendency was observed indicating that bilingual students in the final years of the degree displayed lower HA preference (as expected), but the effect was not significant. In the PVT, it was expected that L1 Spanish-L2 English bilinguals with increased amount of instruction, i.e., those in the final years of the degree, would display higher response times in the HA condition and shorter RTs in the LA condition compared to those with fewer amount of instruction. However, they appear to show similar response patterns regardless of exposure. Overall, length of intensive L2 instructed exposure does not seem to account for variability in the bilingual data.

7.5. Discussion of picture verification task data

This section will offer an in-depth discussion of the results from the auditory sentence-picture verification task conducted in the first language of all participant groups: instructed L1 Spanish-L2 English bilinguals, Spanish monolinguals and English monolinguals. To accomplish this, and following the structure employed in the discussion of the PST results (see Section 6.5), this section will revisit the research questions and hypotheses outlined in Section 7.1 for the picture verification data. Each question will be examined separately, providing individual and detailed discussions for each of them.

Firstly, RQ_6 was divided into two questions. RQ_{6a} addressed the attachment strategies of instructed bilinguals compared to those of Spanish monolinguals and English monolinguals to disambiguate relative clauses, Additionally, RQ_{6b} compared picture verification findings with offline results from the picture selection task. Participants' strategies were explored based on the acceptance rates for each condition. In the HA condition, Spanish monolinguals were predicted to exhibit the highest acceptance rate, followed by bilinguals, and then, English monolinguals. In contrast, in the LA condition, English monolinguals were expected to show the highest percentage of *accept* responses, followed by bilinguals and finally, Spanish monolinguals. PVT results were expected to align with the offline responses in the PST, with Spanish monolinguals clearly favouring HA over LA, while the opposite would hold for English monolinguals. Bilinguals were predicted to show similar acceptance rates across conditions, in line with the intermediate position reported in the PST (see Section 6.4.1).

To answer these RQs, the statistical analysis focused on participants' final response (accept vs. reject) provided for each target trial. Participants listened to an ambiguous sentence and afterwards, an image was displayed. The image could represent either a HA or LA interpretation of the sentence and participants were instructed to either accept or reject the image as an appropriate representation of the preceding ambiguous sentence. Results evidenced significant *group* and *condition* effects on participants' responses, with their interaction also being significant.

Results from the PVT partially confirm the predictions formulated for RQ_6 (see Section 4.2). Predictions for the Spanish monolingual and bilingual groups have been confirmed, while those for English natives have not. As predicted, **Spanish monolinguals** exhibit the most categorical responses, illustrated by the raw descriptive data in Figure 8 and later confirmed by statistical analyses. In the HA condition, the Spanish monolingual group shows the highest rate of *accept* responses, meaning that they are significantly more likely to accept a HA-biased image as an appropriate representation of an ambiguous RC than bilinguals and English monolinguals. Additionally, they barely provide *accept* responses in the LA condition, exhibiting significantly lower likelihood of accepting a LA-biased image than the other two groups, as expected. These findings provide further evidence of the strong preference to attach high in native Spanish, confirming both the predictions made in this PhD thesis and findings in previous literature where HA is reported to be the preferred strategy in L1 Spanish. The strong HA preference found in the PVT for native Spanish also coincides with offline findings from the PST (see Section 6.4.1), where Spanish monolinguals selected significantly more HA images than LA images compared to the other groups, evidencing a bias for a final HA interpretation.

Instructed L1 Spanish-L2 English **bilinguals**, as predicted, show evidence of L1 attrition in both the HA and LA conditions. In the former, they show significantly lower likelihood of accepting the L1-preferred HA interpretation, whereas in the LA condition, bilinguals exhibit increased acceptance of the L1-disprefered LA strategy. When a HA-biased image is displayed, bilinguals show high acceptance of HA interpretations (see Figure 8), which indicates that their L1 bias for HA is still present, but is significantly lower than that of Spanish monolinguals. This attenuated HA preference evidences L1 attrition effects. Additionally, in the LA condition, the fact that bilinguals accept more frequently a LA-biased image than Spanish monolinguals in their L1 Spanish suggests that bilinguals tolerate more a LA interpretation of an ambiguous RC. Such increased acceptance of their L1-dispreferred LA strategy, together with the reduced acceptance of their L1-preferred HA mechanism, reveal a departure from native Spanish behaviour. This confirms our predictions for bilinguals, who behave as expected in the PVT.

In fact, descriptive results from the raw data in Figure 8 illustrate that bilinguals' percentage of *accept* responses in the HA vs. LA conditions is the most balanced of the three groups, which is in line with the optionality of attachment preferences reported in the picture selection data. Although the nature of the data from the PST and the PVT is different, triangulating results from these two tasks, allows us to gain wider perspective on the nature of L1 attrition in bilinguals. The key finding from both tasks is that instructed bilinguals exhibit a significantly attenuated HA preference when compared to Spanish natives, although the HA bias is still present. Such reduced preference for HA is in favour of increased acceptance of the LA condition, they typical strategy of their L2 English. These findings are also in line with offline results from the PST, which revealed optionality in bilinguals' offline attachment preferences (see Section 6.4.1). Their number of HA responses was significantly lower than that of Spanish natives, as it is the case in the PVT, but also significantly higher than that of English natives, meaning that bilinguals are still far from the LA preference of English natives.

However, English monolinguals do not seem to behave according to expectations. It is in the comparison between instructed bilinguals and English monolingual where we find the most surprising results. Results for this group are surprising since a stronger preference for LA was expected, reflected by low *accept* responses when a HA-biased image is displayed and by high acceptance when presenting a LA-biased image. However, we observed the opposite pattern. When a HA-biased image is displayed following an ambiguous RC, English natives exhibit high acceptance rates in their L1 English, not differing from L1 Spanish-L2 English bilinguals. Considering Figure 8, the rate of *accept* responses in the English group is very high (mean = 82.6%), indicating that they often tolerate a HA interpretation of an ambiguous RC. Although statical analyses reported significant differences between Spanish and English monolinguals, meaning that English natives do not reach Spanish levels of HA acceptance, these results were unexpected. The unexpected high acceptance of HA in native English speakers will be discussed in more depth in the following paragraphs, once data for the LA condition have been presented

Regarding the LA condition, English monolinguals were hypothesised to show the highest acceptance rate, reflecting their L1 preference to attach low. However, this is not observed. Statistical analyses reveal that English natives are significantly more likely than Spanish monolinguals to accept a LA-biased image, as expected, but no differences are reported when compared to instructed bilinguals, i.e., English natives are equally likely than bilinguals to accept a LA interpretation. Given that bilinguals behave according to our predictions, it is the native English data which offers surprising response patterns. As illustrated in Figure 8, this lack of difference is not because bilinguals radically favour LA, but because English natives' bias for LA is surprisingly low. They accept the LA-biased image around 50% of the time, which implies greater hesitation and lower preference for LA than expected. This pattern, although surprising, provides evidence that the English preference for LA may not be as strong as commented on previous literature. In fact, offline responses in the PST (see Section 6.4.1) evidence that the LA preference of the English group is weaker than the HA preference of the Spanish group.

Several explanations can be provided for the unexpected results in English natives. All of them are build on the premise that the LA preference in native English appears to be more moderate or milder than the HA preference in native Spanish, as evidenced in the PST (see Section 6.4). Therefore, it may potentially be more susceptible to influence from other factors. Such factors may be the nature of the task, the conditions under which it was administered and the stimuli employed. Regarding the former, differences in the bias strength within the same participants (i.e., English monolinguals) might be due to the task-specific characteristics, particularly given that their LA preference has already been found to be weaker than the Spanish HA preference in the picture selection data and therefore, potentially more vulnerable. Thus, such lower preference may have been enhanced by the characteristics of the picture-verification task. The PVT is similar to an acceptability task, in which participants accept or reject a given interpretation represented by either a HA or a LA image. In this context, accepting or rejecting a specific interpretation does not necessarily involve that such interpretation is the preferred or dispreferred strategy, respectively, of these participants. Previous studies using acceptability tasks have reported less clear-cut patterns and higher variability in the results obtained (Bel et al., 2016; de Rocafiguera, 2023; De Rocafiguera & Bel, 2022; Martín-Villena, 2023). This variability has been evidenced particularly in comparison with forced-choice tasks such as the PST presented in Chapter 6, which tend to reveal clearer patterns. These tasks seem to more clearly reflect participants' preferences, since choosing between different interpretations is a more natural task than being forced to accept or reject a specific one. Thus, the nature of the PVT, along with the lower LA preference in native English may account for unexpected results in English monolinguals.

A second explanation is related to the conditions under which the PVT was administered. It is worth noting that the PVT was conducted remotely, and participants completed it at home. The fact that it was not administered in a control lab setting with the researcher may have influenced results. This potential task-administration effect may be more pronounced in English monolinguals since they show a milder attachment preference compared to Spanish monolinguals. Participants in the native Spanish group may be so biased towards HA that the conditions under which the PVT was conducted do not exert any effect in their responses. On the contrary, for English monolinguals, the fact that their LA preference is less pronounced, together with the fact that the task was conducted at home, with potential distractions, may have led to the unexpected results for this group. To address this, it would be necessary to replicate this task in a controlled lab setting to compare results and determine whether this may have been a factor.

A final explanation is related to the stimuli employed. Previous RCA studies that forced either a HA or a LA interpretation have exclusively relied on written stimuli, i.e., written sentences. Researchers have tested attachment preferences using written sentences that forced a specific disambiguation strategy via morphological agreement, pragmatics, etc. Consequently, the forced disambiguation typically occurs before the sentence has been completely uttered. However, the present PVT introduces a visual component (images), and sentences are disambiguated after they have been pronounced. Thus, participants fully listen to a globally ambiguous sentence, which is then "resolved" using either a HA or a LA image. This design allows participants to create a mental representation of the sentence, in contrast with previous studies. Importantly, all images (HA or LA) depict a grammatically-possible visual representation of the sentence, regardless of whether participants initially depicted the scene in that way or not. This means that, once participants see the image, they may realise a different conceptualisation is possible, leading to more variability in their decisions. If this is so, it could affect all participant groups. However, due to the strength of the HA preference in Spanish, Spanish monolinguals may be more faithful to their initial HA interpretation and not modify it depending on the image displayed. Conversely, PST data show that the LA preference in English is milder, suggesting that these participants may be more likely to adjust their interpretation based on the image shown.

It might be argued that some characteristics of the English participants themselves may have influenced the results obtained. However, the careful control exerted during the participation process suggests otherwise. To take part in the study, candidates had to meet specific participation requirements, particularly related with factors that have been found to influence attrition effects such as L2 exposure and use, proficiency, and dominance, among others. To ensure that these variables did not interfere in the results, participants in the monolingual groups, including English monolinguals, were required to have no current exposure to and use of an L2, little knowledge of an L2, being L1 dominant, etc. (see Section 5.1.2 for further details on English monolinguals' participation criteria). The careful control of these variables makes us believe that the final English group was an appropriate one to explore RCA preferences as close as possible to those of a "true" monolingual. Additionally, our participants are similar to those in previous studies: they have been born and raised in an L1 English-speaking environment (Cambridge, UK), were living there at the time of testing, and had never lived abroad. However, given the unexpected results obtained, it will be necessary to further explore the linguistic background of these participants to address any potential factor that may have influenced the final outcomes.

To conclude, the key findings from acceptance rates in the PVT will be compiled. Compared to Spanish monolinguals, instructed bilinguals reveal L1 attrition effects by accepting significantly fewer HA interpretations, but significantly more LA ones. However, they do not differ from English monolinguals, likely due to the unexpected patterns observed in the English group. This is supported by PST findings, where instructed bilinguals do differ from English natives since the response patterns of the latter group met the behaviour reported in previous studies, i.e., a LA preference (Bergmann et al., 2008; Cuetos & Mitchell, 1988; Dussias, 2003). Since English monolinguals show a more evident LA bias in the PST, this differentiates them from instructed bilinguals, who deviate from the L1 HA strategy but still do not reach English levels. In the PVT, in contrast, since English do not exhibit the typical LA preference, bilinguals are not statistically different from them.

An additional RQ_5 addressed potential **garden-path effects** examining participants' response times. It asked whether garden-path effects would be observed in the RTs of L1 Spanish-L2 English instructed bilinguals compared to Spanish and English monolinguals. The fact that participants first listened to an ambiguous sentence without any visual stimulus allowed them to create a mental representation of the scene using a specific attachment strategy (HA or LA). This initial parsing was either confirmed or disconfirmed when a HA-biased or LA-biased image was displayed after the end of the sentence. As outlined in Section 4.2, if garden-path effects were to be observed in L1 Spanish-L2 English instructed bilinguals, it was predicted that these would be reflected as longer RTs in the HA condition compared to those of Spanish monolinguals. This condition depicts bilinguals' L1 preferred disambiguation strategy and therefore, additional time in their responses would indicate reanalysis, suggesting that LA, rather than HA, had been employed in the initial analysis.

As expected, higher RTs were found in the **HA condition** of instructed bilinguals compared to Spanish monolinguals, particularly when they provide an *accept* response. As predicted, when a HA image is presented, instructed bilinguals show significantly longer RTs (i.e., slower responses) than the Spanish monolingual group. This seems to evidence additional processing cost in bilingual speakers when they accept a HA interpretation, likely due to reanalysis of the preceding ambiguous sentence. The fact that bilinguals reanalyse the sentence suggests that the HA strategy depicted in the image does not coincide with the one initially implemented. L1 Spanish-L2 English bilinguals may have experienced a disruption between the initial mental representation they had created while the sentence unfolded, and the HA representation depicted in the image. Such disruption was reflected in higher processing cost. Bilinguals therefore appear to rely more often on LA, which is the preferred strategy in their L2 English. These findings are considered evidence of L1 attrition in instructed bilinguals. The processing costs in bilinguals compared to Spanish monolinguals confirm that the two groups do not pattern together. Bilinguals seem to have increased the use of LA as the default attachment parsing strategy in their L1 Spanish.

This additional processing cost was already observed in the PST results (see Section 6.4.2), adding further robustness as the same pattern emerges across two different tasks. However, it is worth noting that the forcing-HA conditions in the PST and PVT are not comparable, as their nature differs considerably. Findings from the HA condition in the PVT correlate with those in the ambiguous condition in the PST. In the latter, bilinguals provided significantly slower responses when confronted with ambiguous sentences, suggesting that they were not consistently applying the default, L1-Spanish HA strategy. In contrast, in the PVT, the reduced processing advantage for HA is reflected in the HA condition, where participants created a mental image using a specific attachment mechanism (HA or LA). Slower responses when a HA-biased image was displayed imply that, in line with the PST findings, HA was not the strategy initially used by bilinguals.

This common pattern across tasks is extremely relevant because both instructed bilinguals and Spanish monolinguals were tested in their L1 Spanish and were comparable in many respects. For instance, they live in the same L1 environment, are of similar age, have a similar age of L2 onset, and most importantly, all of them had received formal instruction in English during primary and secondary education. However, only bilinguals diverge from the attested HA preference in native Spanish, suggesting that being enrolled in an English Studies degree and receiving immersed instruction in the L2 is a key factor to experience L1 attrition. As will be discussed in more detail in the final discussion in Section 9, being immersed in an instructed L2 English context, with extensive L2 input and opportunities to use the L2, can lead to L1 attrition regardless of whether the L2 is the dominant language or whether bilinguals are naturalistically immersed, two assumptions that have traditionally guided prior research.

Regarding the **LA condition**, and compared to Spanish monolinguals, bilinguals were expected to show a processing advantage when *accepting* the L2-preferred LA strategy, as well as increased processing cost (i.e., slower responses) when *rejecting* LA. These predictions have been partially confirmed. RTs for bilinguals significantly differ from those of Spanish natives, but only when they *reject* a LA-biased image. In these cases, Spanish monolinguals respond significantly faster than both the bilingual and the English groups, with bilinguals and English natives not differing from each other. Conversely, no significant differences are found for *accept* responses between the three groups. This seems to suggest that instructed bilinguals experience a processing cost when rejecting a LA interpretation, which confirms garden-path effects for this group in their L1-dispreferred attachment mechanism. The fact that bilinguals find it more difficult to reject a LA interpretation than Spanish monolinguals in their L1 Spanish suggests that this attachment strategy is more prevalent for bilinguals than for Spanish natives. Differences between Spanish monolinguals and bilinguals in their L1 Spanish, with bilinguals beginning to pattern like English monolinguals, are still not significant across all conditions and responses. This may indicate when processing cost is considered, instructed bilinguals are in initial stages of L1 attrition.

Finally, two research questions were formulated to account for potential variability in response times modulated by individual differences. RQ_8 addressed whether **language dominance** modulate instructed L1 Spanish-L2 English bilinguals' RTs when confronted with ambiguous relative clauses. This was explored analysing data for the bilingual group only, including language dominance as a predictor in the regression model predicting response times in bilinguals (see Section 7.4.2.1). A language dominance effect was predicted for the bilingual group, although such influence was expected to differ across experimental conditions. In the HA condition, faster responses were expected for bilinguals who are for more Spanish-dominant, whereas slower responses were predicted for those with increased dominance in English. In the LA condition, on the other hand, slower responses were predicted for Spanish-dominant bilinguals, while faster responses would be associated with more English-dominant bilinguals. As expected, a language dominance effect was observed. Findings reveal a main effect of language dominance in the bilingual group, with higher scores in the BLP questionnaire, which indicate higher dominance in English, being associated with longer RTs in providing an accept response in the HA condition. To put it simply, more English-dominant bilinguals seem to be slower when accepting a HA-biased image. This reflects additional processing costs when accepting the default mechanism of bilinguals' L1, i.e., HA. Such processing cost, likely due to reanalysis of the sentence, may indicate that bilinguals have been misleaded. If they had initially parsed the sentence using HA, they would have accepted the image fast since there would be a correlation between their initial mental representation and what the image depicts. However, the fact that their responses are significantly slower suggest that the sentence was first reanalysed, implying that a low-attachment analysis had been implemented, and then, accepted. This is considered evidence of L1 attrition in instructed bilinguals.

Finally, and continuing with the role of individual differences, RQ_9 investigated whether **length of L2 immersed instruction** modulates instructed the response times of L1 Spanish-L2 English bilinguals when confronted with ambiguous relative clauses. As outlined in Section 7.1, it was predicted that attrition effects observed in bilinguals' RTs would be further modulated by cumulative instructed exposure to their L2 English. More pronounced attrition effects were expected among bilinguals with longer L2 exposure. Additionally, if such LoII modulating effect was to be found, it would be reflected differently based on the experimental condition. In the HA condition, which represents the default strategy in bilinguals' L1 Spanish, longer response times were predicted for bilinguals who have been exposed to the L2 for higher number of years. This would evidence more pronounced processing cost in the HA condition for long-exposed bilinguals. Conversely, in the LA condition lower RTs were expected for bilinguals with increased exposure, displaying an advantage for the L1-dispreferred mechanism.

The findings disconfirm the above predictions as no effect of length of L2 immersed instruction was found on bilingual data. L1 Spanish-L2 English bilinguals seem to display the same response patterns regardless of the number of years they have been exposed to their L2 in a university, instructed setting. The fact that length of instructed exposure does not account for variability in response patterns aligns with the offline results from the picture selection task. In the PST, no significant effect of length of L2 instruction was reported, although a tendency was observed in the expected direction: bilinguals with longer L2 immersed instruction, i.e., those in the final years of the degree, were predicted to decrease the preference for HA. Findings from the present PVT contribute to those from the PST in the previous chapter, as no effect of LoII is found either on bilinguals' final interpretation or on response times, i.e., potential processing cost.

This lack of significance may have several explanations. Firstly, it may relate to how LoII has been operationalised. In this PhD thesis, LoII was measured in terms of years, with bilinguals ranging from 1 year of immersed instruction (i.e., bilinguals in the first year of the degree) to 4 years of immersed instruction (i.e., bilinguals in the final year). However, a 4-year scale may not be an appropriate predictor as it does not contain sufficient variability to capture a potential effect. A better approach might be to measure LoII in number of months rather than years, so that it becomes a more specific predictor.

Secondly, another explanation may be due to the range of the LoII variable (1 to 4 years). Although, as shown in this thesis, this is a sufficient time to experience attrition effects, it may not be sufficient to further modulate such effect. Maybe, it would be necessary to be immersed in an instructed setting for longer time to observed modulating effects. An additional explanation may be due to lack of statistical power. The limited nature of the LoII variable, which does not include a wide range of variability, together with the fact that the number of participants could be higher, may result in insufficient data to predict attachment preferences or response times based on LoII. Finally, given that no effect has been found both in online and offline measures, the last explanation may be that LoII is not a modulating predictor of L1 attrition effects. To confirm this, future studies should investigate this variable with a wider range and testing other linguistic phenomena.

Taken together, PVT results offer relevant insights and contribute to those obtained from the PST in the previous chapter. Evidence of L1 attrition has been observed among instructed bilinguals both in their acceptance rates for HA and LA, as well as in their L1 processing cost. Regarding the former, bilinguals increased their acceptance of a LA interpretation, typical of their L2 English. Although their acceptance of HA is significantly lower compared to Spanish monolinguals revealing a departure from native patterns, Figure 8 shows that their acceptance rates are still high. This suggests that the bilingual group is the one with the lowest discrimination across conditions, being the most flexible ones to accept either interpretation. Bilinguals' optionality in attachment preferences aligns with the pattern reported in the PST (see Chapter 6). Additionally, and also in line with PST results, picture-verification data reveals L1 attrition regarding processing cost. Bilinguals require more time to accept a HA interpretation and reject a LA one, which would be the default behaviour in native Spanish. Increased processing cost in ambiguous sentences was also reported in the PST, indicating that bilinguals are more hesitant to commit to a final interpretation. Such cost is further modulated by language dominance, as increased dominance in English relates to slower responses and therefore, higher optionality. Overall, PVT results align with those previously reported for the PST in Chapter 6 and will also do for those obtained from the eye-tracking experiment, which will be explained in the following chapter.

Chapter 8: Visual world eye-tracking task

This chapter will present an eye-tracking experiment designed to examine attachment parsing strategies in the first language of instructed L1 Spanish-L2 English bilinguals. The goal of this chapter is twofold: on the one hand, to investigate the attachment strategies employed in online processing, and on the other, to explore the time-course of attachment resolution among participants to determine the timing of disambiguation of sentences containing an ambiguous relative clause. The eye-tracking task has been designed using the visual world paradigm (VWP), which allows us to elicit online data evidencing the parsing strategies employed in real-time as participants look at a visual display and listen to spoken language. The eye-tracking data will serve as a complement to both the offline interpretative biases reported in the picture selection task (see Chapter 6) and the data on processing cost reported in the sentence-picture verification task (see Chapter 7). The implementation of different methodologies will allow us to examine the same phenomenon, i.e., potential L1 attrition effects on RCA preferences, from different perspectives, ensuring a complete triangulation and understanding of this phenomenon. Therefore, the present experiment will contribute to the evidence already presented in this PhD thesis with an online perspective.

As discussed in Section 3.4.2.2, research on adult bilinguals has extensively studied the online processing of structurally complex sentences containing an ambiguous relative clause. However, studies on bilinguals' processing of RCA ambiguities have extensively relied on methodologies that do not inform about real-time interpretation during listening. This is the case, for example, of self-paced reading studies (Carreiras & Clifton, 1993; Cuetos & Mitchell, 1988; Dussias, 2003; Fernández, 2002; Jegerski, Keating, et al., 2016; Papadopoulou & Clahsen, 2003; Rodríguez, 2004) or the picture-verification task in this PhD thesis (see Chapter 7). While these tasks are informative regarding processing costs, they do not inform about the specific moment when disambiguation occurs. This is an aspect of interest that will be addressed using eye-tracking data in the following sections. As a result, this will allow to triangulate results of different nature (offline interpretation preferences, processing cost, and online parsing strategies) using the same stimuli and data from the same participants. Among the different types of eye movements, this study will analyse fixations, and particularly, fixation proportions. Table 41 below summarises frequent terms in visual-world eye-tracking studies for the reader’s convenience.

Table 41:

Summary of visual-world eye-tracking terms

Term	Definition
Fixation	Time period during which eye gaze is stable on a specific location
Fixation proportion	Percentage of time participants fixate their looks on an interest area within a time window, which is then averaged across trials
Interest area	Predefined area used to assess whether a specific region was fixated
Interest period	Predefined time window in which the experimental effect is expected. Data in the interest period are used for the analysis
Saccade	Rapid, simultaneous movement of both eyes between fixations. For instance, the movement between fixating one image and the other
Time bin	Small time segment within an interest period, for which fixation proportions are computed. Binned fixation data are used in time-course plots (see Figure 19) to explore the emergence of an effect as the sentence unfolds

In addition, most existing eye-tracking studies on relative clause attachment preferences have focused on the real-time processing of bilinguals’ L2, while comparatively fewer research has examined their L1. This has been so to investigate whether bilinguals may reach native-like behaviour in their L2, showing similar parsing preferences to those of L1 speakers. In this regard, there is considerable literature on relative clauses and L2 processing (Y. Cheng et al., 2021; Cunnings & Fujita, 2021; Dekydtspotter et al., 2008; Hopp, 2014). This has been so because given the language-specificity of relative clause attachment strategies (see Section 3.3), this structure offers the possibility to test whether L2 learners show the same parsing preferences as L1 speakers in their native language.

However, such language-specificity can also offer relevant insights into potential L1 attrition effects on bilinguals whose languages rely on different parsing mechanisms. This is still an underexplored field, particularly in comparison to the L2 processing literature.

This PhD thesis will attempt to bridge this gap by investigating the L1 processing of garden-path sentences in bilingual speakers using the visual-world eye-tracking paradigm. An additional novelty of the present investigation is related to the population tested, as most eye-tracking data on RCA preferences have focused on the L2 of bilingual immigrants who have been extensively immersed in an L2 naturalistic environment. On the contrary, bilinguals tested in this PhD thesis have always lived in an L1 environment, Spain, where their first language is their functional language, but are extensively exposed to the second language in a classroom instructed setting. To date, and to the best of our knowledge, the present investigation will constitute the first online study addressing the L1 processing of ambiguous relative clauses using the visual-world paradigm in this bilingual population.

The present chapter is structured as follows. Section 8.1 will revisit the research questions related to the eye-tracking data. Section 8.2 will focus on the methodological aspects, providing the necessary context to understand both the eye-tracking methodology and the visual world paradigm. Section 8.3 will describe the pre-processing and data cleaning process, carried out prior to the statistical analysis. The analyses themselves along with the results obtained will be presented in Section 8.4. Finally, Section 8.5 will offer a thorough discussion of all results presented.

8.1. Research questions

This chapter will present the findings from the visual-world eye-tracking experiment, which was designed to examine processing patterns and address the corresponding research questions. Although the complete set of research questions and hypotheses formulated for this PhD thesis were outlined and discussed in Chapter 4, the specific RQs for the eye-tracking experiment will be presented here again. This will serve to contextualise the online findings reported in the following sections and to facilitate readers' interpretation of those results. Therefore, the present chapter will attempt to answer the following research questions:

RQ9 Does the **time course** of processing ambiguous relative clauses reveal evidence of L1 attrition effects among instructed bilinguals compared to Spanish and English monolinguals?

H9. If time course processing reveals L1 attrition effects on bilinguals, these effects will manifest as delayed looks at the target image compared to the monolingual groups. Spanish and English monolinguals are expected to resolve ambiguous sentences more quickly and therefore, be faster than bilinguals in directing their looks at their corresponding target image. The target image for each group is the one that represents the default parsing strategy based on previous literature: HA for the Spanish group and LA for the English group.

RQ10 Does the **proportion of fixations** on the HA vs. LA-biased image differ between instructed bilinguals, Spanish monolinguals and English monolinguals for ambiguous relative clauses?

H10. If differences in the proportion of fixations emerge across groups, it is predicted that the Spanish monolingual group will exhibit the highest proportion of fixations on the HA-biased image, followed by bilinguals and then, by English monolinguals. Conversely, the reverse pattern is expected for the LA-biased image. The English group is expected to show the highest proportion of fixations, followed by bilinguals first and then, by Spanish monolinguals, who are predicted to have the lowest proportion.

RQ11 Does **language dominance** modulate fixation patterns in instructed bilinguals when they are confronted with ambiguous relative clauses in their first language?

H11. If a dominance effect is observed in bilinguals' eye-tracking data, it will be reflected in increased proportion of fixations to the LA-biased image among bilinguals with higher dominance in L2 English. On the other hand, instructed bilinguals who are more Spanish dominant will reveal stronger preference for the HA-biased image, manifested by increased fixations at the HA-biased image.

RQ12 Does **length of L2 immersed instruction** modulate fixation patterns in instructed bilinguals when they are confronted with ambiguous relative clauses in their first language?

H12. If an effect of length of L2 immersed instruction emerges, it will be manifested in higher proportion of fixations in the image depicting the L1-dispreferred parsing strategy, i.e., the image depicting a LA interpretation, among bilinguals with increased exposure to the L2. Conversely, those bilinguals who have received fewer exposure to their L2 English in a classroom setting will behave more similarly to Spanish monolinguals, showing higher preference for the HA-biased image.

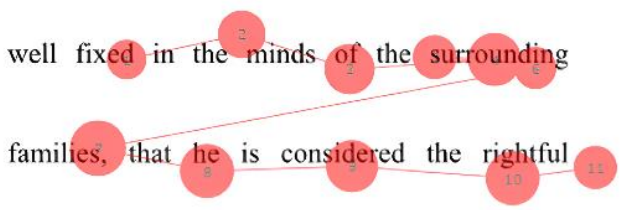
8.2. Methodology

8.2.1. The Visual World Paradigm

In eye-tracking research, two main methods can be distinguished: eye-tracking while reading and the visual world paradigm (VWP). The former, eye-tracking while reading, focuses on how humans process written text, with participants typically reading sentences or paragraphs on a screen while their eye movements are recorded. During reading, humans move their vision area across the text, and this is done by saccades (i.e., quick movements) and fixations (i.e., when the eye gaze is stable on one location) (Attardo & Pickering, 2023; Kliegl & Laubrock, 2018). This is illustrated in Figure 13, where fixations are shown as red circles, indicating the order of fixation, and saccades are the lines connecting them.

Figure 13:

Example of eye-movement patterns in eye-tracking while reading, from Attardo and Pickering (2023, p. 75)



A second common method in eye-tracking research is the implementation of the visual world paradigm. The eye-tracking experiment in the present PhD thesis was conducted using the visual world paradigm, which has been extensively used to investigate spoken language processing (Amos et al., 2022; Gómez Carrero, 2023; Pozniak et al., 2018). This experimental method involves the monitoring of eye movements using an eye tracker while participants either produce language or listen to an auditory stimulus (words or sentences) and simultaneously look at either real objects or a visual display on a computer (Allopenna et al., 1998; Huettig et al., 2011; Salverda & Tanenhaus, 2017).

The VWP was first implemented in the seminal paper by Cooper (1974), who explored the relation between real-time language processing, eye movements and visual information. Participants were instructed to listen to short narratives while several objects were displayed, some of which were mentioned in the texts. Results offered two main findings. Firstly, the existence of a relation between what participants heard and what they looked at, since they were more likely to direct their attention to objects mentioned in the texts or to those semantically related to them. Secondly, eye movements were time-locked to spoken input, meaning that participants' eye gaze was directed to these objects at a specific moment: looks were triggered while the object was mentioned or within 200 milliseconds after the word offset. Despite the relevant findings offered by this investigation and the introduction of a new research method to explore language processing, Cooper's (1974) study received very little attention by psycholinguistic research at the time. It was not until years later that the VWP began to attract attention with the publication of several articles (Allopenna et al., 1998; Tanenhaus et al., 1995). Since then, an increasing number of studies have used the VWP validating its effectiveness to address parsing strategies in real time (Attardo & Pickering, 2023; Henderson & Ferreira, 2004).

From its origins with the seminal work by Cooper (1974), and as mentioned earlier, a premise in WVP studies is that eye movements are time-locked, meaning that the software can provide information not only of the position of eye gaze, but also its timing. This methodological approach relies on the Linking Hypothesis (Just & Carpenter, 1980; Tanenhaus et al., 2000), which states that there is an association between eye movement patterns and cognitive language processes. Consequently, eye-tracking data can be interpreted as a reflection of such cognitive processes. Thanks to the high resolution of current eye-trackers, eye-tracking data in general, and visual-world data in particular, can offer relevant insights into participants' parsing mechanisms while they are exposed to spoken language in real time. The most common way of implementing the VWP is in tasks where participants observe a visual display while simultaneously listening to an auditory stimulus, with their eye movements being recorded throughout the task. However, some variations have been implemented in previous literature, with, for example, visual-world studies using printed words rather than images (Huettig & McQueen, 2007). This VWP study will use a visual display on a computer screen.

As justified in Section 4.3, a visual-world rather than a while-reading eye-tracking task was chosen for several reasons. Firstly, it allowed to maintain consistency across experimental tasks, meaning that all tasks administered, i.e., picture verification task and eye-tracking experiment, contain a visual (images) and auditory component (recorded sentences)[34]. This ensures comparability across tasks, allowing to reliably compare the results obtained. In addition, although an eye-tracking methodology has been extensively used to examine the processing of RCA ambiguities, most previous eye-tracking research has relied on while-reading data (Carreiras & Clifton, 1999; Dussias & Sagarra, 2007; Valenzuela et al., 2020). The findings from the present VWP eye-tracking study will contribute to the understanding of this phenomenon via a new methodological approach.

8.2.2. Task design and procedure

The present visual-world eye-tracking experiment was conducted in a lab, so the session was held in person for all groups. The lab for data collection from Spanish monolinguals and bilinguals was *BilinguaLab* at the University of Granada[35], while the lab for English monolinguals was the *Cambridge Processing and Acquisition of Language Lab* (CAMPAL) at the University of Cambridge[36]. The experimental session began with the researcher providing verbal instructions regarding the task procedure to ensure that all understood it prior to task performance. Eye movements were monitored with an SR Research Eyelink Portable Duo eye tracker using the head-stabilized mode. This setup required participants to rest their chin on a chin rest in order to minimise head movements while doing the task and prevent potential loss of eye gaze data. The position of the monitor, eye tracker and participants' head on the chin rest was always the same. However, the position of the eye tracker was sometimes adjusted manually in situ, together with the focus of the camera, to ensure that both the pupil's threshold and the corneal reflection were appropriate. Eye movements were sampled at 1000Hz.

Additionally, participants were given headphones to ensure they could clearly hear the following auditory stimuli, avoiding potential interference of external noises and therefore, distraction during the task. The volume was adjusted for each participant before

[34] Recall that the picture selection data was integrated within the eye-tracking task, rather than an independent task. Given that the same experimental in-situ experiment offered two types of data (those of the picture selection component and eye-tracking data), the former have been presented as a separate task in this PhD thesis.
[35] Lab webpage: https://bilingualab.ugr.es/
[36] Lab webpage: https://www.mmll.cam.ac.uk/campal

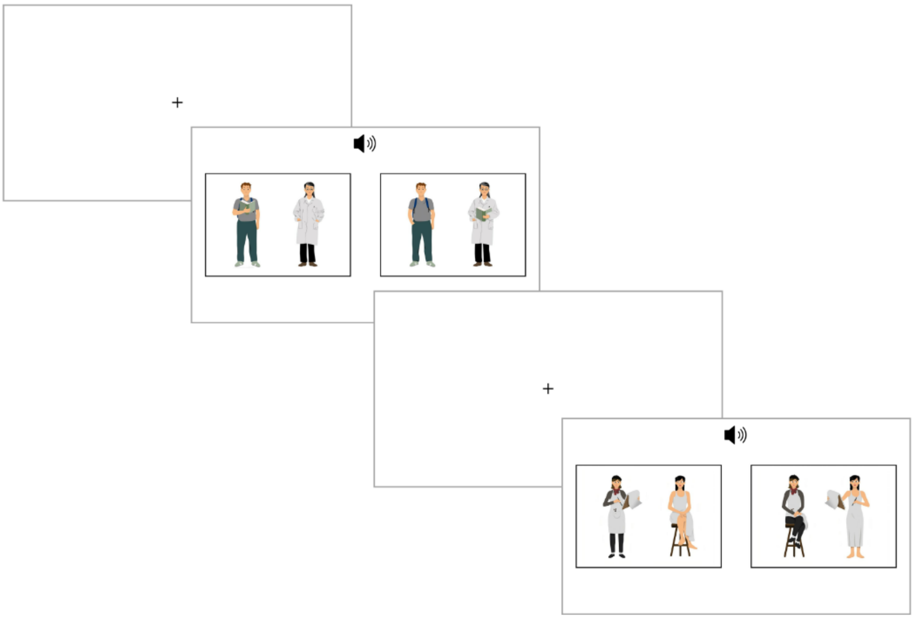
beginning the task. Once participants had placed their chin on the chin rest and had the headphones on, they were asked to keep their hands on the keyboard throughout the entire task. The researcher started the experiment from a host computer, while participants viewed and completed it on a display computer. To ensure participants felt as comfortable as possible during the task, the researcher remained out of sight but monitored the process from the host computer to resolve any issues that may arise. In the lab in Granada, the researcher was in the same room as the participants but sat behind them to remain out of their view while still being able to monitor their progress throughout the task. Conversely, in the Cambridge lab, the researcher was in an adjacent room, monitoring participants' progress through a window located behind participants. It is also important to specify that, although viewing was binocular, eye movements were recorded for the right eye only. For each participant, the experiment began with a calibration of the eye-tracker on a 9-point grid. If calibration succeeded, the actual task began. During task performance, calibration was adjusted when needed between trials as sometimes the eye-tracker lost participants' eye gaze.

The visual-world eye-tracking experiment was designed and implemented in Experiment Builder (*SR Research Experiment Builder*, 2020), a stimulus presentation software for psycholinguistic experiments. It first presented the written instructions, which covered a couple of displays (see Appendix L: Written instructions for eye-tracking task and PST). Once participants read the instructions in the first display, they pressed the spacebar to proceed to the following instructions window. These instructions had been already provided verbally, but they were also provided in a written format to ensure all participants could read them at their own pace and understand them. After the instructions, the experiment started, although participants could familiarise themselves with the procedure before proceeding to the actual experiment since they first completed a series of practice trials (N = 4). The procedure was identical in both the practice part and throughout the main task.

For clarity purposes, Figure 14 illustrates two consecutive trials in the eye-tracking experiment. Before each trial, a fixation cross appeared in the middle of a blank screen on the display computer. If participants fixated their eyes on the fixation cross for at least 500 milliseconds, the trial started automatically. Two images automatically appeared, and a sentence previously recorded was played (see Section 5.4.3 for further details). There was a preview time of 500 milliseconds between the images were displayed and the sentence began. Each image was displayed on one side of the screen, i.e., one image on the left-hand side and the other, on the right-hand side. The linguistic, visual and auditory stimuli employed in the eye-tracking experiment have been described in detail in Section 5.4. Given that Figure 14 only illustrates the visual aspects of the trials, example (72) below is included to also show the linguistic stimuli, i.e., recorded sentences, associated with the images in each trial[37].

Figure 14:

Example of two consecutive trials in the eye-tracking experiment[38]



(72) **Stimuli sample:**

(72a) **Forcing-HA**

*Observa aquí al alumno$_i$ de la científica$_j$ **el cual$_i$** lee un libro atentamente*

(72b) **Forcing-LA**

*Observa aquí al alumno$_i$ de la científica$_j$ **la cual$_j$** lee un libro atentamente*

---

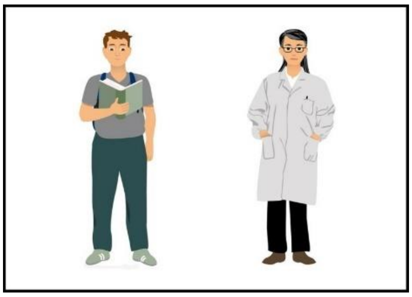
[37] This example was presented earlier, see example (49) in Section 6.2, but is reintroduced here again for the reader's convenience.

[38] The audio icon in the images display was not present in the original experiment. Instead, it has been added to the figure to indicate that a sentence was played while the images were displayed.

(72c) **Ambiguous**

Observa aquí al alumno$_i$ de la científica$_j$ ***que$_{i/j}$*** *lee un libro atentamente*

Observe now the student$_i$ of the scientist$_j$ **who$_{i/j}$** reads a book carefully



Taking the above as an example of a trial, participants were presented with two images, as the ones above, and simultaneously listen to one of the sentences. The Spanish version of the experiment, administered to both the Spanish monolingual group and the bilingual group, contained three experimental conditions: forcing-HA in (72a), forcing-LA in (72b) and ambiguous in (72c). Here, each participant only saw one condition per experimental item. Regarding the English version of the experiment, completed by the English monolingual group, it contained the ambiguous condition only (exemplified in (72c) above), so participants always heard an ambiguous sentence. This was explained in more detail in Section 5.4.1.

Participants were required to listen carefully to the sentence and look at the images displayed while their eye movements were monitored. As observed in (72), one image always represented a high-attachment interpretation, whereas the other represented a low-attachment interpretation. At the end of each recording, a sound explicitly marked the end of the sentence. After the sound, participants chose the image that best represented the meaning of the sentence they just heard. They indicated their preference by pressing either the F or J keys in the keyboard. If they wanted to select the image on the left, they had to press the F key, while if they wanted to select the image on the right, they had to press the J key. After making a choice, the two images disappeared from the screen, and the next trial began. A more detailed description can be found in Section 6.2.

The design of the eye-tracking experiment allows us to examine the proportion of fixations to each image and the time course of attachment resolution. Regarding the former, two images are displayed in this visual-world experiment: one image represents a HA interpretation, while the other represents a LA interpretation. Thus, the proportion of fixations on each image during the specific time window within a trial will reveal participants' preferred strategy to resolve ambiguous relative clauses (either HA or LA). This is illustrated in Figure 15 with a heat map. Although statistical analyses will not use heat maps, this offers an optimal visual representation for clarity purposes. In Figure 15, the image on the right depicts a HA interpretation (HA-biased image), while the image on the right depicts a LA interpretation (LA-biased image). Additionally, fixation proportions are represented by colours: with green tones indicate fewer looks and red tones indicate more looks. The fact that all characters have a green circle suggests that participants looked at all of them at some point. However, red tones, i.e., higher proportion of fixations, are observed only in the image representing a HA interpretation, suggesting that this is the preferred strategy in this trial. Interestingly, not only are there more looks directed toward the HA-biased image, but within that image, fixations are concentrated on the first-mentioned character, which is the character doing the action of the RC if it is attached high.

Figure 15:

Heat map of fixations proportions to the HA-biased and LA-biased images

Regarding the time course of attachment resolution, the fact that the two images were simultaneously presented provide relevant insights into where participants directed their looks at each specific moment during sentence processing. Looks at a specific image, for instance, at the HA-biased image, will be interpreted as if that is the attachment strategy currently being processed. This is particularly relevant right after the relative pronoun is pronounced. Considering example (72) above, in the Spanish version of the experiment, quicker looks are expected in the forcing-HA and forcing-LA conditions to the image that depicts the only grammatically possible interpretation. Conversely, a delay is expected in the ambiguous condition. When comparing the three groups in the ambiguous condition, the two monolingual groups are expected to direct their looks to their L1-preferred representation (i.e., HA for Spanish monolinguals and LA for English monolinguals) faster than the bilingual group. Conversely, bilinguals are predicted to exhibit delayed looks at the image depicting their L1-preferred attachment strategy (HA), which will be considered evidence of L1 attrition. Thus, examining the time course will provide evidence of when disambiguation occurs. The image participants look at the end of the trial, i.e., they image the finally opt for, will be interpreted as their attachment preference.

8.3. Data cleaning and pre-processing

The raw eye-tracking data was cleaned and pre-processed in two stages. First, it was cleaned using the Data Viewer software (*EyeLink Data Viewer*, 2024) and then, pre-processed in R (R Core Team, 2024). Regarding the first step, the eye-tracking data were collected using Experiment Builder, which outputs an individual data file containing the eye-tracking data of each participant. The data files of all participants were imported into Data Viewer, a software designed to visualise, group and pre-process gaze data recorded with EyeLink eye trackers. The first step was to set an interest period to focus on a specific time window within the trials (Huettig et al., 2011). This is essential to restrict the following analysis to the time period within the experimental trials where differences are expected. By default, data are collected from the moment the eye-tracker starts recoding eye gaze data until the time it stops recording it for each trial. For the present eye-tracking experiment, an interest period was created to focus on the *pronoun window*. The start of the time window was set at the onset of the relative pronoun (*que/who, el cual, la cual*), while the end was set 1500 milliseconds later. From here on, this will be referred to as *pronoun window*. This 1500-millisecond window was chosen to ensure that all trials across all participants included existing eye-tracking data. Given that trials have different duration, it was decided not to define the end of the time window based on the trials end, i.e., when participants pressed a key on the keyboard. Doing so would imply having more data in some trials or from some participants than others, and this could influence the results obtained. To avoid this, a time window was stablished in which all participants, across all trials, contained fixation data. Thus, subsequent analyses will include data that fell only within this time window, while data outside of it were excluded.

Another crucial step for eye-tracking data analysis is the specification of interest areas. An interest area can be defined as a specific region of the computer screen where a stimulus was shown during the experimental trials, and which is critical for the analysis (Ito & Knoeferle, 2022). In a reading eye-tracking experiment, these interest areas may contain individual words within a sentence. However, in this visual-world task, the interest areas correspond to the two images displayed, each enclosed within a black framework as observed in (72) above. This framework not only allowed participants to easily differentiate the images but was also used to define the interest areas in Experiment Builder when programming the experiment. Thus, the interest areas correspond to the exact dimensions of the images since they align with the black frames.

The eye-tracking experiment required participants to listen to a sentence while looking at a visual display on a computer screen. Such visual display consisted of two images: a HA-biased and a LA-biased image, depicting a HA and a LA representation of the target sentences, respectively (see the trial example in (72) above). These two images constituted the two interest areas considered in the following analyses. The use of interest areas allows us to explore eye patterns in relation to those areas. For instance, it allowed to explore the amount of time within each trial participants fixated their looks on each image. However, Data Viewer also provided a third interest area that involves all remaining parts of the screen that do not correspond to the two images. This is so because during a trial, sometimes participants may fixate their eyes somewhere on the screen outside the two images and the eye-tracker stores this information. These gaze data were removed prior to the statistical analysis because fixations outside the two main interest areas were not relevant to the research questions formulated and could introduce noise into the analysis.

The final step in Data Viewer was to create the final output records containing the pre-processed data for subsequent analyses. However, at this point, the information in Data Viewer only contained eye movement data. In particular, data regarding eye fixations on the two interest areas (HA image and LA image) during the *pronoun window* for all participant groups. Information about experimental variables were included in the final output record when this was created in the software. These experimental variables included trial-based information of interest for the analyses. For example, variables regarding condition, group, etc. The resulting data output files were then uploaded to R (R Core Team, 2024).

The manipulation in the R environment was the second stage in the cleaning data process. To ensure that eye-tracking data included in the analysis was reliable, comprehension accuracy was checked in the filler items to assess participants' attention. This procedure has been already explained in Section 6.3 for the offline picture selection data. The visual-world eye-tracking experiment was conducted with 146 participants: Spanish monolinguals (N = 50), instructed bilinguals (N = 47) and English monolinguals (N = 49). More information about participants can be found in Section 5.1. A total of 10 participants were excluded because they did not reach the 80% accuracy threshold, so the subsequent statistical analyses were conducted for the remaining 136 participants: Spanish monolinguals (N = 44), bilinguals (N = 45) English monolinguals (N = 47). This is illustrated in Table 42.

Table 42:

Number of participants before and after data cleaning

Group	**Original number**	**Number after cleaning**
Spanish monolinguals	50	44
Bilinguals	47	45
English monolinguals	49	47
Total	146	136

Additionally, to analyse the time course of attachment resolution, a specific process had to be conducted. First, before conducting the eye-tracking experiment, I marked the timing of critical words within the relative clause so that participants' fixations could be later plotted in relation to those times. In the data file uploaded to Experiment Builder, several columns were created to mark the exact onset of these critical words for each individual recording, i.e., the onset of the relative pronoun introducing the relative clause, the verb, direct object and adverb. These times were marked in milliseconds relative to the start of the recording, as shown in Table 43. Given that eye-tracking data is time-locked, marking the timing of specific words within the recordings allows us to know where each participant is looking at a particular time.

Table 43:

Original onset times of critical words in milliseconds (relative to recording start)

Participant	Pronoun	Verb	Direct object	Adverb
1	3180	3438	3770	4550
2	2875	3179	3514	4216

Thus, the data output record obtained from Data Viewer after conducting the experiment contained the times illustrated in Table 43 above. However, for the analyses, it was necessary to recalculate these values so that the onset of the critical words (verb, direct object and adverb) was aligned relative to the beginning of or *time window* of interest, which starts with the onset of the relative pronoun. To achieve this, the onset times of these critical words were recalculated by subtracting the onset time of the relative pronoun from the onset times of the other critical words (verb, direct object and adverb). The adjusted values are illustrated in Table 44.

Table 44:

Recalculated onset times of critical words in milliseconds (relative to pronoun onset)

Participant	Pronoun	Verb	Direct object	Adverb
1	0	258	590	1370
2	0	304	639	1341

Finally, demographic information was added. Similarly to the pre-processing implemented for the picture selection and picture verification data, the eye-tracking data were combined with demographic data into one single dataset. These data included information regarding participants' language dominance, L2 proficiency, and working memory scores, among others. This was done to add these variables as predictors in the statistical models, providing insights into their potential effects on participants' processing of relative clauses. Importantly, the language dominance variable was recalculated following the same procedure outlined for the picture selection and picture verification data (see Section 6.3 and Section 7.3, respectively).

8.4. Results

This section will present the results from the visual-world eye-tracking experiment. Two types of analyses were conducted. Firstly, a time course examination to determine the time course of attachment resolution. Secondly, an analysis of the proportion of fixations to both the HA image and the LA image in a specific time window. This was followed by some additional analyses focusing on the role of individual differences such as language dominance and length of L2 immersed instruction, where each predictor was separately added to the maximal model. Descriptive results for the time course of fixations will be reported first (see Section 8.4.1), followed by statistical analyses of fixation proportions data in Section 8.4.2. Finally, results for the potential modulating effect of individual factors will be presented in Section 8.4.2.1 and Section 8.4.2.2.

8.4.1. Time course of attachment resolution

This section will attempt to address RQ_9: Does the time course of processing ambiguous relative clauses reveal evidence of L1 attrition effects among instructed bilinguals compared to Spanish and English monolinguals? As discussed in Section 8.1, L1 attrition effects in bilinguals will be reflected in delayed looks at the image depicting their L1-preferred attachment strategy (HA). In contrast, Spanish and English monolinguals are expected to disambiguate sentences more quickly and, consequently, direct their gaze faster towards the image representing their L1-default strategy, based on previous literature, i.e., HA for Spanish monolinguals and LA for English monolinguals.

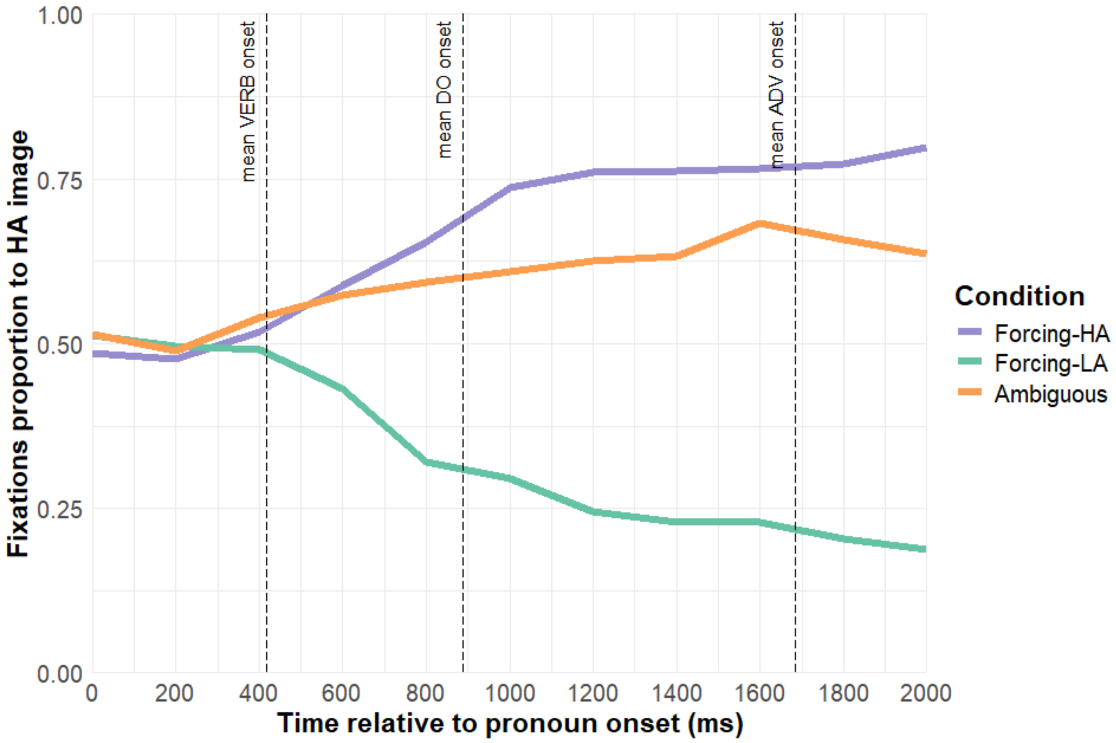
To address this question, the first step will be to present the time course for each group individually. This will allow us to explore the timing of attachment resolution in each experimental condition for each group. It is worth noting that while the statistical analyses in Section 8.4.2 will only contain data within the *pronoun window*, the figures in the present section will display a broader time period as their objective is illustrative. Specifically, all figures will show the time course of attachment resolution from the onset of the relative pronoun to 2000 milliseconds later, ensuring a complete illustration of the proportion of fixations throughout the sentence.

Results will be provided for Spanish monolingual first, followed by instructed bilinguals and finally, English monolinguals. Focusing on the Spanish monolingual group, Figure 16 below illustrates their time course of attachment resolution, measured in proportion of looks to the HA-biased image across all experimental conditions. Keeping in mind that the time window begins with the mean onset of the relative pronoun, differences begin to appear at around 300 milliseconds, i.e., approximately 300 milliseconds after the mean pronoun onset (*el cual, la cual, que*). However, it is worth noting that disambiguation occurs slightly earlier in the forcing-HA and ambiguous conditions compared to the forcing-LA condition. Focusing on the first two conditions (forcing-HA and ambiguous), there is an increase in the proportion of fixations towards the HA-biased image at around 200 milliseconds after the onset of the pronoun. This means that Spanish monolinguals quickly disambiguate the sentence favouring a HA interpretation in both conditions. This tendency is maintained and strengthened as the sentence unfolds. However, as expected, this increase is much more pronounced in the forcing-HA condition (which only allows for a HA interpretation) than in the ambiguous condition (which allows more variability).

In contrast, in the forcing-LA condition, the proportion of fixations remain relatively balanced between both images until nearly 400 milliseconds. At this point, the proportion of looks to the HA-biased image start to decrease (i.e., the proportion of looks to the LA-biased image start to increase). This means that Spanish monolinguals opt for a LA interpretation when this is explicitly forced, but disambiguation seems to occur a bit later than for the other two conditions. The fact that Spanish monolinguals take a bit longer to direct their gaze to the LA-biased image in the forcing-LA condition aligns with offline data from the PST (see Figure 2 in Section 6.4.1), where a small percentage of HA responses in the forcing-LA condition, although a HA interpretation was not possible. Overall, this suggests that when monolingual Spanish speakers are forced into an unnatural LA preference, they are slower to accept it.

Figure 16:

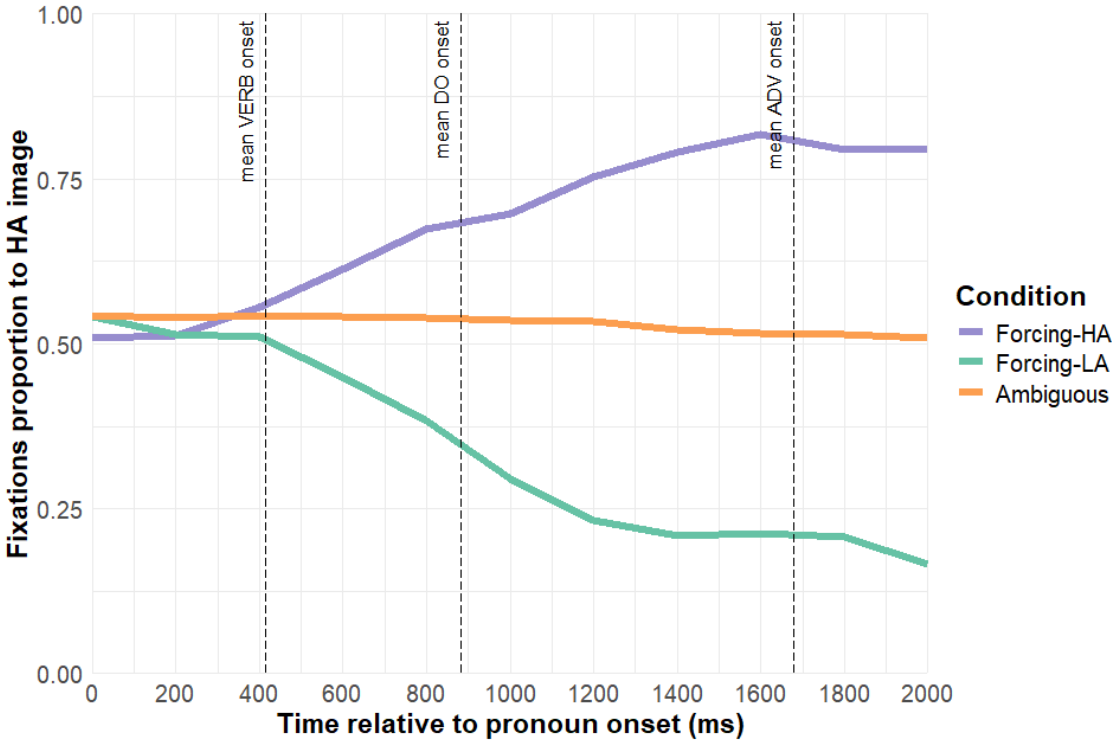
Fixation proportions to HA image for Spanish monolinguals



Turning now to the bilingual group, Figure 17 below presents the time course of relative clause attachment resolution for the instructed L1 Spanish-L2 English bilinguals. To be more precise, Figure 17 plots the time course of proportion of fixations to the HA-biased image in the bilingual group across the three experimental conditions: forcing-HA, forcing-LA and ambiguous. In both forcing conditions, bilinguals exhibit similar patterns to those observed earlier in Spanish monolinguals. In the forcing-HA condition, an increase of fixation proportions to the HA-biased image is observed at around 200 milliseconds after the pronoun onset. This proportion steadily increases as the sentence unfolds, evidencing that bilinguals effectively implement HA when they process sentences that force a HA interpretation. Conversely, in the forcing-LA condition, fixations to the HA-biased image clearly decrease over time, beginning at approximately 400 milliseconds after the pronoun onset. This shows a shift of attention from the HA-biased to the LA-biased image when LA is forced. As we observed with the Spanish monolingual group, bilinguals also implement a LA strategy when LA is forced, but disambiguation occurs slightly later than in the forcing-HA condition.

Figure 17:

Fixation proportions to HA image for instructed L1 Spanish-L2 English bilinguals



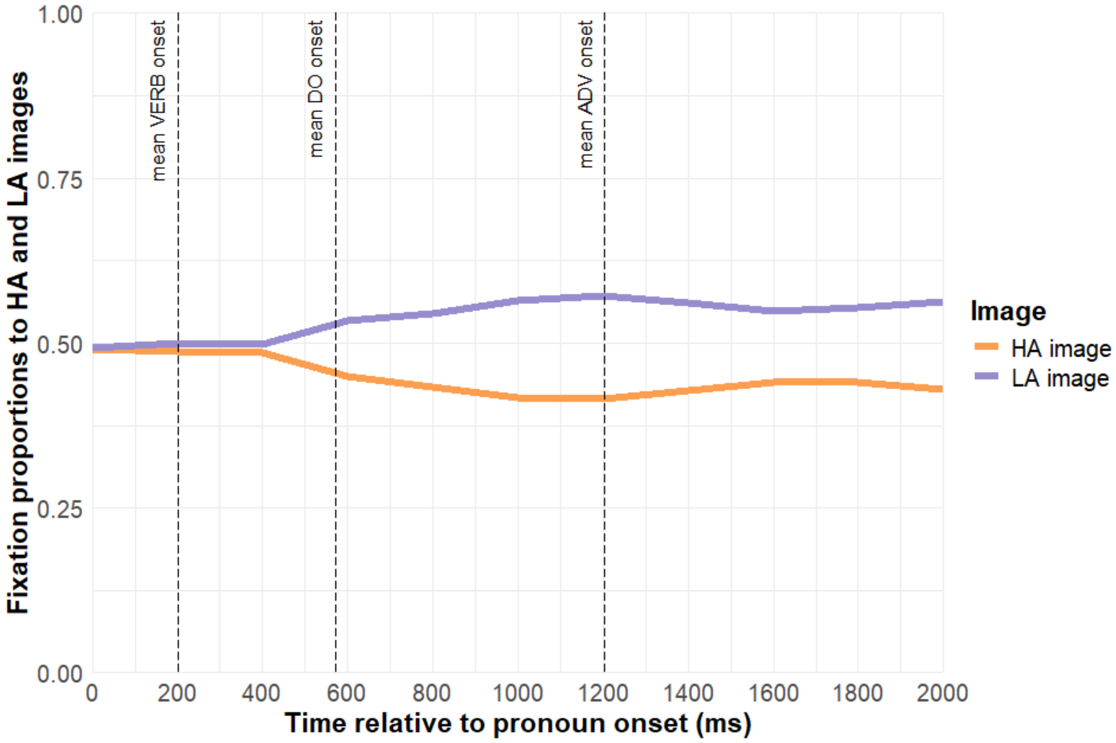
Finally, focusing on the ambiguous condition, the proportion of fixations to the HA-biased image remains quite stable over time, which indicates that instructed bilinguals had a balanced distribution of looks to the HA and LA-biased images. To put it simply, when there are no disambiguating clues, the stable distribution of fixations between the two images over time suggest that bilinguals favour neither HA nor LA when processing ambiguous relative clauses. This contrasts with the two forcing conditions, where there is a shift in gaze direction at around 200 milliseconds for the forcing-HA condition and 400 milliseconds for the forcing LA-condition. Additionally, it also contrasts with the pattern of Spanish monolinguals in ambiguous sentences, who quickly disambiguate towards HA, although to a lesser extent than in the forcing-HA condition. Overall, the fact that bilinguals show an even distribution and that there is no moment marking a shift of attention to a specific image, indicates that they do not have a clear disambiguation preference at any point while processing ambiguous RCs.

Finally, findings for the English monolingual group are presented in Figure 18 below. This plot is different from the previous ones because it illustrates the proportion of looks to both the HA-biased and the LA-biased image in the ambiguous condition only.

This is so because the English version of the eye-tracking task only included the ambiguous condition, so there is no data for the other two control conditions (forcing-HA and forcing-LA conditions).

Figure 18:

Fixation proportions to HA and LA images in ambiguous sentences for English monolinguals

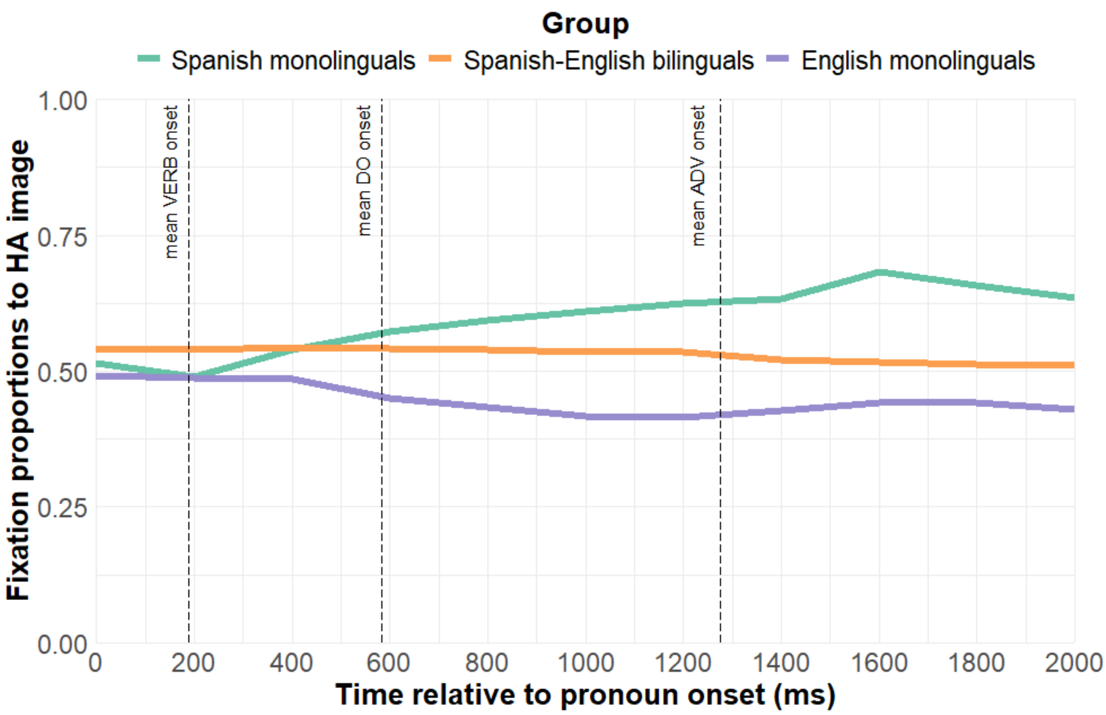


As observed, differences begin to appear at approximately 400 milliseconds, i.e., after the mean onset of the verb in the relative clause. After the verb has been pronounced, the proportion of looks to the HA-biased image slightly decrease in favour of an increase in fixations to the LA-biased image. This seems to suggest that English monolinguals display a gradual preference for LA as ambiguous relative clauses unfold. Thus, English monolinguals show a subtle preference for the LA-biased image, which increases over time. This preference seems to stabilise at around 600 milliseconds, coinciding with the average onset of the direct object. The subtle LA preference in the time course of English monolinguals aligns with findings from previous tasks (see PST results in Section 6.4 and PVT results in Section 7.4). Considering all tasks, although native English speakers favour an LA interpretation, this preference is as strong as expected, especially when compared to the HA preference observed in Spanish monolinguals.

The previous plots reveal the participant groups, i.e. Spanish monolinguals, instructed bilinguals and English monolinguals, differ in their fixation patterns during processing. These differences are particularly relevant in the ambiguous condition, as this is the critical condition for the present PhD thesis. To facilitate the understanding of such differences, Figure 19 illustrates the time course of attachment resolution, measured in fixation proportions to the HA image, for the three groups in ambiguous sentences only.

Figure 19:

Fixation proportions to HA image for all groups in ambiguous condition



Groups differ regarding the time disambiguation begin to occur. In the Spanish monolingual group, fixation patterns in ambiguous sentence show an increase of fixations to the HA-biased image at approximately 200 milliseconds after the mean pronoun onset. From that moment, the proportion of looks to the image depicting a HA interpretation gradually increases. The opposite scenario is observed for English natives. Differences in ambiguous sentences begin to appear around 400 milliseconds after the pronoun onset, with an increase of fixations to the LA-biased image. This means that English natives fixate less on the HA-biased image as the ambiguous sentence unfolds, with a consequent higher proportion of fixations to the LA-biased image. Interestingly, despite showing a preference for LA, this preference emerges later than in Spanish monolinguals and is less pronounced. Findings from the time course of fixation patterns suggest that Spanish and

English monolinguals have opposing preferred parsing mechanisms in their corresponding L1. For Spanish monolinguals, increased looks to the HA-biased image indicate a preference for HA, while increased looks to the LA-biased image in English monolinguals suggests a preference for LA.

Results for the bilingual group evidence that they do not pattern neither with Spanish monolinguals nor with English monolinguals. From the beginning to the end of the time window, bilinguals do not show a preference for none of the two images, which involves a lack of preference between a HA or a LA interpretation. These findings reveal that the HA bias in Spanish monolinguals is moderated and almost disappears for bilinguals. Overall, data from the time course of attachment disambiguation in bilinguals reveal they seem to be in an intermediate position in comparison with the two control groups, i.e., they neither show the strong HA preference typical of native Spanish nor the LA preference of native English. This will be further evidenced in the following section, where statistical analyses of fixation proportions for each image will be conducted.

8.4.2. Proportion of fixations

Following with the eye-tracking data, this section will address RQ_{10}: Does the proportion of fixations on the HA vs. LA-biased image differ between instructed bilinguals, Spanish and English monolinguals for ambiguous relative clauses? As discussed in Section 8.1, if differences emerge across groups, it is predicted that the Spanish monolinguals exhibit the highest proportion of fixations on the HA-biased image, whereas the English group is expected to show the highest proportion of fixations on the LA-biased image. Bilinguals are expected to pattern more closely to Spanish monolinguals, but with a significantly reduced tendency to HA. To explore this, analyses were conducted for the proportion of fixations to the two interest areas, i.e., the HA-biased and LA-biased images, using linear-mixed effects models.

Before presenting the results from the statistical analyses, the descriptive results will be offered. Figure 20 represents the mean proportion of fixations to both the HA and LA-biased images for all participant groups (Spanish monolinguals, L1 Spanish-L2 English bilinguals and English monolinguals) in the ambiguous condition only. The data in Figure 20 is restricted to the *pronoun window*, which begins at the onset of the relative pronoun introducing the relative clause. For more details, Table 45 introduces the overall means and standard deviations of fixation proportions to the two interest areas (HA-biased and LA-biased images) across all groups and conditions in the *pronoun window*.

Figure 20:

Mean fixation proportions to HA and LA images in ambiguous sentences for all groups within the pronoun window

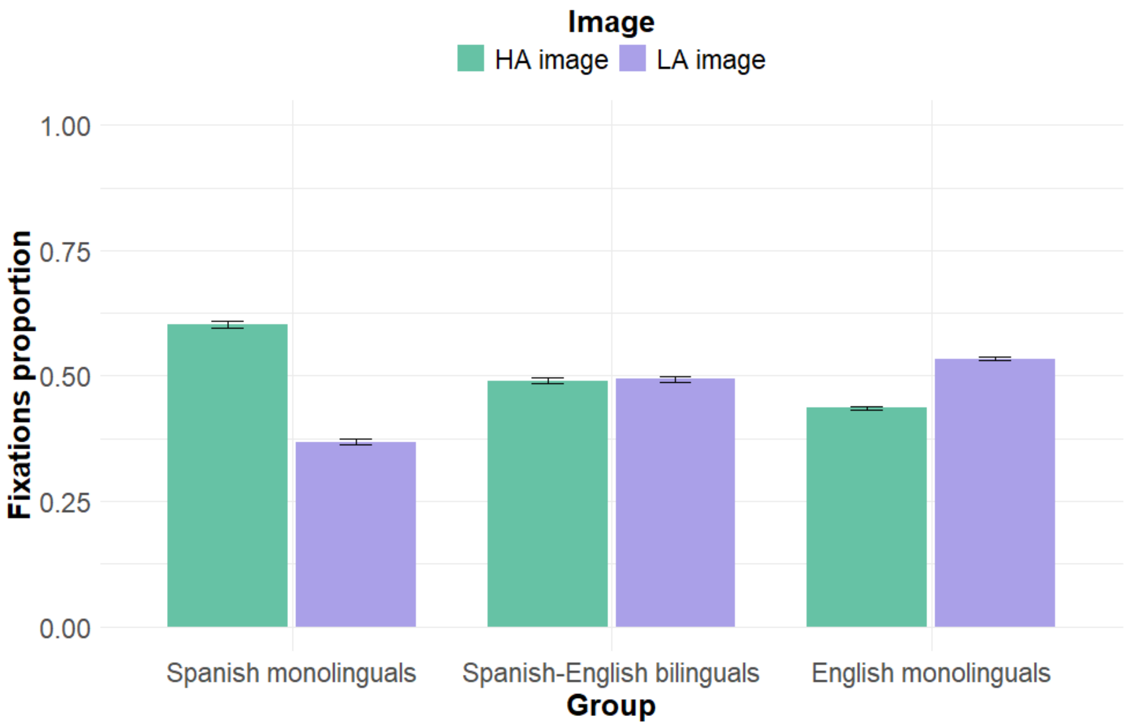


Table 45:

Means and standard deviations of proportion of fixations to the HA and LA images across groups and conditions[39]

		Interest areas			
		HA-biased image		LA-biased image	
Group	**Condition**	*mean*	*SD*	*mean*	*SD*
Spanish	Forcing-HA	0.74	0.42	0.23	0.41
	Forcing-LA	0.24	0.42	0.72	0.43
	Ambiguous	0.60	0.47	0.37	0.47
Bilinguals	Forcing-HA	0.77	0.40	0.21	0.39
	Forcing-LA	0.22	0.40	0.75	0.42
	Ambiguous	0.49	0.48	0.49	0.47
English	Ambiguous	0.43	0.48	0.53	0.48

As observed in Figure 20, for the ambiguous condition, groups differ in their distribution of fixations within the *pronoun window*. Spanish monolinguals look more frequently at the HA-biased image than at the LA-biased image (HA image: mean = 0.60, SD = 0.47; LA image: mean = 0.37, SD = 0.47), suggesting a preference for this parsing strategy in the processing of ambiguous clauses. Conversely, the opposite pattern is found in the English monolingual group, who display more looks at the LA-biased image (HA image: mean = 0.43, SD = 0.48; LA image: mean = 0.53, SD = 0.48). Interestingly, although a LA bias is found in English monolinguals, this preference seems to be milder compared to the HA preference of Spanish monolinguals. This is observed in Figure 20, as well as in the mean percentages reported in Table 45. This mild preference has been reported for L1 English in previous online studies. For instance, Carreiras and Clifton (1993) found non-significant differences in mean RTs between sentences forcing HA and LA, reporting a lack of processing preference. Similarly, in a reading ET experiment, Cheng et al. (2021) observed a processing cost in forcing-HA sentences, but no processing advantage in the forcing-LA condition, as it was expected. This pattern is in line with the general pattern of English monolinguals in this PhD thesis.

Finally, fixations distribution in the bilingual group diverges from that of Spanish and English natives. L1 Spanish-L2 English bilinguals seem to look equally often at the two images during the *pronoun window* when they are confronted with an ambiguous

[39] Note that the sum of fixation proportions in the HA and LA-biased images may not equal 100% because fixations outside these two interest areas were excluded from the analysis, as explained in Section 8.3.

relative clause (HA image: mean = 0.49, SD = 0.48; LA image: mean = 0.49, SD = 0.47). These findings indicate no clear preference for any specific disambiguation strategy in the processing of these sentences. Although bilinguals do not fully behave like English natives do in their L1, they also, and most importantly, diverge from the strong HA preference observed in the L1 of Spanish monolinguals, exhibiting optionality in their parsing strategies to resolve ambiguous RCs.

Once the descriptive data have been illustrated, the results of the statistical analyses will be presented. However, prior to reporting the results, it is important to specify the dependent and independent variables included in the statistical models. Regarding the former, data were transformed to obtain a DV that could be used in the models, and a log-ratio transformation was applied to the data (Arai et al., 2007; Ito & Knoeferle, 2022). In VWP studies, the comparison of fixations between two, or more, competing interest areas (HA-biased and LA-biased image in the present study) violates the assumption of independence. This is so because fixations are non-independent. For example, if a participant fixates their eyes on one interest area, it consequently implies that the other interest area is not being fixated. Thus, increased fixation on one image inherently means decreased fixations on the other one. To address this issue, the log-ratio of those fixations was used as a more appropriate dependent variable in the models. To obtain this variable, the proportion of fixations to the HA-biased and the LA-biased image were calculated separately within a specific time window, i.e., within the *pronoun window*. The log-ratio transformation was applied as follows. First, a small constant (0.1) was added to the fixation proportions to avoid issues with zero fixations. Then, the adjusted fixation proportion of HA was divided by the adjusted proportion of LA to obtain the ratio and finally, the logarithm of such ratio was calculated. The resulting variable, i.e., the log-ratio of fixation proportions, represents the relative fixation bias between the HA-biased and the LA-biased images. Applying the log-ratio transformation allows to create a single dependent variable that can be included in the following mixed-effects models, effectively addressing the issue of non-independence of the eye-tracking data. Given that the log-ratio of fixation proportions is a continuous variable, it will be analysed using linear mixed-effects models with the *lmer* function of the *lme4* package (Bates et al., 2015) in R (R Core Team, 2024). The models reported in this section contain the maximal random-effects structure that converged (Barr et al., 2013).

The output of the regression models predicting the log-ratio of fixation proportions is presented in Table 46 and Table 48. As mentioned in previous sections, the eye-tracking experiment included the three experimental conditions for the Spanish monolingual and the bilingual groups (forcing-HA, forcing-LA and ambiguous), while the version administered to the English group only contained the ambiguous condition. Thus, two separate models were conducted. A first model predicted data for the three groups in the condition shared by all of them, i.e., the ambiguous condition, to test potential group effects in ambiguous sentences. Additionally, a second model included data from two groups only, i.e., the Spanish monolingual and the instructed bilingual groups, across conditions to examine not only group but also condition effects. If group differences are observed in the first model, the second analysis will allow to determine whether such differences are limited to the ambiguous condition, as expected, or rather emerge across all of them.

Considering the first model, it contains data for the ambiguous condition in the three groups and the dependent variable is the log-ratio of fixation proportions within the *pronoun window*, as outlined earlier. Regarding the independent variables, the fixed-effects structure of the model includes the main effect of *group* (Spanish monolinguals, instructed bilinguals and English monolinguals). The maximal random-effects structure that converged includes only a by-participant random intercept, as the structure had to be simplified due to a singularity issue. The R code is provided in (73) and the output is reported in Table 46.

(73) **Model fixation proportions:**

```
model ← lmer(log_fixations ~ group + (1 | participant),
                        data = subset_ambiguous)
```

Table 46:

Model output for the log-ratio of fixation proportions in the ambiguous condition for all groups within the pronoun window

	Estimate	Std. error	df	t-value	*p*-value	
Intercept	0.470	0.078	221.05	5.956	< 0.001	***
Group bilinguals	-0.335	0.110	221.55	-3.036	0.002	**
Group English	-0.676	0.096	135.74	-7.009	< 0.001	***

The model compares the fixation patterns of the three groups in the ambiguous condition, with the intercept representing the Spanish monolingual group (β = 0.470, ρ = < 0.001). It is worth emphasising that positive values indicate a bias for the HA image, while negative values indicate a bias for the LA image. In this line, significant *group* differences are reported. The negative estimates in the bilingual and English groups suggest that they have significantly lower bias to the HA image compared to the Spanish group (Bilinguals: β = -0.335, p = 0.002; English: β = -0.676, p = < 0.001). For ambiguous sentences, both groups fixate significantly less on the HA-biased image than Spanish monolinguals do, but this difference is more pronounced for English monolinguals than for bilinguals, as indicated by the larger negative estimate (English: β = -0.676, Bilinguals: β = -0.335). This aligns with previous findings in this PhD thesis, which reveal that bilinguals occupy an intermediate position between Spanish and English monolinguals regarding attachment preferences. To follow up on these significant results, pairwise comparisons were conducted using the *emmeans* package (Lenth, 2024). The results of the contrasts are provided in Table 47.

Table 47:

Pairwise comparisons of log-ration of fixation proportions across groups

Contrasts	Estimate	Std. error	df	t-ratio	*p*-value	
Spanish - Bilinguals	0.335	0.110	240	3.036	0.007	***
Spanish - English	0.676	0.096	148	7.009	< 0.001	***
Bilinguals - English	0.341	0.095	147	3.583	0.001	***

All pairwise comparisons between groups are statistically significant. As reported by the model, Spanish natives show the strongest bias for the HA-biased image. However, the difference between bilinguals and English natives is also significant, with bilinguals displaying significantly more looks at the HA-biased image than the English group. To put it simply, bilinguals have a moderate bias for HA images compared to English speakers, who tend to prefer LA-biased images. This means that when encountered with an ambiguous RC, the Spanish monolingual group exhibits a strong preference for NP1, the English monolingual group exhibits a preference for NP2, and the bilingual group falls in between, with no clear bias for either NP1 or NP2. These findings are in line with all previous tasks, evidencing that bilinguals do not follow the L1 Spanish pattern, and are closer to the behaviour of English natives, but still not showing native English levels. The significantly reduced preference for the HA in bilinguals is considered evidence of L1 attrition, although this will be discussed in more detail in section 8.5.

A second linear mixed-effects model was conducted for the Spanish and bilingual groups only, so that all conditions could be compared. The R code for the model is reported in (74) below. Its fixed-effects structure contains main effects of both *group* (Spanish monolinguals and bilinguals) and *condition* (forcing-HA, forcing-LA and ambiguous), along with their interaction (*condition*group*). The random-effects structure includes by-participant and by-item random intercepts to account for variability at the participant and item levels. The dependent variable of the linear mixed-effects model is, as above, the log-ratio of fixation proportions, where positive values indicate a bias towards the HA image, and negative values indicate a bias towards the LA image. The output of the model can be found in Table 48.

(74) **Model fixation proportions for Spanish and bilingual groups:**

```
model ← lmer(log_fixations ~ condition * group +
                    (1 | participant) + (1 | item),
                    data = subset_spa_biling)
```

Table 48:

Model output for the log-ratio of fixation proportions for Spanish and bilingual groups within the pronoun window

	Estimate	Std. error	df	t-value	*p*-value	
Intercept	0.794	0.072	209.16	10.90	< 0.001	***
Condition forcing-LA	-0.324	0.089	1474.38	-3.61	< 0.001	***
Condition ambiguous	-1.558	0.089	1474.38	-17.33	< 0.001	***
Group bilinguals	0.081	0.097	405.83	-0.84	0.401	
Ambiguous: bilinguals	-0.414	0.125	1475.40	-3.29	0.001	**
LA: bilinguals	-0.073	0.125	1475.35	-0.58	0.559	

The intercept of the model (β = 0.794, ρ = < 0.001) is the averaged log-ratio of fixation proportions when the other predictors are at their reference levels, i.e., forcing-HA for the *condition* variable and Spanish monolinguals for the *group* variable. The model reports significant main *condition* effects for both the forcing-LA and ambiguous conditions. The interaction between the ambiguous condition and the bilingual group also reaches significance. For the baseline Spanish group, the negative estimates in the forcing-LA and ambiguous conditions indicate that Spanish monolinguals fixate less on the HA-biased image in these two conditions compared to the reference forcing-HA condition (Forcing-LA: β = -0.324, ρ = < 0.001; Ambiguous: β = -1.558, ρ = < 0.001). However, no *group* effect is observed, meaning that bilinguals and Spanish natives do not differ in the forcing-HA condition. Additionally, the interaction *ambiguous*bilinguals* represents how the ambiguous condition differs from the forcing-HA condition between bilinguals and the Spanish group. The negative estimate suggests that L1 Spanish-L2 English bilinguals have a stronger bias towards the LA image than the Spanish group has in the ambiguous condition. This difference is significant. To follow up on these findings, pairwise comparisons were conducted using the *emmeans* package (Lenth, 2024).

The comparison of the two groups in each condition only reports significant differences in the ambiguous condition, while no significant effect is found neither in the forcing-HA nor in the forcing-LA conditions. These findings suggest that, when no ambiguity is involved and the gender-marked relative pronoun *el cual*/*la cual* resolves the final interpretation, both Spanish monolinguals and bilinguals are sensitive to this morphological cue in their L1, as expected, and therefore process these sentences similarly. This demonstrates that relative pronoun provides a strong morphological resolution. However, when an ambiguity is encountered, Spanish natives fixate significantly more on the HA-biased image than instructed bilinguals do. The processing preference for high attachment in L1 Spanish reported in previous eye-tracking literature seems to be mitigated in instructed bilinguals, which aligns with attrition effects observed for naturalistically immersed bilinguals, as will be discussed in Section 8.5.

8.4.2.1. Eye-tracking patterns and language dominance

This PhD thesis not only aims to explore potential L1 attrition effects on instructed bilinguals, but also the role of some individual differences. The present section will focus on the role of language dominance. Results reported for the time course of attachment resolution and analyses on fixation proportions suggest that, although instructed bilinguals do not seem to differ from monolinguals in the timing of disambiguation, their L1 parsing mechanisms have departed from those of native Spanish speakers, showing a pattern that falls between that of Spanish and English monolinguals. The fact that L1 Spanish-L2 English bilinguals significantly differ from Spanish monolinguals in the processing of ambiguous relative clauses provides evidence of L1 attrition effects in this population.

In this line, the present section will explore whether these processing patterns are further modulated by language dominance, measured with the Bilingual Language Profile (BLP) questionnaire (for further details, see Section 5.3.2). To ensure the interpretability of the following statistical analyses, it is worth remembering the type of data provided by the questionnaire and the transformations implemented to this variable. The BLP test provides a score from -218 to +218 to each individual participant, where negative values correlate with dominance in the L2, and positive values correlate with dominance in the L1. Given that the three participant groups have different L1-L2 combinations, participants' scores were transformed in such a way that they were all placed within the same Spanish-English continuum (see Section 6.3 for a more detailed explanation of this procedure). Consequently, the resulting BLP variable was identically interpreted for all groups. Values closer to the negative end of the Spanish-English continuum indicate dominance in Spanish, whereas values closer to the positive end indicate dominance in English. To investigate potential dominance effects, two separate models were used. A first model was conducted with all participants only in the ambiguous condition to explore dominance effects across groups. Additionally, a second model was conducted on the bilingual group only.

To investigate the potential influence of language dominance for all groups, a first linear mixed-effects model was conducted. The model, illustrated in (75) below, predicts the log-ratio of fixation proportions in the ambiguous conditions across groups. It is the same as the model in example (73) with the addition of the BLP variable. The fixed-effects structure contained the main effect of *group* (Spanish monolingual, instructed bilinguals and English monolinguals), and *BLP* measuring language dominance, together with their interaction (*group*BLP*). Before its inclusion as a predictor in the statistical model, the BLP variable was scaled but not centered, given that the value 0 has a specific meaning in the original BLP scale, i.e., balanced bilingualism. On the other hand, the random-effects structure contains a by-participant random intercept only. The random-effects structure had to be simplified due to singularity issues. The output of the model is reported in Table 49.

(75) **Model fixation proportions and BLP:**

model_BLP ← lmer(log_fixations ~ group * BLP_scaled + (1 | participant),
data = subset_ambiguous)

Table 49:

Model output for the log-ratio of fixation proportions by group and BLP within the pronoun window

	Estimate	Std. error	df	t-value	*p*-value	
Intercept	1.563	1.154	217.41	1.354	0.177	
Group Bilinguals	-0.868	1.219	217.52	-0.712	0.477	
Group English	-2.252	1.306	155.53	-1.724	0.086	.
BLP	0.972	1.024	217.41	0.949	0.343	
Bilinguals: BLP	0.230	1.312	218.05	0.175	0.861	
English: BLP	-0.576	1.139	161.49	-0.505	0.614	

The intercept in the above model represents the baseline log-ratio of fixation proportions for the reference group, i.e., Spanish monolinguals, when the BLP variable has a value of zero (β = 1.563, ρ = 0.177). Only data for the ambiguous condition within the *pronoun window* have been included in the model. As observed, no significant effect is reported for any of the predictors: main effects of *group*, *BLP* and their interactions (p > 0.05).

These findings suggest that the relationship between BLP and the logged fixation ratio does not vary across groups and therefore, language dominance does not account for variability on the log-ration of fixation proportions for the ambiguous condition.

As anticipated earlier, a second model further explored the role of language dominance in the bilingual group only. To do so, a subset was created including data only from the instructed L1 Spanish-L2 English bilingual group across all experimental conditions. A linear mixed-effects model was conducted, keeping the log-ratio of fixation proportions as the dependent variable. The R code for the statistical model is provided in (76) below. Main effects of both *condition* (forcing-HA, forcing-LA, ambiguous) and *BLP* were included in the fixed-effects structure, along with their interaction (*condition*BLP*). Additionally, by-participant and by-item random intercepts were included in the random-effects structure to account for variability between participants and items. The output provided by the model is reported in Table 50.

(76) **Model fixation proportions and BLP in bilinguals:**

```
model_BLP_biling ← lmer(log_fixations ~ condition * BLP_scaled +
                        (1 | participant) + (1 | item),
                        data = subset_biling)
```

Table 50:

Model output for bilinguals' log-ratio of fixation proportions by condition and BLP within the pronoun window

	Estimate	**Std. error**	**df**	**t-value**	***p*-value**	
Intercept	0.692	0.343	197.06	2.014	0.045	*
Condition Forcing-HA	0.602	0.441	760.10	1.366	0.172	
Condition Forcing-LA	-1.357	0.441	760.10	-3.075	0.002	**
BLP	1.192	0.722	197.57	1.651	0.100	
Forcing-HA: BLP	-0.295	0.927	760.15	-0.318	0.750	
Forcing-LA: BLP	-1.002	0.927	760.15	-1.080	0.280	

The intercept (β = 0.692, ρ = 0.045) represents the estimated log-ratio of fixation proportions for bilinguals when the other predictors are at their reference levels, i.e., ambiguous for the *condition* variable and 0 for the BLP variable. The rationale to choose the ambiguous condition as reference level is because it allows us to directly examine the main effect of BLP in this condition. Results reveal no significant effect of language dominance in the bilingual group. Focusing on the main effect of the continuous *BLP* variable, which measures language dominance, the positive estimate (β = 1.192, p = 0.100) indicates that as bilingual participants become more English dominant, their bias towards the HA image increases. However, this effect does not reach statistical significance. These findings seem to indicate that language dominance has no modulating effect on fixation patterns for the instructed bilingual group. Such lack of effect is in line with results from the picture selection data (see Section 6.4.1.1), but contrasts with the effect observed in the PVT (see Section 7.4.2.1). In the former, dominance did not modulate final interpretation choices, whereas in the latter, it was found to predict processing cost. Interestingly, the picture selection and eye-tracking data were gathered using the same experimental task (i.e., a visual-world eye-tracking task), as explained in Chapter 0. The discrepancy between the existing or the lack of a dominance effect may be explained regarding the characteristics of the tasks and what they measure. It may be the case that increased dominance in the L2 English particularly influences bilinguals' processing cost, as a result of the higher coactivation of both languages. However, their effect may not be so strong regarding final attachment choices. Considering the eye-tracking task, dominance was explored as a predictor of attachment biases to the HA or LA image. Given that the nature of the task involves a constant alternation from one image to the other, it may not reflect a potential effect of language dominance in instructed bilinguals. This will be further discussed in the general discussion offered in Chapter 9.

8.4.2.2. Eye-tracking patterns and length of L2 immersed instruction

Together with language dominance, an additional individual difference explored in this PhD thesis is the length of bilinguals' exposure to their L2 English in a classroom, instructed setting. Previous literature on L1 attrition has evidenced that longer naturalistic immersion in an L2-environment leads to stronger attrition effects on L1 sentence processing (see Sections 2.2 and 2.4.2). Based on this, this PhD aims to study whether increased amount of L2 exposure in an instructed context may also correlate with more pronounced L1 attrition. To address this, length of L2 immersed instruction has been operationalised in terms of the number of years bilinguals have been enrolled in the degree of English Studies. Consequently, given that it is a four-year degree, this variable ranges from 1 to 4. A linear mixed-effects model was conducted on data from the bilingual group only to predict the log-ratio of fixation proportions within the *pronoun* *window*. It is worth remembering the interpretation of the resulting values for the dependent variable. Higher values indicate a bias to the HA image, whereas lower values correlate with more looks to the LA image during the *pronoun window*. Changes in the dependent variable were analysed as a function of the following predictors: *condition* (forcing-HA, forcing-LA and ambiguous), *length of immersed instruction* (LoII) in the L2, and their interaction (*condition*LoII*). Due to a singularity issue, only one random intercept for participant was included in the random-effects structure. The specific structure of the model is illustrated in (77), and the output is reported in Table 51.

(77) **Model fixation proportions and LoII in bilinguals:**

model_LoII_biling ← lmer(log_fixations ~ condition * LoII + (1 | participant),
data = subset_biling)

Table 51:

Model output for bilinguals' log-ratio of fixation proportions by condition and LoII within the pronoun window

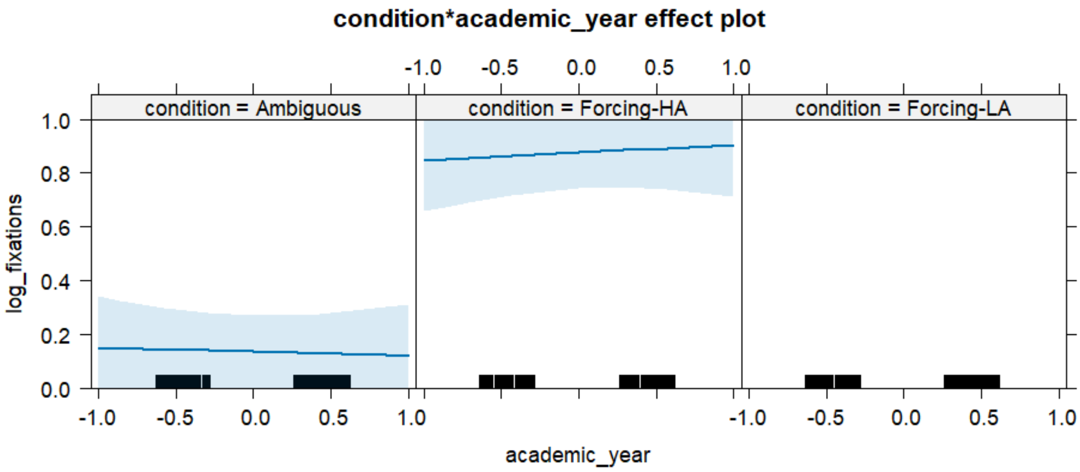
	Estimate	**Std. error**	**df**	**t-value**	***p*-value**	
Intercept	0.135	0.068	187.07	1.971	1.971	.
Condition Forcing-HA	0.740	0.087	760.12	8.497	< 0.001	***
Condition Forcing-LA	-0.889	0.087	760.12	-10.196	< 0.001	***
LoII	-0.014	0.068	186.33	-0.206	0.836	
Forcing-HA: LoII	0.042	0.087	760.05	0.489	0.625	
Forcing-LA: LoII	0.008	0.087	760.05	0.095	0.924	

The intercept of the model represents the baseline for comparison, which includes the ambiguous condition in the bilingual group (β = 0.135, p = 1.971). Significant effects are reported for the *condition* variable. In the forcing-HA condition, bilinguals direct significantly more looks at the HA-biased image compared to the ambiguous condition, whereas the proportion of fixations in the forcing-LA condition significantly decreases (Forcing-HA: β = 0.740, p < 0.001; Forcing-LA: β = -0.889, p < 0.001). Focusing on the role of length of instruction, no significant effect is evidenced (β = -0.014, p = 0.836). The negative estimate, however, indicates that with each additional year exposed to the L2, the bias towards the HA image decreases slightly. While the effect is non-significant, a tendency is observed in the expected direction assuming that length of instruction modulates L1 attrition effects, i.e., as L2 exposure increases, bilinguals' preference for

HA, their L1-preferred strategy, slightly weakens. Regarding the interaction effects, no significant differences are observed. Although these results reveal that the influence of length of L2 instruction does not significantly differ across conditions, the tendency to decrease the proportion of looks to the HA image is more pronounced in the ambiguous condition. The interaction estimates indicate that the main effect of LoII, i.e., fewer looks to the HA-biased image as LoII increases, is weaker in the two forcing conditions. Figure 21 illustrates the predictions of the output model reported in Table 51.

Figure 21:

Predicted log-ratio of fixation proportions to the HA image by condition and LoII among bilinguals



Results reveal that length of L2 immersed instruction does not significantly account for variability in fixation patterns among L1 Spanish-L2 English bilinguals. However, findings are still in the expected direction. Although the main effect of length of immersed instruction is non-significant, the negative estimate suggests, as predicted, that the bias towards the HA image in the ambiguous condition decreases with longer immersed instruction in the L2 compared to the baseline forcing-HA condition. A tendency to look less to the HA-biased image is observed for bilinguals in the final years of the degree, i.e., those with longer L2 exposure, but the effect is non-significant. The lack of a significant effect aligns with the results from the previous tasks (see Section 6.4.1.2 and Section 7.4.2.2 for LoII effects on the PST and PVT, respectively). Findings consistently illustrate that LoII is not a predictor of L1 attrition effects in this PhD thesis. Different explanations may account for these unexpected results. The lack of effect may be due to insufficient data, resulting in a lack of statistical power. It may also be due to lack of sufficient variability in the data as LoII was operationalised regarding number of years, ranging from 1 to 4. The limited nature of this scale and its resulting limited variability may have prevented us from uncovering a potential modulating effect of this variable in our data. Finally, it may be the case that LoII does not predict variability in L1 attrition for our bilinguals due to insufficient time in a context of immersed instruction. Significant differences might be observed in they continue being exposed to their L2 in the same context for a longer period. These ideas will be further discussed in the following section.

8.5. Discussion of online eye-tracking data

This section will revisit the RQs for the eye-tracking data, providing a response to each individual question based on the results obtained. In this regard, RQ_9 addressed whether the **time course** of processing ambiguous relative clauses will reveal evidence of L1 attrition effects among instructed bilinguals compared to Spanish and English monolinguals. The focus of this research question is when disambiguation occurs during sentence processing as the sentence unfolds, and this was examined with time-course data from the three participant groups in the ambiguous condition only. This was so for two reasons. Firstly, it is the only condition shared by all groups, meaning that comparisons across groups can only be made in this condition. Secondly, it is the condition where differences are expected. It was predicted that, if L1 attrition effects were observed in instructed bilinguals, these would emerge as delayed looks at the HA-biased image, especially when compared to the Spanish monolingual group. Focusing on the two control groups, i.e., the Spanish and English monolinguals, their time course will reveal higher speed in resolving ambiguous sentences, with their looks quickly shifting to the image that depicts their L1-preferred parsing strategy: HA-biased image for Spanish natives, and LA-biased image for English natives.

Findings reported in Section 8.4.1 reveal differences in the time course of attachment resolution. The Spanish monolingual group is the fastest one when resolving ambiguous relative clauses. This is so because they quickly shift their eyes to the HA-biased image, rather than the LA-biased image, as soon as they hear the relative pronoun *que*. This pattern suggests two relevant aspects. First, the HA-preference in sentence parsing for native Spanish is very strong, since it is observed at very early stages of processing. Secondly, the increased amount of looks at the HA-biased image increases steadily as the sentence unfolds, which means that HA-preference becomes stronger as

Spanish monolinguals receive new incoming input. These results confirm the predictions for the Spanish group, as they resolve ambiguous RCs favouring a HA interpretation from very early stages of processing, illustrating once more the prominent role of this strategy in native Spanish. Such strength is in line with results from picture selection (see Chapter 6) and picture verification data (see Chapter 7). Spanish monolinguals predominantly resolved ambiguous sentences via a HA interpretation and additionally, accepting such interpretation did not involve any processing cost. Similarly to the lack of processing effort when rejecting LA, as illustrated in Figure 10. In addition to the findings from this PhD thesis, the quick resolution towards HA among Spanish monolinguals also aligns with prior studies on online RCA strategies, which revealed a processing advantage for HA (Carreiras & Clifton, 1993; Dussias, 2003; Dussias & Sagarra, 2007; Jegerski, Keating, et al., 2016). Time-course data contribute to previous findings offering a novel perspective, as they show that disambiguation in favour of HA occurs at very early stages of processing, right after the ambiguous relative pronoun is pronounced. This supports the fact that HA is the default strategy in native Spanish with a strong presence in both online and offline measures.

Regarding the second control group, i.e., English monolinguals, predictions are partially confirmed. This is so because, although the expected LA preference is observed, it is not as pronounced as predicted. Descriptives for their time of disambiguation show that English monolinguals resolve ambiguous RCs through LA. This is so because, as sentences unfold, the proportion of looks to the HA image slightly decrease in favour of increased fixations to the LA image. However, this gradual preference for LA is not as pronounced as expected. Additionally, their shift of attention to the LA-biased image occurs later than that of Spanish monolinguals, who are faster resolving ambiguous sentences through HA. Compared to the Spanish monolingual group, the fact that English monolinguals need more time to disambiguate sentences towards LA may suggest that, although LA is their preferred strategy, it is not as robust as HA in native Spanish. Overall, time-course data show that English monolinguals favour LA in their L1 processing of ambiguous RCs, but the strength of such preference is lower than initially expected. This was also observed in the analyses on fixation proportions, which will be discussed in the following paragraphs. The English group seems to maintain a similar pattern across all tasks within this PhD thesis: they favour LA over HA, but in a weaker way than Spanish monolinguals favour HA over LA. This will be further discussed in Chapter 9, which will provide a general discussion of all findings obtained.

Finally, predictions for the bilingual group have also been confirmed. As expected, findings reveal a mitigated preference for high attachment in online processing, with no clear preference for either HA or LA. The time course of attachment resolution shows optionality and therefore, signs of L1 attrition, as bilinguals deviate from the behaviour of Spanish natives. It was hypothesised that they would fixate on the HA image later than monolinguals, indicating a less pronounced parsing preference and greater hesitation. However, no shift is observed for instructed bilinguals in the distribution of fixations as the sentence unfolds. They display a slight, stable bias to the HA-image during the time window examined, suggesting that they may remain uncertain throughout the entire sentence after the ambiguous relative pronoun is pronounced. Bilinguals do not seem to opt for any specific parsing mechanisms (HA or LA) to resolve ambiguous relative clauses. This optionality clearly differs from the strong HA preference among Spanish monolinguals and is considered evidence of L1 attrition in this instructed bilingual population. Bilinguals are native speakers of Spanish and as so, would be expected to process their L1 similarly to Spanish monolinguals assuming that they are not undergoing L1 attrition. However, their patterns differ, suggesting a readjustment in the online processing of their L1 due to their bilingual experience.

Eye-movement data is a highly precise measure of online sentence processing. In this line, the present eye-tracking experiment has offered reliable data to explore the unfolding of attachment preferences over time across the three groups. The preference for either a HA or a LA interpretation in native Spanish and native English, respectively, is present even at early stages of processing, although it is particularly strong in Spanish monolinguals. Bilinguals, on the other hand, do not pattern with the Spanish monolingual group regarding the processing mechanisms implemented in their L1 Spanish.

In addition, RQ_{10} examined if the **proportion of fixations** on the HA vs. LA-biased images differ between instructed bilinguals, Spanish and English monolinguals for ambiguous relative clauses. The main statistical analysis to address this research question compared all groups in the ambiguous condition regarding their bias to fixate either the image depicting a HA interpretation or a LA interpretation. This approached allows to explore potential group effects. If such differences emerged and the distribution of fixations varied across groups, the Spanish and the English groups are predicted to show the highest and lowest proportion of fixations on the HA image, respectively. The mirror image will hold for the LA image. Instructed bilinguals will significantly differ from Spanish natives with significantly more looks at the LA image, which represents their L1 dispreferred parsing strategy.

Results from a linear-mixed effects model predicting the log-ratio of fixation proportions in the ambiguous condition across groups confirm the above predictions (see the output of the model in Table 46). Compared to Spanish monolinguals, both English monolinguals and instructed bilinguals display significantly more looks at the image that represents a LA interpretation than the one depicting a HA interpretation. This difference is particularly pronounced in the English group, as expected. However, although bilinguals and English monolinguals share a lack of preference for HA, they do not entirely pattern together. The two groups differ in their fixation patterns, with English monolinguals showing a stronger bias towards the LA image than bilinguals. This suggests that English natives tend to favour a LA interpretation more frequently than bilinguals do. The optionality observed in bilinguals indicate that they have not completely reverted their L1 processing preferences to resolve ambiguous relative clauses, i.e., high attachment, and are not replicating L2 patterns in their L1.

It is worth highlighting that bilinguals tested in this PhD thesis show a similar pattern to those examined in the study by Valenzuela et al. (2020), who also found a lack of preference for HA over LA in online processing. The key difference is that bilinguals in Valenzuela et al.'s (2020) study were naturalistically immersed in an L2 environment, while those in this thesis received extensive L2 exposure in an L1 environment. These findings support the ambivalent, optional attachment preferences observed in our bilinguals and suggest that naturalistic immersion does not seem to be a necessary condition for comparable results to emerge in other L2 exposure contexts.

A follow-up analysis was conducted on the two L1 Spanish groups, i.e., the Spanish monolingual and the L1 Spanish-L2 English bilingual group, to address whether the group differences observed emerged across all experimental conditions or were rather restricted to the critical ambiguous condition. Results proved that these groups only differ in the processing of ambiguous relative clauses, showing no differences in the forcing-HA and forcing-LA conditions. When processing non-ambiguous sentences, both groups display the same fixations distribution: a bias to the HA image in the forcing-HA condition and a bias to the LA image in the forcing-LA condition. The fact that they implement the correct parsing mechanisms in these conditions providing a solid ground to claim that group differences can be directly attributed to the manipulation of experimental condition, i.e., the ambiguous condition.

The present PhD thesis also aims to examine if, and to what extent, individual differences may account for variability in the observed patterns. In this regard, RQ_{11} addressed the role of language dominance, asking whether it may modulate fixation patterns in instructed bilinguals when they are confronted with ambiguous relative clauses in their L1 Spanish. If such effect is reported in the eye-tracking data, it is expected for the bilingual group. In particular, stronger evidence of implementing the parsing strategy typically associated with their L2 English, i.e., increased proportion of fixations to the LA-biased image, among bilinguals with higher dominance in English. Conversely, a more frequent bias to the HA image is expected among bilinguals who are more Spanish dominant, as measured by the BLP questionnaire (Birdsong et al., 2012).

Against initial predictions, **language dominance** does not seem to exert an effect on the L1 processing strategies of instructed bilingual speakers. Increased dominance in their L2 English does not seem to correlate with a higher bias to the image depicting a LA representation. In this regard, it is important to bear in mind that none of the bilinguals tested in this study was completely dominant in their L2 English. Bilinguals had higher dominance in English compared to the Spanish monolingual group, but remained more dominant in their L1 Spanish than in their L2 English. Interestingly, an effect of language dominance is observed in the PVT (see Section 7.4.2.1), which measures processing cost, but it is not found in the PST or the eye-tracking task, which are in fact the same experimental task. Thus, given that the effect is reported in one task but not the other, this discrepancy may be related to the stages or processes each task address. While dominance may have a more prominent influence in processing effort, as captured by the PVT, it may have less or no effect on bilinguals' final interpretation (i.e., offline picture-selection responses) or on their interpretation preferences during sentence processing (i.e., preference for one image over the other). The fact that all experimental tasks were completed by the same bilingual participants supports this idea. Otherwise, if dominance had a consistent influence across all measures, its effect should be observed in all tasks. This will be further discussed in the general discussion in the following chapter.

Valenzuela et al. (2020) specifically examined the role of language dominance in the parsing strategies of late L1 Spanish-L2 English bilinguals using a reading eye-tracking task. These participants lived in an L2 English-speaking environment and were dominant in their L1 Spanish based on proficiency and self-reports (see more details of the study in Section 3.4.2.2). If language dominance exerted an effect, the authors predicted that these Spanish-dominant bilinguals would have longer RTs when forcing the dispreferred attachment of their dominant language, i.e., sentences forcing LA. Results for L1 Spanish-L2 English bilinguals tested in their L1 show no differences between sentences forcing HA and forcing LA, as they read both conditions at a similar speed. This suggests that Spanish-dominant bilinguals do not follow the typical L1 Spanish preference for HA (which would result in faster RTs when forcing HA). However, they have not adopted the preferred strategy of their L2 English either. Otherwise, they would have had faster RTs when forcing-LA. This lack of preference in bilinguals who remain L1 dominant aligns with the findings reported in this PhD thesis. However, Valenzuela et al. (2020) measured dominance categorically rather than on a continuum, so they did not explore how this factor may account for variability in attachment preferences. This was done in the present thesis, and findings confirm a lack of effect of language dominance.

Results from this PhD thesis can also be discussed considering those obtained by Dussias and Sagarra (2007), who tested two L1 Spanish-L2 English bilingual groups that were dominant in their L1 Spanish. However, the authors measured language dominance based on proficiency only. Although dominance was not explored as a modulating factor, differences emerged only for those bilinguals with longer exposure to their L2. The fact that differences were only reported for one of the two bilingual groups, i.e., long-immersed bilinguals, may indicate that exposure, rather than dominance, plays a more relevant role in modulating L1 attrition effects. In particular when focusing on bilinguals who remain dominant in their first language. The following paragraphs will further discuss the role of length of L2 exposure in general, and length of L2 immersed instruction in particular.

A final research question was formulated to account for the role of length of exposure to the L2 in a classroom, instructed setting. RQ_{12} explored whether **length of L2 immersed instruction** may modulate fixation patterns in instructed bilinguals when they are confronted with ambiguous relative clauses in their L1 Spanish. This question was motivated by previous eye-tracking research where an effect of L2 naturalistic exposure had been reported. For instance, Dussias and Sagarra (2007) found such effect regarding RCA preferences in L1 Spanish-L2 English bilinguals.

Based on these findings, this PhD thesis aimed at exploring whether a similar effect would be exerted by L2 exposure in an instructed setting. Such effect of LoI would be manifested in higher proportion of fixations in the image depicting the L1-dispreferred parsing strategy, i.e., the image depicting a low attachment interpretation, among bilinguals with longer L2 exposure. On the other hand, bilinguals with fewer exposure to their L2 English in a classroom setting will exhibit higher preference for the HA image. The analysis focused on the bilingual group across all experimental conditions to test the potential influence of length of L2 instruction for instructed bilinguals in all conditions. Length of L2 instruction, as explained in previous sections, was measured in number of years bilinguals had been enrolled in the degree of English Studies at the moment of testing. Results provided by a linear mixed-effects model including LoI as predictor reported no main effect of this variable. Only its interaction with the ambiguous condition reached statistical significance.

These results contrast with those obtained in the study mentioned above by Dussias and Sagarra (2007), who explored the effect of naturalistically immersed L2 exposure on syntactic parsing among bilinguals. Two groups of L1 Spanish-L2 English bilinguals were tested, which varied regarding their amount of L2 exposure in an L2-speaking environment (limited vs. extensive exposure). While limited-exposure bilinguals aligned with Spanish monolinguals in L1 processing of ambiguous RCs, those with extensive exposure significantly differed favouring LA. The authors tested the same bilingual population that is examined in the present PhD thesis: university students who are adult sequential bilinguals with Spanish as their first language and English as their second language. The difference is the type of L2 exposure received. While bilinguals tested by Dussias and Sagarra (2007) had been immersed in an L2 naturalistic environment, the bilingual group in this PhD investigation has only been exposure to their L2 English in a classroom, instructed setting. The authors tested parsing preferences in ambiguous constructions using a reading eye-tracking experiment. They concluded that bilinguals with limited immersed exposure attached ambiguous relative clauses to NP1 (HA), aligning with the Spanish monolingual control group included in their study. However, bilinguals with extensive immersed exposure attached RCs to NP2, following the LA tendency observed for their L2 English.

Similar results were expected for the bilingual group included in this PhD thesis. However, no significant differences are observed between those bilinguals in the first years of the degree and those in the final years. Further research is needed to account for this issue. The statistical analysis conducted by Dussias and Sagarra (2007) may be biased due to the way the dependent variable has been constructed. According to the authors, the DV was the result of subtracting the total RTs for items in the forcing-HA condition from the total RTs of items in the forcing-LA condition. This approach assumes the existence of a condition effect and uses such effect as DV. However, constructing the DV as an effect rather than as an independent measurement makes it difficult to interpret the results as evidence of an actual effect of length of exposure on bilinguals' online processing. An alternative, less biased approach would be to predict RTs separately for each condition using a mixed-effects model, including length of exposure as a predictor and accounting for by-participant variability. This approach has been implemented in the present PhD thesis. However, when applying this more rigorous analysis and this variable is examined in greater detail, the previously observed effect does not hold. This may indicate that the initial findings could have resulted from methodological decisions rather than due to a real, strong relation between online RCA strategies and length of exposure. However, the analysis in this PhD thesis also has limitations. The variability in the tested LoI variable may not be sufficient. The range between 1 to 4 years is small and may not provide enough variability for the analyses to detect an effect. Thus, it may not be the best predictor. It would be necessary to implement current statistical analyses using as predictor a variable that contains greater variation.

To sum up, this chapter leads to several relevant conclusions. L1 attrition has been observed in the online RCA strategies of instructed bilinguals, regarding both the descriptive illustration of their time course of attachment disambiguation and the statistical analyses of fixation proportions. L1 attrition is reflected in terms of optionality, as bilinguals do not exhibit a clear preference for either HA, as Spanish monolinguals do, or LA, typical of native English. Instead, their preferences fall in an intermediate position. Additionally, when examining the influence of modulating factors such as language dominance or length of immersed instruction, no significant effects were found. Higher L2 English dominance did not correlate with a significantly increased preference for LA. Additionally, bilinguals in the final years of the English Studies degree seem to exhibit similar fixation patterns to those in the initial years. However, despite the non-significant effect, a tendency was observed in the expected direction, with longer L2 exposure in an instructed setting corresponding to fewer looks at the HA-biased image, i.e., lower preference for the L1-preferred HA interpretation. These eye-tracking results will be discussed in the following chapter together with previous findings from the PST and PVT to provide a final, general discussion.

Chapter 9: General discussion

Up to this point, the three tasks have been discussed separately. The aim of the present chapter is to bring all results together and provide an in-depth discussion of the main findings and their implications for L1 attrition research. This PhD thesis has followed a methodological triangulation approach by addressing both offline interpretation and online processing with different types of data, i.e., offline responses, response times and eye-movement data. Importantly, all tasks were designed using the same stimuli and completed by the same participants. This will allow us to establish reliable comparisons across tasks, examining the phenomenon from different angles and getting a more complete picture of the nature of L1 attrition. Finally, this chapter will also discuss the role of individual factors like language dominance and length of immersed instruction in L1 attrition as potential predicting variables in attachment preferences.

This chapter is structured as follows. First, findings for each group will be discussed separately across all tasks, to provide a comprehensive interpretation and a wider picture of their performance across different tasks. Secondly, the role of individual factors as potential predictors of L1 attrition will be addressed. Attention will be devoted to language dominance and length of L2 immersed instruction, the variables explored in the present PhD thesis. Finally, the chapter will conclude with a summary of the main findings and their implications before the final conclusion in the following chapter.

L1 attrition effects have been reported for **instructed bilinguals** across all tasks. These effects manifested differently due to the different nature of each task. For the PST, bilinguals' offline responses showed lack of attachment preferences in ambiguous RCs, differing from both Spanish and English monolinguals, who exhibited clear interpretative biases. The Spanish monolingual group exhibited a strong preference for HA, while the

English monolingual group primarily relied on LA, in line with previous studies (Bergmann et al., 2008; Cuetos & Mitchell, 1988; Dussias, 2003). However, the strength of the LA preference in the English group was milder than expected, contrasting with the pronounced HA Spanish preference. This mild LA English preference is observed in **¡Error! No se encuentra el origen de la referencia.**, and aligns with prior research ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"KYgowD7H","properties":{"formattedCitation":"(Bergmann et al., 2008; Hemforth et al., 2015)","plainCitation":"(Bergmann et al., 2008; Hemforth et al., 2015)","noteIndex":0},"citationItems":[{"id":61,"uris":["http://zotero.org/users/local/rkYrsGxU/items/UX9ZL3W9"],"itemData":{"id":61,"type":"paper-conference","container-title":"Proceedings of Speech Prosody 2008","event-place":"Campinas, Brazil","publisher-place":"Campinas, Brazil","title":"Relative clause attachment in English and Spanish: A production study","author":[{"family":"Bergmann","given":"Anouschka"},{"family":"Armstrong","given":"Meghan"},{"family":"Maday","given":"Kristine"}],"issued":{"date-parts":[["2008"]]}}},{"id":332,"uris":["http://zotero.org/users/local/rkYrsGxU/items/5QGLWT6Z"],"itemData":{"id":332,"type":"article-journal","container-title":"Lingua","DOI":"10.1016/j.lingua.2015.08.010","ISSN":"00243841","journalAbbreviation":"Lingua","language":"en","page":"43-64","source":"DOI.org (Crossref)","title":"Relative clause attachment in German, English, Spanish and French: Effects of position and length","title-short":"Relative clause attachment in German, English, Spanish and French","volume":"166","author":[{"family":"Hemforth","given":"Barbara"},{"family":"Fernandez","given":"Susana"},{"family":"Clifton","given":"Charles"},{"family":"Frazier","given":"Lyn"},{"family":"Konieczny","given":"Lars"},{"family":"Walter","given":"Michael"}],"issued":{"date-parts":[["2015",10]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"} (Bergmann et al., 2008; Hemforth et al., 2015). One explanation can be found in the Predicate Proximity principle, which was reported to operate in English (Gibson et al., 1996) favouring HA. However, to our knowledge, its influence in native English, particularly in comparison with recency principles such as Late Closure, remains underexplored and should be accounted for in future research.

Given that bilinguals were equally likely to favour a HA or a LA interpretation, L1 attrition manifested in offline PST data as optionality, with a significantly weakened HA preference compared to Spanish monolinguals and increased bias to the L2 strategy (LA). It is worth noting, however, that bilinguals do not behave as English monolinguals either. Instead, they occupy an intermediate position regarding RCA biases, showing a unique pattern. Data triangulation from three experimental tasks revealed that bilinguals' intermediate position replicated across all tasks, as illustrated in Chapter 7 for PVT data and Chapter 8 for eye-tracking data, increasing the validity of the pattern observed.

To be more precise, offline interpretative biases in the PST are consistent with offline acceptance responses from the PVT. Compared to Spanish monolinguals, bilinguals were significantly less likely to accept an L1-preferred HA interpretation, and exhibited significantly greater acceptance of the L2-preferred LA interpretation. Once again, as in the PST, a pattern of optionality is observed in bilinguals. They show reduced acceptance of HA, although they do not completely reject it, and increased acceptance of LA. This indicates that both parsing strategies are available, and both interpretations are active in bilinguals, which contrast with the pattern in Spanish and English monolinguals, who seem to favour one interpretation, either HA or LA, respectively.

However, although offline data from the PST and PVT can be taken to show offline interpretation, it is worth outlining the different nature of these tasks for the implications of the findings. Offline responses in the PST directly reflect participants' preferred interpretation in a forced-choice manner, which has been naturally built while the two potential interpretations were displayed in two images. In contrast, in the PVT, participants create a mental representation of an ambiguous sentence and are later asked to either maintain or reject it based on the visual scene displayed. Thus, offline PVT responses illustrate the degree of acceptance of the interpretation shown and whether bilinguals maintain or discard their already built mental representation. Together, PST and PVT offline data reveal that bilinguals not only show optionality resulting from decreased HA in favour of LA, but also that the growing LA bias is already rooted as a possible parsing strategy. This is observed in two aspects. In the PST, bilinguals often opt towards LA even when a HA interpretation has been displayed from the beginning of the trial. Similarly, in the PVT, they often accept a LA interpretation when this is displayed after the sentence finished. This pattern suggests either that the LA-biased image matched the parsing strategy employed and therefore, bilinguals had relied on LA, or that they were more inclined to change the (potentially) initial HA interpretation in favour of a LA interpretation. This would indicate lower commitment with their L1-default HA strategy, differing from Spanish monolinguals, who maintain a HA interpretation even if a LA-biased image is displayed. Overall, offline results evidence that bilinguals have higher optionality as they seem to accept both attachment strategies.

These neutral offline preferences in bilinguals' L1 have also been attested on L1 Spanish-L2 English bilinguals by Jegerski, VanPatten, et al. (2016). To account for this, authors referred to the cognitive demands on bilinguals' language processor. Reduced HA interpretations involve increased preference for LA, which is driven by recency principles of language economy such as Late Closure (Frazier, 1978, 1987; Frazier & Clifton, 1996). To counterbalance the potential additional cost of managing two activated languages with opposing attachment strategies, bilinguals may start implementing LA, which is cognitively more economical and enables more straightforward analyses. The ambivalence regarding RCA strategies (HA vs. LA) has not been limited to the L1, as a similar pattern emerges in bilinguals' L2. This suggests that bilinguals may adopt a common processing pattern regardless of language, i.e., what has been referred to as one single language processor. It is beyond the scope of this thesis to address this claim, as it would be necessary to explore the L2 of instructed bilinguals. Since our results show an increased use of the cognitively less demanding strategy (LA), if a similar pattern emerges in the L2, it may be the case that bilinguals tend towards a common language processor guided by cognitive efficacy. Thus, it would be relevant to explore whether the LA bias observed would continue to increase if the context of immersed instruction is maintained.

This connects with online data collected from participants' **response times** in the PST and PVT. Focusing on picture-selection response patterns, these reflect participants' time needed to select a final interpretation (either HA or LA) measured from the end of the sentence, once completely uttered, until participants' keyboard response. Thus, RTs capture the wrap-up processes during which syntactic and semantic information is combined. It is during this wrap-up stage that bilinguals responded significantly slower, i.e., longer RTs, in ambiguous RCs compared to Spanish and English monolinguals, who were faster in providing a response (see Figure 7 in Section 6.4.2). These differences in response patterns evidence, once more, that monolinguals have a preferred strategy that facilitates faster resolution of ambiguous RCs. However, instructed bilinguals seem to experience additional processing cost, likely due to the increased optionality observed in offline data.

Processing costs were specifically addressed in the PVT, which examined potential garden-path effects in ambiguous RCs. As expected, instructed L1 Spanish-L2 English bilinguals were significantly slower than Spanish monolinguals when accepting a HA interpretation in their L1 Spanish, as well as when rejecting a LA interpretation. This is interesting because bilinguals diverge from Spanish monolinguals precisely in those contexts that represent typical Spanish native patterns: accepting HA and rejecting LA. Assuming no L1 attrition was involved, instructed bilinguals would quickly accept HA and quickly reject LA, as Spanish monolinguals do. L1 Spanish-L2 English bilinguals do not follow this behaviour, indicating that their parsing preferences no longer pattern with those of Spanish monolinguals. Against the clear bias in the Spanish monolingual group, bilinguals do not systematically accept or reject any specific interpretation. The HA preference is not as pronounced for bilinguals as it is for Spanish monolinguals, while LA has become a more feasible mechanism for bilinguals than compared to Spanish natives as the former needs to make more effort to reject a LA interpretation.

When processing data are considered together with the offline PVT data above, a consistent pattern emerges. Offline responses show that bilinguals accept HA but to a lower extent than Spanish monolinguals do, while showing greater tendency to accept LA. Thus, the lower preference for HA correlates with the higher processing time required to accept it. Similarly, the increased acceptance of LA in the offline data also correlates with online results, as bilinguals may take longer to reject it because they have incorporated LA as a possible interpretation. These key findings are summarised in Table 52 below. In summary, bilinguals show an attenuated but not eradicated HA strategy, and have also incorporated LA. This optionality, rather than a complete shift towards LA (typical of their L2 English) is logical considering that these are instructed bilinguals, not naturalistically immersed ones. Future studies should explore RCA preferences among immersed bilinguals in an L2-country to compare their results with that of the bilingual under study in this thesis.

The processing cost observed in the PVT aligns with the one reported above for the PST. The fact that the same pattern emerges in two tasks makes results more solid and increases the validity of these findings. Overall, results reveal L1 attrition in online processing among instructed bilinguals, challenging traditional claims that restrict L1 attrition to a knowledge representational level, i.e., offline comprehension. This PhD thesis reveals attrition effects in offline interpretative biases (responses from the PST and PVT) but also, and crucially, reveals attrition effects in online processing. Schmid and Köpke (2017) are against the limited view of L1attrition as permanent influence at a representational level. They argue that permanent representational readjustments and online ones represent different stages along the same developmental continuum, with L1 attrition encompassing all of them. In their view, changes would first involve production and/or processing and in some cases, the process may also lead to readjustments at the level of knowledge representation. This PhD thesis builds on the broader, more open perspective on L1 attrition introduced by Schmid and Köpke (2017) and therefore, online results from both the PST and PVT are taken as evidence of attrition effects.

Finally, fixations data from the visual-world eye-tracking experiment also reveals attrition in online processing. Descriptives of the time-course of attachment resolution suggest that, while Spanish and English monolinguals resolve ambiguous RCs towards their L1-preferred strategy, no such disambiguation is observed for instructed bilinguals. Additionally, statistical analyses on the distribution of fixations to the HA and LA-biased images showed that instructed bilinguals exhibited a lack of bias for one image, i.e., interpretation, over the other. The bilingual group looked at the image depicting a LA interpretation significantly more often than Spanish monolinguals, although bilinguals also differed from English monolinguals, who displayed the strongest bias towards the LA image, as expected. This optionality in fixation patterns coincides with the optionality observed in offline picture selection data. This is important because, as mentioned in Chapter 0, the PST and eye-tracking experiment were one single experimental task, although the different nature of the data collected made us present results as two separate tasks. The implication is that bilingual participants show no parsing preference either in online processing as the sentence unfolds, or once they have been uttered and all information has been integrated. This is in line with the lack of RCA preference reported by Valenzuela et al. (2020). However, bilinguals tested in their study were naturalistically immersed in an L2-speaking country, while bilinguals in this thesis received extensive L2 immersed instruction in an L1 environment. The fact that similar patterns are observed in two bilingual population with different type of L2 exposure seem to indicate that naturalistic immersion is not a necessary condition for L1 attrition. Overall, bilinguals' results are in line with predictions from the ATH and the Linguistic Tuning hypothesis, as L1 attrition effects are attested in instructed bilinguals compared to Spanish monolinguals, who differ regarding amount of L2 input and opportunities of L2 use.

An interesting finding involves **English monolinguals in the PVT**, as they did not behave according to expectations. Against the predicted LA preference, results evidenced great acceptance of HA images (i.e., HA interpretations) in their native English, not differing from L1 Spanish-L2 English bilinguals. Statistical analyses revealed that English monolinguals were significantly more likely than Spanish monolinguals to accept a LA image, as predicted, but no differences were found when compared to instructed bilinguals, suggesting that both groups are equally likely to accept a LA interpretation. This similarity is not due to a strong LA preference in bilinguals, but rather to the surprisingly low bias for LA among English monolinguals (see Figure 8). They accept the LA image around 50% of the time, revealing a lower preference for LA than expected.

Although several explanations have been provided in the discussion of PVT data in Section 7.5, this is most likely due to the nature of the task. The PVT is similar to an acceptability task, with participants either accepting or rejecting an image (i.e. interpretation) displayed. However, accepting a specific image does not imply that the interpretation depicted is the preferred one. The PST has a forced-choice nature presenting the two alternatives from the beginning, while the PVT requires to accept or reject the only interpretation presented. The latter may result in greater variability, as both interpretations can be accepted. Thus, this may explain why the PST provides clearer, more categorical results. In fact, this has been observed in previous studies that combined both forced-choice and acceptability tasks. For instance, Martín-Villena (2023) explored L1 attrition regarding subject referring expressions in L1 Spanish and compared results from a PST and comprehension questions included in a SPRT. It is also been reported by de Rocafiguera (2023). Although the PVT leads to potentially more variability in the results, findings for the Spanish monolingual group and bilinguals meet our predictions. The HA preference among Spanish monolinguals is evident, suggesting that this parsing strategy is deeply rooted, particularly when compared to the LA preference among English monolinguals, which is affected by the nature of the task. This PhD has shown that the LA preference in native English may be weaker than the HA preference in native Spanish, so we may conclude that languages not only differ regarding their default RCA strategy, but also regarding the strength of such preference. Given the lower strength of the LA mechanism in English, the acceptability nature of the PVT me have enhanced variability in their responses. Future studies should address this issue in more detail.

The present PhD thesis also addressed the role of individual factors on attachment preferences. Focusing on **language dominance**, different results were obtained across tasks. A significant effect of language dominance was observed in bilinguals' response times in the PVT. Instructed L1 Spanish-L2 English bilinguals with increased English dominance (i.e. higher BLP scores) took significantly more time to accept a HA-biased image, which represented a HA interpretation. Overall, in the PVT, bilinguals experience a processing cost with ambiguous sentences compared to monolinguals, but this cost is particularly pronounced among those who are more dominant in English. This correlates with findings reported earlier on bilinguals' optionality in processing. It is among more English-dominant bilinguals that higher RTs are found, suggesting that both HA and LA may be more active for these bilinguals. Greater dominance in their L2 English may involve higher coactivation of their two languages, which in turn may lead to both strategies being simultaneously active and equally feasible for bilinguals. The higher the dominance in English, the more accessible LA may have become for bilinguals, which will explained the additional processing cost to accept a HA interpretation, typical of their L1 Spanish. Thus, for the PVT, L1 attrition effects seem to be further modulated by language dominance and particularly, by increased dominance in the L2.

However, and against initial predictions, no significant within-group effect of language dominance was found in offline attachment choices (PST) and fixation patterns (ET). These findings are interesting considering that the PST and eye-tracking experiment were the same experimental task, i.e., a visual-world eye-tracking task. The discrepancy between the effect observed in the PVT and the lack of effect in the PST and eye-tracking data may be explained in terms of task characteristics. The PVT measured online processing cost, while offline responses in the PST reflect bilinguals' final interpretation of ambiguous sentences. The influence of language dominance may be more clearly captured in online measures than in final interpretation preferences. As observed in our results, instructed bilinguals require additional processing time when resolving RCA ambiguities, and this is further modulated by dominance: the more L2 dominant, the slower the responses. However, the influence of language dominance may be diluted in final stages, particularly when final choices are measured. It may be the case that dominance may account for processing cost and additional effort, but that it does not influence their final decision. Based on our results, a common tendency is observed for all bilinguals regardless of whether they are more Spanish or English dominant, i.e., optionality of their attachment preferences. Thus, although more Spanish-dominant bilinguals may differ from more English-dominant ones in processing effort, they may reach similar final interpretations. As for the eye-tracking experiment, data from fixation patterns seem to correlate with this idea. The nature of the task required participants to look at both images displayed, alternating their gaze. Given that each image represents a specific interpretation (HA or LA) and that no dominance effect is reported in bilinguals' fixation patterns, this reinforces the idea that the influence of language dominance may be better captured in terms of processing cost rather than interpretative biases.

These findings are relevant because, even within the same bilingual population and considering the same linguistic phenomenon (RCA ambiguities), the significance of the dominance effect varies depending on the experimental methodology employed, i.e., PST, PVT or visual-world eye-tracking. This evidences that conclusions cannot be reached relying on evidence from one single methodology. Otherwise, it is likely that the effect remains uncovered. Against this approach, there is a need to triangulate data using, for example, a variety of experimental tasks, as this thesis has done. By comparing results across different tasks addressing both online and offline measures, we can get more solid results and draw more reliable conclusions.

Additionally, findings are relevant considering the profile of the bilingual population tested. Although a within-group effect has only been reported in the PVT, all findings from this PhD are crucial since attrition effects were found in L1-dominant bilinguals (see Section 5.1). Participants in the Spanish monolingual and the bilingual group are dominant in Spanish, the only difference being their *degree* of L1 dominance, with the former being more dominant in Spanish than the latter. This thesis has evidenced L1 attrition across all task for instructed bilinguals, even if they are L1-dominant speakers as measured by the BLP questionnaire (Birdsong et al., 2012). These findings are crucial for L1 attrition research as they challenge the traditional view that attriters must be L2-dominant bilinguals, showing that bilinguals do not need to be dominant in their L2 to experience attrition in L1 interpretation and processing. Having considerably fewer dominance in their L1 Spanish, with the resulting increased dominance in L2 English seems to be sufficient to modulate RCA preferences. Thus, future studies should explore L1 attrition in non-L2-dominant populations to gain a wider understanding of this phenomenon. Additionally, it is necessary to consistently include this variable as a potential predictor in their analyses to study whether dominance in fact influences processing cost primarily, or whether it can also account for variability at other levels.

Finally, together with language dominance, this PhD thesis has also examined whether **length of L2 immersed instruction** (LoII) may modulate L1 processing and interpretation in instructed L1 Spanish-L2 English bilinguals. Initially, it was predicted that longer L2 immersed instruction would result in more pronounced L1 attrition effects. However, bilingual data across all experimental tasks revealed a lack of LoII modulating effect of L1 attachment preferences. This indicates that variability in bilinguals' RCA preferences cannot be explained in terms of LoII as observed attrition effects were not more prominent among bilinguals in the final years of the English Studies degree, i.e., among bilinguals with increased LoII.

These results do not support exposure-based models such as the ATH and the Linguistic Tuning hypothesis. Although attrition effects are attested when groups are compared, in line with the predictions of these models, length of L2 immersed instruction cannot explain variability in bilinguals' preferences at the within-group level. One possible explanation for this lack of effect may lie in how the LoII variable was operationalised. In this PhD thesis, it was measured as the number of years bilinguals had been exposed to L2 English in an instructed university setting. Thus, this variable represents the academic year they were in at the time of testing, ranging from ranging from first-year to fourth-year students. However, a scale of 1 to 4 years offers relatively limited variability and therefore, it may not have been sensitive enough to capture variability in the bilingual data. When a predictor shows little internal variation, it cannot function effectively as an explanatory variable and restricts the prediction ability of the statistical models to uncover potential effects. Future research should therefore consider more fine-grained measures of L2 immersed instruction, for example operationalising LoII in months rather than years. This approach would allow for a more sensitive analysis of whether increased L2 exposure in an instructed setting may modulate L1 attrition.

Despite the LoII effect being non-significant, findings from this PhD thesis are relevant as they demonstrate the need to broaden the scope of L1 attrition. Attrition effects have been found in bilinguals who, according to traditional views, were not susceptible to experience it because they were L1-dominant speakers and were not naturalistically immersed in an L2-speaking country for an extended period. Thus, our findings challenge two traditional conditions: the need for naturalistic immersion and the need for this immersion to be extensive (above 10 years), as attrition may emerge in other L2 exposure contexts (even within an L1 environment) and after shorter periods of exposure. This challenges previous studies which set a minimum length of residence in an L2-speaking country (Bot et al., 1991; Cuza, 2010; Gürel, 2004; Tsimpli et al., 2004).

The need to move beyond L2 naturalistic immersion is additionally justified due to the current nature of such L2 exposure. The interest on naturalistic immersion was justified as it involved reduced use of and exposure to the L1, which was so few decades ago. However, nowadays technology, streaming platforms, messaging applications, etc. allow for a constant contact with the L1. Naturalistic environments do no longer guarantee reduced contact with the L1 and therefore, future L1 attrition research should broaden its scope to accommodate the new realities of current populations. This PhD thesis has done so, showing that exposure in an instructed, classroom setting is sufficient to trigger L1 attrition effects. Our findings align with those by Martín-Villena (2023), who also found evidence of L1 attrition in the production, processing and comprehension of subject referring expressions among instructed L1 Spanish-L2 English bilinguals.

To conclude and provide a final, more visual, summary of the present PhD thesis, Table 52 below gathers the main findings regarding evidence of L1 attrition, along with modulating effects of language dominance and LoII, across the three experimental tasks. The implication of results below is that the L1 seems to be more flexible and susceptible to change than initially assumed. This finding makes it necessary to further explore the true extent of such L2-to-L1 influence, examining different linguistic phenomena with both online and offline measures, and considering a wider range of bilingual profiles. It is also crucial to explore L1 attrition from a developmental perspective, testing the same participants over time to determine whether observed attrition effects may be maintained, strengthened or weakened based on the continuity of discontinuity of L2 input. To do so, it will be necessary to consider a longer period than the one in this PhD thesis.

Table 52:

Summary of main findings across tasks for L1 Spanish-L2 English bilinguals

Task	L1 attrition	Dominance	LoII
PST	**Offline** Optionality in HA and LA preferences: attenuated L1-preferred HA in favour of growing L2-preferred LA **Online** Processing cost with ambiguous RCs: slower responses than monolinguals	No effect	No effect
PVT	**Offline** Optionality. Lower HA acceptance in favour of increased acceptance of LA **Online** Processing cost when accepting HA and rejecting LA. Departure from expected behaviour in native Spanish	Within-group effect: higher English dominance leads to higher processing cost	No effect
ET	**Time course:** no disambiguation **Fixation proportions:** optionality Lack of preference	No effect	No effect

To sum up, this PhD thesis has revealed evidence of L1 attrition in instructed bilinguals. Attrition effects have been attested both in the offline interpretation and online processing of RCA ambiguities, manifested primarily as optionality of parsing preferences and additional processing cost. These results add to the bulk of literature on L1 attrition. However, the greatest contribution of this thesis relies in the profile of the bilingual group tested. L1 attrition effects in instructed bilinguals are comparable to those of naturalistically immersed bilinguals, which have been traditionally viewed as the only susceptible population to experience attrition. This has been so because they typically meet conditions related to extensive L2 naturalistic immersion, limited L1 use and exposure, as well as L2 dominance. These drastic requirements were considered necessary for attrition to emerge. However, findings from this PhD thesis have challenged the need of these conditions. This is of interest for future research, as it evidences the need to broaden the scope of L1 attrition beyond traditional naturalistic settings.

Chapter 10: Conclusion

The present PhD thesis has examined L1 attrition in the interpretation and processing of ambiguous relative clauses in L1 Spanish-L2 English instructed bilinguals. In particular, it has challenged conditions traditionally associated to the emergence of attrition effects, providing evidence of this process in a bilingual population that, from traditional views, would not have been predicted to experience L1 attrition. Previous research has restricted the scope of attrition to naturalistically immersed bilinguals, typically L2-dominant speakers, who have lived in an L2 environment for an extensive period. This limited view has resulted in scarcity of data from other bilingual populations. Building on few previous studies on the L1 of instructed bilinguals (Martín-Villena, 2023; Requena & Berry, 2021) and the need to identify the extralinguistic conditions under which L1 attrition may emerge (Hicks et al., 2024), this PhD thesis aimed to broaden the scope of L1 attrition, and findings obtained have confirmed such need.

L1 attrition was explored regarding bilinguals' **RCA preferences**, using a picture verification task and a visual-world eye-tracking experiment with a picture selection component. Based on results obtained, which were discussed in the previous chapter, it seems relevant to address the general research question (RQ_0) that has guided this investigation. It was introduced in Chapter 4 and is as follows: Does immersed instructed exposure to a second language influence L1 Spanish-L2 English bilinguals' interpretation and/or processing of RCA ambiguities in their L1 Spanish? Results from all tasks confirmed this RQ as they revealed a consistent pattern: instructed bilinguals show increased processing cost when confronted with ambiguous sentences and optionality in their attachment preferences (reduced bias towards HA, typical of their native Spanish, in favour of LA, typical of L2 English). This has been taken as evidence of L1 attrition.

In the PST data, attrition emerged as higher selection rates of a LA interpretation, i.e., the L2-preferred strategy, together with reduced selection of a HA interpretation, typical of their L1 Spanish. Together with this optionality, bilinguals showed slower responses in ambiguous sentences than both monolingual groups. While monolinguals were more categorical and quicker in their responses, bilinguals needed more time due to increased hesitation. Regarding the PVT, a processing cost was observed when accepting a HA interpretation, as well as a when rejecting a LA one, which evidences the increased availability of both strategies in bilinguals with extensive L2 immersed instruction. Finally, eye-tracking data showed no disambiguation at any point during sentence processing and consequently, similar fixation proportions on the image depicting HA compared to the image depicting LA. Overall, all findings point to the same direction: instructed bilinguals do not pattern with Spanish monolinguals in their L1 interpretation and processing of ambiguous RCs. While Spanish monolinguals consistently favour HA, as expected, bilinguals show increased preference for the L2 strategy (LA).

Findings gain additional support given the **triangulating approach** of this thesis. Different tasks were administered to ensure L1 attrition could be addressed from different angles. PST data offered insights into the final comprehension stages and wrap-up processes in which syntactic integration and semantic interpretation are completed. Additionally, the PVT provided relevant information, particularly regarding processing cost. Finally, eye-tracking is a precise method to explore real-time processing as sentences unfold. Thus, findings are particularly reliable because they were obtained from different online and offline measures, using a variety of experimental tasks with the same stimuli. The fact that a consistent pattern is observed across all these different methods reinforces the validity of our results, as effects cannot be due to a specific methodology, measure or difference in stimuli design. As a result, this PhD thesis has contributed with a fully rounded picture of L1 attrition and its scope.

Results confirm the predictions of the Activation Threshold (Paradis, 1993, 2007) and the Linguistic Tuning hypotheses (Cuetos et al., 1996; Mitchell et al., 1995), which highlight the role of language experience in bilinguals' strategies. These models predict increased use and preference for the linguistic forms most frequently exposed to, with higher exposure to a given language promoting the preference for its linguistic forms and preferences. This is observed in this thesis, as bilinguals reduce the preference for HA in favour of LA, typical of their L2 English. The main difference between the Spanish monolingual and bilingual groups lies in their language experience, with the former being almost exclusively exposed to their L1 Spanish, and the latter being extensively exposed to their L2 English, resulting in lower opportunities of L1 use and exposure. It is in the group with more L2 use and exposure where L1 changes in processing and interpretation of ambiguous RCs are found. Additionally, results from the two monolingual groups in this thesis further support the cross-linguistic variation originally reported by Cuetos and Mitchell (1988) and confirmed by following studies (Bidaoui et al., 2016; Y. Cheng et al., 2021; Dussias, 2003; Hemforth et al., 2015; Papadopoulou & Clahsen, 2003; Zagar et al., 1997). Overall, Spanish monolinguals show a strong preference for HA in both online and offline measures, while native English speakers tend to favour LA.

An interesting finding, however, relates to the **strength of RCA preferences**. Our results show a strong HA bias in native Spanish, whereas the LA tendency in native English, although evident, is less pronounced. This may be explained by the coexistence of Recency and Predicate Proximity principles (Frazier, 1978, 1987; Gibson et al., 1996), which favour LA and HA attachment, respectively. Both principles seem to interact in the resolution of ambiguous RCs and their strength will determine the general preference of each language. A preference for HA occurs if Predicate Proximity predominates, while LA arises if Recency principles prevail. Future research should address not only RCA preferences across different languages, but also the *strength* of such preferences across languages to gain a more comprehensive understanding of this phenomenon. Based on the mild LA bias in native English observed in our results, Predicate Proximity may play a more relevant role than initially assumed. Future research should address the extent of its influence, particularly in comparison with recency principles such as Late Closure.

Additionally, this thesis has explored the effect of **individual variables**, focusing on language dominance and length of L2 immersed instruction. As for the former, a main contribution of this thesis is the presence of attrition effects in **L1-dominant bilinguals**. Traditionally, L1 attrition research has focused on L2-dominant bilinguals, restricting the emergence of this process to bilinguals whose L2 has become their dominant language. However, this thesis has demonstrated that L2 dominance is not a necessary condition for attrition effects to manifest. A reduction of L1 dominance due to the increased role of bilinguals' L2 in their daily life seems to be sufficient, confirming the predictions of the ATH in L1 attriters. Instructed bilinguals, with lower L1-dominance and who use / are exposed to their L2 more frequently and recently than Spanish monolinguals, were found to deviate from typical native Spanish patterns. Additionally, dominance was found to modulate processing cost at the within-group level, with stronger attrition effects among those bilinguals with increased L2 dominance. These findings evidence the importance of language dominance, measures within a continuum, as a predictor factor in L1 attrition and research should further address the extent of its influence in this process.

Regarding **length of L2 immersed instruction**, no within-group effect was found. Given that, in naturalistic contexts, modulating effects seem to emerge only during early years of exposure (Schmid, 2019), a similar effect was expected for instructed exposure. However, the nature of instructed settings in general, and immersed instruction in particular, may require either longer exposure (in terms of months or years) or more intensive exposure (e.g., more hours of L2 input/exposure within the same period) before similar effects can be observed. In addition, the scale of the LoII variable may not have been sensitive enough to capture within-group differences, as already discussed. It is necessary that future studies consider a broader length of L2 instructed exposure and more subtle measures to uncover potential LoII effects. Despite the lack of a within-group effect, the major contribution of this thesis is the presence of L1 attrition in an L2-exposure context other than L2 naturalistic environments. Against traditional views, these findings suggest that L2 naturalistic immersion is no condition for attrition to emerge. This is supported by the lack of RCA preferences found by Valenzuela et al. (2020) in naturalistically immersed bilinguals. Our results reveal no differences in the strength of L1 attrition between bilinguals in the early and final years of the English Studies degree. However, as a group, they clearly differ regarding L1 processing and interpretation from their monolingual counterparts, who are not immersed in an L2 instructed environment. This confirms, once again, the predictions of the ATH and Linguistic Tuning hypothesis.

This PhD investigation has certain **limitations**. One of them relates to the experimental conditions administered to each participant group. Since the present study focuses on L1 interpretation and processing, all tasks were designed in a Spanish and an English version so that each group completed them in their corresponding L1. However, given that forcing conditions were resolved via gender-marked pronouns in Spanish (*el cual* / *la cual*), these could not be included in the English tasks as English has no relative pronouns grammatically marked for gender. Consequently, while Spanish monolinguals and instructed bilinguals were exposed to three conditions (forcing-HA, forcing-LA and ambiguous), English monolinguals were only exposed to the ambiguous one. Given that forcing conditions were simply used as control measures and that it is the ambiguous condition the one of interest for this PhD thesis, this involved no major problems because all groups could be compared in ambiguous sentences across all tasks. However, future studies should consider this and administer the same conditions to all groups.

A second limitation relates to the data collection process. In particular, the PVT was administered online through *Open Sesame* via a JATOS server. Gathering RT data from the PVT online my present several challenges that may compromise its validity. For instance, differences in the hardware and software used, which could lead to delays in some cases. Other challenges are potential distractions while completing the task at home and the impossibility of marking target keys with stickers to help participants identify which key to press. However, the decision to conduct this task online was not arbitrary, but rather motivated to promote participation. The study design required participants to complete a wide range of tasks, including a compulsory in-person session for the eye-tracking experiment. If the PVT would have also been conducted in-person, it might have been difficult to find sufficient candidates willing to participate. To counterbalance potential issues related to online data collection, participants received detailed task instructions (see Appendix M: Written instructions for PVT). In addition, the use of different devices does not seem to be an issue when collecting online data compared to lab-based experiments (Mathôt & March, 2022). Although online tasks are a viable alternative, future research should be conducted in a lab environment to compare whether results from our PVT are replicated under more controlled conditions.

Finally, some **avenues for future research** will also be proposed. Firstly, this thesis has only examined one L1-L2 combination, i.e., L1 Spanish-L2 English. Thus, attrition effects may be the result of direct L2 influence in the L1 or due to a more general consequence of bilingualism. In the first scenario, bilinguals are expected to incorporate L2-specific patterns into their L1, leading to variation in the behaviour of different L1-L2 bilinguals. In the second scenario, similar patterns would be observed regardless of the L1-L2 language pair. To address this, future research should investigate a wider range of L1-L2 configurations. Some studies should test languages with the same attachment strategy, like L1 Spanish-L2 French, while it is also necessary to explore languages with opposing ones, such as L1 English-L2 Dutch or L1 Greek-L2 English. Comparing findings from different language pairs would provide valuable insights into whether L1 attrition effects are a general by-product of bilingualism or, on the contrary, are specifically influenced by the L2.

It is also necessary replicate this study in an L2 naturalistic context. Future research should investigate RCA preferences among bilinguals naturalistically immersed in an L2-speaking country to compare their findings with those of the bilinguals studied in this thesis. Our instructed bilinguals exhibit a reduced, although not completely abandoned, HA strategy, while they have also incorporated LA. These bilinguals show optionality, rather than a shift towards LA (typical of their L2 English). This aligns with expectations given that these are immersed in an instructed setting, not a naturalistic one. It is relevant to study whether attrition effects, if any, in L1 Spanish-L2 English bilinguals living in an English-speaking manifest as optionality or whether effects are more pronounced.

In addition, it is necessary to study L1 attrition from a longitudinal perspective. This approach will allow us to determine whether attested attrition effects are maintained, strengthened or attenuated over time in relation to (dis)continuous L2 exposure to the L2, particularly in contexts of L2 immersed instruction. This thesis has reported no within-group modulating effect of LoII in a range of 4 years of L2 exposure. However, it is relevant to investigate whether longer periods of L2 contact may lead to stronger attrition effects. Similarly, further research is needed to explore bilinguals who, having evidenced L1 attrition, are no longer exposed to the L2 in such an intensive way. This would be the case, for instance, of instructed bilinguals tested in this investigation. Students from the degree of English Studies who have already finished the degree but have developed a professional career in which they do not use or are exposed to their L2. Testing them years after the degree would offer insights into whether attrition effects are still present.

Finally, future attrition studies are needed on instructed bilinguals, particularly in relation to other linguistic phenomena and considering a wider range of individual factors. This thesis has demonstrated L1 attrition effects in RCA, and similar outcomes were found by Martín-Villena (2023) regarding subject referring expressions, but it is necessary to explore other linguistic structures such as use of tense and aspect forms, direct object marking or lexical variety. In addition, future research should also explore in more detail the role of individual variables in L1 attrition, comparing its influence on different L2 contexts. Language dominance, for instance, seems to be a predictor of L1 attrition regarding processing costs, particularly when measured as a continuous predictor with the BLP questionnaire. Therefore, future studies should include this variable in their statistical models to account for variability in bilingual data.

To sum up, this PhD thesis has provided evidence of L1 attrition in instructed bilinguals. This is a relevant contribution to the field of bilingualism in general, and L1 attrition in particular, as it demonstrates that attrition effects are not restricted to L2 naturalistic settings when the L2 is the functional, dominant language. Instead, they can also occur in other L2-exposure contexts like university classroom settings, showing that the L1 seems to be more susceptible to change than initially assumed. As a result, this study has offered valuable insights into the true scope of L1 attrition, highlighting the need to explore other bilingual populations and contexts to foster our current understanding of L1 attrition.

Capítulo 11: Conclusión

Esta tesis ha investigado la atrición de la L1 en la interpretación y procesamiento de cláusulas de relativo ambiguas (RCA) en bilingües instruidos L1 español-L2 inglés. En particular, ha cuestionado las condiciones asociadas tradicionalmente a la aparición de atrición, proporcionando evidencia de este proceso en una población bilingüe que, desde puntos de vista tradicionales, no se habría predicho que experimentara atrición de la L1. Estudios previos han restringido el alcance de la atrición a bilingües inmersos de forma naturalista durante un periodo extenso, normalmente dominantes en su L2. Esto ha dado lugar a escasez de datos de otras poblaciones bilingües. Partiendo de los pocos estudios sobre la L1 de bilingües instruidos (Martín-Villena, 2023; Requena & Berry, 2021) y de la necesidad de identificar las condiciones extralingüísticas en las que puede surgir la atrición (Hicks et al., 2024), esta tesis doctoral pretendía ampliar el concepto de atrición, y los resultados obtenidos han confirmado dicha necesidad.

Se estudió la atrición en bilingües en relación con las **preferencias de adjunción** de cláusulas de relativo (RCA), utilizando una tarea de verificación de imágenes (PVT) y una tarea de seguimiento ocular con un componente de selección de imágenes (PST). En base a los resultados obtenidos, parece pertinente abordar la pregunta general de investigación (PI_0) que ha guiado esta investigación. Se introdujo en el Capítulo 4 y es la siguiente: ¿Influye la inmersión formal a una segunda lengua en la interpretación y/o el procesamiento de ambigüedades RCA en la lengua materna de bilingües L1 español-L2 inglés? Los resultados de todas las tareas confirmaron esta PI: los bilingües instruidos muestran un mayor coste de procesamiento cuando se enfrentan a oraciones ambiguas, así como opcionalidad en sus preferencias de adjunción (menor preferencia por una adjunción alta típica de su español nativo, a favor de una adjunción baja, típica su inglés L2). Esto se ha considerado evidencia de atrición de la L1.

En la PST, la atrición se manifestó como una mayor selección de LA, es decir, la estrategia preferida en la L2, junto con una menor selección de HA, típica del español L1. Junto con esta opcionalidad, los bilingües respondieron de forma más lenta en oraciones ambiguas que ambos grupos monolingües. Mientras que los monolingües fueron más categóricos y rápidos en sus respuestas, los bilingües necesitaron más tiempo debido a una mayor indecisión. En cuanto a la PVT, se observó un coste de procesamiento al aceptar una interpretación HA, así como al rechazar una LA, lo que evidencia la mayor disponibilidad de ambas estrategias en bilingües con amplia inmersión formal en su L2. Por último, la tarea de seguimiento ocular no mostró ningún punto de desambiguación en durante el procesamiento de las frases, así como proporciones de fijación similares en la imagen que representaba HA y en la que representaba LA. Todos los resultados apuntan en la misma dirección: los bilingües con instrucción formal no siguen el patrón de los monolingües españoles en su interpretación y procesamiento de CR ambiguas en su L1. Mientras que los monolingües españoles favorecen sistemáticamente HA, como era de esperar, los bilingües muestran una mayor preferencia por la estrategia de la L2 (LA).

Los hallazgos son especialmente fiables gracias a la **triangulación de datos** realizada. Se administraron distintas tareas para garantizar que la atrición de la L1 pudiera abordarse desde distintos ángulos. La PST ofreció información sobre las fases finales de comprensión en las que se realiza la integración sintáctica y la interpretación semántica. Además, la PVT proporcionó información sobre el coste de procesamiento. Por último, el seguimiento ocular es un método preciso para explorar el procesamiento en tiempo real a medida que se desarrollan las frases. Así pues, los resultados son especialmente fiables porque se obtuvieron a partir de medidas online y offline, utilizando una variedad de tareas experimentales con los mismos estímulos. El hecho de que se observe un patrón consistente en todos estos métodos refuerza la validez de nuestros resultados, ya que los efectos no pueden deberse a una metodología, medida o diferencia específica en el diseño de los estímulos. Como resultado, esta tesis ha contribuido con una visión completa de la atrición de la L1 y su alcance.

Los resultados confirman las predicciones de la Activation Threshold Hypothesis (Paradis, 1993, 2007) y de la Linguistic Tuning Hypothesis (Cuetos et al., 1996; Mitchell et al., 1995). Estos modelos predicen un mayor uso y preferencia por las formas lingüísticas a las que se está expuesto con mayor frecuencia, de modo que una mayor exposición a una lengua determinada fomenta la preferencia por sus formas lingüísticas.

Esto se observa en esta tesis, ya que los bilingües reducen la preferencia por HA en favor de LA, propia del inglés L2 al que están muy expuestos. La principal diferencia entre los españoles monolingües y bilingües radica en su experiencia lingüística. Los primeros están expuestos casi exclusivamente a su L1 español, y los segundos están muy expuestos a su L2 inglés, lo que se traduce en menores oportunidades de uso y exposición a la L1. Es en el grupo con mayor uso y exposición a la L2 donde se encuentran cambios en el procesamiento e interpretación de CR ambiguas. Además, los resultados de los dos grupos monolingües apoyan aún más la variación interlingüística reportada originalmente por Cuetos y Mitchell (1988) y confirmada por estudios posteriores (Bidaoui et al., 2016; Y. Cheng et al., 2021; Dussias, 2003; Hemforth et al., 2015; Papadopoulou & Clahsen, 2003; Zagar et al., 1997). Los monolingües españoles muestran una fuerte preferencia por HA procesamiento y comprensión, mientras que los ingleses tienden a favorecer LA.

Un hallazgo interesante se refiere a la **fuerza de las preferencias de adjunción**. Nuestros resultados muestran un fuerte sesgo HA en los nativos españoles, mientras que la tendencia LA en los nativos ingleses, aunque evidente, es menos pronunciada. Esto puede explicarse por los principios de Recencia y Proximidad del Predicado (Frazier, 1978, 1987; Gibson et al., 1996), que favorecen LA y HA, respectivamente. Ambos principios parecen interactuar en la resolución de CR ambiguas y su fuerza determinará la preferencia general de cada lengua. La preferencia por HA se produce si predomina la Proximidad de Predicado, mientras que LA surge si prevalecen principios de Recencia. Próximos estudios deberían abordar no sólo las preferencias de adjunción en las distintas lenguas, sino también la fuerza de dichas preferencias. Basándonos en el leve sesgo de LA en inglés nativo observado en nuestros resultados, la Proximidad de Predicado puede desempeñar un papel más relevante de lo que se creía inicialmente. Es necesario estudiar el alcance de su influencia, especialmente en comparación con principios de Recencia.

Además, esta tesis ha explorado el efecto de **variables individuales**, centrándose en la dominancia lingüística y la duración de la instrucción inmersa en la L2. En cuanto a la primera, una de las principales aportaciones de esta tesis es la presencia de atrición en **bilingües dominantes en su L1**. Tradicionalmente, la investigación sobre atrición de la L1 se ha centrado en bilingües dominantes en su L2, restringiendo la aparición de este proceso a dichos bilingües. Sin embargo, esta tesis ha demostrado que la dominancia de la L2 no es una condición necesaria para que se manifieste atrición. Una reducción de la dominancia de la L1 debida al aumento del papel de la L2 parece ser suficiente, confirmando las predicciones de la Activation Threshold Hypothesis. Se observó que los bilingües, con menor dominancia de la L1 y que usan / están expuestos a su L2 con mayor frecuencia que los monolingües españoles, se desvían de los patrones típicos del español nativo. Además, se observó que la dominancia modula el coste de procesamiento, con efectos de atrición más fuertes entre los bilingües con mayor dominancia de la L2. Estos hallazgos ponen de manifiesto la importancia de la dominancia lingüística, medida dentro de un continuo, como factor predictivo en la atrición, por lo que se debería profundizar en el alcance de su influencia en este proceso.

En cuanto a la **duración de la inmersión formal en L2**, no se encontró efecto. Dado que, en contextos naturalistas, los efectos moduladores parecen surgir sólo durante los primeros años de exposición (Schmid, 2019), se esperaba un efecto similar para la exposición formal. Sin embargo, la naturaleza de los contextos formales en general, y de la instrucción inmersiva en particular, puede requerir una exposición más prolongada (en términos de meses o años) o una exposición más intensiva (por ejemplo, más horas de exposición a L2 en el mismo período) antes de que se puedan observar efectos similares. Además, la escala en que se midió esta variable puede no haber sido lo suficientemente sensible como para captar diferencias dentro de los bilingües. Es necesario que futuros estudios consideren una duración más amplia de la exposición formal y medidas más sutiles. A pesar de la falta de un efecto dentro del grupo, la principal contribución de esta tesis es la presencia de atrición en un contexto de exposición a L2 distinto de los entornos naturalistas. En contra de las opiniones tradicionales, estos resultados sugieren que la inmersión naturalista no es condición necesaria para que surja atrición. Esto es apoyado por la falta de preferencias de adjunción encontradas por Valenzuela et al. (2020) en bilingües naturalistas. Nuestros resultados no revelan diferencias en la intensidad de la atrición entre bilingües de los primeros y últimos cursos del grado en Estudios Ingleses. Sin embargo, como grupo, difieren claramente en el procesamiento e interpretación de sus homólogos monolingües, que no están inmersos en un entorno de instrucción de L2. Esto confirma, una vez más, las predicciones de la Activation Threshold y Linguistic Tuning Hypotheses.

Esta tesis también presenta ciertas **limitaciones**. Una de ellas se relaciona con las condiciones experimentales administradas a cada grupo. Dado que esta tesis se centra en la interpretación y el procesamiento de la L1, las tareas se diseñaron en español e inglés para que cada grupo las completara en su L1 correspondiente. Sin embargo, dado que las condiciones forzadas en español se resolvieron mediante pronombres con género gramatical (*el cual*/*la cual*), estos no pudieron incluirse en las tareas en inglés, ya que el inglés no tiene pronombres relativos marcados por género. En consecuencia, mientras que los monolingües españoles y los bilingües fueron expuestos a tres condiciones (HA forzada, LA forzada y ambigua), los monolingües ingleses solo vieron la ambigua. No obstante, las condiciones forzadas se utilizaron como control, mientras que la condición ambigua es la de interés para esta tesis. Dado que todos los grupos pudieron compararse en oraciones ambiguas, esto no supuso mayor problema. No obstante, estudios futuros deben considerar esto y administrar las mismas condiciones a todos los grupos.

Una segunda limitación se relaciona con el proceso de recogida de datos. En concreto, la PVT se administró de forma remota a través de *Open Sesame* con un servidor JATOS. La recogida remota de datos de tiempo de respuesta puede presentar desafíos que podrían comprometer su validez. Por ejemplo, las diferencias en el hardware y el software utilizados, que podrían provocar retrasos en algunos casos. Otros desafíos son las posibles distracciones al completar la tarea en casa y la imposibilidad de marcar las teclas con pegatinas para ayudar a los participantes a identificar qué tecla presionar. Sin embargo, la decisión de realizar esta tarea de forma remota tuvo como motivación promover la participación. Este estudio requería que los participantes completaran una amplia gama de tareas, incluyendo una sesión presencial obligatoria para seguimiento ocular. Si la PVT se hubiera realizado presencialmente, podría haber sido difícil encontrar suficientes candidatos dispuestos a participar. Para contrarrestar los posibles problemas relacionados con la recogida remota, los participantes recibieron instrucciones detalladas (véase el Appendix M: Written instructions for PVT). Además, el uso de diferentes dispositivos no parece ser un problema en comparación con experimentos en un laboratorio (Mathôt & March, 2022). Pese a ello, se deberían realizar estudios en un entorno de laboratorio para comparar si los resultados de nuestra PVT se replican en condiciones más controladas.

Finalmente, se propondrán algunas **líneas futuras de investigación**. En primer lugar, esta tesis solo ha examinado una combinación L1-L2: L1 español-L2 inglés. Por lo tanto, la atrición puede ser el resultado de la influencia directa de la L2 en la L1 o una consecuencia más general del bilingüismo. En el primer escenario, se espera que los bilingües incorporen patrones específicos de L2 en su L1, lo que lleva a una variación en el comportamiento de diferentes bilingües L1-L2. En el segundo escenario, se observarían patrones similares independientemente la combinación L1-L2. Para abordar esto, se debe investigar una mayor variedad de L1-L2. Se debería analizar idiomas con la misma estrategia de adjunción, como L1 español-L2 francés, así como idiomas con estrategias opuestas, como L1 inglés-L2 holandés o L1 griego-L2 inglés. Comparar hallazgos de diferentes combinaciones proporcionaría información sobre si la atrición es consecuencia general del bilingüismo o, por el contrario, se debe a influencia directa de la L2.

También es necesario replicar este estudio en un contexto naturalista. Se debe investigar las preferencias adjunción en bilingües inmersos en un país de habla inglesa para comparar sus hallazgos con los de los bilingües de esta tesis. Nuestros bilingües instruidos muestran una estrategia HA reducida, aunque no completamente abandonada, a la vez que han incorporado LA. Esto implica opcionalidad, en lugar de una tendencia completa hacia LA (típica de su L2 inglés). Esto concuerda con las expectativas, dado que están inmersos en un entorno formal, no en uno naturalista. Es necesario estudiar si los efectos de atrición, si los hay, en bilingües L1 español-L2 ingles que viven en un país de habla inglesa se manifiestan como opcionalidad o si son efectos más pronunciados.

Además, es necesario estudiar la atrición desde una perspectiva longitudinal. Este enfoque nos permitirá determinar si los efectos de atrición se mantienen, refuerzan o atenúan con el tiempo en relación con la (dis)continua exposición a la L2, particularmente en contextos de instrucción inmersa en la L2. Esta tesis no ha reportado ningún efecto modulador en un rango de 4 años de exposición. Sin embargo, es relevante investigar si períodos más largos de contacto con la L2 pueden conducir a efectos más fuertes. De manera similar, es necesario explorar a bilingües que, habiendo evidenciado atrición, ya no están expuestos a la L2 de una manera tan intensiva. Este sería el caso, por ejemplo, de los bilingües de esta tesis. Estudiantes del grado en Estudios Ingleses que hayan terminado sus estudios y hayan desarrollado una carrera profesional en la que no usan ni están expuestos a su L2. Estudiarlos años después del grado ofrecería información sobre si los efectos de atrición todavía están presentes.

Finalmente, próximos futuros estudios sobre atrición en bilingües instruidos deben centrarse en otros fenómenos lingüísticos y considerando una gama más amplia de factores individuales. Esta tesis ha demostrado efectos de atrición en preferencias de adjunción y Martín-Villena (2023) vio resultados similares en expresiones referenciales, pero es necesario explorar otras estructuras lingüísticas como formas verbales de tiempo y modo, marcación del objeto directo o variedad léxica. Además, futuras investigaciones deberían explorar con más detalle el papel de variables individuales en atrición, comparando su influencia en diferentes contextos. La dominancia lingüística, por ejemplo, parece ser un predictor de atrición en relación con los costes de procesamiento, especialmente cuando se mide de forma continua. Por tanto, es necesario considerar esta variable para tener en cuenta la variabilidad en los datos bilingües.

En resumen, esta tesis doctoral ha aportado evidencia de atrición de la L1 en bilingües con instrucción formal. Esta es una contribución relevante al campo del bilingüismo en general, y al de atrición en particular, ya que demuestra que los efectos atrición no se limitan a entornos naturalistas donde la L2 es la lengua dominante. También pueden ocurrir en otros contextos de exposición a la L2, como las aulas universitarias, lo que demuestra que la L1 parece ser más susceptible al cambio de lo que se suponía inicialmente. En consecuencia, esta tesis ha aportado información valiosa sobre el verdadero alcance de la atrición, destacando la necesidad de explorar otras poblaciones y contextos bilingües para profundizar nuestra comprensión actual del abandono de la L1.

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Appendices

13.1. Appendix A: Participation requirements

Spanish functional monolinguals
Desde el grupo de investigación ANACOREX, estamos realizando una investigación sobre cómo los hablantes comprendemos nuestra lengua materna. Para ello, buscamos participantes que cumplan estos requisitos: ▪ Lengua materna: español peninsular ▪ Edad: entre 18 y 30 años ▪ No ser bilingüe de nacimiento ▪ Nivel de inglés: BAJO (A1, A2). No es necesario un certificado oficial ▪ No ser estudiante de un grado de idiomas ▪ No tener dominio en una tercera lengua ▪ No haber vivido más de 1 mes en el extranjero ▪ No haber estudiado en un colegio/instituto bilingüe

L1 Spanish-L2 English instructed bilinguals
Desde el grupo de investigación ANACOREX, estamos realizando una investigación sobre cómo los hablantes comprendemos nuestra lengua materna. Para ello, buscamos participantes que cumplan estos requisitos: ▪ Lengua materna: español peninsular ▪ Edad: entre 18 y 30 años ▪ No ser bilingüe de nacimiento ▪ Estudiante del grado en Estudios Ingleses ▪ Nivel de inglés: ALTO (C1, C2). No es necesario un certificado oficial ▪ No tener dominio en una tercera lengua ▪ No haber vivido más de 1 mes en un país de habla inglesa

English functional monolinguals

Within the ANACOREX research group, we are investigating how speakers process and understand their mother tongue. To do so, we are looking for native speakers of English with the following characteristics:

- Age: 18-30 years old
- Not being bilingual from birth
- Low proficiency level in a second language
- Not to study languages or a language-related degree
- Never lived abroad
- Never studied in a bilingual school or high school

13.2. Appendix B: Calls for participation

Spanish monolinguals	L1 Spanish-L2 English bilinguals

English monolinguals

13.3. Appendix C: Syllabus for the degree of English Studies

First year		
Subject	**ECTS**	**Language**
El Español Actual: Norma y Uso	6	Spanish
Idioma Moderno Inicial I	6	Other
Inglés Instrumental I (Nivel B2)	6	English
Inglés Instrumental II (Nivel B2)	6	English
Lingüística General	6	Spanish
Idioma Moderno Inicial II	6	Other
Inglés Instrumental III (Nivel B2)	6	English
Inglés Instrumental IV (Nivel B2)	6	English
Lengua Clásica	6	Spanish
Técnicas de Estudio de la Literatura en Lengua Inglesa	6	English
Second year		
Subject	**ECTS**	**Language**
Gramática Inglesa I: Introducción a la Morfosintaxis	6	English
Idioma Moderno Intermedio I	6	Other
Inglés Instrumental V (Nivel B2+)	6	English
Lengua y Cultura de los Países de Habla Inglesa I	6	English
Literatura Inglesa I	6	English
Gramática Inglesa II: Estructura de la Oración	6	English
Idioma Moderno Intermedio II	6	Other
Inglés Instrumental VI (Nivel B2+)	6	English
Introducción a los Estudios Literarios	6	English
Literatura Inglesa II	6	English
Third year		
Subject	**ECTS**	**Language**
Fonética y Fonología del Inglés I	6	English
Gramática Inglesa III: Estructura del Sintagma	6	English
Literatura Inglesa III	6	English
Literatura Norteamericana I	6	English
Gramática Inglesa IV: Lingüística del Texto	6	English
Literatura Inglesa IV	6	English
Literatura Norteamericana II	6	English
Créditos de optatividad	18	English
Fourth year		
Subject	**ECTS**	**Language**
Adquisición del Inglés Como Segunda Lengua I	6	English
Fundamentos de la Lingüística Aplicada a Enseñanza del Inglés	6	English
Lengua y Cultura de los Países de Habla Inglesa II	6	English
Semántica y Pragmática de la Lengua Inglesa	6	English
Adquisición del Inglés Como Segunda Lengua II	6	English
Historia de la Lengua Inglesa	6	English
Inglés Instrumental VII (Nivel C1)	6	English
Trabajo Fin de Grado	6	English
Créditos de optatividad	12	English

13.4. Appendix D: Oxford Quick Placement Test

Este cuestionario contiene el test de nivel de inglés que nos permitirá determinar tu nivel gramatical en este idioma. El cuestionario está estructurado de la siguiente manera. En primer lugar, se te pedirán algunos datos personales para poder asociar tu respuesta con los datos que nos proporcionaste anteriormente. A continuación, comenzará la prueba en sí (las instrucciones aparecen a continuación).

Una vez completes todas las preguntas y hayas enviado tu respuesta, contactaré contigo para confirmar tu continuidad en el experimento.

DATOS PERSONALES:

- Iniciales
- Edad
- Correo

Aquí comienza el test de nivel. De ello dependerá que puedas continuar con el experimento. Al terminar, podrás saber cuántas preguntas has acertado y conocer tu nivel de inglés según el Marco Europeo de Referencia (A1, A2, B1, B2, C1, C2).

INTRUCCIONES:

- Hay 60 preguntas en total. Es obligatorio responderlas todas
- Elige únicamente una de las posibles respuestas para cada una de las preguntas

OXFORD QUICK PLACEMENT TEST:

Questions 1 – 5

Where can you see these notices? For questions 1 to 5, choose one letter A, B or C.

1.	**Please leave your room key at Reception.**	A. in a shop B. in a hotel C. in a taxi
2.	**Foreign money changed here**	A. in a library B. in a bank C. in a police station
3.	AFTERNOON SHOW BEGINS AT 2PM	A. outside a theatre B. outside a supermarket C. outside a restaurant
4.	**CLOSED FOR HOLIDAYS** Lessons start again on the 8 th January	A. at a travel agent's B. at a music school C. at a restaurant
5.	**Price per night:** £10 a tent £5 a person	A. at a cinema B. in a hotel C. on a campsite

Questions 6 – 20

In this section you must choose the word which best fits each space in the text below. For questions 6 to 20, choose one letter A, B or C.

Text 1: Scotland

Scotland is the north part of the island of Great Britain. The Atlantic Ocean is on the west and the North Sea on the east. Some people (6) .... Scotland speak a different language called Gaelic. There are (7) .... five million people in Scotland, and Edinburgh is (8) .... most famous city. Scotland has many mountains; the highest one is called 'Ben Nevis'. In the south of Scotland, there are a lot of sheep. A long time ago, there (9) .... many forests, but now there are only a (10) .... Scotland is only a small country, but it is quite beautiful.

6.	A. on	B. in	C. at
7.	A. about	B. about	C. about
8.	A. his	B. your	C. its
9.	A. is	B. were	C. was
10.	A. few	B. little	C. lot

Text 2: Alice Guy Blaché

Alice Guy Blaché was the first female film director. She first became involved in cinema whilst working for the Gaumont Film Company in the late 1890s. This was a period of great change in the cinema and Alice was the first to use many new inventions, (11) .... sound and colour. In 1907 Alice (12) .... to New York where she started her own film company. She was (13) .... successful, but, when Hollywood became the centre of the film world, the best days of the independent New York film companies were (14) .... When Alice died in 1968, hardly anybody (15) .... her name.

11.	A. bringing	B. including	C. containing	D. supporting
12.	A. about	B. ran	C. entered	D. transported
13.	A. next	B. once	C. immediately	D. recently
14.	A. after	B. down	C. behind	D. over
15.	A. remembered	B. realised	C. reminded	D. repeated

Text 3: UFOs. Do they exist?

UFO is short for 'unidentified flying object'. UFOs are popularly known as flying saucers, (16) .... that is often the (17) .... they are reported to be. The (18) .... "flying saucers" were seen in 1947 by an American pilot, but experts who studied his claim decided it had been a trick of the light. Even people experienced at watching the sky, (19) .... as pilots, report seeing UFOs. In 1978 a pilot reported a collection of UFOs off the coast of New Zealand. A television (20) .... went up with the pilot and filmed the UFOs. Scientists studying this phenomenon later discovered that in this case they were simply lights on boats out fishing.

16.	A. because	B. therefore	C. although	D. so
17.	A. look	B. shape	C. size	D. type
18.	A. last	B. next	C. first	D. oldest
19.	A. like	B. that	C. so	D. such
20.	A. cameraman	B. director	C. actor	D. announcer

Questions 21 – 40

In this section you must choose the word or phrase which best completes each sentence. For questions 21 to 40 choose A, B, C or D.

21. The teacher encouraged her students .... to an English penfriend.

A. should write B. write C. wrote D. to write

22. They spent a lot of time .... at the pictures in the museum.

A. looking B. for looking C. to look D. to looking

23. Shirley enjoys science lessons, but all her experiments seem to .... wrong.

A. turn B. come C. end D. go

24. .... from Michael, all the group arrived on time.

A. Except B. Other C. Besides D. Apart

25. She .... her neighbour's children for the broken window.

A. accused B. complained C. blamed D. denied

26. As I had missed the history lesson, my friend went .... the homework with me

A. by B. after C. over D. on

27. Whether she's a good actress or not is a .... of opinion.

A. matter B. subject C. point D. case

28. The decorated roof of the ancient palace was .... up by four thin columns.

A. built B. carried C. held D. supported

29. Would it .... you if we came on Thursday?

A. agree B. suit C. like D. fit

30. This form .... be handed in until the end of the week.

A. doesn't need B. doesn't have C. needn't D. hasn't got

31. If you make a mistake when you are writing, just .... it out with your pen.

A. cross B. clear C. do D. wipe

32. Although our opinions on many things .... , we’re good friends.

A. differ B. oppose C. disagree D. divide

33. This product must be eaten .... two days of purchase.

A. by B. before C. within D. under

34. The newspaper report contained .... important information.

A. many B. another C. an D. a lot of

35. Have you considered .... to London?

A. move B. to move C. to be moving D. moving

36. It can be a good idea for people who lead an active life to increase their ...... of vitamins

A. upturn B. input C. upkeep D. intake

37. I thought there was a .... of jealousy in his reaction to my good fortune.

A. piece B. part C. shadow D. touch

38. Why didn’t you .... that you were feeling ill?

A. advise B. mention C. remark D. tell

39. James was not sure exactly where his best interests ....

A. stood B. rested C. lay D. centred

40. He’s still getting .... the shock of losing his job.

A. across B. by C. over D. through

Questions 41 – 50

In this section you must choose the word or phrase which best fits each space in the texts. There are two texts. For questions 41 to 45 (first text) and 46 to 50 (second text), choose A, B, C or D.

Text 1: The tallest buildings. Skyscrapers

Nowadays, skyscrapers can be found in most major cities of the world. A building which was many (41) ……………….. high was first called a skyscraper in the United States at the end of the 19th century, and New York has perhaps the (42) ……………….. skyscraper of them all, the Empire State Building. The (43) ……………….. beneath the streets of New York is rock, (44) ……………….. enough to take the heaviest load without sinking, and is therefore well-suited to bearing the (45) ……………….. of tall buildings.

41. A. stages B. steps C. storeys D. levels

42.	A. first-rate	B. top-class	C. well-built	D. best-known
43.	A. dirt	B. field	C. ground	D. soil
44.	A. hard	B. stiff	C. forceful	D. powerful
45.	A. weight	B. height	C. size	D. scale

Text 2: Scrabble

Scrabble is the world's most popular word game. For its origins, we have to go back to the 1930s in the USA, when Alfred Butts, an architect, found himself out of (46) ……………….. . He decided that there was a (47) ………………. for a board game based on words and (48) ………………. To design one. Eventually he made a (49) ………………. from it, in spite of the fact that his original (50) ………………. was only three cents a game.

46.	A. earning	B. work	C. income	D. job
47.	A. market	B. purchase	C. commerce	D. scale
48.	A. took up	B. set out	C. made for	D. got round
49.	A. wealth	B. find	C. cash	D. fortune
50.	A. receipt	B. benefit	C. profit	D. allowance

Questions 51 – 60

In this last section you must choose the word or phrase which best completes each sentence. For questions 51 to 60 choose A, B, C or D.

51. Roger's manager .... to make him stay late if he hadn't finished the work.

A. insisted B. warned C. threatened D. announced

52. By the time he has finished his week's work, John has hardly .... energy left for the weekend.

A. any B. much C. no D. same

53. As the game .... to a close, disappointed spectators started to leave.

A. led B. neared C. approached D. drew

54. I don't remember .... the front door when I left home this morning.

A. to lock B. locking C. locked D. to have locked

55. I .... to other people borrowing my books: they always forget to return them.

A. disagree B. avoid C. dislike D. object

56. Andrew's attempts to get into the swimming team have not .... with much success.

A. associated B. concluded C. joined D. met

57. Although Harry had obviously read the newspaper article carefully, he didn't seem to have .... the main point.

A. grasped B. clutched C. clasped D. gripped

58. A lot of the views put forward in the documentary were open to ....

A. enquiry B. query C. question D. wonder

59. The new college .... for the needs of students with a variety of learning backgrounds.

A. deals B. supplies C. furnishes D. caters

60. I find the times of English meals very strange – I'm not used .... dinner at 6pm.

A. to have B. to having C. having D. have

13.5. Appendix E: University of Wisconsin Placement Test

This is a test that will allow us to determine your level of Spanish. The questionnaire is structured as follows. First of all, you will be asked for some personal details so that we can match your answer with the information you have already given us. Then, the actual test will begin (instructions are given below).

PERSONAL INFORMATION:

- Initials
- Age
- Email

This is where the test begins. At the end of it, you will know how many questions you got right and your level of Spanish according to the Common European Framework of Reference for Languages (A1, A2, B1, B2, C1, C2).

INSTRUCTIONS:

- There are 43 questions in total. You must answer all of them.
- Choose only one of the possible answers for each of the questions.

PLACEMENT TEST:

Section 1: multiple choice

For questions 1 to 32, choose the option that best fits in each sentence

1. No veo .... los muchachos.

A) a B. --

2. ¡Pobre Pablo! Hoy .... enfermo.

A) está B. es

3. Speaker A: "¿Te costó mucho el libro?"
Speaker B: "Sí, pagué veinte dólares .... este libro."

A) para B. por

4. Tomás siempre escuchaba la radio mientras ....

A) leía B. leyó

5. Nadie nos lo había dicho antes, pero anoche .... la noticia de su muerte.

A) supimos B. conocimos

6. La mamá .... preocupada porque Ángela no ha llegado.

A) es B. está

7. En vez de ...., fuimos al cine.

A) estudiar B. estudiando

8. No .... cuándo vendrán.

A) conocemos B. sabemos

9. No veo .... nadie.

A) a B. --

10. Ella .... mira a sí misma.

A) se B. la

11. ¡ .... fabuloso es esquiar!

A) Qué B. Cómo

12. Speaker A: "¿Qué programa prefiere usted?"
Speaker B: "Prefiero ____."

A) el nuevo B. la nueva

13. Hay .... mil personas aquí.

A) un B. una C. uno D. --

14. Speaker A: "Mi tío tenía un coche muy bonito".
Speaker B: "¿De qué color?"
Speaker A: " .... rojo y negro".

A) era B. fue C. estaba D. eran

15. Cuando yo .... joven, fui a Chile.

A) fue B. soy C. era D. fui

16. Juan me dijo .... su hermana iba a visitar España el año que viene.

A) que B. cual C. quien D. --

17. Speaker A: "¿Te gustaría ayudar a la gente pobre?"
Speaker B: "Sí, me gustaría ...."

A) ayudarla B. ayudarlas C. la ayudo D. los ayuda

18. Cuando necesito dinero, ... pido a mi padre diez o quince dólares.

A) le B. lo C. les D. los

19. .... un examen el viernes.

A) Ha B. Es C. Está D. Hay

20. Speaker A: "¿Cuándo es tu cumpleaños?"
Speaker B: "Es .... tres de abril."

A) a B. en C. el D. --

21. ¿Conoces a alguien que .... bien?

A) cante B. cantes C. cantas D. canta

22. Si no estuviésemos en clase, ...en la playa.

A) estamos B. estaremos C. habríamos D. estaríamos

23. No hay duda de que ellos .... dinero.

A) ganan B. ganen C. ganasen D. hayan ganado

24. Speaker A: "¿Debo decirte la verdad?"
Speaker B: "Sí, ¡ .... la verdad !"

A) dime B. me dice C. me dices D. me digas

25. Speaker A: "Anoche hablé con Ricardo."
Speaker B: "¿Y qué dijo?"
Speaker A: "Que .... hoy."

A) él te llame B. te llamo C. te haya llamado D. te llamaría

26. Su esposa esperaría hasta que él ....

A) volviera B. volvería C. haya vuelto D. había vuelto

27. Paco es .... alto .... Juanita.

A) tan, de B. tan, que C. más, de D. más, que

28. El edificio es alto pero la montaña es más alta. El edificio es .... la montaña.

A) alto como B. más alto que C. tan alto como D. menos alto que

29. Cuando la vi, ... triste.

A) estás B. estaban C. estaba D. estuviera

30. Voy a buscar .... mi abrigo.

A) a B. por C. para D. --

31. Enrique compró unas rosas y .... las dio a sus padres.

A) me B. le C. se D. les

32. ¡Cuidado! ¡No .... caigas!

A) se B. le C. tú D. ti

Section 2: Story in Spanish

The following questions (33 to 43) are part of a story. Read the story and choose the appropriate words to complete it.

Text

Como me gusta ayudar a otras personas y tengo bastante tiempo libre, (33) ………………. voluntaria en un hospital muy grande de la ciudad de Milwaukee. A veces es muy agradable (34) ………………. allí, pero también, de vez en cuando, tenemos problemas con (35) ………………. paciente majadero y con ciertos doctores arrogantes que se creen muy importantes. Con frecuencia, para (36) ………………. el tiempo, nos reunimos los voluntarios y nos contamos chistes. Un día, un paciente me (37) ………………. este chiste que me pareció muy gracioso: Dicen que un hombre que tenía cien años se murió y fue directamente al cielo. Allí (38) ………………. encontró en una enorme cafetería con muchas personas que hacían cola para que les sirvieran la comida. De repente, un hombre vestido de blanco que acababa de llegar pasó del último lugar hasta el primero sin hacer caso a los demás. El hombre recién llegado al cielo (39) ………………. muy enojado: "Pero, ¿quién es ese señor?". Otro que (40) ………………. pacientemente en la cola (41) …………… contestó: "¡Hombre! Ese (42) ………………. Dios, pero a veces cree que es médico". Todos nos reímos, (43) ………………. sabíamos que no todos los médicos son así.

33.	A. estoy	B. tengo	C. soy
34.	A. trabajo	B. trabajar	C. trabajando
35.	A. algún	B. alguna	C. alguno
36.	A. pasando	B. pasar	C. pasado
37.	A. contó	B. contaría	C. conté
38.	A. se	B. me	C. les
39.	A. preguntó	B. preguntara	C. preguntaría
40.	A. esperó	B. esperando	C. esperaba
41.	A. Le	B. Lo	C. Se
42.	A. es	B. sea	C. está
43.	A. desde que	B. aunque	C. tanto que

13.6. Appendix F: ESL French placement test

This is a test that will allow us to determine your level of French. The questionnaire is structured as follows. First of all, you will be asked for some personal details so that we can match your answer with the information you have already given us. Then, the actual test will begin (instructions are given below).

PERSONAL INFORMATION:

- Initials
- Age
- Email

This is where the test begins. At the end of it, you will know how many questions you got right and your level of French according to the Common European Framework of Reference for Languages (A1, A2, B1, B2, C1, C2).

INSTRUCTIONS:

- There are 40 multiple-choice questions in total. You must answer all of them.
- Select the right word to complete the following sentences.
- Choose only one of the possible answers for each of the questions.

1. Bonjour monsieur, ……………… le journaliste ?

A. tu es B. ils sont C. on est D. vous êtes

2. Marguerite est ……………… au restaurant.

A. serveur B. serveuse C. service D. sert

3. Est-ce que tu vois ……………… voiture noire?

A. du B. de C. la D. l’

4. ……………… ton numéro de téléphone?

A. Il y a B. Quelle est C. Quel est D. Quels sont

5. Je te présente ……………… frère et ……………… amie.

A. mon / son B. mon / sa C. ton / t' D. mon / ma

6. Est-ce que tu as fait ……………… tennis hier?

A. au B. du C. le D. de le

7. Il est ……………… (15h 15min) ……………….

A. trois heures moins le quart B. trois heures plus le quart C. trois heures et quart D. trois heures et demi

8. Je viens ……………… Allemagne.

A. de B. d’ C. la D. du

9. Je vais ……………… Portugal.

A. au B. en C. à D. aux

10. Elles ……………… à la chorale du village.

A. chante B. chanté C. chantent D. chanter

11. Ils ……………… cette chanson.

A. mangent B. chantent C. parlent D. naviguent

12. Ce film est terrifiant, j'ai ………………

A. faim B. envie C. peur D. soif

13. Cet après-midi, nous ……………… le musée des Beaux-Arts.

A. aller visiter B. allons visiter C. allons visite D. aller visitons

14. Tu veux dormir ……………… moi?

A. á B. de C. chez D. pour

15. ……………… tu as dit à Romain?

A. Quoi B. Que C. Qu'est-ce que D. Est-ce

16. Donnez-moi un kilo ……………… pommes de terre.

A. des B. de C. de les D. du

17. Pourquoi tu ne ……………… écoutes pas? Nous sommes tes parents!

A. me B. lui C. leur D. nous

18. Sébastien ……………… parle (à Anne).

A. la B. lui C. elle D. se

19. Demain, nous ……………… faire du bateau.

A. sommes allés B. étions allés C. irons D. ayons

20. ……………… demandé à ma mère de venir.

A. Je suis B. J'ai C. Je D. Tu

21. Elle ……………… de la maison.

A. a sorti B. a sortie C. est sorti D. est sortie

22. Mon voisin ……………… son chien trois fois ce matin.

A. est sorti B. a sorti C. sont sortis D. ont sorti

23. Tu veux du chocolat?

A. Oui, j'en veux B. Oui, j'y veux C. Non, j'en veux D. Non, j'y veux

24. Il va à Marseille?

A. Oui, Felix y va B. Oui, Felix en va C. Non, Felix y va D. Non, Felix en va

25. ……………… quand je te parle!

A. Ecoutez-moi B. Ecoute-me C. Ecoutes-moi D. Ecoute-moi

26. Je connais bien cet homme ……………… est sur la photo.

A. que B. qui C. où D. tu

27. Béatrice est une amie ……………… j'adore

A. qui B. qu’ C. où D. que

28. C’est mon parapluie! C’est ………………

A. le miens! B. la mien! C. le mienne! D. le mien!

29. Pour ……………… des médicaments, il faut ……………… à la pharmacie.

A. achète / que je vais B. acheter / aller C. vendre / aller D. achète / aller

30. J'habite en France ……………… 6 ans.

A. il y a B. de C. depuis D. en

31. ……………… quelques années, je suis allée en vacances au Mexique.

A. Il y a B. De C. Depuis D. En

32. Quand j’étais plus jeune, je ……………… tous les week-ends.

A. ai skié B. skiais C. j’aurais skié D. skierai

33. Julien est parti en voyage hier. Il ……………… son vol sur internet.

A. avait réservé B. aurait réservé C. réservais D. réserve

34. Excusez-moi madame, je ……………… essayer une autre taille s’il vous plaît.

A. veut B. ai voulu C. voulais D. voudrais

35. Oh tu sais, je ne pense pas qu’il ……………… à ta fête.

A. viens B. était C. vienne D. est

36. Si! Je suis sûre que Marie ……………… ce soir.

A. viendra B. vienne C. viennent D. viens

37. Si je gagnais au loto, ……………… un grand bateau.

A. j’achèterai B. j’achèterais C. j’achetais D. j’aurais acheté

38. Je travaille en ……………… de la musique.

A. écouter B. écoutant C. écoute D. écoutons

39. Il faut que tu ……………… attention à ta grammaire!

A. fais B. fasses C. faire D. feras

40. Si ……………… un oiseau, ……………… par dessus les arbres.

A. je serais / je volerais B. je suis / je vole C. je serais / je volais D. j'étais / je volerais

13.7. Appendix G: Bilingual Language Profile test

Este cuestionario servirá para recoger información sobre tu historial lingüístico, así como tu uso, actitudes y competencia en aquellas lenguas que has estudiado o dominas. De esta forma, podremos conocer tu perfil en diferentes contextos.

Te llevará unos 15 minutos completar el formulario. No se trata de un examen y por tanto, no hay respuestas correctas ni incorrectas. Por favor, responde con sinceridad a todas las preguntas, ya que solamente así se podrá garantizar el éxito de esta investigación.

¡Muchas gracias!

I. INFORMACION BIOGRÁFICA

- Iniciales
- Edad
- Género
- Lugar de residencia actual: ciudad
- País de residencia actual
- Tiempo que llevas en dicho país (número de años y meses)
- Si durante los últimos 6 meses has viajado a otro país por una duración de 2 semanas o más, indica dónde, cuándo y la duración. Si no ha sido así, indica NO
- Si has vivido en algún país extranjero, indica dónde, cuándo y la duración. Si no ha sido así, indica NO
- Nivel más alto de formación académica completada:
    - Inferior a la educación secundaria
    - Educación secundaria
    - Un poco de universidad
    - Universidad (diplomatura/licenciatura/grado)
    - Un poco de escuela graduada
    - Máster
    - Doctorado
    - Otro

II. HISTORIAL LINGÜISTICO

Esta sección contiene algunas preguntas sobre tu historial lingüístico. Por favor contesta a cada pregunta seleccionando la respuesta apropiada en el menú desplegable.

Indica tu lengua materna. Si eres bilingüe de nacimiento, indica tus lenguas maternas.

1. ¿A qué edad empezaste a aprender las siguientes lenguas?

¿A qué edad empezaste a aprender ESPAÑOL?

Desde el nacimiento 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

¿Cómo has aprendido ESPAÑOL mayoritariamente?

- Instrucción formal en el aula

- Inmersión (exposición natural fuera de clase)
- Ambas

¿A qué edad empezaste a aprender INGLÉS?

Desde el nacimiento 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

¿Cómo has aprendido INGLÉS mayoritariamente?

- Instrucción formal en el aula
- Inmersión (exposición natural fuera de clase)
- Ambas

2. ¿A qué edad empezaste a sentirte cómodo/a usando las siguientes lenguas?

¿A qué edad empezaste a sentirte cómodo/a usando ESPAÑOL?

Tan pronto como recuerdo Aún no me siento cómodo 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

¿A qué edad empezaste a sentirte cómodo usando INGLÉS?

Tan pronto como recuerdo Aún no me siento cómodo 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

3. ¿Cuántos años de clases (gramática, historia, matemáticas, etc.) has tenido en las siguientes lenguas (desde la escuela primaria a la universidad)?

¿Cuántos años de clases has tenido en ESPAÑOL?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

¿Cuántos años de clases has tenido en INGLÉS?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

4. ¿Cuántos años has pasado en un país donde se hablan las siguientes lenguas?

¿Cuántos años has pasado en un país/región donde se habla ESPAÑOL?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

¿Cuántos años has pasado en un país/región donde se habla INGLÉS?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

5. ¿Cuántos años has pasado en familia/en casa hablando las siguientes lenguas?

¿Cuántos años has pasado en familia/casa hablando ESPAÑOL?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

¿Cuántos años has pasado en familia/casa hablando INGLÉS?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

6. ¿Cuántos años has pasado en un ambiente de trabajo donde se hablan las siguientes lenguas?

¿Cuántos años has pasado en un ambiente de trabajo donde se habla ESPAÑOL?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

¿Cuántos años has pasado en un ambiente de trabajo donde se habla INGLÉS?

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20+

III. USO DE LENGUAS

Esta sección contiene algunas preguntas sobre tu uso de lenguas. Por favor, contesta a cada pregunta seleccionando la casilla apropiada en el menú desplegable.

7. **En una semana normal, ¿qué porcentaje del tiempo usas las siguientes lenguas con tus amigos?** (El total debe sumar 100%)

En una semana normal, ¿qué porcentaje del tiempo usas ESPAÑOL con tus amigos?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

En una semana normal, ¿qué porcentaje del tiempo usas INGLÉS con tus amigos?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

En una semana, ¿qué porcentaje del tiempo usas OTRAS LENGUAS con tus amigos?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. **En una semana normal, ¿qué porcentaje del tiempo usas las siguientes lenguas con tu familia?** (El total debe sumar 100%)

En una semana normal, ¿qué porcentaje del tiempo usas ESPAÑOL con tu familia?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

En una semana normal, ¿qué porcentaje del tiempo usas INGLÉS con tu familia?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

En una semana, ¿qué porcentaje del tiempo usas OTRAS LENGUAS con tu familia?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. **En una semana normal, ¿qué porcentaje del tiempo usas las siguientes lenguas en la universidad/el trabajo?** (El total debe sumar 100%)

En una semana normal, ¿qué porcentaje del tiempo usas ESPAÑOL?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

En una semana normal, ¿qué porcentaje del tiempo usas INGLÉS?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

En una semana normal, ¿qué porcentaje del tiempo usas OTRAS LENGUAS?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. Cuando te hablas a ti mismo/a, ¿con qué frecuencia te hablas a ti mismo/a en las siguientes lenguas? (El total debe sumar 100%)

Cuando te hablas a ti mismo/a, ¿con qué frecuencia te hablas en ESPAÑOL?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Cuando te hablas a ti mismo/a, ¿con qué frecuencia te hablas en INGLÉS?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Cuando te hablas a ti mismo/a, ¿con qué frecuencia te hablas en OTRAS LENGUAS?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

11. Cuando haces cálculos, ¿con qué frecuencia cuentas en las siguientes lenguas?

Cuando haces cálculos contando, ¿con qué frecuencia cuentas en ESPAÑOL?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Cuando haces cálculos contando, ¿con qué frecuencia cuentas en INGLÉS?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Cuando haces cálculos contando, ¿con qué frecuencia cuentas en OTRAS LENGUAS?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

IV. COMPETENCIA LINGÜISTICA

En esta sección, nos gustaría que consideres tu competencia o nivel de idiomas marcando una casilla de 0 (no muy bien) a 6 (muy bien, como un nativo). Por favor, contesta a cada pregunta seleccionando la casilla apropiada.

12. ¿Cómo hablas en las siguientes lenguas?

¿Cómo hablas en ESPAÑOL ahora?

(no muy bien) 0 1 2 3 4 5 6 (muy bien)

¿Cómo hablas en INGLÉS ahora?

(no muy bien) 0 1 2 3 4 5 6 (muy bien)

13. ¿Cómo entiendes / comprendes en las siguientes lenguas?

¿Cómo entiendes en ESPAÑOL ahora?

(no muy bien) 0 1 2 3 4 5 6 (muy bien)

¿Cómo entiendes en INGLÉS ahora?

(no muy bien) 0 1 2 3 4 5 6 (muy bien)

14. ¿Cómo lees en las siguientes lenguas?

¿Cómo lees en ESPAÑOL ahora?

(no muy bien) 0 1 2 3 4 5 6 (muy bien)

¿Cómo lees en INGLÉS ahora?

(no muy bien) 0 1 2 3 4 5 6 (muy bien)

15. ¿Cómo escribes en las siguientes lenguas?

¿Cómo escribes en ESPAÑOL ahora?

(no muy bien) 0 1 2 3 4 5 6 (muy bien)

¿Cómo escribes en INGLÉS ahora?

(no muy bien) 0 1 2 3 4 5 6 (muy bien)

V. ACTITUDES LINGÜISTICAS

Esta sección contiene afirmaciones sobre tus actitudes lingüísticas. Por favor, valora cada afirmación y responde a cada frase seleccionando la casilla apropiada.

16. Me siento "yo mismo/a" cuando hablo en las siguientes lenguas

Me siento “yo mismo/a” cuando hablo en ESPAÑOL.

(no estoy de acuerdo) 0 1 2 3 4 5 6 (estoy de acuerdo)

Me siento “yo mismo/a” cuando hablo en INGLÉS.

(no estoy de acuerdo) 0 1 2 3 4 5 6 (estoy de acuerdo)

17. Me identifico con las siguientes culturas. Esta pregunta no está relacionada con ideas políticas, religiosas, etc. Se refiere a tu sensación de apego a una cultura hispana o mediterránea vs. a una cultura anglosajona en estilo de vida

Me identifico con una cultura HISPANOHABLANTE

(no estoy de acuerdo) 0 1 2 3 4 5 6 (estoy de acuerdo)

Me identifico con una cultura ANGLOHABLANTE

(no estoy de acuerdo) 0 1 2 3 4 5 6 (estoy de acuerdo)

18. Es importante para mí usar / llegar a usar las siguientes lenguas como un nativo

Es importante para mí usar (o llegar a usar) ESPAÑOL como un hablante nativo.

(no estoy de acuerdo) 0 1 2 3 4 5 6 (estoy de acuerdo)

Es importante para mí usar (o llegar a usar) INGLÉS como un hablante nativo.

(no estoy de acuerdo) 0 1 2 3 4 5 6 (estoy de acuerdo)

19. Quiero que los demás piensen que soy hablante nativo de las siguientes lenguas

Quiero que los demás piensen que soy un hablante nativo de ESPAÑOL

(no estoy de acuerdo) 0 1 2 3 4 5 6 (estoy de acuerdo)

Quiero que los demás piensen que soy un hablante nativo de INGLÉS

(no estoy de acuerdo) 0 1 2 3 4 5 6 (estoy de acuerdo)

13.8. Appendix H: Working memory task. Spanish version

Practice trials
Estaba tan distraído que tuvimos que llamarle varias veces para que nos hiciera caso Se tapó los oídos con las manos porque no podía soportar aquellos gritos
Aunque el profesor explicó el problema, todos nos quedamos con bastantes dudas Después de terminar todos los exámenes, tuvimos vacaciones durante casi una semana
Debido a la lluvia y el fuerte viento no pudimos seguir mucho tiempo en moto Estábamos paseando por la Casa de Campo cuando nos encontramos a tus padres
Block 1
Según todas las encuestas, Robert Redford es el actor más famoso del cine Aquel verano hizo tanto frío que mucha gente tuvo que cambiar sus planes
Ayer todo el pueblo acudió al ayuntamiento para escuchar el discurso del alcalde Por haber aprobado todo el curso su abuelo le regaló una preciosa pluma
Sus bonitos y expresivos ojos se volvieron hacia mí con una profunda mirada Cuando nos dimos cuenta de que tenía fiebre, fuimos corriendo a avisar al médico
Block 2
Aunque estuvimos toda la tarde estudiando, no encontramos la solución del problema Como no tengamos cuidado es posible que agotemos todos los recursos de la tierra Ahora que un hombre había muerto, la policía no tendría más remedio que actuar
Cansada del mal comportamiento de la clase, la profesora fue a quejarse al director Después del concierto los músicos salieron a saludar mientras el público aplaudía y cantaba Con el fin de realizar los análisis médicos el doctor hospitalizó al enfermo
El jefe de policía informó al presidente de que los terroristas planeaban matarle Los monumentos históricos son numerosos y están bien presentados en la nueva guía Su mujer le regañaba con frecuencia porque no se preocupaba de los niños
Block 3
Las películas no muestran las cosas tal y como ocurren en la vida real Con gran interés Pedro contempló muy detenidamente todos los cuadros del museo Cuando el abogado terminó de interrogar al testigo, el juez levantó la sesión En la ciudad en la que vivo amanece muchos días con una ligera niebla
La anciana señora estuvo charlando con su nueva vecina mientras daban un paseo Los leñadores trabajaron mucho hasta que consiguieron toda la madera para la casa Muchos campesinos pensaron que el reparto de los terrenos no había sido justo En comparación con sus primeros trabajos, Dalí llegó a tener un estilo muy personal
El tremendo alboroto que provocaba el juego de los niños molestaba a algunos vecinos El sonido de un tren que se aproximaba lo despertó y comenzó a caminar Los obreros decidieron alargar la jornada de trabajo para conseguir una paga extra Los alumnos que presentaron algún trabajo no tuvieron que hacer el examen
Block 4
A pesar del frío que hacía, los jóvenes continuaron su excursión en canoa Antes de acabar la fiesta pasamos un buen rato mirando nuestro álbum de fotos Se pidió a los fumadores que se aguantaran hasta que terminara la reunión No quiso echar mucha cebolla a la ensalada porque no le gustaba su olor

Sin la rehabilitación mi rodilla no se habría recuperado en tan poco tiempo

Cuando los niños tienen problemas siempre cuentan con la intervención de su héroe
Me gusta su manera de comportarse, pero no estoy de acuerdo con sus ideas
Al final del largo pasillo me encontré frente a una gran puerta de madera
No entiendo por qué se enfadó Andrés, aunque creo que fue por mi culpa
El joven estudiante decidió leer el libro antes de que terminara el año

Supongo que te habrán informado de cuál es el verdadero motivo de mi visita
En un momento de la discusión, Jaime recordó detalles que no venían al caso
El niño fue castigado severamente por su falta de respeto a los mayores
Los exámenes se adelantaron a mayo para hacer el viaje de fin de curso
Para olvidarse de los problemas de la oficina comenzó a leer una novela

Block 5

Cuando terminó la actuación de la orquesta, el público aplaudió durante varios minutos
El artículo sobre los dinosaurios me pareció aburrido, confuso y excesivamente largo
Los efectos devastadores de la inundación no se notaron realmente hasta meses después.
Descansó un momento en el puente mientras los dos policías le vigilaban a distancia
A las dos horas de iniciarse el incendio, los bomberos pudieron controlar la situación.
No podía evitar que los recuerdos volvieran una y otra vez a su mente

No consiguió llegar muy lejos porque, sin darse cuenta, había dado un gran rodeo
Cuando levanté la moto del suelo vi que no había sufrido demasiados daños
Durante el tiempo que duró la operación todos permanecimos en la sala de espera.
Varios leños ardían lentamente en la chimenea, ya que la noche era fría
Como no contestaban al teléfono decidí ir a verle personalmente a su despacho.
Juan se enfadó con Carmen debido a su mala costumbre de comerse las uñas

Todavía faltaba una hora para el desayuno y la casa estaba silenciosa y dormida
La mejor forma de aprovechar las vacaciones es irse a conocer nuevos lugares
Afortunadamente, el nuevo plan de paz fue apoyado por todos los países.
El profesor nos dijo muy enfadado que en el futuro no admitiría más errores
Quisimos avisarles, pero nos volvimos atrás cuando vimos que les habíamos cogido.
Su hijo no era buen estudiante, pero demostraba tener una gran voluntad

13.9. Appendix I: Working memory task. English version

Practice trials
When baking cookies, Bob always followed the recipe to the letter Snow White bit into the poisoned apple that the wicked witch had given her
The scientists were about to launch the rocket when the message was received George Washington admitted that he chopped down the cherry tree in his yard
Bill and Ted were so thirsty they ordered a drink as they walked into the store The weather forecast called for clouds and a sixty percent chance of rain or snow
Block 1
He often placed an old thimble on the end of his cane in order to make a loud noise He put the book back on the shelf and hurried out of the library
She stared at the spider crawling down her sleeve in the garden He cracked his gum and blew a big bubble during the boring class lecture
Peter wanted the shirt to look like the one the groom was wearing at the wedding The pond had a few fish and a small green turtle swimming near the shore
Block 2
We went to the airport to watch the plane land on the runway He thought that the question of whether to raise taxes would be discussed with great interest Kim and Susan drove to the town beach after a long day at the office
To install an air conditioner in a casement window requires a special attachment The teacher told the children to take out a pencil to write down their assignments The schedule for the conference included morning and afternoon meetings
I woke up in the middle of a vivid dream in which I was taking a trip into outer space The cake recipe required two cups of flour as well as four eggs and a teaspoon of vanilla Pamela wished that she could recreate the image of small village where she had lived
Block 3
The men decided to meet at the building and rob it during the holiday The children used an old broom, a blanket, and some string to make a hobby horse Kurt knew he would have difficulty hammering nails without a hole The good reputation of the harbour reflected the care taken by their employees
Patricia answered that the measuring instrument was stored in the drawler over there The woman examined the condition of the wheat that had been growing on her land She took her mittens and long, woolen scarf out of the storage chest They compared the different varieties of candies from all over the world
The man reviewed the assistant and told his staff to give the boy a large salary raise The photographer took a picture of the peak because its shape was unique The devices did not surprise the man from the spy agency's office at all Gloria knew that the lighting was the first of many renovations for the old playhouse
Block 4
The boy advised the woman to see the veterinarian as soon as possible Nobody thought that it was a good summer at all, because it was too humid Since Peggy had never seen such a huge frog, she took several pictures of the boy's pet John wanted to know more about the club, although it was a dangerous organisation

George gave his girlfriend a present because he desired to adorn her with emeralds

Carl hesitated to show his stomach because it was covered with wounds from the war
Tony knows that the walrus is located at the zoo according to the map
He wants to deposit all of the money at the credit union
The marks that James noticed on the bill were so strange that he asked the waitress
The student cannot remember where he has put the important document

The committee wants to control the size of the sports equipment
Joan showed us the pencil she had bought for the English class she was going to take
Several bullets had grazed the cowboy during the heavy shooting
The woman had forgotten about the band until she listened to its wonderful interpretation
The chocolate cake cooked by Alice is too sweet and impossible to eat

Block 5

The mother told her son not to hurt his ankle while running through the field
In fact, they sold the pottery at a surprisingly high price
The child had such knowledge of the machine that it would embarrass well-educated adults
She pulled back the plastic shower curtain and stepped into the red tub
The dealers knew the quality of the drug was very poor
Herb was confused because he had no idea why the mail was addressed to him last week

The boy reached up to grab the bolt and tightened it with all his strength
The mother was surprised when she discovered the fungus at school
Keith is worried about the difficulties and related problems of an ethnic group
The little boy saw some insects eating something into the roots
The little boy saw some insects eating something into the roots
Brian did not notice until he saw some blood running from the wound

Although it is rather thin, Shelton likes the umbrella
The young man showed off his muscles and recommended that we also buy some barbells
Paul found the brown mitt that had been under the stairs since baseball season
The moon would be difficult to see because the sky was covered with a thick cloud
The family cannot believe the musician had never noticed the problem
Michael wondered where the catcher had gone and decided to ask the sport manager

13.10. Appendix J: Target sentences

TARGET SENTENCES

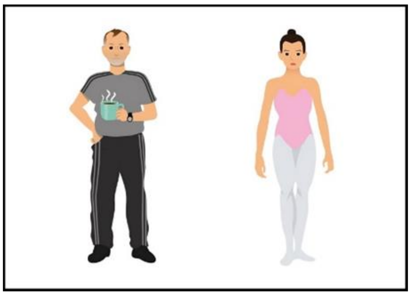
Item	Cd.	Sentence
1	a	Observa aquí al abogado de la ladrona *el cual* bebe un zumo tranquilamente
	b	Observa aquí al abogado de la ladrona *la cual* bebe un zumo tranquilamente
	c	Observa aquí al abogado de la ladrona *que* bebe un zumo tranquilamente
		Observe here the lawyer of the thief who drinks a juice calmly

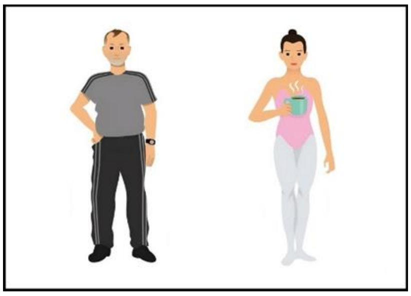

Item	Cd.	Sentence
2	a	Mira aquí al sirviente de la empresaria el cual escucha música con entusiasmo
	b	Mira aquí al sirviente de la empresaria la cual escucha música con entusiasmo
	c	Mira aquí al sirviente de la empresaria que escucha música con entusiasmo
		Look here at the servant of the businesswoman who listens to music enthusiastically


Item	Cd.	Sentence
3	a	Presta atención al fotógrafo de la actriz el cual sujeta un globo felizmente
	b	Presta atención al fotógrafo de la actriz la cual sujeta un globo felizmente
	c	Presta atención al fotógrafo de la actriz que sujeta un globo felizmente
		Pay attention to the photographer of the actress who holds a balloon happily

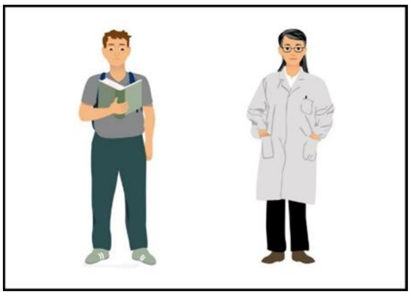

TARGET SENTENCES

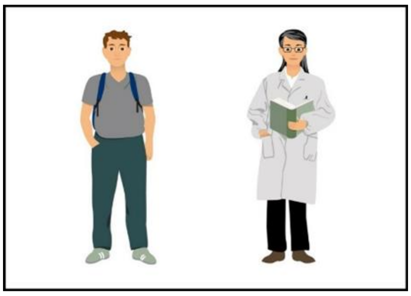
Item	Cd.	Sentence
4	a	Fíjate aquí en el entrenador de la bailarina el cual toma un café relajadamente
	b	Fíjate aquí en el entrenador de la bailarina la cual toma un café relajadamente
	c	Fíjate aquí en el entrenador de la bailarina que toma un café relajadamente
		Watch here the trainer of the dancer who has a coffee peacefully





Item	Cd.	Sentence
5	a	Observa ahora al alumno de la científica el cual lee un libro atentamente
	b	Observa ahora al alumno de la científica la cual lee un libro atentamente
	c	Observa ahora al alumno de la científica que lee un libro atentamente
		Observe now the student of the scientist who reads a book carefully



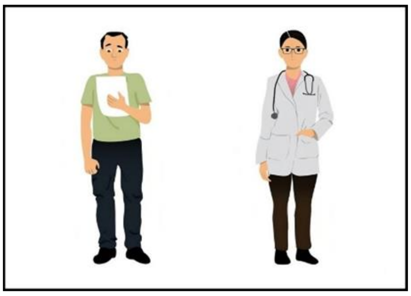


Item	Cd.	Sentence
6	a	Mira ahora al hermano de la granjera el cual saca la basura con desagrado
	b	Mira ahora al hermano de la granjera la cual saca la basura con desagrado
	c	Mira ahora al hermano de la granjera que saca la basura con desagrado
		Look now at the brother of the farmer who takes out the rubbish unwillingly

TARGET SENTENCES

Item	Cd.	Sentence
7	a	Presta atención al nieto de la marquesa el cual pasea un perro con cariño
	b	Presta atención al nieto de la marquesa la cual pasea un perro con cariño
	c	Presta atención al nieto de la marquesa que pasea un perro con cariño
		Pay attention to the grandson of the duchess who walks a dog with great affection


Item	Cd.	Sentence
8	a	Fíjate ahora en el paciente de la doctora el cual mira los análisis con preocupación
	b	Fíjate ahora en el paciente de la doctora la cual mira los análisis con preocupación
	c	Fíjate ahora en el paciente de la doctora que mira los análisis con preocupación
		Watch now the patient of the doctor who looks at the tests with concern




Item	Cd.	Sentence
9	a	Mira aquí al guardaespaldas de la princesa el cual lleva un paraguas alegremente
	b	Mira aquí al guardaespaldas de la princesa la cual lleva un paraguas alegremente
	c	Mira aquí al guardaespaldas de la princesa que lleva un paraguas alegremente
		Look here at the bodyguard of the princess who carries an umbrella cheerfully


TARGET SENTENCES

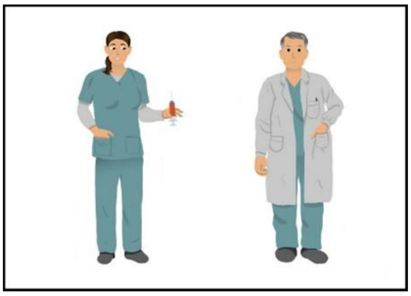
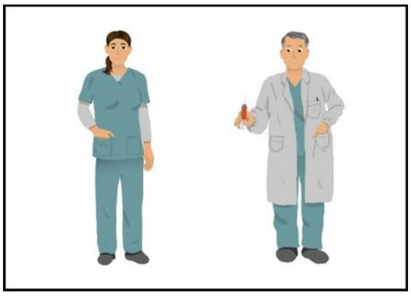
Item	Cd.	Sentence
10	a	Presta atención a la amiga del policía la cual fuma un cigarro lentamente
	b	Presta atención a la amiga del policía el cual fuma un cigarro lentamente
	c	Presta atención a la amiga del policía que fuma un cigarro lentamente
		Pay attention to the friend of the policeman who smokes a cigarette slowly


11	a	Fíjate aquí en la sobrina del cocinero la cual mira el reloj con ansiedad
	b	Fíjate aquí en la sobrina del cocinero el cual mira el reloj con ansiedad
	c	Fíjate aquí en la sobrina del cocinero que mira el reloj con ansiedad
		Observe here the niece of the cook who looks at the watch with concern


12	a	Observa aquí a la peluquera del jardinero la cual usa el móvil constantemente
	b	Observa aquí a la peluquera del jardinero el cual usa el móvil constantemente
	c	Observa aquí a la peluquera del jardinero que usa el móvil constantemente
		Watch here the hairdresser of the gardener who uses the phone constantly


TARGET SENTENCES

Item	Cd.	Sentence
13	a	Mira ahora a la enfermera del cirujano la cual sostiene una jeringuilla con cuidado
	b	Mira ahora a la enfermera del cirujano el cual sostiene una jeringuilla con cuidado
	c	Mira ahora a la enfermera del cirujano que sostiene una jeringuilla con cuidado
		Look now at the nurse of the surgeon who holds a syringe carefully

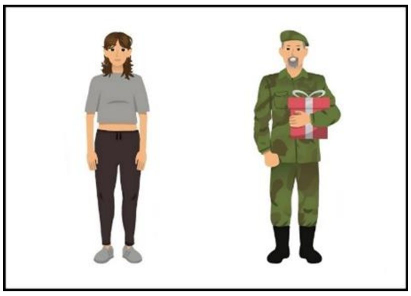
14	a	Presta atención a la modista del príncipe la cual come un helado con ganas
	b	Presta atención a la modista del príncipe el cual come un helado con ganas
	c	Presta atención a la modista del príncipe que come un helado con ganas
		Pay attention to the dressmaker of the prince who eats an ice-cream with pleasure


15	a	Fíjate ahora en la abuela del explorador la cual lleva un sombrero con orgullo
	b	Fíjate ahora en la abuela del explorador el cual lleva un sombrero con orgullo
	c	Fíjate ahora en la abuela del explorador que lleva un sombrero con orgullo
		Watch now the grandmother of the explorer who wears a hat proudly


TARGET SENTENCES

Item	Cd.	Sentence
16	a	Observa ahora a la secretaria del político la cual sujeta un maletín con firmeza
	b	Observa ahora a la secretaria del político el cual sujeta un maletín con firmeza
	c	Observa ahora a la secretaria del político que sujeta un maletín con firmeza
		Observe now the secretary of the politician who holds a briefcase tightly


17	a	Observa ahora a la hija del soldado la cual sostiene un regalo con emoción
	b	Observa ahora a la hija del soldado el cual sostiene un regalo con emoción
	c	Observa ahora a la hija del soldado que sostiene un regalo con emoción
		Observe now the daughter of the soldier who holds up a gift with excitement

18	a	Fíjate aquí en la azafata del piloto la cual lleva una maleta con cansancio
	b	Fíjate aquí en la azafata del piloto el cual lleva una maleta con cansancio
	c	Fíjate aquí en la azafata del piloto que lleva una maleta con cansancio
		Watch here the stewardess of the pilot who carries a suitcase exhaustedly

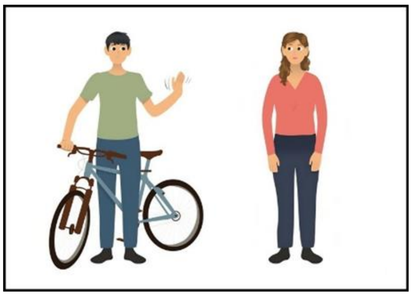
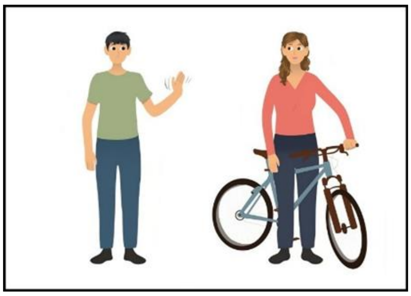

13.11. Appendix K: Practice and filler items

PRACTICE ITEMS

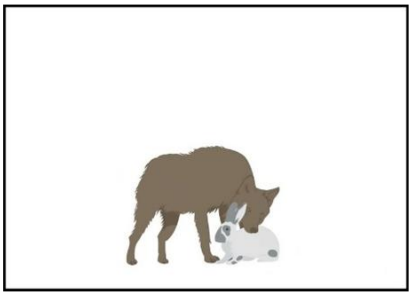
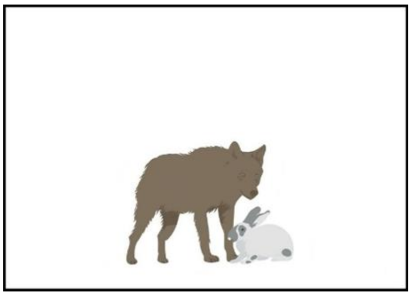
Item **Sentence**

1 Aquí tienes al padre que besa a la novia durante la boda
Here you have the father who kisses the bride at the wedding


2 Atiende al chico que saluda a la mujer mientras monta en bicicleta
Observe the boy who greets the woman while she rides a bike

3 El lobo muerde al conejo con manchas grises en la pata
The wolf bites the rabbit with grey spots on its paw

4 Presta atención al intérprete de la ministra que lleva una mochila con desgana
Pay attention to the interpreter of the minister who carries a bag unwillingly

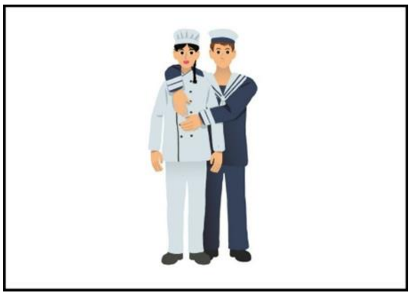

FILLER ITEMS

Item **Sentence**

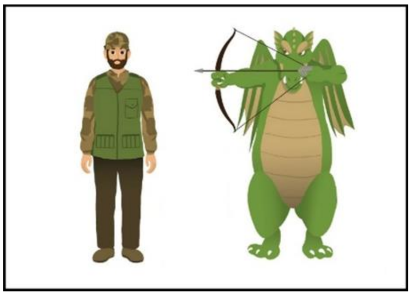
1 Aquí tienes al bombero que saluda a la dentista de camino al trabajo
Here you have the firefighter who greets the dentist on his way to work


2 Aquí tienes al duende que levanta al hada muy amablemente
Here you have the elf who lifts up the fairy very kindly

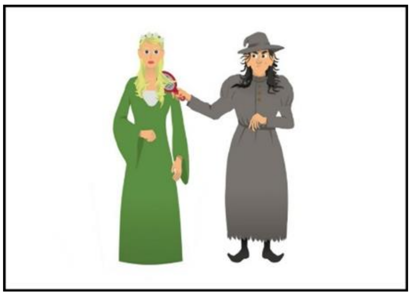

3 Aquí tienes a la pastelera que abraza al marinero con mucho cariño
Here you have the baker who hugs the sailor with great affection

4 Aquí está el cazador que ataca al dragón con un arco de madera
Here is the hunter who attacks the dragon with a wooden bow

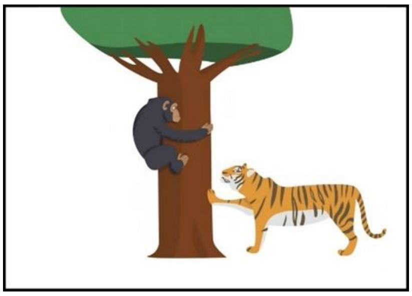
5 Aquí está la doncella que peina a la bruja para la fiesta en el castillo
Here is the maid who does the witch's hair for the party at the castle

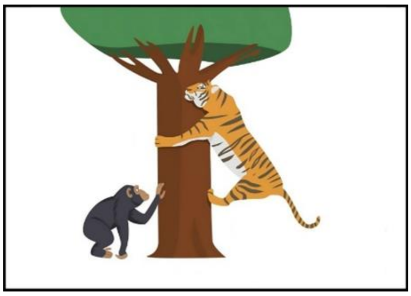


6 Aquí está la psicóloga que consuela a la anciana después del accidente
Here is the psychologist who comforts the old woman after the accident

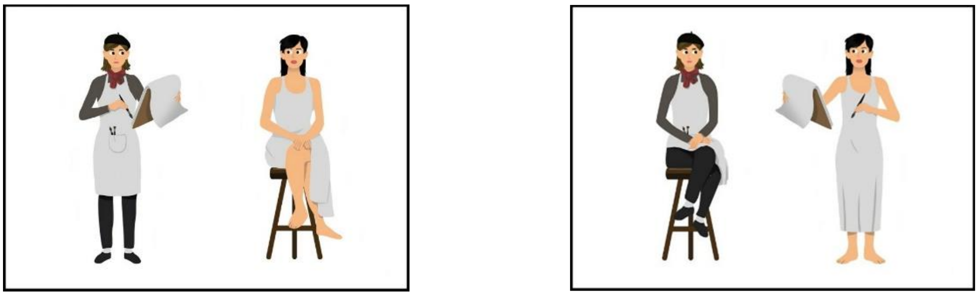
7 Aquí tienes al militar que empuja al preso que tiene las manos atadas
Here you have the military man who pushes the prisoner whose hands are tied

8 Aquí tienes al tigre que persigue al mono que escala el árbol
Here you have the tiger that chases the monkey that climbs the tree

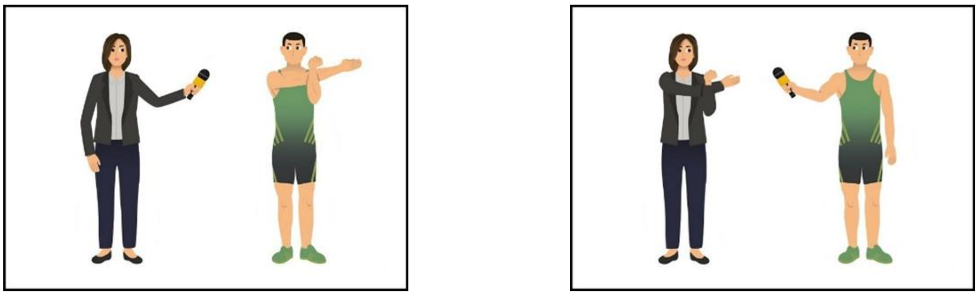




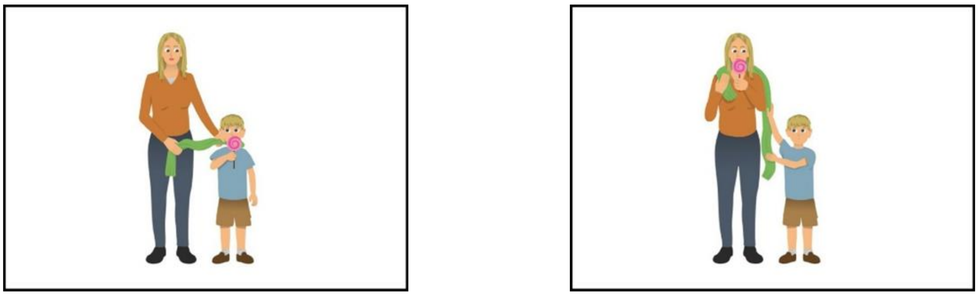
9 Aquí tienes a la pintora que pinta a la modelo que está sentada
Here you have the painter who paints the model who is sitting down



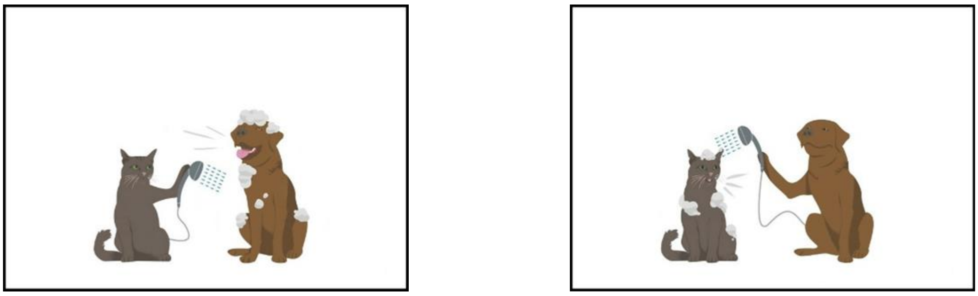
10 Aquí está la periodista que entrevista al atleta que está calentando
Here is the journalist who interviews the athlete who is warming up



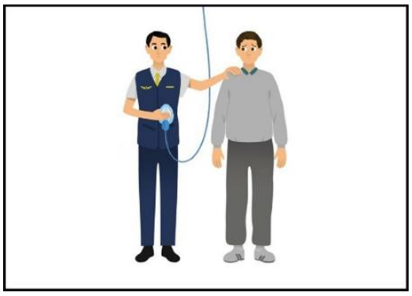
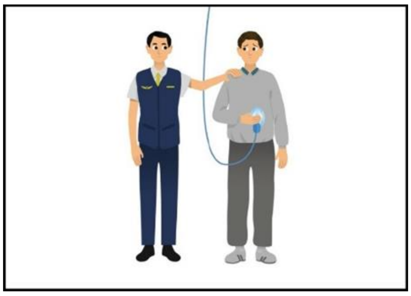
11 Aquí está la madre que viste al niño que come una piruleta
Here is the mother who dresses the boy who eats a lollipop



12 Aquí está el gato que lava al perro que ladra felizmente
Here is the cat that washes the dog that barks happily



13 Atiende al azafato que calma al pasajero mientras sujeta la máscara de oxígeno
Look at the flight attendant who calms the passenger while he holds the oxygen mask

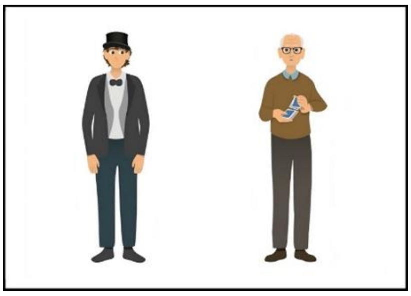



14 Contempla a la limpiadora que saluda a la jueza mientras habla por teléfono
Look at the cleaner who greets the judge while she talks on the phone

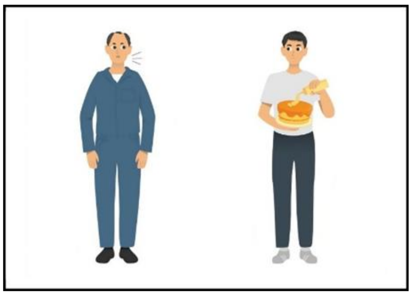
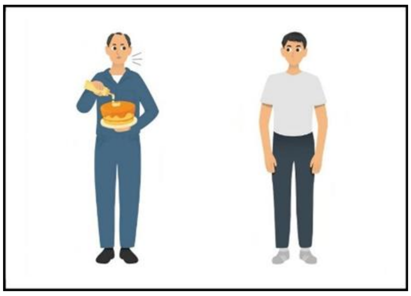

15 Atiende a la monja que sonríe a la mujer mientras riega las plantas del jardín
Look at the nun who smiles at the lady while she waters the plants in the garden


16 Contempla a la vendedora que atiende a la clienta mientras ella sujeta una bolsa
Look at the saleswoman who serves the customer while she holds a bag

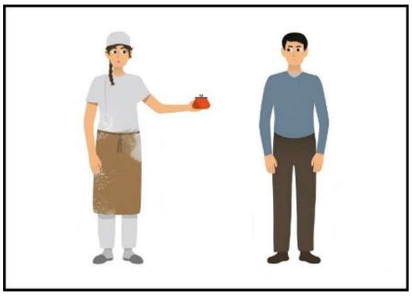
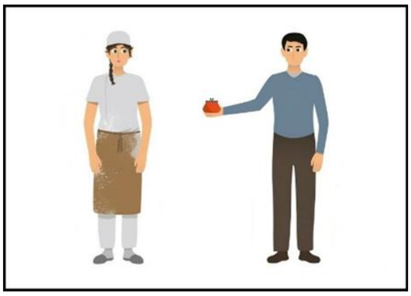

17 Atiende al mago que sorprende al anciano mientras él baraja las cartas
Look at the magician who surprises the old man while he shuffles the cards

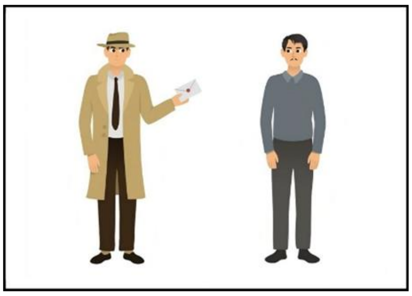
18 Contempla al mecánico que llama a su hijo mientras él prepara una tarta
Look at the mechanic who calls his son while he makes a cake

19 La panadera le cuenta a su amigo que ha encontrado un monedero
The baker tells her friend that she has found a purse

20 El detective le explica al cliente que ha descubierto una carta importante
The detective explains to the client that he has discovered an important letter

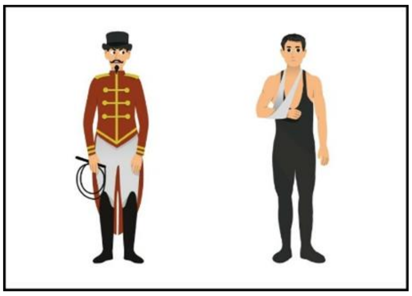
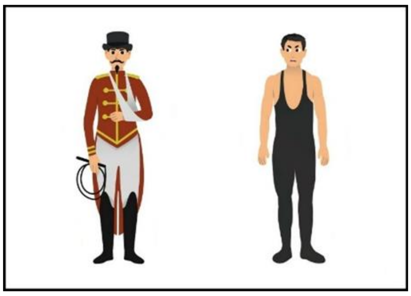



21 El futbolista le dice a su sobrino que ha comprado unas entradas para el cine
The football player tells his nephew that he has bought tickets for the cinema

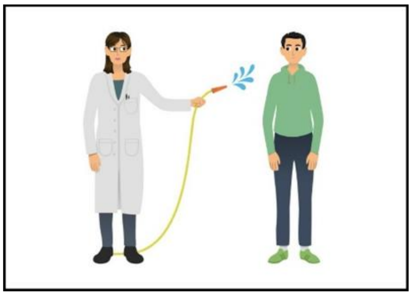
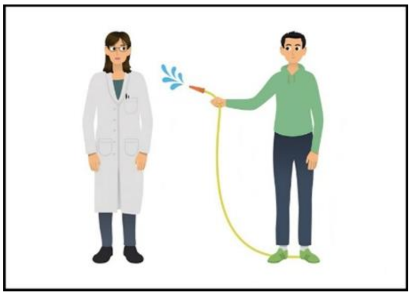

22 El agente le reprocha al pirata que haya robado un tesoro valioso
The agent reproaches the pirate for stealing a valuable treasure


23 El sacerdote le recrimina a la señora que haya robado un bolso
The priest reprimands the woman for having stolen a bag

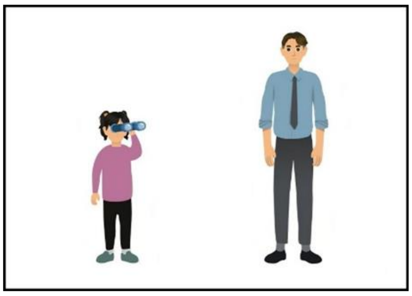
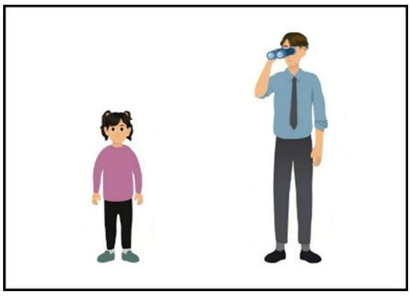

24 El domador le critica al acróbata que haya tenido un accidente
The tamer criticizes the acrobat for having had an accident

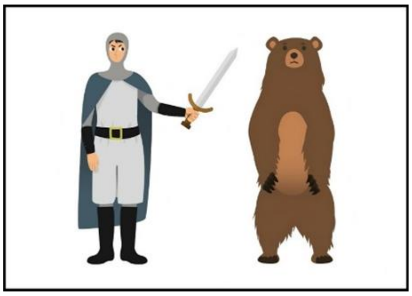
25 La profesora moja al joven estudiante con una manguera
The teacher soaks the young student with a hose

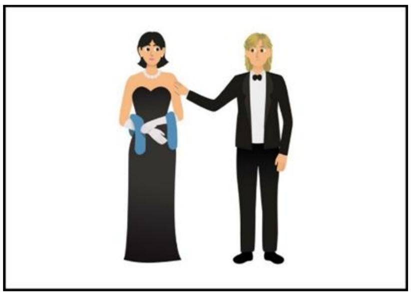
26 La niña espía a un hombre con unos prismáticos en el parque
The girl spies on a man with binoculars in the park

27 El caballero amenaza al oso con una espada durante la expedición
The knight threatens the bear with a sword during the expedition




28 La cantante de ópera toca al músico con el pelo largo
The opera singer touches the musician with long hair

29 El corresponsal entrevista al náufrago con una herida en la pierna
The correspondent interviews the shipwrecked sailor with a wounded leg

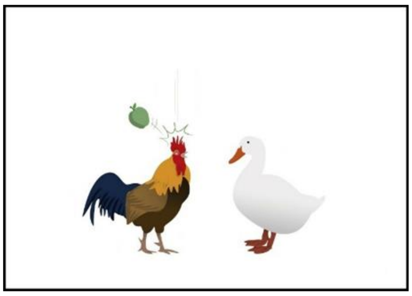
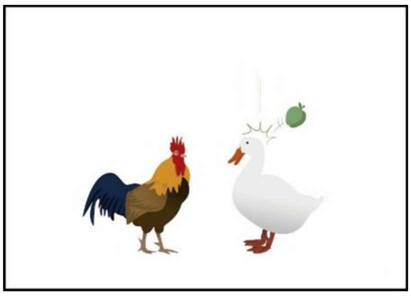
30 El reportero fotografía a la tenista con trenzas en el pelo
The reporter photographs the tennis player with braids in her hair

31 El fontanero y el abuelo paseaban cuando un perro lo mordió
The plumber and the grandfather were walking when a dog bit him

32 El gallo y el pato andaban cuando una manzana lo golpeó
The rooster and the duck were walking when an apple hit it

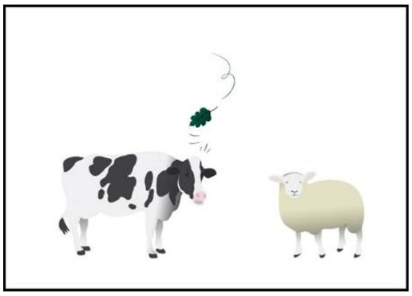
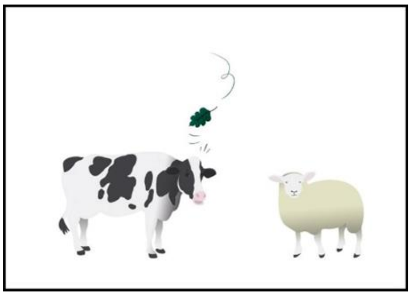
33 El payaso y el señor hablaban cuando una avispa lo picó
The clown and the gentleman were talking when a wasp stung him

34 La sirena y la tortuga conversaban cuando una ola la mojó
The mermaid and the turtle were talking when a wave soaked her

35 La vaca y la oveja descansaban cuando una hoja la asustó
The cow and the sheep were resting when a leaf scared it

36 La reina y la faraona bailaban cuando una mosca la molestó
The queen and the pharaoh were dancing when a fly bothered her

13.12. Appendix L: Written instructions for eye-tracking task and PST

SPANISH VERSION

Estás a punto de participar en un experimento lingüístico. Nos gustaría informarte de que la participación es anónima, por lo que tu nombre no se asociará con los resultados, y que no supone riesgos conocidos para su salud.

Para asegurarnos que tu participación no esté condicionada, la finalidad concreta de este estudio se explicará al finalizar la sesión.

Si tienes alguna pregunta que hayamos tratado, no dudes en preguntar. Puedes interrumpir el experimento en cualquier momento si te sientes incómodo/a.

¿Qué debes hacer?

A lo largo del experimento, escucharás una oración mientras se muestran dos imágenes en la pantalla. Una vez finalice cada oración, oirás un sonido tipo "ding".

Tu tarea consiste en escuchar atentamente cada grabación mientras miras ambas imágenes. Cuando escuches el sonido que marca el fin de la grabación, debes seleccionar la imagen que mejor represente lo que has escuchado.

- Para elegir la imagen de la IZQUIERDA, pulsa F
- Para elegir la imagen de la DERECHA, pulsa J

Antes de comenzar con el experimento real, vamos a hacer una breve práctica para que te familiarices con el procedimiento

ENGLISH VERSION

You are about to take part in a linguistic experiment. We would like to inform you that participation is anonymous, so your name will not be associated with the findings, and that it poses no known risks to your health.

To ensure that your participation is not conditioned, you will be provided with a brief explanation of the questions this study addresses upon completion of your participation.

If you have any questions not addressed here, please do not hesitate to ask the researcher in charge. You can stop at any time during experiment if you feel uncomfortable.

What exactly is the task you are about to perform?

Throughout the experiment, you will hear a sentence while two images are displayed on the screen. At the end of each sentence, you will hear a "ding" sound.

Your task is to listen carefully to each recording while looking at both images. When you hear the sound that marks the end of the recording, you must select the picture that best represents what you have heard.

- To choose the image on the LEFT, press F
- To choose the image on the RIGHT, press J

Before you begin with the actual experiment, let's do a short practice to familiarise yourself with the procedure.

13.13. Appendix M: Written instructions for PVT

SPANISH VERSION

¡Gracias por participar!

Estás a punto de participar en un experimento lingüístico. Queremos informarte de que esta prueba no supone daños conocidos contra tu salud y de que la participación es anónima, por lo que tu nombre no se asociará con los resultados obtenidos.

Para garantizar que tu participación no se vea condicionada, los objetivos específicos de la investigación se te detallarán, si así lo deseas, una vez finalices el experimento.

Si tienes alguna pregunta, no dudes en consultar a la investigadora a cargo.

Puedes finalizar tu participación en cualquier momento si te sientes incómodo/a.

¿Qué debes realizar a continuación?

Se trata de un experimento muy sencillo. En primer lugar, escucharás una oración y una vez haya finalizado, aparecerá una imagen en la pantalla.

Tu tarea consiste en escuchar atentamente cada audio y, cuando se muestre la imagen, debes indicar si dicha imagen representa o no representa la oración que has escuchado.

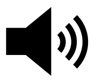
- En caso de que SÍ corresponda, pulsa F
- En caso de que NO corresponda, pulsa J

Intenta visualizar la oración conforme la escuchas, esto te ayudará cuando veas la imagen.

También se recomienda mantener los dedos índices posicionados sobre las teclas F y J durante el experimento.

Durante el experimento, los audios empezarán y terminarán automáticamente.

En la pantalla aparecerá este símbolo cuando se reproduzcan:



Cada audio se reproducirá una única vez, por lo que debes prestar atención.

Antes de comenzar con el experimento real, vamos a hacer una breve práctica para que te familiarices con el procedimiento

ENGLISH VERSION

Thanks for participating!

You are about to take part in a linguistic experiment. We would like to inform you that participation is anonymous, so your name will not be associated with the findings, and that it poses no known risks to your health.

To ensure that your participation is not conditioned, you will be provided with a brief explanation of the questions this study addresses upon completion of your participation.

If you have any questions not addressed here, please do not hesitate to ask the researcher in charge.

You can stop at any time during experiment if you feel uncomfortable.

What exactly is the task you are about to perform?

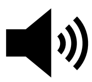
This is a simple experiment. Firstly, you will hear a sentence and once it has finished, an image will appear on the screen.

Your task is to listen carefully to each recording and, once the image has been displayed, you must indicate whether or not the picture represents the sentence that you just heard.

- If it DOES correspond, press F
- If it DOES NOT correspond, press J

Try to visualise the sentence as you hear it, this will help you when you see the image. It is also recommended to keep your index fingers positioned on the F and J keys during the experiment.

During the experiment, the audios will start and stop automatically. The image below will appear on the screen when they are played:



You will hear the sentence only once, so you must pay attention.

Before you begin with the actual experiment, let's do a short practice to familiarise yourself with the procedure.