Doctoral Dissertation

Language coactivation in bilingual writing

Coactivación de idiomas en la escritura bilingüe

International PhD candidate

Antonio José Martínez Iniesta

Advisors

Daniela Paolieri

Mª Teresa Bajo Molina

PhD in Psychology

Department of Experimental Psychology

University of Granada

April, 2022

Editor: Universidad de Granada. Tesis Doctorales
Autor: Antonio José Martínez Iniesta
ISBN: 978-84-1117-356-8
URI: http://hdl.handle.net/10481/75441

AGRADECIMIENTOS

El doctorado es un programa formativo mediante el cual se adquieren habilidades para poder llegar a ser un investigador competente. Sin embargo, esta experiencia ha sido mucho más que esto para mí. En el camino, he ido construyendo una gran familia en la que cada persona me ha aportado cosas indescriptibles y con las que tenido experiencias y vivencias tan importantes que podría escribir otro libro con todas ellas. Un niño de pueblo empezaba esta experiencia con muchos sueños y una mochila de muchos miedos e inseguridades. Ahora mirando atrás, solo puedo recordar momentos de risas, lagrimas, abrazos, crecimiento personal, ruptura de barreras y miedos, y siempre rodeado de gente bonita celebrando cada avance. Cierro esta etapa estando muy orgulloso de mi camino y de las personas que me han acompañado. A todos y especialmente a todas, gracias de corazón.

Gracias Teresa por muchas cosas. La primera por darme esta oportunidad, por confiar en mí desde el principio, sin conocerme. Por ese "sí" que ha cambiado mi vida para siempre. La segunda por ser referente de amor a tu trabajo a pesar de todas las dificultades, por trasmitir tu ilusión, tu dedicación, y tu visión crítica, por las discusiones, enseñanzas, conversaciones, confidencias y por respetar mi autonomía y por ordenar y estructurar mi cabeza loca. Por el reto a seguir creciendo, y luchando, y por las todas las oportunidades que hemos podido vivir gracias a ti. Sobre todo, por impulsarme a mí y al grupo en los momentos más difíciles, por ser el centro de todo y todos.

No hay palabras que puedan mostrar mi agradecimiento a Daniela. Gracias por ser y por estar. Por ser referente sin pretenderlo, por ser la red de salvación, por inculcarnos tu amor genuino a la investigación, por fomentar las relaciones sanas, por enseñarnos la importancia de ser familia vayamos donde vayamos o hagamos lo que hagamos y por tu infinita generosidad. Por no dudar en coger el remo para ayudar a remar, por la importancia de ayudar sin esperar nada a cambio, porque este grupo no sería lo mismo sin ti, y porque mi camino no hubiera sido lo mismo tampoco.

Tengo que hacer especial mención a Paqui Serrano. Contigo empezó todo. Fuiste la que primero creyó en mí, la primera oportunidad, la que me animó para romper todas las barreras y saltar. Gracias por enseñarme a caminar, por creer en mí incondicionalmente, por apoyarme por encima de muchas cosas y situaciones, por ser familia.

Gracias a mis padres (María Teresa y Antonio) y mis hermanos (Ana y Mario), por apoyarme en cada decisión y confiar en mi a pesar de no entender muy bien algunas de ellas, por aguantar muchas horas de teléfono, por haber desarrollado y mantenido una base a la que volver y recargar. Por respetar desde el cariño y el apoyo mi caminar y mi crecer. Gracias Ana, mi abuelita, por ser el faro de mi vida.

Gracias a mi núcleo, el despacho 312, sin vosotras esto no hubiera sido posible. Alba por cada abrazo, conversación, paseo, lagrima, bailes, por hacernos entender la importancia del grupo, por empoderarnos, y enseñarnos otra forma de hacer ciencia, y de vivir la vida. A mi melli Marta. Simplemente esto no hubiera tenido sentido sin ti, eres mi mitad. Siempre de la mano para lo bueno y lo malo. Y a Tania, solo decir que te adoro. Gracias por demostrarme que desde la independencia se puede conseguir todo.

El despacho 312 no es un simple lugar, es un concepto, formado por muchas más personas y vivencias. Chus, la referencia, el amor incondicional, el abrazo y el cariño constante, la racionalidad. Mi hippie Nuria, la gran compañera en el camino, y la hermandad. Ana Belén, mi luchadora, referente de tesón y constancia. Cristi, la gran sorpresa. Gracias por mostrarte, por romper barreras, y por ser hogar, compañera de cine, de desayunos y de conversaciones. A mi debilidad, Marta Reyes por tu inocencia. Ha sido un gran aprendizaje observarte crecer y explorar. Al constante y genuino Filip, por el camino compartido. Por tu atención a lo no evidente, y por la mano en el hombro en momentos importantes. A Nuria Montoro, la compañera de viaje, la compañera de web inmobiliarias y de planes disparatados.

Gracias a las últimas y no por ello menos importantes incorporaciones de la familia (Raquel, Melodie, Miguel, Guille, y Ana Rita) por vuestra energía fresca, rarezas, abrazos, risas, locuras, y por aguantarnos y empujarnos a los mayores cuando no nos quedaba más energía. Al resto del grupo Memoria y Lenguaje (y asociados), particularmente a Sandra, Bernal, David, Borja, Patri Román, Ana Pérez y Jose. Gracias por compartir estos últimos años conmigo, por vuestro apoyo y cariño, por enseñarnos que hay cosas más allá de los problemas. En especial gracias a Pedro, por ser un referente, por inculcarme el amor por el lenguaje, por encender la mecha.

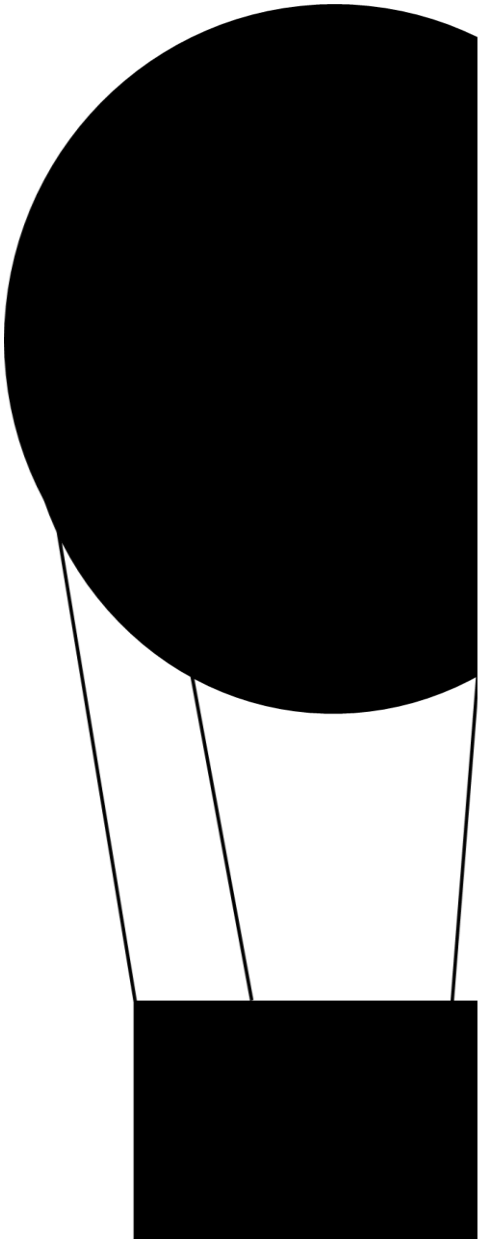
Gracias a mis *** coloraos (Fer, Ana, y Jeanette), porque esto lo empezamos juntos y lo acabamos juntos. Gracias por el camino, las risas, la evolución, los gifs y videos divertidos, por ser un lugar de seguridad y confianza, por ser la familia del barrio.

A los Sex (Oscar, Ana y Laura) por ser explosión, agujetas, bailes, carcajadas, gritos, ruido, cenas, locuras. Gracias por estar y permanecer.

Gracias Eleonora, y Sumi por hacer de mi estancia y de Florida un hogar; una parte de mi se quedó en Gainesville. Gracias por vuestro constante apoyo y ánimos. Por enseñarme que la mejor ciencia se hace con amigas.

A todos vosotros y a muchos amigos más que han caminado junto a mí, los de siempre, los nuevos, temporales, incombustibles, españoles, guiris, gracias de corazón. Muchas canciones importantes representan muchos momentos, pero escucha mi voz porque, aunque no volveré a seguir tus pasos, te llevaré conmigo aquí. Siempre funcioné en equipo, y el germen del trabajo colaborativo viene de Lidia, Loreto y Anita. Gracias por hacerme aterrizar, por hacerme valorar las oportunidades, y por apoyar e impulsarme en cada una de las aventuras, y celebrarlas como propias. Por enseñarme la importancia de la amistad genuina, y la importancia de caminar sin miedos, porque el miedo se huele… y las barreras son excusas.

Every end indicates a new beginning. Thank you, Deb, (and all your students) for giving me the opportunity to keep fighting for my dream, and to live the most challenging and exciting experience of my life. Montreal, see you soon!



The Journey

I

Buscar la palabra entre cientos

-miles, millones – del diccionario.

¿Almas gemelas? Copias perfectas.

Piano, chocolate y gobierno.

¿Govierno?

Si no soy dueño ni de mi tiempo.

II

Cruzar el océano,

perder el dinero, ganar otros tantos.

Superar el miedo,

vivir de improviso, basado en detalles,

¿globales?

Locales -de fiesta-.

III

Cerrar una puerta,

mirarte a un espejo,

tener paciencia,

llamarte de lejos,

esperar las respuestas,

ir con todo,

defendernos a risas

y seguir sin frenos.

IV

Echarte de menos.

Marta Rivera

INTRODUCTORY NOTE

This work has been developed thanks to the doctoral research grand **FPU16/01748** to the author between 2017 and 2022, and by grants from the Ministerio de Ciencia, Innovación y Universidades-Fondos Feder to Mª Teresa Bajo (PGC2018-093786-B-I00) and Daniela Paolieri (PCIN-2015-165-C02-01), and from the Feder Andalucía to Mª Teresa Bajo (A-CTS-111-UGR18 and P20.00107) and Daniela Paolieri (A-SEJ-416-UGR20). The contents of this doctoral dissertation have been drawn up according to the regulations of the University of Granada to obtain the International Doctorate Mention in the Psychology Doctoral Program. According to this, the majority of the thesis has been written in English. Specially, the theoretical introduction (Chapters 1, 2, and 3) is presented in English. Next, the empirical section (Chapter 4, 5 and 6) also proceeds in English. The general discussion, concluding remarks and future directions are also written in English (Chapter 7 and 8). Finally, a charter including a summary and conclusions of the thesis is presented in Spanish (Capítulo 9).

CONTENTS

PREFACE

This story began with a complicated family event. My grandmother (Ana) suffered a stroke when I was 16 years old, and as a consequence "a Broca's Aphasia that required intensive speech therapy" according to a medical report. Aphasia? Speech therapy? a new world was opening up to me. The most complicated situations sometimes lead your life path. I wanted to be a speech therapist and help other people. However, the research came into my life suddenly. The first opportunity was made possible thanks to Paqui Serrano. We decided to develop and validate an intervention program for the improvement of writing and orthographic skills for students with learning difficulties following evidence-based practice. However, the first steps in research were not easy because there were few opportunities for speech therapist in academia (limited number of official master's degrees, no PhD programs, difficulties in accessing training scholarships). Thanks to an unexpected call from Marta, and the support of Teresa and Daniela, I was able to apply for a research grant to pursue my PhD, and become part of the Memory and Language research group. Considering my background in writing research, and the strong tradition of the group in bilingualism research, we decided to develop a new research line about writing and bilingualism.

There is an increasing number of bilingual or multilingual people in the world and many others are in the process of becoming bilingual or multilingual. In fact, bilingual competencies have become especially relevant for different educational and work systems. In parallel, writing is a skill with an important impact in school, professional and social contexts, with an exponential influence due to the explosion of the digital era and the generalization of the use of computers as a way of communication.

"Writing is the Painting of the Voice"

Voltaire

Being able to speak several languages obviously has important communicative, social, cultural and professional benefits that are undeniable. But it also has some consequences on language processing that are important to characterize. The most important and most replicated discovery in the field of bilingualism is language coactivation. That is, when bilinguals are speaking, reading or understanding a message in one language, the language representations that are not being used are activated in parallel, although the person is not aware of it. Current knowledge about language processing in bilinguals is considerable; however, this knowledge comes mainly from studies of spoken language and reading. Unfortunately, writing has not been extensively studied, and some assumptions have been generalized from studies of oral production and reading comprehension to writing without specific evidence to support them.

The main goal of this thesis was to analyze in depth the BILINGUAL WRITING PRODUCTION, exploring and characterizing the language coactivation in writing and some important factors that could mediate the strength or properties in which languages are coactivated, such as proficiency and learning background of the bilinguals and the transparency of the language. We focused on the mechanisms underlying the production of isolated words as a first step to understand the writing processes underlying more complex sentences and text writing (see Perret & Olive, 2019). Therefore, this dissertation is a first and small grain of sand to an emerging field of study with a promising horizon to explore.

Most of this work has been carried out at the Mind, Brain and Behavior Research Center, University of Granada, under the supervision of Daniela Paolieri and Mª Teresa Bajo. Another part was developed at the University of Florida in collaboration with Eleonora Rossi. During the development of the dissertation, we had to deal and cohabit with the sanitary crisis of COVID-19. Consequently, in addition to a lot of effort, enthusiasm, and perseverance, this work also includes many challenges and complicated situations.

"I can shake off everything as I write. My sorrows disappear, my courage is reborn"

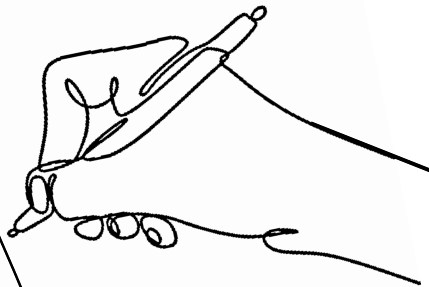
Anne Frank

La palabra precisa
es aquella que te encuentra
sin saber que la buscabas.
Es aquella,
que te aclara la mirada
y te quita la prisa,
sin saber que la esperabas.

Las palabras precisas
te vacían el dolor del pecho.
Y al hacerse trazo,
les dan forma a todos los instantes
que se llenaron de silencio.

Y es ahí cuando te escribo,
y puedo parar el tiempo.
Y te cuento, y te canto
Y te lloro y te entiendo.

Cuando las palabras
que son precisas
se deslizan por el lienzo,
mi cuerpo se calma,
mi alma se sana
y amanece de nuevo.



Laura Mas

PART I

INTRODUCTION

CHAPTER 1.

EXPERIMENTAL APPROACH TO WRITTEN LANGUAGE PRODUCTION

The development of writing is probably one of the most important contributions made by humanity. Speaking allowed the first humans to communicate with other people, but this communication was restricted to situations in which two or more individuals were physically present, and the duration of this message was ephemeral. Writing allowed humans to produce an enduring message over time and space. It also provided the possibility of collecting information or recording historical events more efficiently and freely from the distortions produced by spoken language production.

The first evidence of writing can be situated 5000 years ago, when pictograms started being used to designate concepts (Yule, 2006). One of the most important logographic systems, the cuneiform script, was introduced by Sumerians. In the 30th century B.C., the Sumerians used a strictly pictographic writing system, but the pictograms were losing iconicity, becoming forms completely unrelated to the aspect of the concept that they represent (see Figure 1). Nowadays, some languages have writing systems that include logographic characters, such as Chinese. However, visual and logographic representations are not the most common codes used for written communication, and writing systems of different natures have been developed to represent language.

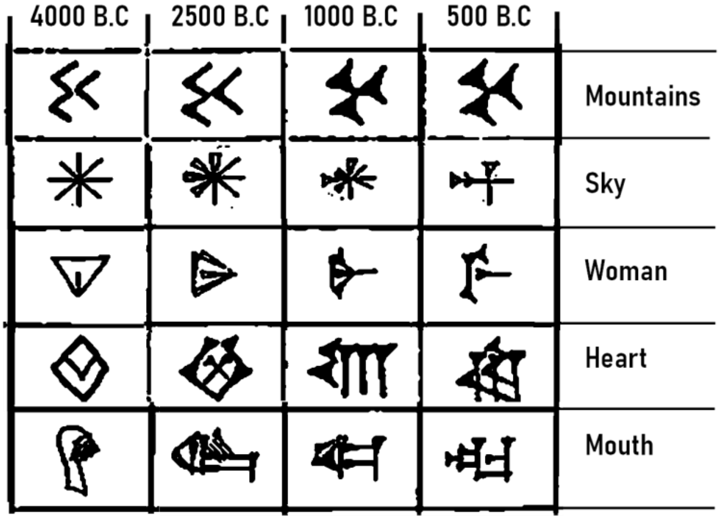


Figure 1. The cuneiform script. The figure represents the gradual loss of the iconicity of some words (adapted from Fay et al., 2014).

Thus, many current writing systems involve alphabetic scripts, in which symbols are used to represent the sounds of the language. The first alphabet composed of consonants and vowels originated in Greece and spread to the rest of Europe. Variations of the Greek alphabet resulted in the actual Latin alphabet, among others (Yule, 2006).

Over time, modern societies have started to rely more and more on the writing form of linguistic production. The historical event that promoted this trend was the invention of printing in the 15th century, creating the possibility of disseminating written language to all social strata. In the twenty-first century, writing has maintained its relevance as one of the central channels of communication. Writing is a fundamental skill in scholarly, professional, and social contexts (Graham et al., 2006), as many daily activities involve written language production, including personal development (personal diary, agenda, notes, etc.) and social and academic success (administrative process, exams, etc.; Bazerman, 2009).

Nowadays, the critical role of writing in society has grown exponentially. The advent of technology and the Internet Era have extended writing to many contexts—paper and pen, books, but also computers, web pages, smartphones, tablets—and have established new channels of communication, such as text messages, chats, blogs, and social media profiles, through the predominant typing production of written language (Pinet et al., 2016). The revolution of new technologies and the dissemination of computers and the internet to the general population are progressively replacing pens for keyboards.

Language production is described as all the processes required to translate nonlinguistic conceptual information into spoken, written, or typed linguistic output (e.g., McDonald, 2013). The psycholinguistic study of language production was initially forgotten in favor of the study of language comprehension. Some decades ago, the literature on speech production started to increase, but the writing literature remained scarce in comparison with spoken language production, despite the impact of writing in professional and social life (Graham et al., 2006). In addition, most writing research has focused on instruction programs to improve writing in school-ages (e.g., Hofslundsengen et al., 2016; Iniesta & Serrano, 2020; Rosário et al., 2019), and few studies have addressed the mechanisms underlying written language production.

In this chapter, we provide an overview of the predominant models of written language production, the procedures used to explore it, and some important modulatory aspects to consider when conducting writing research. In this overview, we focus on the mechanisms underlying the production of isolated words as a first step to understanding the writing processes underlying more complex sentences and texts (see Perret & Olive, 2019). It is important to point out that most of the models presented in this chapter were initially proposed for reading (e.g., dual-route model of reading aloud, with lexical and phonological routes [Ellis & Young, 1988; Coltheart et al., 1993]), and they were extended to writing due to the similarity in the processes assumed to underlie reading and writing and the close relationship between the two skills. Note, however, that although the reading models have been theoretically extended to writing, in many cases, this extension does not have specific empirical support (e.g., Deane et al., 2008; MacArthur & Graham, 2016).

ARTICULATING THE COMPONENTS OF THE WRITTEN LANGUAGE PRODUCTION SYSTEM

Given the theoretical and research preference toward oral production, the first psycholinguistic models considered written language production as a simple "parasite" of spoken language (e.g., Wernicke, 1874). Writing processes were conceptualized as parallel to spoken language production, and they were considered symmetrical and dependent on spoken processes (Lichtheim, 1885). However, later evidence from neuropsychological studies of patients with brain injuries (e.g., Tainturier & Rapp, 2001) indicated that the parallel between written and spoken language was not as it had been previously theorized. Thus, these studies reported that people with agraphia or dysgraphia (which are specific impairments of writing representations) did not present difficulties with spoken language, indicating that writing involves specific processes that might not be shared by spoken language production (e.g., Beauvois & Dérouesné, 1981; Roeltgen & Heilman, 1984; Shallice, 1981).

Additionally, the evidence suggests that writing has some characteristics that make it special and conceptually distinguishable from spoken language production (Afonso & Álvarez, 2019; Rayner & Clifton, 2009). Writing is slower than spoken language production; while the rate of speech is about 200 words per minute, the rate of writing drops drastically to 50 words per minute (Rayner & Clifton, 2009). Therefore, it is possible that much linguistic processing for writing takes place during preparation time, so that other processes might be taking place during the writing process itself (Afonso & Álvarez, 2019). The spoken modality of language production is natural for humans, as we are prepared to acquire it if we have enough exposure, whereas the writing modality is an artificial convention that has to be explicitly learned through formal instruction. Thus, in a developmentally appropriate situation, children start to produce their first syllables around the end of the first year of life and can produce functional speech by 2–3 years old. Conversely, writing requires extensive formal instruction to achieve skilled levels of performance. In a literate and typical schooling situation, children start to write at around 5 years old, and this skill is not mastered until adolescence (van Galen, 1991).

General approaches such as the psychomotor model of writing (Kandel et al., 2011; van Galen, 1991) have identified central and peripheral components as the two main components in the writing process, which have been supported by brain imaging data (e.g., Planton et al., 2013; Purcell et al., 2011). Central processes involve the cognitive mechanisms for retrieving, assembling, and selecting linguistic information from long-term memory and working with this information to create lexical and sublexical representations for the intended word. The peripheral process relates to the translation of the linguistic representation into motor commands to create a motor response that supports motor execution, resulting in written output (e.g., Delattre et al., 2006; Ellis, 1988; Rumelhart & Normal, 1982). The model also proposes that processing modules are activated hierarchically, moving from cognitive and linguistic processing to motor programming. The output of each stage is the input of the subsequent stages (see Figure 2A).

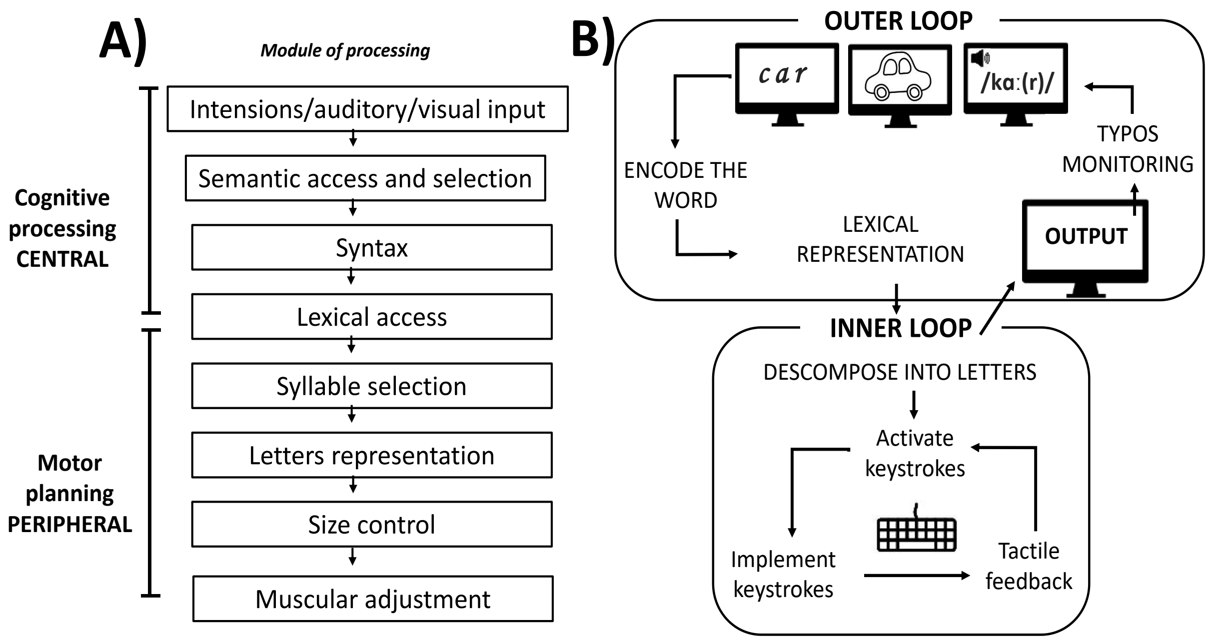


Figure 2. Theoretical models of written language production. On the left (A) is the psychomotor model of handwriting developed by van Galen (1991). The syllable module was subsequently introduced by Kandel et al. (2011) (adapted from Barnett & Prunty, 2021). On the right (B) is the two-loop theory of typewriting for copy, naming, and writing to dictation (adapted from Snyder et al., 2015).

In the same vein, the two-loop theory of typewriting (Figure 2B; Logan & Crump, 2011) proposed two independent and hierarchical loops of processing. The outer loop is responsible for language comprehension and the generation of lexical representations of words. The inner loop translates the representation into graphemic representation and then into motor outputs—finger movements and keystrokes. Hence, lexical and sublexical processing depend on different loops of processing, and the communication between them is conceptualized as hierarchical (see Figure 2B).

The main limitation of the psychomotor and two-loop models is the assumption that writing is always lexically mediated. For example, the psychomotor model (Kandel et al., 2011; van Galen, 1991) and the two-loop theory (Logan & Crump, 2011) would not be able to explain the processing underlying the written language production of Spanish pseudowords such as *corala* (presented as an unfamiliar and meaningless item). In both models, lexical retrieval is mandatory, but corala is not represented in the lexical or semantic system since it is not a word. In the same vein, imagine that a teacher wants to introduce a new word in a school class (e.g., "This part of the ear is called tympanum. Please write down the name on your notebook…"). Children do not have previous experience with the concept "tympanum" and have never seen this new word written; therefore, according to the model, they would not be able to write it. However, this is not the case, and children and adults are able to write new words, even though they are not part of their lexicon. As the previous examples illustrate, access to orthographic representation cannot be conceptually or lexically driven in all writing situations.

To address this problem, dual-process models assume that writing can also be accomplished through letter-by-letter processing and converting the phoneme to grapheme until the word is completed (Tainturier & Rapp, 2001). That is, the sublexical and phonological strategy of processing through the phonology-to-orthography conversion (POC) system. In the next section, we attempt to disentangle lexical and sublexical contributions during written language production following the dual-route framework.

At this point, it is important to introduce a relevant clarification of the term *sublexical* adopted in this section. We have used *sublexical level* and *sublexical procedure* to refer to different aspects. We understand the sublexical level of processing as the linguistic level of the language production system (e.g., Caramazza, 1997; Dell, 1986; Levelt, 1989). Concretely, written language production refers to the graphemic representation of the words to be written in terms of concrete orthographic and phonological representations of the words represented at the lexical level (e.g., Bonin et al., 2015; Roux et al., 2013). However, we understand the sublexical procedure as the sublexical/phonological route within the dual-route theoretical account (Tainturier & Rapp, 2001) proposed as the alternative to lexical processing to write regular, unknown, or low-frequency words and pseudowords (Bonin et al., 2001). In this case, sublexical does not refer to the graphemic representation itself but to an alternative processing route to reach it. This distinction is important since this work focuses, to a large degree, on the distinction between lexical and sublexical processing following the dual-route framework. In the next section, we discuss this approach.

LEXICAL AND SUBLEXICAL PROCESSING OF WRITING: DOUBLE-ROUTE MODELS

The processes involved in written language production have been conceptualized within a dual-route theoretical account (see Figure 3; Tainturier & Rapp, 2001). This account argues that the graphemic representation of a target word can be accessed and executed through lexical and sublexical routes (Bonin et al., 2001).

The so-called lexical route is responsible for the retrieval of the orthographic representation as a whole from long-term memory. In Figure 3, the pathway marked with the letters A (writing to dictation) and B (conceptual-driven/spontaneous writing and written naming) represents the direct link between the input, the semantic-lexical components, and the graphemic buffer. In contrast, the sublexical/phonological route bypasses semantic and lexical representations and relies on sound-to-letter conversion rules. That is, the orthography is encoded through the POC system; each phoneme is translated into a corresponding grapheme. The sublexical process can be activated by external (audio) or internal (inner speech) phonological input and operates based on the frequency of the mappings. This pathway marked with the letters C and D in Figure 3 represents the indirect link between the input, the POC system, and the graphemic buffer.

Lexical and sublexical routes have been associated with the processing of different types of words. The lexical route is involved in the processing of familiar and short words (Tainturier & Rapp, 2001). The sublexical route is also involved during the processing of unknown words, low-frequency words, and pseudowords or when retrieving specific letters of the words (Ardila & Cuetos, 2016; Caramazza, 1988;

Grainger & Ziegler, 2011). For words with atypical POC correspondences, such as irregular words, sublexical processing results in incorrect graphemic representation. According to the model, for these particular words, the lexical route would be responsible for the correct retrieval of the lexical entry needed for written language production.

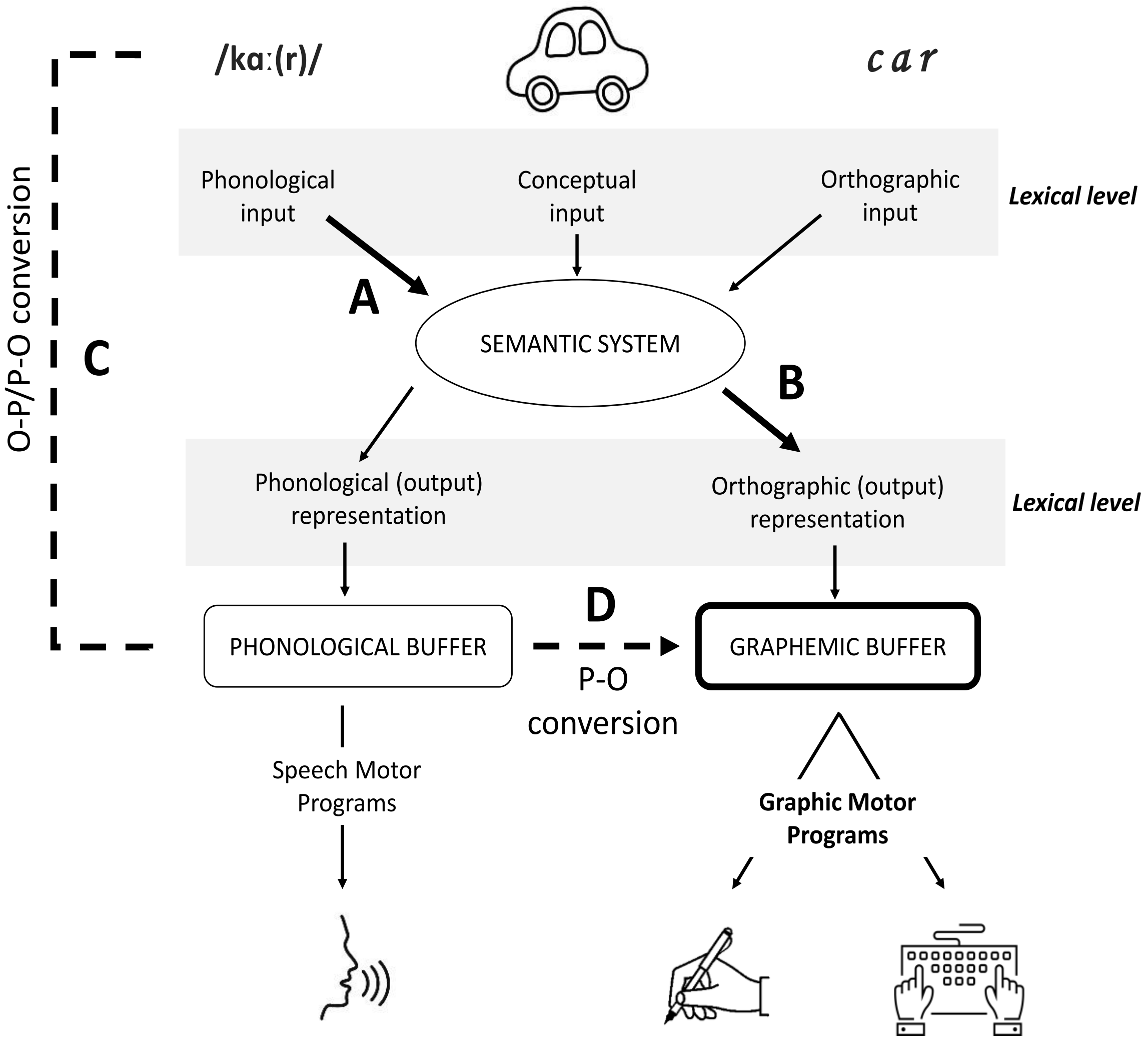


Figure 3. Dual-route accounts for writing to dictation and conceptually driven written language production (adapted from Beeson et al., 2000, and Rapp & Fischer-Baum, 2015).

One of the central issues concerning sublexical processing is the role of phonology in accessing graphemic representation during written language production. Two classical conceptions have been considered regarding the activation of phonological information based on the observation of neurologically impaired individuals (e.g., Bonin et al., 2001; Rapp et al., 1997). The obligatory phonological mediation hypothesis (Rapp & Caramazza, 1994) assumes that writing always requires the activation of phonological codes before accessing the corresponding orthographic codes. Thus, written output is always affected by phonological sublexical information. A second view, the orthographic autonomy proposal (Miceli et al., 1997; Rapp & Caramazza, 1997; Rapp et al., 1997), suggests that the orthography of a word is activated directly from the lexical-semantic system without phonological activation, and, therefore, the writing output would be unaffected by phonological information.

As illustrated in Figure 3, during written language production, the output of both routes converges in a shared graphemic buffer, where the graphemic representation of the word is stored before peripheral processing. This buffer has been related to the capacity of working memory to maintain the graphemic representations active in what has been termed orthographic working memory (Buchwald & Rapp, 2003; Purcell et al., 2011).

Although it has been demonstrated that lexical and sublexical processing share a common graphemic buffer (e.g., Bosse et al., 2003; Roux & Bonin, 2012; Tainturier et al., 2013), it is still unclear how these two linguistic levels interact between them during written language production and how the activation flows between levels of processing (Delattre et al., 2006; Kandel & Valdois, 2005; Roux & Bonin, 2012). Several findings suggest that information cascades through the central and peripheral components of the written language production system (Kandel et al., 2013; Roux et al., 2013; Scaltritti et al., 2017). However, evidence focusing specifically on the central/linguistic modules (semantic-lexical-sublexical) is scarce (e.g., Afonso, 2014; Bonin et al., 2012). In the next section, we review some of the most relevant experimental paradigms for studying written language production that can be used to explore this question and the general organization of the writing system.

EXPERIMENTAL APPROACHES TO ISOLATED WORDS WRITING

The first experimental approach to the study of word writing was based on offline methodology (Henderson & Beers, 1980) and through the analyses of the quality and quantity of errors, mainly in neuropsychological studies of patients with brain injuries (Tainturier & Rapp, 2001). These studies have made a large theoretical contribution to the understanding of writing processes. However, these initial studies did not directly investigate the mechanisms involved in correct writing in healthy participants. Later studies involved online measurements in healthy non-clinical individuals (e.g., Bonin & Fayol, 2000; Bonin et al., 2019; Kandel et al., 2019; Zhang & Damian, 2010). In comparison with the simple observation of the results of the final writing output, a real-time online approach permits the study of processing dynamics during writing and, specifically, the time course of the activation of different types of representations through the linguistic system. Time-course analyses are possible thanks to the development of software that records reaction times (e.g., E-prime or OpenSesame). Moreover, digitizers and specialized software (such as Ductus, see Guinet & Kandel, 2010; MovAlyzeR, see Neuroscript, 2018) have been developed to explore the dynamics of concrete movements during handwriting.

Writing tasks: To map the entire writing spectrum, three main tasks—picture naming, copying, and writing to dictation—have been employed to explore the dynamics of processing in different input modalities (conceptual, phonological/auditory, and orthographic/visual). During the picture naming task, participants have to write the name of the picture presented on the screen (Bock & Levelt, 1994), and lexical and sublexical manipulations, such as length or frequency, can be included (Bonin et al., 2001; 2015).

One variant of picture naming is the picture–word interference (PWI) task (Bonin et al., 1997). In this procedure, participants are asked to write down the names of the pictures on the screen and to ignore the distractor words overlapping the target picture. An extensive number of distractor–target relationships can be manipulated in this procedure. For example, Zhang and Damian (2010) manipulated the phonological and orthographic relationship between the first letter of the distractor words and the first letter of the target, but other relations involving different parts of the words could also be manipulated. Picture naming procedures have also involved implicit manipulations. For example, some experiments used implicit priming, in which the words of one particular experimental block have the same lexical or sublexical property (e.g., all words start with the same initial sound; Roelofs, 1997). Some experiments used masked priming, in which a prime word is presented briefly (almost impossible to perceive), and the impact on the subsequent target words is explored (Bonin et al., 1998; Qu & Damian, 2016). In prime words, multiple manipulations can also be included, such as including other words with orthographic or phonological to target words.

In the copy task, the participants are asked to copy a word presented on the screen, whereas in writing to dictation, the participants have to write down a word presented in the auditory modality. As with picture naming, in these tasks, lexical and sublexical variables can be manipulated, and they can also be done with implicit and explicit procedures.

A significant problem with the three experimental writing paradigms is difficult to separate the production stage from the comprehension processes that each task requires. A delay in the writing response has been proposed as a way to ensure that the reported effects reflect production processes. The delay between the presentation of the to-be-written stimulus and the writing response is assumed to permit comprehension to take place and finish before written language production starts (e.g., Bonin et al., 1998; Chua & Richard, 2014; McRae et al., 1990; Savage et al., 1990).

Finally, although the three tasks involve lexical and sublexical processing to a certain degree (Bonin et al., 2015; Rapp et al., 2002), the degree to which these processes are involved differs. Thus, picture naming and copy tasks seem to involve lexical processing to a greater extent, whereas writing to dictation seems to involve lexical and sublexical processing. Thus, Bonin et al. (2015) carried out cross-task comparisons, and the findings suggest that writing to dictation strongly involves the lexical and sublexical pathways, suggesting that this might be the most appropriate task to explore the dynamics of lexical and sublexical processing.

Online measures: Due to the influence of speaking and reading studies, the first approach to studying the writing processes online was to explore writing latencies, or the time between the offset of the stimuli and the beginning of the written response (e.g., Bonin & Fayol, 2000; Bonin et al., 2019; Damian et al., 2011; Delattre et al., 2006; Kandel et al., 2019; Lambert & Quémart, 2019; Zhang & Damian, 2010). Latencies in spoken language production are considered to reflect the processes involved in central linguistic processing, from perceptual and conceptual identification to the encoding of the word form articulation to finishing up with the actual word articulation (see Shao et al., 2014). However, as highlighted earlier in this chapter, word writing is slower than spoken language production. Therefore, it is possible that writing latency reflects unfinished linguistic or central processing, so that during the actual motor production of writing, some of these linguistic processes would still be taking place (Afonso & Álvarez, 2019).

As a result, other online measures have been proposed for more in-depth exploration of writing, such as the duration of each letter, the speed of writing (Kandel et al., 2013; Quemárt & Lambert, 2019), the inter-letter interval (ILI; Afonso et al., 2019; Rønneberg & Torrance, 2019), and the pressure of the pen (Afonso et al., 2019). However, some of these measures require adapted procedures that use unnatural manners of writing, such as capitalizing and/or breaking down letters (e.g., Kandel et al., 2006), which might not generalize to real production.

Recent studies have used both latencies and writing duration (Delattre et al., 2006) to capture different writing processes. For example, Muscalu & Smiley (2018) used a typing paradigm to explore writing performance in two different temporal moments. The latency from the offset of the stimuli to the first keystroke was used for lexical access because when the writing starts—latency—the complete representation of the word to be written would have to already be active, whereas writing duration—the time from the first keystroke to the end of the word—would capture the retrieval of the sublexical graphemic representation since total time would depend on successful assembly of grapheme information. In this way, within the same task and procedure, it is possible to differentiate between lexical and sublexical processing.

Typing procedures: Whereas many writing studies have used handwriting, typing is also a relevant procedure for exploring written language production (Pinet et al., 2016). Similar to what handwriting and speaking studies have shown, typing latencies and durations seem to be affected by critical lexical and sublexical linguistic properties, such as lexical frequency (Baus et al., 2013; Pinet et al., 2016; Viviani & Laissard, 1996), sound-spelling consistency (Pinet et al., 2016), word length (Gagné & Spalding, 2014; 2016), morphological complexity (Beth-Feldman et al., 2019), lexicality and syllable structure (Gentner et al., 1988), and age of acquisition (AoA; Scaltritti et al., 2016). Therefore, questions regarding the interactions between lexical and sublexical processes and how the activation flows between levels can also be open to inquire using typewriting.

The latencies and writing duration can be modulated by the internal characteristics of the orthographic system on which each language is based since they can modulate the relative contribution of lexical and sublexical strategies of processing (Barry & De Bastiani, 1997; Cuetos, 1991; Cuetos & Labos, 2001). In the next section, we address the impact of the transparency or opacity of the languages on the dynamics of writing processing and the experimental procedures used to study them.

THE IMPACT OF ORTHOGRAPHIC TRANSPARENCY ON THE LEXICAL AND SUBLEXICAL PROCESSING

As mentioned previously, the orthography in alphabetic systems differs in terms of the degree of consistency in the relationship between graphemes and phonemes (Schmalz et al., 2015). Importantly, orthographies like Spanish and Italian have a high degree of consistency since, in most cases, they have a one-to-one relationship between sounds and letters, and each letter corresponds consistently to one specific phoneme. However, in orthographies such as English or French, the relationship between letters and sounds is not consistent, and there is a one-to-more-than-one option (Ziegler et al., 1997).

The grapheme–phoneme consistency determines the degree of transparency of a specific orthography and varies across languages. Orthographies that contain words that have simple and consistent phoneme–grapheme relationships are classified as transparent or shallow orthographies. In contrast, if the phoneme–grapheme relationships are ambiguous, with multiple options, the orthographies are classified as opaque or deep (Seymour et al., 2003). Figure 4 represents the transparency differences across languages as a continuum based on internal regularity.

The relevance of orthographic transparency is based on its subsequent impact on linguistic processing (Frost, 1994; 2012; Katz & Frost, 1992). For example, in transparent languages, phonological awareness is acquired faster than in opaque languages (Goswami et al., 2005; Patel et al., 2004). Conversely, rapid automated naming, a lexical access measure, is better performed in opaque orthographies than in transparent orthographies (e.g., Caravolas et al., 2012; Moll et al., 2014). Similarly, in event-related potential (ERP) studies, the N320 component, a component related to sublexical decoding, consistently appears in transparent orthographies (Proverbio et al., 2004; Simon et al., 2006), whereas a specific component related to lexical processing, such as the N400 component, is more evident in opaque orthographies (Koester et al., 2007). In sum, the evidence suggests that phonological information is activated to a greater extent during the processing of transparent orthographies (Afonso & Álvarez, 2011), and lexical information is activated to a greater extent during the processing of opaque orthographies (Shen et al., 2013).

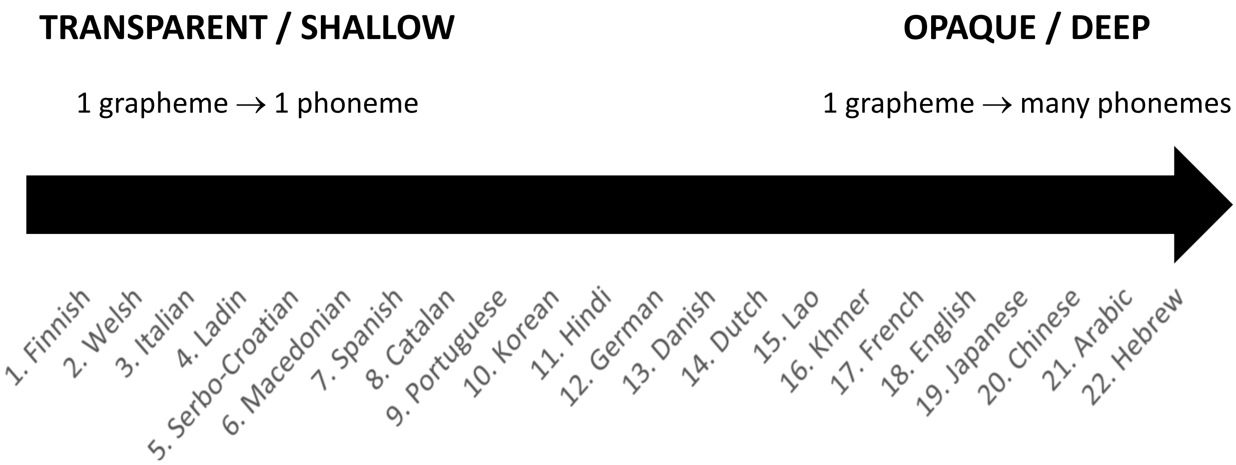


Figure 4. Orthographic transparency across some languages in the world (adapted from Liu & Cao, 2016 and Perfetti & Dunlap, 2008).

The orthographic depth hypothesis assumes that transparent orthographies rely on phonological processing primarily because most words can be decoded by the POC system due to the high consistency between graphemes and phonemes. Similarly, it assumes that reading in transparent orthographies is facilitated (e.g., Cossu et al., 1988) because the phonemes are always pronounced in consistent manners (Ziegler & Goswami, 2005). This can be seen in Figure 5A, where the output of the phonological and lexical processing is the same. However, in deep orthographies, where inconsistent words are the default mode, reading through the POC system produces inaccurate reading. In this case, lexical processing is essential to retrieve the correct pronunciation of words (Bolger et al., 2005; Glushko, 1979; Seidenberg & McClelland, 1989; Seymour et al., 2003; Ziegler & Goswami, 2005). This can be seen in Figure 5B, where the output of phonological and lexical processing is different, with the lexical output being the correct one.

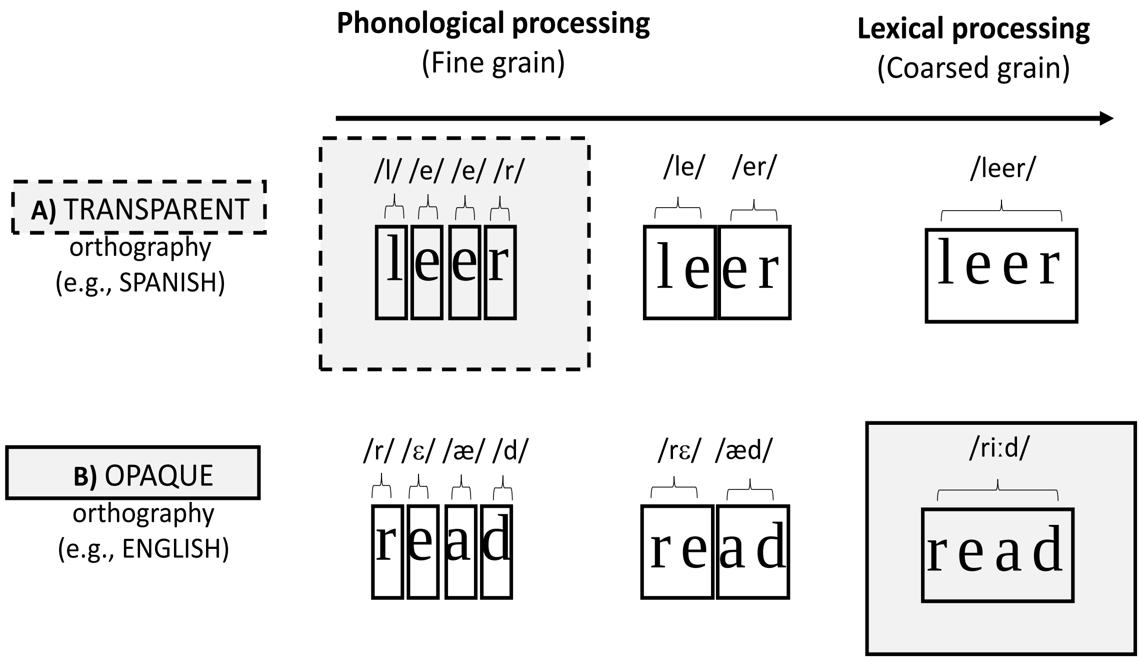


Figure 5. Lexical and phonological processing in transparent versus opaque orthographies. Transparent orthographies use a finer grain size (left gray box) and opaque orthographies use a coarse grain size (right gray box). Note that in the transparent orthography, the results from lexical and phonological processing are the same. However, in the opaque orthography, the results differ depending on the type of processing (adapted from Lallier & Carreiras, 2018).

In parallel with the orthographic depth hypothesis, psychological grain size theory (PGST; Ziegler & Goswami, 2005) further explains why readers of deeper orthographies rely more on lexical processing than readers of shallower orthographies who rely more on phonological processing. PGST proposes that differences in terms of consistency also result in the size of the processing grain differing. That is, languages with transparent orthographies (which can rely on phonological processing; Figure 5A) are associated with finer-grain coding, a smaller processing window that includes letters and whole words in the processing window. On the contrary, languages with opaque orthographies (which cannot rely on phonological processing; Figure 5B) are associated with coarser-grain coding, a larger processing window, including whole words rather than letters in the processing window (Grainger & Ziegler, 2011; Ziegler & Goswami, 2005).

Both phonological and lexical processing strategies require the contribution of auditory and visual processes (Zoubrinetzky et al., 2014). The role of visual attention in reading has received little interest (Goswami, 2015), even much less in writing, despite the evidence that pointed out her influence on performance (Franceschini et al., 2013; Lallier & Valdois, 2012; Valdois et al., 2014). Some evidence suggests that orthographic depth should modulate the size of the visual window used during processing (Franceschini et al., 2021; Perry et al., 2010).

In this chapter, we provided a general vision of the state of written language production research, theoretically and methodologically, and we highlighted orthographic transparency as an important modulator that must be considered when performing writing research. However, the characteristics of the individual who is writing can also play a fundamental role in the processing of the writing, such as age, schooling level, the context in which they learned to write, access to written material during the learning process, and motivation (Applebee & Langer, 2011; De Smedt et al., 2016; Wilcox et al., 2016; for a review, see Graham, 2019).

A particularly interesting population in this context is people who are multilingual. Thus, a single individual may present linguistic variability in terms of the transparency of the two languages they speak and, at the same time, personal variables, such as having representations of two languages with different degrees of proficiency and different learning contexts for each language. Globalization and the overwhelming development of technology are creating a complex social network where people from all over the world can interact. Additionally, the increasing use of bilingual competencies in educational and professional contexts is causing the number of bilingual people to grow exponentially. Studying the effects of being bilingual on written language production is particularly important in our contemporary society. Therefore, in the following chapter, we address the intersection between bilingualism and writing, focusing on some experimental evidence and theoretical models relevant to language processing in this population, and we consider some important modulators to address in bilingualism research.

CHAPTER 2.

LANGUAGE COACTIVATION IN BILINGUALS: WRITTEN LANGUAGE PRODUCTION

Worldwide, speaking several languages is the rule rather than the exception (Graddol, 2004; Grosjean, 1992). More than eight thousand languages are spoken around the world (UNESCO, 2021), and half of the world's population is bilingual or multilingual, with many more in the process of becoming bilingual (Bhatia & Ritchie, 2014; Grosjean, 2010). Additionally, European countries with a strong monolingual tradition in their educational systems, have progressively implemented bilingual education to a greater extent. Content and language integrated learning (CLIL) was promoted by the European Union to promote bilingual and multilingual competences in regular schools (e.g., Nikula et al., 2016). There is also an increasing number of jobs requiring speaking and writing in several languages. For instance, in countries where English is not an official language, 49% of jobs call for candidates with an advanced level of English and 33% require an intermediate level of English (Keirstead et al., 2016). Regarding this background, it becomes especially relevant to understand the consequences of bilingualism over language processing, and how bilingualism influences linguistic selection during written language production.

There is no universal definition of bilingualism because it is a heterogeneous and polyhedric construct. According to the most rigid accounts of bilingualism, bilinguals are people with a native-like competence in two or more languages (Bloomfield, 1933), using labels such as “perfect” or “balanced” to refer to these speakers. However, this restrictive vision of bilingualism has been strongly criticized and challenged by several researchers because it excludes a vast number of people who know two or more languages but simply not at the mother tongue (L1) proficiency level.

Perhaps the most accurate and widely employed perspective assumes bilingualism as a continuum (e.g., Macnamara, 1967) composed of people who use two languages in their daily lives with different proficiency levels (Cenoz et al., 2003). From this view, the coexistence of more than one language can be considered bilingualism (Hakuta, 2009), with bilinguals with a hard dominance of one language over the other at one end of the continuum and those with a high and balanced proficiency of the two or more languages at the other end.

The most important and most replicated finding in the past 30 years in the field of bilingualism is that all languages are activated simultaneously (e.g., Kroll & Dussias, 2013). That is, when bilinguals speak, read or understand a message in a language, the representations of the non-target language are activated in parallel (Costa et al., 1999; Dijkstra et al., 2005; Kroll et al., 2008; Marian & Spivey, 2003; Sadat et al., 2015). The non-selective activation of both target and non-target languages is a phenomenon called language coactivation or cross-language activation. Cross-language activation has been pointed out in all bilinguals independent of the languages they speak, including different scripts, such as English-Chinese bilinguals (Thierry & Wu, 2007) and different modalities, such as English-ASL (sing language) bimodal bilinguals (Monford et al., 2011). Being able to speak several languages has obvious and undeniable communicative, social, cultural, and professional benefits. However, language coactivation has consequences for language processing (Kroll et al., 2015), even when bilinguals are unaware of these influences.

In this chapter, we review the nature of language coactivation, the differences between L1 and L2, and the mechanism underlying the correct selection of the intended representations. Based on the spreading of activation assumption (Collins & Loftus, 1975; Costa et al., 2000; Dell, 1986; Levelt et al., 1999), we also discuss the time course of coactivation through the bilingual language system. Additionally, we explore some variables that could modulate and impact the coactivation process. Specifically, we focus on bilinguals' learning background as one of the main modulators of cross-language activation. With all of these pieces, we will review the theoretical proposals specifically for written language production, as this is the central topic of this dissertation.

THE NATURE OF LANGUAGE COACTIVATION

According to widely cited bilinguals' models of language comprehension (i.e., Multilink [Dijkstra et al., 2019]; The Bilingual Interactive Activation – BIA [Dijkstra & van Heuven, 1998], and BIA + [Dijkstra & van Heuven, 2002], when a word is visually presented, the lexical candidates from both target and non-target languages are coactivated due to bottom-up spreading activation, which, in turn, activates their semantic representations. Hence, according to this proposal, bilinguals have a unified orthographic lexicon with lexical nodes for words in both languages (Dijkstra & van Heuven, 2002; Lemhöfer & Dijkstra, 2004).

An important characteristic of the coactivation phenomenon is its non-selectivity and universality. That is, the evidence suggests that coactivation is present with different language combinations, in different tasks, in the L2 as well as the native L1, and with varying degrees of proficiency (Duyck et al., 2007; Kroll et al., 2006; Libben & Titone, 2009; Van Assche et al., 2009).

In language production, there is also evidence for language coactivation, even in situations where a bilingual wants to speak only in one language (e.g., Colomé, 2001; Costa et al., 2000; Kroll et al., 2012; Marian & Spivey, 2003), supporting the concept that language selection is non-specific. The conceptual representations of the intended message spread from top-down activation to the corresponding lexical representations of the two languages. Consequently, two lexical representations would be simultaneously coactivated during language production and, importantly, both would compete for selection (e.g., de Bot, 1992; Hermans et al., 1998; Poulisse & Bongaerts, 1994).

In general, L1 seems to be less susceptible to language coactivation than L2 does (Gollan et al., 2008; Hanulová et al., 2011; Kroll et al., 2010). L1 has direct access to meaning, whereas L2 requires L1 mediation. L2 lexical representations are directly connected to the L1 translation equivalents (see Kroll & Stewart, 1994) in low proficiency bilinguals (Duyck & Warlop, 2009). As proficiency increases, L1 mediation decreases and more independent relationships are established between the semantic system and the L2 lexicon. Consequently, the activation of L1 during L2 production is more evident and has more important effects than activation of L2 during L1 production. The disadvantages found in the dominant L1 are probably less noticeable. In comparison with monolinguals, slower latencies have been pointed out during naming (Gollan et al., 2008; Sadat et al., 2012). Furthermore, a smaller lexical repertoire and a slower lexicon access speed have been found in bilingual participants (Bialystok et al., 2008; Gollan et al., 2007; Roberts et al., 2002) with a higher proportion of "tip of the tongue" states (Sandoval et al., 2010).

Evidence for the coactivation of the two languages comes from various experimental paradigms. In the phoneme-monitoring task (Broos et al., 2018; Colomé, 2001; Hermans et al., 2011), participants have to decide if a specific phoneme is present in the name of a picture. Bilinguals showed longer reaction times when rejecting phonemes presented in the translation of the target word. For example, for the picture of a table, Catalan-Spanish bilinguals needed more time to reject the phoneme /m/, which is not present in their Catalan lexical representation "taula" but is present in the Spanish translation "mesa", than the phoneme /p/, which is present in neither "taula" nor "mesa". This result was interpreted as evidence of non-target lexical coactivation and spreading activation from non-target lexical representation to non-target phonological representation.

Additional evidence comes from the picture–word interference paradigm, in which participants have to name pictures while ignoring distractor words, usually auditorily and visually presented (Boukadi et al., 2015; Klaus et al., 2018). For example, Hermans et al. (1998) asked Dutch-English bilinguals to name pictures in English, their L2. If a phonological English distractor appeared (e.g., "bench") and was related phonologically to the non-target L1 ("bench" is phonologically related to the Dutch translation of mountain "berg") the responses of the bilingual participants were slower as evidence of coactivation but also of competition during lexical selection (Costa et al., 2008).

The most relevant evidence in the context of the current dissertation comes from specific words with high form similarity across languages and with the same meaning. These specific words, cognates, can be found across several languages; for example, piano (English) and piano (Spanish); wolf (English) and wolf (Dutch); ambulance (English) and ambulance (French). Overwhelmingly, some picture naming studies have shown better performance for cognates than for non-cognates as evidence of language coactivation, which facilitates lexical access and selection (Christoffels et al., 2007; Grasso et al., 2018; Hoshino & Kroll, 2008; Li & Gollan, 2021; Strijkers et al., 2010; Woumans et al., 2021; see Figure 6).

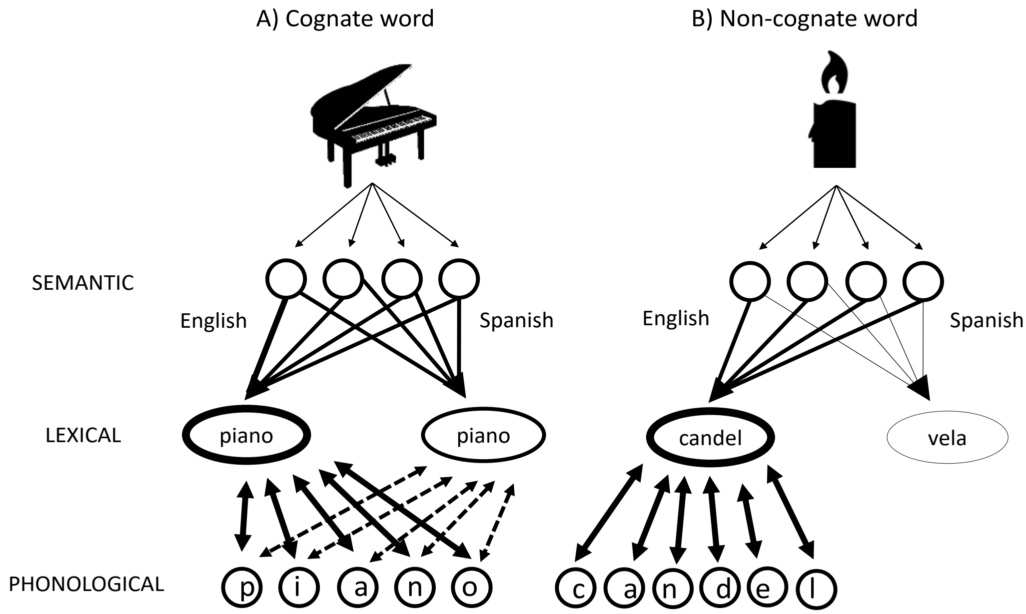


Figure 6. Facilitation effect in cognates (A) in comparison with non-cognates (B), suggesting that the lexical candidate in the non-target language (Spanish) is activated and spreading activation to the phonological level (adapted from Costa et al., 2005).

Language coactivation is evident for this type of word because bilinguals have a lower probability of falling in a "tip of the tongue" state–a state in which the speaker cannot retrieve the lexical representation of a target word, although they can retrieve the meaning of the word or similar words with the same meaning—when naming cognates than when naming non-cognates (Gollan & Acenas, 2004). Additionally, cognates are learned faster, are more resistant to being forgotten after learning (Wood et al., 2016), and are more resistant to impairment in disorders such as aphasia (Roberts & Deslauriers, 1999) or Alzheimer's disease (Costa et al., 2012).

However, cognates are not always perfect matches in the two languages; that is, some lexical representations are highly similar across languages, but their orthographic/phonological overlap is incomplete. For example, triangle (English) and triángulo (Spanish); tiger (English) and tigre (Spanish); circle (English) and cirkel (Dutch). Some evidence indicates that identical and non-identical cognates might not be processed in the same way (e.g., Dijkstra et al., 2010; Duyck et al., 2007). The coactivation of two very similar lexical representations with different subtle differences between them could produce competition between representations and could consequently interfere with the selection of the target representation. This effect has been called the cognate interference effect (Comesaña et al., 2012; Dijkstra et al., 2010; Muscalu & Smiley, 2018; Schwartz et al., 2007), and it indicates that the two languages are activated and compete for selection. In the same vein, language coactivation has been observed through interference with interlingual homographs (e.g., Martín et al., 2010); in this type of word, the orthographic representation is analogous between the two languages, but the meaning is different (e.g., pie means foot in Spanish but is a type of dessert in English). Interlingual homographs take longer to process, presumably due to the competition between both coactivated representations during selection (Jared & Szucs, 2002; Lagrou et al., 2011; Smits et al., 2006).

In sum, language coactivation may facilitate or hinder the retrieval of words. Facilitation has been interpreted as due to the cross-linguistic activation of both languages, which helps with the effective selection of the correct representation (Kroll et al., 2006). Interference has also been interpreted as due to the dual activation of the two languages, but in this case, the competition between representations needs to be effectively resolved, which leads to some cost (Hermans, 2004; Kroll & Stewart, 1994). Importantly, both facilitation and interference can be considered evidence of the coactivation of languages during linguistic processing.

L1 and L2 interferences in bilinguals are generally associated with a lexical processing cost due to this parallel activation and competition for appropriate target selection (Kroll et al., 2006). However, the evidence of competition for selection, and the consequent interference could contrast with the observation that bilinguals rarely make mistakes or mix languages when they are talking. Hence, there should be a mechanism to solve interference between languages. The idea of inhibitory processes acting during lexical selection was introduced by the inhibitory control (IC) model (Green, 1998; Green & Abutalebi, 2013). This model has attracted much attention, as it has been supported by many empirical studies (e.g., Levy et al., 2007; Linck et al., 2009; Misra et al., 2012; Philipp et al., 2007). According to the IC model, inhibition is launched in the presence of competition (Abutalebi & Green, 2008; Stuss, 2011). Hence, inhibition would behave reactively to reduce the competition between representations, where it is only applied after the competition appears, and depends on the strength in which representations are coactivated because the higher the level of activation of the non-target language, the more inhibition will be necessary.

Another important assumption is that the inhibitory control employed during language selection is from domain-general mechanisms, and it is conceptualized as the supervisory attentional system (SAS; Norman & Shallice, 1980; Timmer et al., 2021). SAS activates and inhibits specific schemas of the task. Schemas are considered the components or processes involved in doing a specific task (i.e., during a picture naming task) and can be inhibited globally, where all the components and processes of a target language are activated, but those of a non-target language are inhibited, or locally, where activation and inhibition are focused on specific elements. The impact of cognitive control over language has been extensively explored (e.g., Bobb & Wodniecka, 2013; Christoffels et al., 2007; Declerck, 2020; Declerck & Philipp, 2015).

Importantly, language coactivation and selection have been shown at all linguistic levels: conceptual, lexical, or sublexical (Jacobs et al., 2016; Kroll et al., 2006). In the following section, we discuss theoretical models and empirical approaches that attempt to explain the direction and spread of activation at different levels.

THE TIME COURSE OF ACTIVATION THROUGH THE LANGUAGE PRODUCTION SYSTEM

Speech production models assume the spreading activation between the conceptual and lexical levels (e.g., Caramazza, 1997; Dell, 1986; Levelt, 1989). However, there is still no agreement about how activation propagates between lexical and sublexical levels (Muscalu

& Smiley, 2018). There are two opposing views regarding this question: modular versus non-modular models.

The modular/discrete models propose that the language system is composed of independent and encapsulated modules (Garrett, 2000; Laver, 1980; Levelt, 1989; Levelt et al., 1999). Concretely, the conceptual module is responsible for generating the message; the formulator is responsible for turning the message into linguistic representations, providing the grammatical and phonological forms to messages, and the articulator is responsible for the motor execution of the message. The activation flows in a top-down direction so that activation at lower processing levels occurs after higher levels have been activated. Hence, the lexical representations that are not finally selected do not spread activation, and consequently, their sublexical information is not activated.

The opposite viewpoint is taken by the non-modular/cascade models (Caramazza, 1997; Dell, 1986; Navarrete & Costa, 2005; Rapp & Goldrick, 2000; Starreveld & La Heij, 1996), which propose a more flexible and interactive relationship between components and argue that lexical selection is not a requirement for propagation. The activated but not selected lexical representations also propagate activation to the sublexical representations, and while activation spreads in the top-down direction, it also spreads in the bottom-up direction. Thus, lexical selection can be influenced by sublexical features in terms of phonology and orthography (e.g., Lambert et al., 2011; Morsella & Miozzo, 2002).

Importantly, language coactivation and the relationship between linguistics levels seem to be modulated by language use, which is highly dependent on the context of immersion or, even more importantly, the context in which the L2 was learned and developed.

In the following section, we focus on the role of the context and the characteristics of the input in language processing, with special attention to the context during the learning and acquisition period. Following this argument, we will approach the role of linguistic experience by considering a group of speakers who have a particular linguistic experience, heritage speakers, and we will see the fundamental role of studying linguistic and social background due to its impact on the organization of the linguistic system.

THE INFLUENCE OF THE LEARNING CONTEXT AND LANGUAGE EXPERIENCE

The accessibility and selection of L1 and L2 during language production has been shown to be sensitive to contextual variations, such as the order in which languages are spoken (i.e., after another dominant language or after a weaker language) (Misra et al., 2012; Van Assche et al., 2013) or the contexts in which the bilinguals are speaking. Some evidence suggests that if a bilingual is speaking in a context in which they can use only one language, they name faster in L1 than in L2 (Christoffels et al., 2007; Gollan & Ferreira, 2009). However, if they have to switch between languages, depending on the cues of the context (Bobb & Wodniecka, 2013; Christoffels et al., 2007), they name slower in L1 than in L2 (Christoffels et al., 2007). In this dual context, both L1 and L2 are highly coactivated, so to access words from the less proficient language, it is necessary to suppress or inhibit the more dominant L1 during L2 processing to a greater extent than the weaker L2 needs to be suppressed during L1 processing, as evidence that the immediate contextual and situational demands modulate the availability of each language (Gollan & Ferreira, 2009;

Yang et al., 2018). In addition, bilinguals who live and speak in dual-language contexts have shown a more efficient resolution of conflicts than bilinguals who live and speak in a single-language context (Hartano & Yang, 2016; Ooi et al., 2018).

An immersive context seems to have an important role in the accessibility of the L1 and L2 (Baus et al., 2013; Linck et al., 2009) and in cognitive control (Beatty-Martinez et al., 2019). After an intense immersion experience, bilinguals have shown a reduction in accessibility to their L1 in comparison with classroom learners, indicating that, during L2 immersion, the L1 is inhibited (Link et al., 2009). Coactivation effects, such as grammatical gender information, seem to disappear in immersive contexts (Morales et al., 2014). These results point to the necessity of taking into account the nuances of the language environment (see Beatty-Martínez et al., 2019).

The linguistic context is not only relevant at the specific time for language production, but it also has an influence during the language-learning process. The first trajectory in terms of language exposure seems to both modulate the course of language development (Iverson et al., 2003) and have an important impact on brain organization (Mechelli et al., 2004; Newman et al., 2002). Children are born open to the language of their environment (Byers-Heinlein et al., 2010; Werker & Byers-Heinlein, 2008). The factors that characterize the environment and the nature of language input have been pointed out as important modulators (Kroll et al., 2018; Zirnstein et al., 2019), especially during the early years of development (Iverson et al., 2003; Mechelli et al., 2004; Newman et al., 2002). In this sense, age of acquisition (AoA) has been an important factor to study when investigating language coactivation and language production (e.g., Canseco-Gonzalez et al., 2010; Shook & Marian, 2019).

The variability in language exposure and context during learning has increased due to international mobility, multicultural families, immigration, and government policies to maintain and support minority languages and minority communities. A comparative approach that examines language experiences during learning can facilitate a better conceptual understanding of bilingualism and language processing. Regarding the main argument of the dissertation and this specific chapter, we will discuss here the nature of L2 input as an important factor that can modulate language processing. However, we would like to highlight the importance of other factors, such as social and cultural aspects, although they will not be discussed here in depth (see Pearson, 2007 for further discussion).

Classic psycholinguistic studies have focused on the nature of language input as a critical factor modulating language proficiency and language use. Differences in the quality and quantity of input influence the process of language acquisition and have important effects on language outcomes, such as the number of words in vocabulary (Hoff et al., 2012; Paradis et al., 2011). The nature of language input has a direct link with language proficiency (see the input-proficiency-use cycle, Pearson, 2007). However, recent approaches also emphasize the context of learning as influencing specific features of the language. As mentioned, the evidence suggests that phonemic learning favors an immersive context over classroom settings (Jacobs et al., 2016) and that language control is stressed in immersive contexts (Link et al., 2009).

However, if context is broadly considered, it is evident that people learn different languages in distinctive sociolinguistic contexts, resulting in a wide variety of monolingual and bilingual speakers, including speaking two languages, speaking only one language while signing the other, speaking several languages without being literate in all of them, and speaking one language without knowing how to write due to informal education. In this context, a special situation group would be the children of immigrants in a community with a different majority language. Here, the home language is not the dominant language of the community, and the children are learning two languages in special situations. That is, they are immersed in a minority language at home and a majority language at school with new social relationships. These speakers inherit the minority language at home, with the L1 being their parents' language; they are heritage speakers (HSs; Valdés, 2005) and the most representative of bilinguals in the United States (American Academy of Arts and Sciences, 2017).

These HS bilinguals could be qualitatively different from monolinguals and late bilinguals (see Kupisch & Rothman, 2016; Montrul, 2016; Polinsky, 2018; Rothman, 2009). HSs are exposed to a specific language during childhood, but at a certain point in their lives, they change to the socially dominant or majority language (Scontras et al., 2018), sequentially or simultaneously (Rothman, 2009). This switch in language use results in a downward trajectory of the heritage language and an incremental development of the dominant language (Valdés, 2000). HS bilingualism is usually imbalanced and L2 dominant, with variable competence in the heritage language.

In typical late-sequential bilingualism, children learn the majority language at home and school and can use this language in their daily context, and they later learn a second language, which is less frequently used in their context (Figure 7a). However, HS bilinguals are highly exposed to a language before switching to the majority language (Figure 7b; Rothman, 2009; Scontras et al., 2018).

The consequences of the differential developmental trajectories for the two languages impact the quantity and quality of the input, with the heritage language restricted to a naturalistic environment (home/family context) and characterized by poorer input quantity and quality (e.g., Bayram et al., 2017; Karayayla & Schmid, 2017), which is usually reduced to oral interactions.

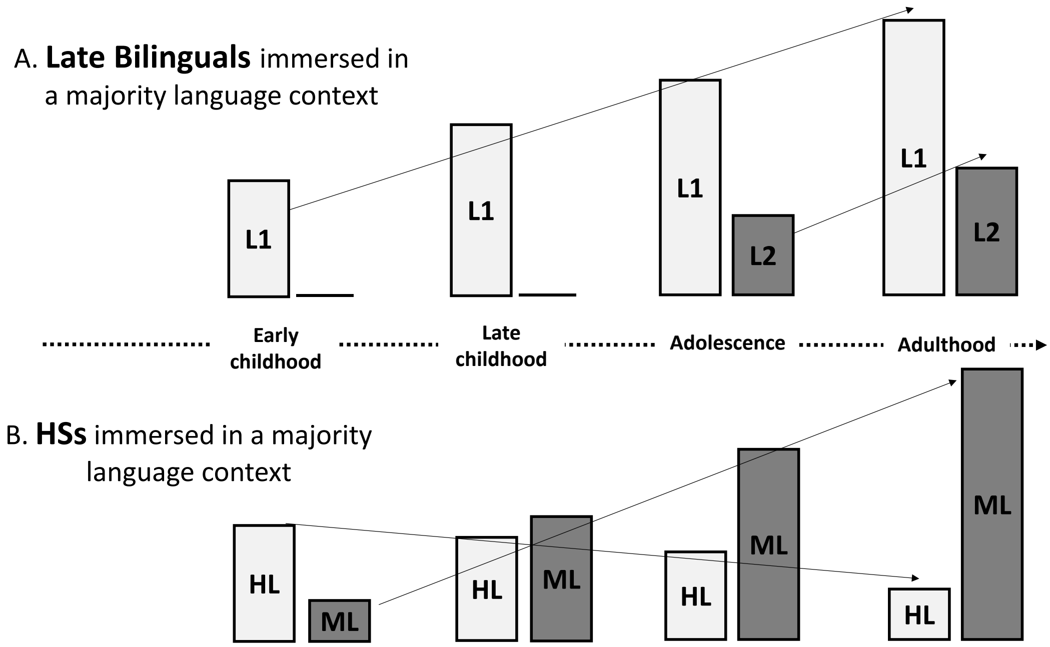


Figure 7. The developmental dynamic of L1/majority language (ML; English) and L2/minority language (heritage language: HL) in late bilinguals (A) and heritage speakers (B), both immersed in a majority language context (adapted from Montrul, 2012).

If the heritage language is not academically supported at school, as is most often the case, the outcomes will be a non-native-like competence, with better comprehension skills than production skills and evidence of important grammatical errors, such as gender agreement or word order (Montrul, 2011; O'Grady et al., 2011). Some production and comprehension problems have been pointed out in HSs (Fenyvesi, 2005; Polinsky, 2006), showing general linguistic insecurity (Klein & Martohardjono, 2009). These critical differences in language use, and the fact that they represent a large bilingual population, make it important to investigate how linguistic processing is modulated by this language experience. This is even more important when investigating writing processes since they constitute a special bilingual population where many linguistic skills in one language were not acquired through formal education.

In sum, some characteristics of writing skills (slower production rate, the need for formal education, a later learning process; see Chapter 1) might be especially relevant when considering contextual variables during second-language acquisition. Because writing is conceptually distinguishable from spoken language production and reading, it is relevant to study writing and the variables that influence coactivation and selection in a bilingual context. In the next section, we address the bilingual writing process and the predictions regarding language coactivation during written language production.

LANGUAGE COACTIVATION IN BILINGUAL WRITTEN LANGUAGE PRODUCTION

Considering the impact of written language production in academic, professional, and social contexts (Bazerman, 2009; Graham et al., 2006) and the global expansion of bilingualism (Bhatia & Ritchie, 2014; Graddol, 2004; Grosjean, 2010; Grosjean, 1992; Keirstead et al., 2016; Nikula et al., 2016), the study of the writing processes of bilinguals is clearly relevant. The effect of bilingualism on writing was theoretically addressed for the first time by the theory of bilingual spelling in alphabetic systems (BAST; Tainturier, 2019). The general architecture of BAST is presented in Figure 8.

This model is basically an adaptation and extension of the dual-route theoretical account proposed for monolingual reading (Coltheart et al., 2001) and writing (Tainturier & Rapp, 2001). Accordingly, the model assumes the existence of two processing routes. The lexical route is assumed to be responsible for the retrieval of words from long-term memory. This route might be used to write familiar, short words, and irregular words that do not follow POC rules. In contrast, the sublexical/phonological route relies on POC rules, and it is useful for unknown words, low-frequency words, and pseudowords that do not have a lexical representation. According to the model, the goal of lexical and sublexical processing is to activate sublexical orthographic units at the graphemic level prior to the selection of specific typing strokes or hand movements.

The BAST model proposed some predictions based on spoken language and reading studies in monolinguals and bilinguals, which were extended to bilingual writing without specific evidence from writing tasks in bilingual participants. Thus, following previous evidence on spoken language production (e.g., Colomé, 2001; Costa et al., 2000; Kroll et al., 2012; Marian & Spivey, 2003), access to lexical representations during bilingual writing is assumed to be non-specific so that the representations of both languages are coactivated, even in single-language contexts. Coactivation would include the representation of a target word, the translation equivalents in the non-target language and, to a lesser extent, the semantically and orthographically related words in both languages.

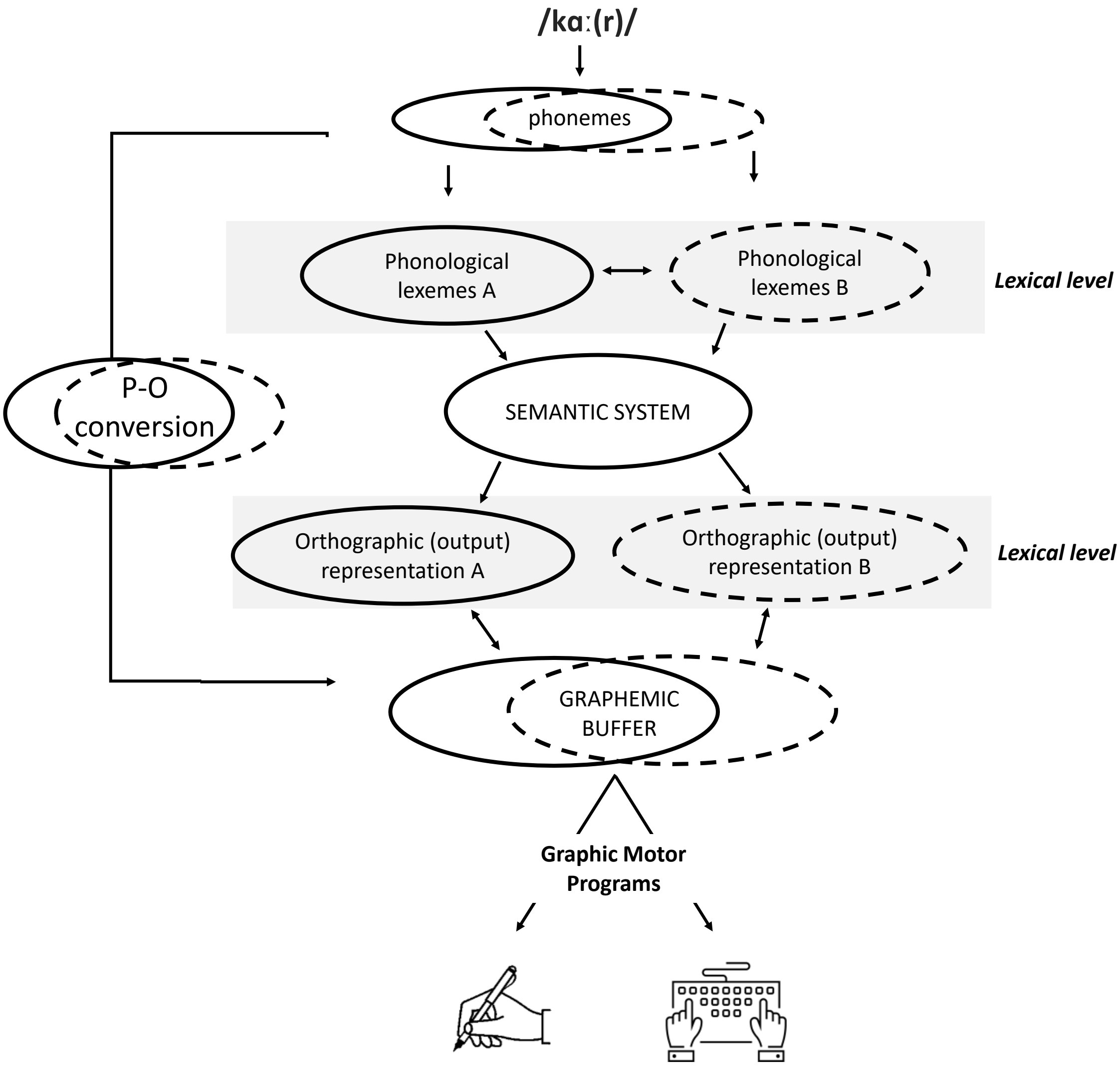


Figure 8. Bilingual spelling in two alphabetic orthographies is represented by solid versus dashed lines. The overlap between representations varies across levels and interlanguage similarities (adapted from Tainturier, 2019).

Similar to spoken language production models, BAST also assumes the spreading of activation through the linguistic system (Collins & Loftus, 1975; Costa et al., 2000; Dell, 1986; Levelt et al., 1999). Specifically, the BAST model proposes that coactivation flows in a cascade between lexical and POC processing and the sublexical graphemic level. The outputs of both routes converge in a shared graphemic buffer where the graphemic representations of the word are stored before the conversion into motor movements. The BAST model proposes that the graphemic buffer includes activated sublexical elements from the lexical and/or POC systems of both languages. Cascade activation assumes both top-down and bottom-up spreading, so that activation spreads from the upper lexical and sublexical levels to the lower graphemic level and vice versa.

Regarding the modulators of cross-language coactivation, the BAST model considered language similarity and language transparency to be the most important factors to address. The strength of coactivation depends on the similarity and overlap between representations in terms of orthographic and phonological similarities. One of the central points in this model is the differential processing of deep versus shallow orthographies. In parallel with the orthographic depth hypothesis, it was proposed that transparent orthographies rely more on phonological and POC processing because of the high consistency between graphemes and phonemes. However, deep orthographies with many inconsistent words rely more on lexical processing (Ziegler & Goswami, 2005). Hence, BAST proposes that similar orthographies such as Italian and Spanish—both of these being transparent orthographies—have stronger coactivation effects across the POC system (sublexical/phonological route) since they have more similarities than, for example, Italian and English, which are transparent and opaque orthographies, respectively.

The BAST model presents some limitations that previous research in writing and bilingualism, separately, have made evident (e.g., Byers-Heinlein, 2013; Fricke et al., 2019; Kroll et al., 2018; van Hell & Tanner, 2012). First, the proficiency of bilinguals in each language was not taken into consideration (e.g., Duyck & Warlop, 2009; Witzel & Forster, 2012). The BAST model assumes that coactivation is equally distributed between the two languages since the predictions of the model were restricted to highly proficient balanced bilinguals. In addition, although it has been proposed that the strength of coactivation depends on orthographic and phonological similarities, the model does not specify which of the two properties has the greater influence during written language production. Furthermore, despite the impact of the environment and the nature of language input during learning on how language is processed (Iverson et al. 2003; Mechelli et al., 2004; Newman et al., 2002) and how phonology and orthography are related, the BAST model does not address this modulator of cross-linguistic coactivation. Lastly, the mechanisms underlying the differential lexical versus phonological processing during writing in opaque versus transparent orthographies are not addressed by the model because “one difficulty in making predictions about bilingual spelling performance patterns is that it requires adopting fine-grained processing assumptions that remain controversial in monolingual research” (Tainturier, 2019, p. 77). Therefore, the BAST model introduces the idea of differential grain coding and differential processing windows associated with lexical and phonological processing depending on the transparency or opacity of the orthography (Ziegler & Goswami, 2005), but the concrete processing underlying these differences has not been specified.

Finally, the model’s predictions were based on evidence in spoken language production and reading, under the assumption that word writing parallels spoken word production. In the present dissertation, we aim to directly address some of these questions by looking at some of the BAST predictions for writing tasks and bilingual contexts.

CHAPTER 3.

WRITTEN LANGUAGE PRODUCTION IN BILINGUALS. OBJECTIVES AND OUTLINE OF THE EXPERIMENTS.

As discussed in previous chapters, the literature on writing remains scarce in comparison with spoken language production literature, and the evidence underlying the predictions of the BAST model comes exclusively from spoken language or reading studies. However, neuropsychological studies and some characteristics of the writing skill (see Chapter 1) make evident the specificities of the writing process and the need to distinguish between written and spoken language production. Therefore, direct cross-task generalization may not be adequate.

The aim of this dissertation is to analyze written language production in bilinguals, with a focus on language coactivation and the time course of activation through the lexical and sublexical levels of processing in the bilingual language system. Additionally, we aim to investigate some modulatory factors, such as the role of proficiency, the interplay of orthographic and phonological similarities, learning background and linguistic experience, and language transparency.

We decided to explore the writing process from the writing-to-dictation perspective for several reasons. Writing to dictation is extensively used in everyday life, especially in educational and work contexts. Writing to dictation is also sensitive to sublexical variables and requires lexical processing (Bonin et al., 2015), which makes it especially suitable to explore the dynamic between lexical and sublexical information. The dynamic of the bilingual language system has been focused on conceptual and orthographically driven processes since the most employed experimental tasks were naming and reading tasks, with much less focus on phonological variables. Writing to dictation provides an opportunity to explore the dynamic of the bilingual system facing phonological input, a modality that has been less investigated.

The assumption of non-specific selection and the consequent coactivation of the representations from both languages has been evidenced in spoken language production (e.g., Broersma et al., 2016; Strijkers et al., 2010) using different experimental paradigms (phoneme-monitoring task, picture-word interference, picture naming) and including different experimental materials (perfect and non-perfect cognates, interlingual homographs; see Chapter 2). However, studies on language coactivation during written language production in both handwriting and typing are practically nonexistent (e.g., Muscalu & Smiley, 2018; Woumans et al., 2021). Considering the specificities of the writing process, research on language coactivation during writing and typing is especially relevant. For this, we will follow the assumptions of the BAST model and apply them to the writing process.

In the **FIRST STUDY** of this dissertation entitled **“Bilingual writing coactivation: Lexical and sublexical processing in a word dictation task”** we addressed the nature of coactivation and the time-course of the activation between lexical and sublexical levels in the dominant-L1 (Spanish) and the weaker-L2 (English) of highly proficient unbalanced bilinguals.

The BAST model proposes that activation flows through the linguistic system in a cascade so that retrieval of the graphemic information starts from the very beginning of the spelling processing, and that the non-selected lexical and sublexical representations propagate activation (Caramazza, 1997; Dell, 1986; Navarrete & Costa, 2005; Rapp & Goldrick, 2000; Starreveld & La Heij, 1996). Importantly, this vision of a flexible and interactive relationship between components comes from writing studies that showed that the interactions between the central linguistic and peripheral motor processes occur in a cascade (e.g., Kandel et al., 2013; Roux et al., 2013; Scaltritti et al., 2017). This evidence has been generalized to how language is processed between lexical and sublexical levels without direct evidence that supports this assumption.

In fact, the theoretical frameworks on writing contradict this prediction. That is, the psychomotor model of writing (Kandel et al., 2011; van Galen, 1991) and the two-loop theory of typewriting (Logan & Crump, 2011) conceptualized processing as hierarchical, with output of each stage being the input of the subsequent stage, supporting a more modular and discrete vision. In the same vein, relevant results in bilingual writing using a translation paradigm have found evidence in favor of this more discrete vision (Muscalu & Smiley, 2018). Interestingly, they explored the performance of cognates versus non-cognates in a translation task. Bilinguals had to translate cognates and non-cognates from L2 (English) to L1 (Romanian) and type the translations, and the latency and duration of typing were measured. As mentioned, the latency from the offset of the stimuli to the first keystroke was used for lexical access because during latency, the complete representation of the word to be written would have to be already active, whereas writing duration would capture the retrieval of the sublexical graphemic representation since total time would depend on successful assembly of grapheme information. The results showed shorter lexical latencies for cognates than for non-cognates, suggesting that lexical access was facilitated by the cognate status of the words. In contrast, they observed longer sublexical durations for cognates, indicating that orthographic overlap interfered with sublexical retrieval. As facilitation and interference operated serially, they interpreted hierarchically influenced lexical and sublexical levels as evidence of discrete and modular processing.

One of the most important limitations of the BAST model is that it was restricted to highly proficient balanced bilinguals. As stated in Chapter 1, bilingualism is a continuum that encompasses many proficiency levels (Cenoz et al., 2003). Hence, many questions about the role of language proficiency in language coactivation during written language production remain unanswered. In general, L1 seems to be less susceptible to language coactivation than L2 (Kroll et al., 2010), although it is necessary to explore whether these possible differences are also present in bilingual writing.

To answer these questions, we implemented the lexical versus sublexical, specifically latency versus duration, dissociation introduced by Muscalu & Smiley (2018) in the writing-to-dictation paradigm (Bonin et al., 2015). We took advantage of the orthographic features of Spanish and English orthographies and the presence of polyvalent graphemes in Spanish to create the experimental conditions. Remember that the polyvalent graphemes have two orthographic representations for one single phoneme (b/v; j/g; h/without h; q/c; z/c; ll/y; gu/g; x/s; m/n in the vowel-[V]consonant [C] structure). The congruent condition consisted of words whose translations contained the same representation for the polyvalent grapheme (e.g., *g* in English and Spanish; surgery, cirugía). The incongruent condition consisted of translations that had different representations of the polyvalent graphemes in each language (e.g., *v* in English and *b* in Spanish governor, gobernador). To explore the possible differences between L1 and L2, both English and Spanish blocks were included and counterbalanced.

We hypothesized faster and more accurate performance with words with congruent representations between languages in the specific polyvalent graphemes than words with incongruent representations as evidence of language coactivation in writing, specifically in the writing duration as evidence of sublexical representation coactivation. Additionally, if the processing is discrete and modular, and the lexical access is consequently prior to sublexical retrieval, the lexical latency should not show any orthographic congruency effect. On the contrary, if the processing is cascaded and non-modular, the orthographic congruency effect would be evident in lexical latency. We expected to find larger and more widespread coactivation effects in L2 than in L1 as evidence of the higher susceptibility of L2 to language coactivation.

In the **SECOND STUDY** of this dissertation entitled "**The Influence of Cross-Linguistic Similarity and Language Background on Writing to Dictation**" we addressed the interplay of orthographic similarities (OS) and phonological similarities (PS) during written language production in two populations with different learning backgrounds: late bilinguals (LBs) and heritage speakers (HSs).

The BAST model assumes that the strength with which the representations are coactivated depends on the similarity of and overlap between languages. Evidence in favor of this idea is the cognate facilitation effect, which seems to be greater for identical cognates than non-identical cognates (Comesaña et al., 2015; Guasch et al., 2017), with larger facilitation for greater orthographic similarity (Dijkstra et al., 2010). However, the similarity between languages is not restricted to OS, since OS interacts with PS. However, as we pointed out in Chapter 2, the role of phonology during processing is controversial, as there are studies in which PS affects performance (e.g., Marian et al., 2008), and others in which it does not seem to have an influence (e.g., Comesaña et al., 2012; Schwartz et al., 2007). The obligatory phonological mediation hypothesis (Rapp & Caramazza, 1994) proposes that the activation of phonological information is mandatory, so the linguistic output would be affected by PS between languages. In contrast, the orthographic autonomy hypothesis (Miceli et al., 1997; Rapp & Caramazza, 1997; Rapp et al., 1997) assumes that the orthography is activated directly from the lexical-semantic system without phonological activation, and hence, the linguistic output would not be affected by PS. Most reading studies focusing on the interplay between OS and PS (Comesaña et al., 2012; Schwartz et al., 2007) have shown that the coactivation of phonology seems to be OS-dependent, thus favoring the orthographic autonomy hypothesis, as only when the OS between languages was high was the phonology activated. However, it is necessary to explore the role of PS in writing, especially in writing to dictation, where phonological processing is mandatory.

An effective approach to explore the interplay of OS and PS seems to be the orthogonal manipulation of both variables (Comesaña et al., 2012; Schwartz et al., 2007), creating four main conditions: O+P+ (hospital-HOSPITAL), O+P− (genuino-GENUINE), O−P+ (noción-NOTION), and O−P− (músculo-MUSCLE). Following previous studies (i.e., Schwartz et al., 2007), we included cognates and non-cognates in the writing-to-dictation task. We also included the orthogonal manipulation of OS and PS in the cognate conditions.

Following previous studies investigating bilingual word recognition, we expected that the cognate facilitation effect (e.g., Costa et al., 2005; Dijkstra et al., 2010; Hoshino & Kroll, 2008; Lemhöfer et al., 2008) would be modulated by orthography and, more importantly, also by the phonological overlap across languages. However, although evidence in reading studies (Comesaña et al., 2012; Schwartz et al., 2007) has indicated that phonology is OS-dependent in favor of the orthographic autonomy hypothesis, we proposed that there is a bias in reading toward orthographic analysis, whereas in writing to dictation, this might not be the case. That is, the input for reading is a string of letters, so the first analysis would be orthographic and phonological activation would occur subsequently; thus, phonological activation would not affect response times. However, during a writing-to-dictation task, the first input is phonological and precedes activation of orthographic information; therefore, the phonology would directly impact performance. As such, we hypothesized that in writing to dictation, phonology would have a general effect that would not be mediated by OS.

Importantly, although the BAST model does not address any modulator of the activation levels in the bilingual system, the activation and the strength of the activation of specific features, such as phonology and orthography, may depend on the type of previous language experiences (e.g., the context of learning; Jacobs et al., 2016). Language background can have consequences for language processing (Fricke et al., 2019; Kroll et al., 2018) and language outcomes (Byers-Heinlein, 2013; Place & Hoff, 2011). In this context, it is fundamental to consider differences between naturalistic and classroom settings (Rothman & Guijarro-Fuentes, 2010). It is well known that in a naturalistic setting, the input is mostly oral and phonological, in comparison with classroom settings where the input is mostly written and orthographic.

To explore the impact of the learning background on coactivation and on the relationship between orthography and phonology during written language production, we included populations with extreme differences in the learning environment in one language (Spanish) and minimal differences in the other (English). The first group was composed of native English speakers who were Spanish learners. In this case, they were LBs with formal education in Spanish. The other group was composed of Spanish HSs who had acquired English and Spanish at an early age in their households but did not receive formal education in Spanish. Both groups were immersed in an English-dominant context, and they received formal education in English. Hence, in this study, our comparison focused on the differences between academic literacy experience and formal instruction in Spanish and English and academic literacy experience and formal instruction in only English (Carrasco-Ortiz et al., 2019).

Because HSs seem to have phonological advantages in comparison with L2 learners (Chang et al., 2011; Gor, 2014) but also have difficulties in orthography due to their reduced contact with formal orthographic input during learning (Elola & Mikulski, 2016), we expected stronger impact of PS in HSs but stronger impact of OS in LBs as evidence of the impact of learning background on language processing during written language production.

In the **THIRD STUDY** of this dissertation entitled "**Transfer effects from language processing to the size of the attentional window: the impact of orthographic transparency"** we addressed the possible differential processing depending on the transparency in writing to dictation. We aimed to extend the evidence from reading theories (orthographic depth hypothesis and psycholinguistic grain size theory) to word written language production in monolinguals (Experiment 1), and bilinguals (Experiment 2). Additionally, we explored the grain size change in bilinguals for different transparencies.

The BAST model, following the orthographic depth hypothesis for reading, proposed differential processing in opaque versus transparent orthographies based on the regularity of the grapheme–phoneme correspondences (Frost et al., 1987). Deep orthographies with many inconsistencies rely more on lexical processing, while transparent orthographies with high regularity rely more on phonological processing (Bolger et al., 2005; Seymour et al., 2003; Ziegler & Goswami, 2005). Additionally, BAST introduces the idea of differential grain coding and differential processing windows associated with lexical and phonological processing depending on the transparency or opacity of the orthography (Ziegler & Goswami, 2005) but without concrete specifications.

Following PGST (Ziegler & Goswami, 2005), orthographic depth should have an impact on the size of the visual grain during processing (Franceschini et al., 2021; Perry et al., 2010) as a consequence of lexical or phonological preferential processing. Although it is necessary to test this relationship in monolingual writing, a prediction from this is that bilinguals may adapt their reading grain size with the transparency of each language (Buetler et al., 2014; Rau et al., 2015) or accommodate their processing into a hybrid grain size (Lallier & Carreiras, 2018) during written language production.

We selected Spanish as a transparent orthography and English as an opaque orthography based on the opacity-transparency continuum (Liu & Cao, 2016; Perfetti & Dunlap, 2008). Thus, three groups of participants performed a writing-to-dictation task: English monolingual, Spanish monolingual, and Spanish-English bilingual. To explore the dominance of lexical versus phonological processing during writing, some linguistic properties were considered. Specifically, frequency, AoA, and concreteness were considered lexical properties (Bonin et al., 2004) and were expected to have effects when the dictation task was performed in the opaque orthography. On the contrary, word length and orthographic neighbors were considered sublexical/phonological properties (Burani et al., 2007), and expected to have effects when the dictation task was performed in the transparent orthography.

To explore the transfer effects from language transparency to attentional windowing, the global-local letter task (Navon, 1977) was administered after each block. Participants were presented with a large letter composed of small letters, and they were instructed to respond to the large letter (global task) or the small letters (local task). We hypothesized that phonological processing in a transparent orthography would activate local attentional processing, while global processing would be induced by lexical processing in an opaque orthography.

To explore the grain size change in bilinguals, Spanish-English bilinguals performed the writing-to-dictation task in both languages. The task was composed of 2 separated and counterbalanced Spanish and English blocks. We explored the transfer effects from differential language processing depending on the opacity or transparency of the language over the attention task. We expected to find evidence of phonological processing when performing a Spanish block of the dictation task (effect of length and orthographic neighbors) and evidence of local processing in the subsequent attentional tasks. In contrast, we expected to find evidence of lexical processing when performing an English block of the dictation task (frequency, AoA, and concreteness) and evidence of global processing in the subsequent attentional task. This pattern would support the idea that bilinguals adapt their processing to the orthographic transparency of the language. That is, bilinguals adapt their processing mode and grain size depending on the transparency of the orthography that they are using in each moment.

In sum, the empirical work in this thesis addresses eight main questions across the three studies which constitute the chapters of the experimental section following the general structure below:

*CHAPTER 4. “**Bilingual writing coactivation: Lexical and sublexical processing in a word dictation task***

(1) Language coactivation at sublexical level
(2) The time course of the activation
(3) The role of proficiency: the differences between the dominant-L1 and the weaker-L2

*CHAPTER 5. “**The Influence of Cross-Linguistic Similarity and Language Background on Writing to Dictation**”*

(4) The coactivation at lexical level and the impact of orthographic (OS) and phonological similarities between languages
(5) The influence of the context of learning

*CHAPTER 6. “**Transfer effects from language processing to the size of the attentional window: the impact of orthographic transparency**”*

(6) The impact of language transparency on the linguistic processing
(7) The impact of language transparency on the attentional windowing in monolinguals
(8) The changes of the grain size in bilinguals to different transparencies

PART II

EXPERIMENTAL SECTION

CHAPTER 4.

BILINGUAL WRITING COACTIVATION: LEXICAL AND SUBLEXICAL PROCESSING IN A WORD DICTATION TASK

ABSTRACT

Bilinguals' two languages seem to be coactivated in parallel during reading, speaking, and listening. However, this coactivation in writing has been scarcely studied. This study aimed to assess orthographic coactivation during writing to dictation. We took advantage of the presence of polyvalent graphemes in Spanish (one phonological representation with two orthographic specifications, e.g., / b /for both the graphemes v and b) to manipulate orthographic congruency. Spanish–English bilinguals were presented with cross-linguistic congruent (mo**v**ement–mo**v**imiento) and incongruent words (go**v**ernment–go**b**ierno) for a dictation task. The time and accuracy to initiate writing and to type the rest of the word (lexical and sublexical processing) were recorded in both the native language (L1) and the second language (L2). Results revealed no differences between conditions in monolinguals. Bilinguals showed a congruency and language interaction with better performance for congruent stimuli, which was evident from the beginning of typing in L2. Language coactivation and lexical–sublexical interaction during bilinguals' writing are discussed.

Keywords. Bilingual writing processing; language coactivation; cross-linguistic orthographic effect; writing to dictation; polyvalent graphemes.

Iniesta, A., Paolieri, D., Serrano, F., & Bajo, M. T. (2021). Bilingual writing coactivation: Lexical and sublexical processing in a word dictation task. *Bilingualism: Language and Cognition, 24*, 902-917. doi: 10.1017/ S1366728921000274

INTRODUCTION

A large number of studies have shown that, when bilinguals produce or understand a message in a language, the representation of the non-required language is activated in parallel (Costa et al., 1999; Kroll et al., 2008; Marian & Spivey, 2003; Sadat et al., 2015). Bilingual production models postulate that the conceptual representations of the intended message spread activation to the corresponding lexical representations of the two languages. Hence, bilingual speakers need not only to select the lexical node corresponding to the target concept, but also the lexical representation that corresponds to the intended appropriate language (Costa, 2005; Costa, et al., 1999; Green, 1998; Hermans et al., 1998; La Heij, 2005; Poulisse & Bongaerts, 1994). In addition, bilingual comprehension models (e.g., Bilingual Interactive Activation Plus - BIA+ model; Dijkstra & Van Heuven, 2002) postulate that bilinguals have a unified orthographic lexicon with lexical nodes for words in both languages. Thus, the visual presentation of a word would lead to the coactivation of associated orthographic and phonological representations of the words in the two languages, which in turn would activate their semantic representations (Dijkstra & Van Heuven, 2002; Lemhöfer & Dijkstra, 2004).

Much of the evidence of bilingual language coactivation derives from the study of cognate words; this type of word shares phonological–orthographic representations across languages (e.g., piano in both, English and Spanish), and they are easier to process during production (e.g., Broersma et al., 2016; Christoffels et al., 2007; Gollan & Acenas; 2004; Linck et al., 2008; Strijkers et al., 2010) and word recognition tasks (e.g., Dijkstra et al., 2010; Lemhöfer & Dijkstra, 2004; Peeters et al., 2013; Van Hell & Dijkstra, 2002). Language coactivation has also been observed through interference phenomena with interlingual homographs (e.g., Martín et al., 2010); with this type of word, the orthographic representation is analogous between the two languages, but the meaning is different (e.g., pie means foot in Spanish, but type of dessert in English). Interlingual homographs are slower to process in both production and comprehension tasks due to the activation of two competing meanings from the two coactivated languages (Jared & Szucs, 2002; Lagrou et al., 2011; Lemhöfer & Dijkstra, 2004; Martin et al., 2010; Smits et al., 2006).

Therefore, simultaneous activation of the two languages in bilingual populations may facilitate or interfere with word processing (e.g., Costa et al., 2003; Poulisse & Bongaerts, 1994). According to Gollan and Kroll (2001), facilitation and interference effects are due to the interplay between activation and selection processes during word retrieval. On the one hand, facilitation can be interpreted as a cross-linguistic activation of both languages including an effective selection of the correct representation (Kroll et al., 2006). On the other hand, interference can also be interpreted as coactivation of the two languages, but in this case, reflecting more difficult selection processes where the competition between representations may not be effectively resolved (e.g., Hermans, 2004; see Santesteban & Schwieter, 2020 for a review).

Language coactivation has been shown to involve all linguistic levels: conceptual, lexical, or sublexical levels (Jacobs et al., 2016; Kroll et al., 2006). Although speech production models assume that activation at the conceptual level spreads to the lexical level (e.g., Caramazza, 1997; Dell, 1986; Levelt, 1989), there is still no agreement about how this activation propagates between lexical and sublexical representations (Muscalu & Smiley, 2018). Discrete processing models

(Levelt, 1989; Levelt et al., 1991; 1999) posit that activation occurs in a top-down direction so that lower levels are activated only after higher levels have been activated and selected. Thus, according to these models, activated lexical representations that are not finally selected do not spread activation to their corresponding sublexical (orthographic–phonological) elements. In contrast, cascade models (Caramazza, 1997; Dell, 1986; Navarrete & Costa, 2005; Rapp & Goldrick, 2000; Starreveld & La Heij, 1996) assume that any activated lexical representation propagates activation to its sublexical segments even if they have not been selected. In addition, these models assume that activation spreads both top-down and bottom-up, so that selection at the lexical level could also be influenced by the activation of their corresponding semantic and phonological representations (MacKay, 1987; Morsella & Miozzo, 2002; Perfetti et al., 1988) or orthographic representations (Lambert et al., 2011; Paap & Noel, 1991).

Current knowledge about the processing architecture underlying language production in bilinguals is considerable; however, this knowledge comes mainly from studies on spoken language (e.g., Butterworth & Hadar, 1989; Dell, 1986; Garrett, 1975; Kuipers & Thierry, 2010; Levelt, 1989), and far too little attention has been paid to written production. Given the relevance of writing in professional and social productivity (Graham et al., 2006), it is important to also understand how bilingual coactivation affects activation and selection at different linguistic levels during writing.

Previous writing studies have used writing to dictation paradigms due to their high sensitivity to sublexical variables (Bonin et al., 2015) and have measured latencies from the onset of the spoken target word until the first stroke as the main measure to capture all the processes involved in this time window (Levelt, 2002; Sternberg, 2001), including spoken word recognition and lexical access. Once the first letter is typed, sublexical processes and response execution are assumed to begin and proceed until the complete word is typed. Hence, the latency to initiate writing is assumed to capture lexical access (lexical latency), indicating that the participant accessed the complete lexical word representation of the target before starting to write it. In contrast, the duration of each writing response would be capturing sublexical processing (sublexical latency) because it indicates the time to retrieve orthographic segments from the target word and the time to produce it (see Muscalu & Smiley, 2018 for a similar approach). These two stages of processing (lexical and sublexical) are also associated with the proposal of Logan and Crump (2011) that there are two distinct processing loops of typewriting: the outer loop is related to the generation of a lexical representation (first key performance), and the sublexical inner loop is related to keystroke production (rest of the word performance).

However, similar to spoken production and comprehension in bilinguals, there is no consensus on the temporal dynamics between lexical and sublexical processing during writing. Thus, although lexical effects are assumed to appear at the first letter typing latencies, and the sublexical effects at whole word typing times, there are numerous reports of both lexical and sublexical effects on writing latencies that show different patterns. For example, a sublexical effect such as orthographic regularity has been reported for first letter latency, where only lexical effects are assumed to occur (Bonin, et al., 2015; Bonin et al., 2002; Bonin et al., 2001), while a lexical property such as lexicality has been reported in whole word writing times where only sublexical effects are assumed to occur (Delattre et al., 2006; Roux et al., 2013), and therefore much more research is needed to clarify the effects, especially in bilinguals for which the research on writing is very scarce.

One of the few studies exploring coactivation in bilingual writing and the time course of lexical and sublexical processing in typing production was reported by Muscalu and Smiley (2018). In their experiment, Romanian–English bilinguals with a medium- to a high-level of English translated cognate and noncognate words from L2 (English) to L1 (Romanian) and typed their word translations. Stimuli were presented either in visual or in visual and auditory modalities, and participants were asked to type the first letter or the entire Romanian translation (depending on the instructions in different experimental conditions). They recorded the time to initiate writing (first letter latency) and the duration of each writing response (the writing offset for the rest of the word) with the purpose of capturing lexical access and sublexical processing, respectively. The results showed shorter lexical latencies (latency to initiate writing) for cognate in comparison with noncognate words, suggesting that lexical access in producing the first letter was facilitated by the lexical cognate status of the words, in line with previous findings in bilingual comprehension and production (Costa et al., 2000; Dijkstra, et al., 2010; Gollan & Acenas, 2004; Kroll & De Groot, 1997; Macizo & Bajo, 2006). In contrast, they observed longer writing offset latencies (sublexical) for cognate words, indicating that orthographic overlap interfered with the typing response of the overall word, a measure that is considered to capture sublexical processes. They interpreted this pattern of results by considering that facilitation and interference operate serially during retrieval and production, in contrast to cascade models which would have predicted that orthographic (sublexical) conflict would also affect lexical processing in a bottom-up manner (Dell, 1986). Thus, in accordance with discrete processing models (Levelt, 1989; Levelt et al., 1991; 1999) facilitation and interference occur at distinct stages, and lexical and sublexical levels are hierarchically influenced.

Because the study by Muscalu and Smiley (2018) was the first study reporting this dissociation, and lexical and sublexical effects do not always behave in a consistent manner, more evidence including different tasks and stimuli is needed to support this lexical–sublexical hierarchical influence. This is especially important since the critical cognate vs noncognate condition in the study by Muscalu and Smiley (2018) involves a lexical more than an orthographical (sublexical) manipulation. In their procedure, easier access to the first letter of cognate words in comparison with noncognates could be due to either faster comprehension of the presented words or to faster retrieval of the lexical information of the translated word since participants in their procedure could start writing before the end of the presented words. Thus, the observed interference effects for cognate versus noncognate words in the word offset might be due to the incongruences in the access of the complete orthographical representation, but also to the contrast with the easiness of the first-word selection.

One way of clarifying and extending these findings is to use a procedure that more clearly separates between comprehension and production and to introduce a manipulation that is clearly sublexical. For the latter, it is possible to explore coactivation effects in language combinations where specific single-letter orthographic incongruences can be manipulated. For example, the presence of polyvalent graphemes in Spanish makes it possible to introduce single-letter incongruencies in writing tasks involving Spanish–English bilinguals. Polyvalent graphemes correspond to a within language property in which a phonological representation could have two orthographic specifications (e.g., in Spanish the grapheme v and b share the same phonological representation / b /; Afonso et al., 2014), and the selection of the appropriate segments can therefore be difficult to accomplish (Burani et al., 2007). Previous studies in the monolingual domain have shown that words with orthographically inconsistent segments are read more slowly and written with less precision than consistent words (Defior et al., 2009; Kreiner & Gough, 1990; Mulatti & Job, 2003). This type of orthographic manipulation has not been widely studied across languages in the bilingual population, although it can be a relevant tool to study bilingual orthographic coactivation and the time course of lexical and sublexical activation during writing production.

Current study

The main aim of this study was to analyze whether the non-selective coactivation of the bilinguals' two languages also extends to writing production in L1 and L2. Following Muscalu and Smiley (2018), we included two reaction times measures: first key latencies and rest of the word latencies. The first measure reflects lexical level processing and the second measure reflects sublexical processes, in order to explore the time course of these two types of activation. We examined the mechanism of language selection through a writing to dictation task (Bonin et al., 2005), and manipulated whether the presented word contained polyvalent graphemes. In a meta-analysis including several writing-production tasks (copying, writing to dictation, picture naming), Bonin et al. (2015) pointed out that the writing to dictation task was the most appropriate task for capturing sublexical information. Because we wanted to focus on language selection during writing production and aimed to dissociate this process from the comprehension of the presented word, participants were asked to listen to the auditorily presented words, and not to start writing until a space bar appeared on the screen. In addition, and differently from Muscalu and Smiley (2018) who employed a translations task involving two languages, we used an experimental task in which the stimuli and responses involved the same language. By using this procedure, we tried to avoid the direct activation of the non-intended language.

We took advantage of the orthographic features of the Spanish and English languages and of the presence of polyvalent graphemes in Spanish to create experimental conditions where we introduced congruent and incongruent stimuli to induce between-language interference. Spanish and English orthographies share 26 graphemes, but only 14 of these graphemes represent the same sound in both languages (Sun-Alperin & Wang, 2008). The congruent condition consisted of words whose translations contained the same grapheme of the polyvalent pair (e.g., "v" in English and Spanish, for example, movement–movimiento). The incongruent condition consisted of translations that had different graphemes of the polyvalent pair (e.g., "v" in English and "b" in Spanish, for example, governor–gobernador).

We hypothesized that bilingual language coactivation would be evident in writing, and therefore, the participants' performance for words with congruent polyvalent graphemes would be faster and more accurate than their performance for words with incongruent polyvalent graphemes. We expected that this manipulation would have an effect on the rest of the word latencies since incongruent polyvalent graphemes is a sublexical manipulation that should have an effect on the sublexical measure. In addition, we also aimed to explore the time course of lexical and sublexical processing, that is, if lexical and sublexical processing occurs sequentially or simultaneously in bilingual writing. If lexical processing precedes sublexical processing, and it is not affected by it, the sublexical consistency condition (congruent vs. incongruent) should not be evident in the latency of the first key (lexical latency). In contrast, if lexical access is influenced by sublexical information, the difference between conditions should also be evident in the performance of the first key, suggesting that coactivation in bilingual writing occurs in cascade and includes both lexical and sublexical elements from the very first steps of writing.

METHOD

Participants

Twenty-four Spanish–English bilingual students from the University of Granada (Spain) participated in the study in exchange for partial course credit. They were native Spanish speakers, with high proficiency in English (a minimum level of B2 in the European Language Framework, and a self-reported score greater than 7 for speaking, reading, and understanding), but Spanish-dominant. Two participants were excluded from the study; the first because English was not his primary L2; the second because his data were not recorded due to equipment failure. The remaining 22 participants (8 were male), had a mean age of 22.5 (ranging from 19 to 27 years of age, SD: 2.43). It is important to note that, although the bilinguals had high L2 proficiency and used their L2 daily, they were not balanced bilinguals, and they were immersed in their L1 environment for many of their activities.

In addition, 22 Spanish monolinguals from the University of Granada (7 males, mean age: 22.05, SD: 3.22) and 23 English monolinguals from Pennsylvania State University (State College, PA, USA; 3 males, mean age: 21.86, SD: 2.62) were recruited as control groups for the selection of the experimental materials. Participants did not have any type of hearing or uncorrected visual impairments, and they did not report language or neurological deficits. All the participants in this study had typing skills and were able to type using all 10 fingers (assessed visually).

A minimum sample size of 22 was required to obtain 95% power to detect a moderate effect of Cohen's $f = .40$ (Cohen, 1977) and a $\eta^2_p = .14$ based on a priori calculation with the G*Power program for F tests (Test family) specifying repeated measures analysis of variance (ANOVA) with two (congruent vs. incongruent) conditions (Erdfelder et al., 1996). In addition, Muscalu and Smiley (2018), following a procedure similar to that used in the present study, also included 22 participants in the bilingual group. As our data were implemented in mixed-effects regression analysis, we performed an a posteriori analysis of our sample size based on Markov Chain Monte Carlo (MCMC) sampling (Brysbaert & Stevens, 2018) in order to check that the number of participants that we included was enough for the analysis with the subject and items as random effects. We used the data of our first 10 participants as pilot data. The simulation analysis using the SIMR package was implemented with the software R statistics (Green & MacLeod, 2016; R Core Team, 2014). With 100 randomizations, the simulation showed that a sample size of 21 would be needed to accomplish 80% power (95% confidence interval).

The three groups of participants (bilingual and two monolingual controls) completed the Language Experience and Proficiency Questionnaire (LEAP-Q; Marian et al., 2007). Table 1 summarizes the participants' language proficiency characteristics. The questionnaire provides ratings for comprehension, reading, and speaking in L2. In this questionnaire, the item Reading contribution to learning (measured on a scale of 1 to 10 points) reflects the degree of formal language education of the bilingual, which is throughto be an important requirement for correct learning of orthography (Elley, 1991; Elley & Mangubhai, 1983; Hafiz & Tudor, 1990; Mason & Krashen, 1997). All participants reported high scores (>6) in this item, ensuring a high degree of L2 formal education. The experiment was conducted in accordance with the ethical standards approved by the University of Granada Ethical Committee.

Table 1.

Mean scores (with SD in parenthesis) for English language experience in the Spanish–English bilingual group and in the Spanish and English monolingual control groups. Scores refer to English language.

English language		**Spanish–English bilinguals (n = 22)**	**Spanish monolinguals (n = 21)**	**English monolinguals (n = 23)**
Years of exposure		13.14 (3.37)	- -	20.72 (2.6)
Current exposure (%)		30.91 (8.61)	4.57 (3.92)	99.27 (2.33)
Self-assessed capacity	- to speak	7.41 (.91)	2.05 (1.46)	9.72 (.55)
	- to read	7.77 (.81)	2.19 (1.40)	9.81 (.39)
	-to understand	8.05 (0.79)	1.76 (1.30)	9.72 (.46)
Reading contribution to learning		8.45 (1.18)	- -	- -

Materials

We selected 50 nouns (See Appendix 1 for the complete list of the stimuli; pp. 112) in English and 50 in Spanish. For the purpose of the study, we used the Oxford Advanced Learner Dictionary (Oxford University Press, 2013) to search for words that contained polyvalent graphemes. All the polyvalent graphemes present in Spanish (b/v; j/g;

h/without h; q/c; z/c; ll/y; gu/g; x/s; m/n in the vowel-V-consonant-C structure) were included. As a result, we created materials for the two experimental conditions (congruent and incongruent) with 25 words per condition and language: a) congruent condition – words and their translations shared their orthographic representation in critical polyvalent graphemes (e.g., G–G; trian**g**le–*trián**g**ulo*); b) incongruent condition – words that did not share orthographic representations with their translations in the critical polyvalent graphemes (e.g., G–J; gara**g**e–*gara**j**e*).

Items in congruent vs. incongruent conditions were matched for Spanish and English relative lexical frequency (Guasch et al., 2012), English: $t\,(24) = -.16$, $p = .877$, Spanish: $t\,(24) = -.73$, $p = .474$; number of letters (length) (Guasch, et al., 2012), English: $t\,(24) = -1.58$, $p = .128$, Spanish: $t\,(24) = -1.81$, $p = .083$; age of acquisition (AoA) (Alonso et al., 2014; Kuperman et al., 2012), English: $t\,(24) = -1.64$, $p = .115$, Spanish: $t\,(24) = -1.04$, $p = .307$; concreteness (Brysbaert et al., 2014; Duchon et al., 2013), English: $t\,(24) = .63$, $p = .537$, Spanish: $t\,(24) = -.83$, $p = .417$; orthographic neighbors (Marian et al., 2012), English: $t\,(24) = 1.29$, $p = .209$, Spanish: $t\,(24) = 1.58$, $p = .128$, summed bigram frequency (BiF) (Marian, et al., 2012), English: $t\,(24) = -.42$, $p = .676$, Spanish: $t\,(24) = -1.65$, $p = .112$, and the relative position of polyvalent grapheme (dividing the specific position of polyvalent grapheme and the word length), English: $t\,(24) = -1.15$, $p = .260$, Spanish: $t\,(24) = -.940$, $p = .356$.

Finally, orthographic similarity (OS; van Orden & Goldinger, 1994) and Normalized Levensthein Distance (NLD; Levenshtein, 1966; Schepens et al., 2012) between the selected words and their nonresponse language translations were controlled (Guasch et al., 2012); $t\,(24) = .58$, $p = .565$ (OS, English target language); $t\,(24) = .10$,

p = .922 (NLD, English target language); t (24) = –.26, p = .798 (OS, Spanish target language); and t (24) = –.85, p = .401 (NLD, Spanish target language). Based on the OS score (Schwartz et al., 2007), the experimental material was composed mainly of cognate words with low OS between languages (between 0.7 and 0.3; 60% of the stimuli), with the remaining 40% divided between high OS (greater than 0.7; 20% of the stimuli) and noncognates (lower than 0.3; 20% of the stimuli). In addition, the proportion of words that shared the first letter with the translation was similar across the congruent and incongruent conditions was controlled: English: t (24) = 1.28, p = .212; Spanish: t (24) = 1.55, p = .134.

The stimuli for the writing to dictation task were presented in the auditory modality. The words were recorded with a neutral emotional tone, in mono, in 26 bits and with a frequency of 44.100 Hz, and filtered from environmental sounds. Furthermore, we controlled the sound file duration (ms), intensity (db), and fundamental frequency (F0) across conditions. Additionally, and in order to control for the influence of the speaker's gender on lexical access (Casado et al., 2017), we introduced a masculine and a feminine voice that appeared randomly and equally across conditions. The t-test performed on these physical variables did not show significant differences between conditions, t (24) = –.87, p = .391 (English intensity); t (24) = –.43, p = .674 (English F0); t (24) = –1.75, p = .092 (English duration); t (24) = –.09, p = .931 (Spanish intensity); t (24) = –.91, p = .370 (Spanish F0); and t (24) = –1.21, p = .237 (Spanish duration). Table 2 shows descriptive statistics for the experimental material.

Table 2.

Characteristics of the experimental stimuli (mean scores with standard deviation in parenthesis).

		English block		Spanish block	
		Congruent	Incongruent	Congruent	Incongruent
Within-language	Frequency	26.62 (38.14)	28.89 (53.09)	28.64 (37.89)	41.83 (78.59)
	Length	5.96 (1.27)	6.64 (1.99)	6.64 (1.87)	7.60 (2.36)
	AoA	7.09 (1.88)	8.09 (2.43)	6.87 (1.74)	7.51 (2.29)
	Concreteness	3.93 (1.18)	3.72 (1.25)	4.96 (1.40)	5.27 (1.14)
	Neighbors	3.48 (3.93)	2.24 (2.54)	2.28 (3.77)	1.16 (1.49)
	Summed BiF	.04 (.03)	.05 (.04)	.05 (.01)	.12 (.04)
	P.G position	.42 (.25)	.52 (.27)	.44 (.24)	.51 (.32)
Between-language	OS	.51 (.23)	.49 (.19)	.53 (.18)	.54 (.21)
	NLD	.54 (.21)	.54 (.20)	.58 (.19)	.60 (.19)
	First letter	.76 (.44)	.60 (.50)	.84 (.37)	.64 (.49)
Sound file characteristics	Intensity	70.15 (2.91)	70.71 (1.02)	69.95 (1.11)	69.97 (0.15)
	F0	132.10 (52.55)	139.45 (54.93)	139.06 (24.01)	145.44 (26.26)
	Duration	879.56 (107.57)	951.84 (165.37)	1123.68 (150.26)	1191.72 (280.08)

Note. AoA = age of acquisition; BiF = bigram frequency; P.G = polyvalent grapheme (specific position of polyvalent grapheme/word length. Closer to 0 meant that polyvalent grapheme was in initial positions, and closer to 1 meant final positions); OS = orthographic similarity; NLD = Normalized Levensthein Distance; F0 = fundamental frequency.

Procedure

After reading and signing the informed consent form, participants were asked to fill out the LEAP-Q questionnaire (Marian, et al., 2007) to control for their proficiency in English.

The presentation of the stimuli for the writing to dictation task was conducted on a laptop computer using E-Prime version 2.0 (Psychology Software Tools, Pittsburgh, PA, USA). Each trial started with a fixation point which remained on the screen until the audio stimulus finished. Participants heard the target spoken word by headphones, and they were asked to write it as quickly and as accurately as possible in the same language in which they heard it. Participants were asked to start writing at the end of the audio and only after the space bar appeared on the screen. We used this procedure to ensure that the effect that we were capturing was due to the production processes after comprehension had taken place (see Bonin et al., 1998; Chua & Richard Liow, 2014 for a similar approach). Thus, the delay was introduced in order to isolate the writing execution processing of the first letter from the spoken word recognition during writing to dictation (McRae et al., 1990; Savage et al., 1990).

The response was recorded using a QWERTY keyboard, and the letters appeared on the computer screen as they were typed (12-point Verdana font on a black background). The trial finished when the participants pressed the space bar. There was then a black inter-trial screen for 1.000 ms. The participants were instructed to press a random set of keys if they did not know the response, and then go to the next stimulus. An example of the procedure can be seen in Figure 9.

For the bilingual participants, the experiment was composed of an English and a Spanish block. The order of these language blocks was counterbalanced across participants; the presentation of the stimuli within each language block was random; the participant listened to a word in Spanish or English (depending on the block) and had to write this word in the same language. Each block began with 8 practice trials, followed by a block of 50 experimental words. They had a 5 min break between the two blocks. The experimental session lasted approximately 20 minutes. For the two monolingual groups, the experiment consisted of a single block in which they performed the dictation task in their corresponding native language (English or Spanish).

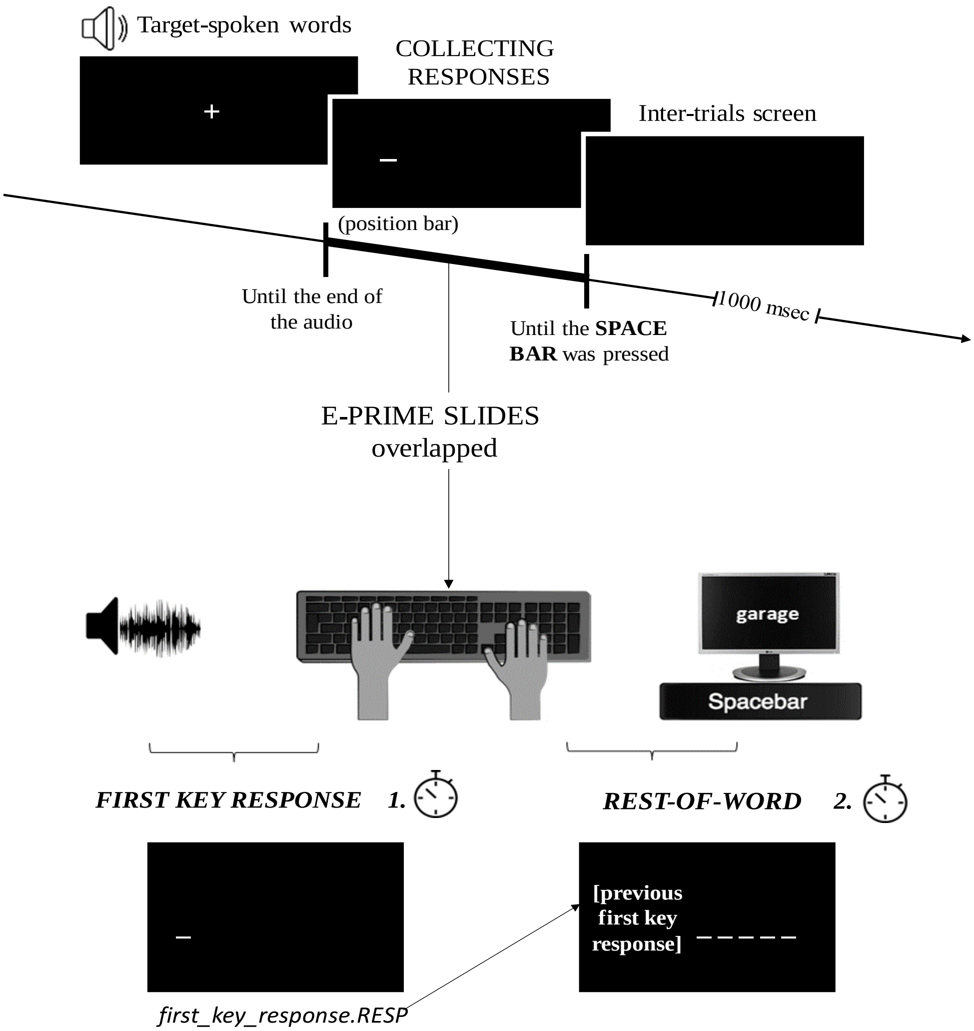


Figure 9. An example of an experimental trial

Following Muscalu and Smiley (2018), two latencies were recorded: 1) from the onset of the signaling stimulus to the first keystroke (lexical latency) and 2) from the first keystroke to the space bar keypress, signaling the final response (sublexical latency). As opposed to Muscalu and Smiley (2018), the two latencies were measured in the same experiment by using two overlapping slides in the e-prime script: the first slide was used to record the first letter and the typing start time, while the second slide was used to record responses for the rest of the word. The *[response.RESP]* e-prime attribute was implemented to register the participant's response from the previous slide automatically and to continue recording the participant's response until the end. This procedure produced an illusion of continuity (see Figure 9) and participants typed the whole word unaware that there were two different slides for the lexical and sublexical latencies.

RESULTS

For analyses, we calculated the mean response times (RTs) for correct responses (CRs) and accuracy (ACC) for each participant and condition for both the first keystroke and the rest of the word. Response times above or below 2.5 SD from the participants' mean were eliminated from the analysis. A within-subject data trimming (e.g., Sullivan et al., 2018) was performed for each monolingual group (2.58% from the Spanish monolingual group, and 2.87% from the English monolingual group) and for each language block in the bilingual group (2.76% of the Spanish block items from the bilingual group; 3.23% of the English block items from the bilingual group).

A mixed-model analysis using the lme4 package (Bates et al., 2015) was implemented with the software R statistics (R Core Team,

2017) by using the ANOVA function with a Kenward–Roger modification for *F*-tests (Halekoh & Højsgaard, 2014). As mentioned, performance of the two monolingual groups were used as controls to test for the experimental material. Note that the critical effect of the polyvalent graphemes should only be present in the bilingual group, since this is assumed to be the result of language coactivation. Analyses on the latencies for these two groups indicated that there was no effect of condition (congruent vs. incongruent) for the Spanish group: first key $F(1, 49.35) = 0.69$, $p = .411$ (congruent mean = 453; incongruent mean = 438) and rest of the word $F(1, 40.34) = .02$, $p = .90$ (congruent mean = 1522; incongruent mean = 1541), nor for the English group: first key (lexical) $F(1, 45.28) = .64$, $p = .428$ (congruent mean = 418; incongruent mean = 440) and rest of the word $F(1, 48.03) = 2.82$, $p = .099$ (congruent mean = 1194; incongruent mean = 1300). The analyses performed for the accuracy data indicated no effect of condition for either the Spanish group: first key $F(1, 48.2) = .21$, $p = .646$ (congruent mean = 0.93; incongruent mean = 0.94) and rest of the word $F(1, 47.20) = .004$, $p = .95$ (congruent mean = 0.91; incongruent mean = 0.91), or the English group: first key $F(1, 49.26) = .42$, $p = .521$ (congruent mean = 0.93; incongruent mean = 0.94) and rest of the word $F(1, 48.24) = .35$, $p = .556$ (congruent mean = 0.95; incongruent mean = 0.92).

In the bilingual group, each ANOVA was conducted with the fixed factors, Language (L1 vs. L2), and Condition (congruent vs. incongruent), and with the random effects, participants, and items. The likelihood ratio test was used to assess the significance of each variable (the code we used in R was as follows: (data <- lmer (RT or ACC ~ Condition * Language + (1|Subject) + (1|Items), data, REML=FALSE). When a significant interaction was found, this was further explored using *post hoc t-tests* with Tukey's multiple comparison correction using the “lsmeans” function. In addition, in order to explore whether the errors were specific to polyvalent graphemes in the bilingual group, we performed additional analyses where we coded as *specific grapheme error* when the error was in a specific polyvalent grapheme, and as *non-specific grapheme error* when the error involved other graphemes in the word (surrounding letters caused by erroneous finger movements by pressing adjacent keys). For this analysis, each ANOVA was conducted with the same fixed and random effects (typeoferror ~ Condition * Language + (1|Subject) + (1|Items), data, REML=FALSE).

First key latency

There were significant effects of Condition, $F(1, 84.21) = 4.61$, $p = .034$, and Language, $F(1, 84.27) = 96.21$, $p < .001$, and an interaction between Condition and Language, $F(1, 84.19) = 4.84$, $p = .03$ (See Figure 10). Thus, when bilinguals did the dictation task in their L2, congruent words (mean = 861) were typed faster than incongruent words (mean = 1203), $t(85.97) = -3.03$, SE = 72.04, $p = .003$. However, in L1, the difference between congruent (mean = 599) and incongruent (mean = 596.82) conditions was not significant, $t(82.39) = .04$, SE = 69.98, $p = .969$.

First key ACC

Analysis showed a significant effect of Language, $F(1, 99.46) = 15.48$, $p < .001$, with more accurate responses for L1 (mean = 0.97) than for L2 (mean = 0.85). However, the main effect of Condition, $F(1, 99.46) = 1.58$, $p = .212$, and the interaction between Condition and Language, $F(1, 99.46) = .004$, $p = .98$, were not significant (see Figure 10). Related to the specificity of errors, there was a main effect of Language, $F(1, 71.57) = 5.14$, $p = .003$. The errors in the Spanish block (mean = 0.66) were more specific than the errors in the English block (mean = 0.34). There was no main effect of Condition $F(1, 69.95) = .02$, $p = .898$ or the interaction between Language and Condition, $F(1, 69.65) = 2.59$, $p = .11$.

Rest of the word latency

There was a main effect of Condition, $F(1, 96.50) = 11.46$, $p = .001$, with faster responses for the congruent (mean = 1411) than for the incongruent condition (mean = 1745). However, the effect of Language, $F(1, 96.73) = .05$, $p = .83$, and the interaction between Condition and Language, $F(1, 96.43) =.45$, $p = .51$, were not significant (See Figure 10).

Rest of the word ACC

The analysis yielded significant main effects of Condition, $F(1, 97.66) = 5 .64$, $p = .02$, and Language, $F(1, 97.67) = 61.74$, $p <.001$, and a significant interaction between Condition and Language, $F(1, 97.65) = 5.45$, $p = .02$. Thus, when the bilinguals were typing the rest of the word in L2, responses were more accurate for the congruent (mean = 0.70) than for the incongruent condition (mean = 0.49), t (97.31) = 3.317, SE = .06, $p = .001$. In contrast, for L1 typing, the difference between congruent (mean = 0.94) and incongruent (mean = 0.94) conditions was not significant, t (98.01) = .03, SE = .06, $p = .977$ (see Figure 10). Related to specificity of error, there was a main effect of Language, $F(1, 75.47) = 5.14$, $p = .02$. The errors in the Spanish block (mean = 0.58) were more specific than the errors in the English block (mean = 0.12). The effect of Condition, $F(1, 75.32) = 3.02$, $p = .09$, and the interaction between condition and Language, $F(1, 75.59) = 2.59$, $p = .96$, were not significant.

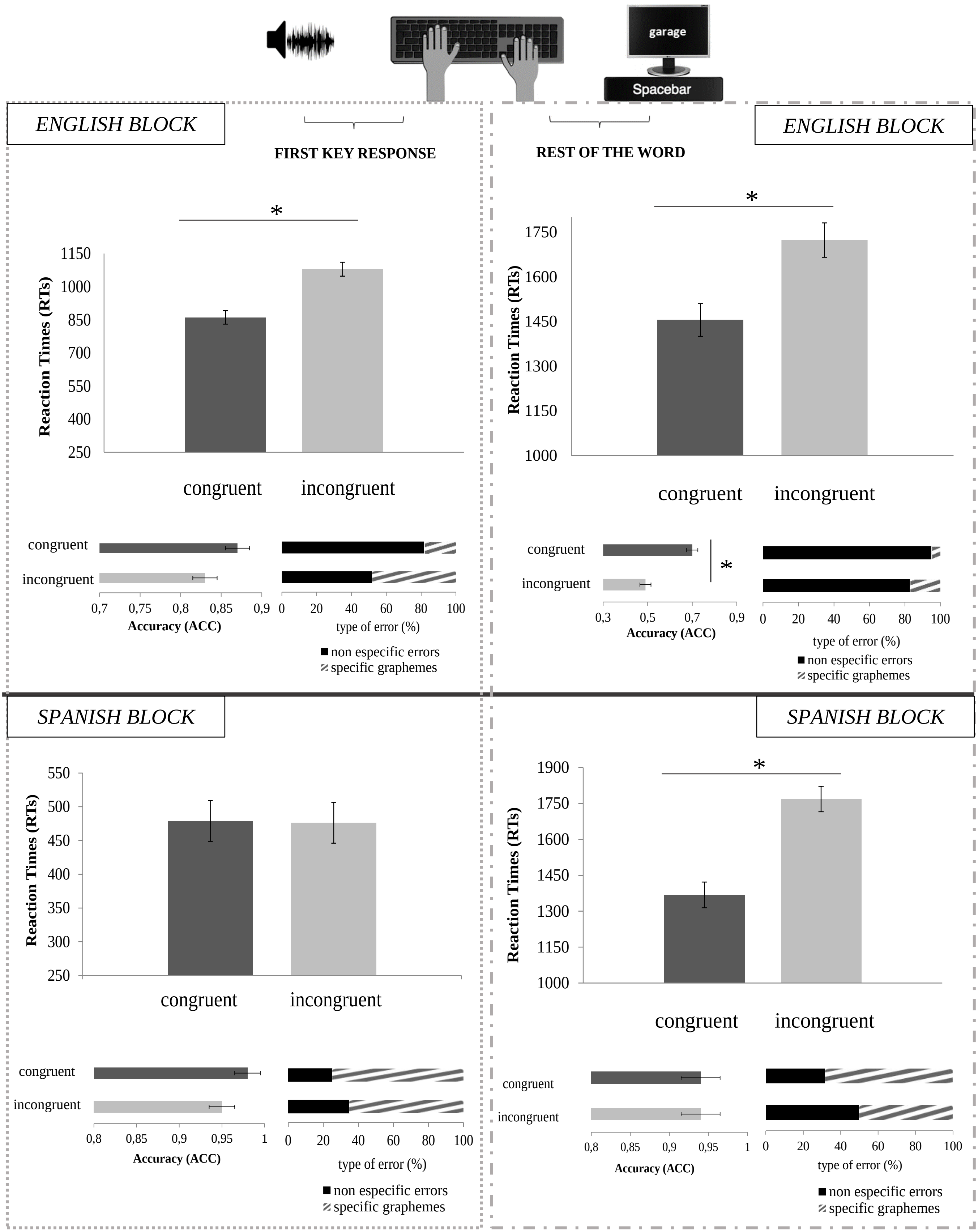

garage
Spacebar
ENGLISH BLOCK
FIRST KEY RESPONSE
REST OF THE WORD
ENGLISH BLOCK
*
Reaction Times (RTs)
1150
1000
850
700
550
400
250
congruent
incongruent
*
1750
1600
1450
1300
1150
1000
congruent
incongruent
congruent
incongruent
0,7
0,75
0,8
0,85
0,9
Accuracy (ACC)
0
20
40
60
80
100
type of error (%)
non especific errors
specific graphemes
congruent
incongruent
*
0,3
0,5
0,7
0,9
Accuracy (ACC)
type of error (%)
non especific errors
specific graphemes
SPANISH BLOCK
SPANISH BLOCK
550
500
450
400
350
300
250
congruent
incongruent
*
1900
1750
1600
1450
1300
1150
1000
congruent
incongruent
0,8
0,85
0,9
0,95
1
Accuracy (ACC)
type of error (%)
non especific errors
specific graphemes

Figure 10. Visual representation of results for the bilingual group. The upper part shows the results for the English block (L2) and the lower part the results for the Spanish block (L1). This represents the data obtained for the RT in ms, accuracy, and specificity of the error for each condition. The left half of the figure shows the data related to lexical processing (first key performance). The right half shows the data related to sublexical processing (rest of the word performance).

To make sure that the orthographic effect in the first key could be interpreted as lexical in nature, we performed an additional (a posteriori) analysis where we eliminated the items in which the polyvalent graphemes were in the first key, and only analyzed the data from words with polyvalent graphemes in any other position of the word[1]. If RTs of the first key reflected lexical and sublexical processing the obtained pattern would be present even when the words did not have polyvalent graphemes in their first position. As predicted, the results of this analysis showed exactly the same pattern as when all the words were included, so that all significant effects and their interactions remained unchanged (See Table 3).

[1]Excluded items: Spanish block, with the English translation on italic letter (babero *bib*, bala *bullet*, guía *guide*, yate *yacht*, bici *bike*, banco *bank*, droga *drug*, barbacoa *barbecue*, zona *zone*, violencia *violence*, jungla *jungle*, vainilla *vanilla*, huérfano *orphan*, hielo *ice*, arpa *harp*, vendaje *bandage*, jirafa *giraffe*, buitre *vulture*, alucinación *hallucination*, armónica *harmonica*) and English block (boat, hawk, hiccup, beast, bottle, vinegar, bible, gender, genius, barrier, horizon, jelly, ginger, ability, varnish, garden, zero, zebra).

Table 3.

The main effects and their interactions in the first key (lexical) and rest of the word (sublexical) performances in the bilingual group with the list of stimuli without polyvalent graphemes in the first letter.

Statistical effects	Writing Performance			
	Lexical latency	Lexical ACC	Sublexical latency	Sublexical ACC
Condition	$F(1, 57.03) = 5.63$, $p = .021$*	$F(1, 61.38) = 2.02$, $p = .159$	$F(1, 59.66) = 7.13$, $p = .009$*	$F(1, 59.66) = 17.89$, $p < .001$**
Language	$F(1, 57.05) = 91.58$, $p < .001$**	$F(1, 61.38) = 8.14$, $p = .005$*	$F(1, 59.69) = .39$, $p = .534$	F 1, 59.65) = 46.90, $p < .001$**
Cond * Lang	$F(1, 57.09) = 4.24$, $p = .043$*	$F(1, 61.39) = .77$, $p = .383$	$F(1, 59.58) = .45$, $p = .501$	$F(1, 59.63) = 23.24$, $p < .001$**

Note. *$p < .05$, **$p < .01$.

In addition, because previous studies including cognates have shown that some effects are restricted to cognate words with high OS between languages (Comesaña et al., 2012; Dijkstra, et al., 2010; Duyck et al., 2007; Schwartz et al., 2007; Van Assche et al., 2011), we performed an additional (*a posteriori*) analysis in the bilingual group.OS was included as a fixed factor, with 3 levels (Schwartz et al., 2007): cognates with a high OS (>0.7), cognates with a low OS (from 0.7 to 0.3), and noncognates (<0.3), along with the previously fixed factors: Language (L1 vs. L2), and Condition (congruent vs. incongruent), participants, and items as random effects. The results showed a significant main effect of OS in the lexical (first key) latency and the sublexical (rest of the word) latency. Tukey's multiple correction *t*-test indicated that, for the first key latency, cognates with high OS (mean = 598) were typed faster than cognates with low OS (mean = 761), $t(112) = -2.625$, SE= 74.8, $p = .041$, but the differences between cognates with high OS and noncognates (mean = 672, $t(113) = -.767$, SE = 95.3, $p = .724$, and between cognates with low OS and noncognates, $t(114) = 1.181$, SE = 75.6, $p = .467$, were not significant. Tukey's test for the rest of the word latency indicated that cognates with high OS (mean = 1879) were typed slower than cognates with low OS (mean = 1544), $t(112) = 2.407$, SE = 139, $p = .046$, and slower than noncognates (mean = 1461), $t(106) = 2.344$, SE = 178, $p = .052$. The differences between cognates with low OS and noncognates were not significant, $t(102) = .776$, SE = 144, $p = .833$. In summary, the OS had a differential effect over lexical (first key) latency and sublexical (rest of the word) latency (Muscalu & Smiley, 2018). During the lexical access, the high OS produced facilitation (cognates with high OS were typed faster than cognates with low OS). On the other hand, during sublexical processing, high OS produced interference (cognates with high OS were typed slower than cognates with low OS). More importantly, however, there were no significant interactions with any other factor, and we obtained the same pattern of significant effects and interactions as in previous analyses (See Table 4), indicating that the congruency effect related to our polyvalent graphemes' manipulation was independent of the cognate status of the words.

Table 4.

The main effects and their interactions in the first key (lexical) and the rest of the word (sublexical) performances in the bilingual group including OS as fixed factor classifying the items in 3 levels (Schwartz et al., 2007): cognates with high OS, cognates with low OS, and noncognates.

Statistical effects	Writing performance			
	Lexical latency	Lexical ACC	Sublexical latency	Sublexical ACC
Condition	$F(1, 83.42) = 4.28$, $p = .041$*	$F(1, 99.74) = .24$, $p = .627$	$F(1, 101.90) = 6.09$, $p = .015$*	$F(1, 97.69) = 7.80$, $p = .006$*
Language	$F(1, 83.58) = 92.08$, $p < .001$**	$F(1, 99.74) = 6.96$, $p = .009$*	$F(1, 102.06) = .03$, $p = .856$	$F(1, 97.69) = 39.15$, $p < .001$**
OS	$F(2, 83.21) = 3.22$, $p = .047$*	$F(2, 99.72) = 1.15$, $p = .322$	$F(2, 95.27) = 3.88$, $p = .024$*	$F(2, 97.67) = 1.33$, $p = .268$
Cond * Lang	$F(1, 83.17) = 3.98$, $p = .042$*	$F(1, 99.74) = .04$, $p = .845$	$F(1, 101.85) = .02$, $p = .891$	$F(1, 97.68) = 4.69$, $p = .032$*
Cond * OS	$F(2, 82.69) = .15$, $p = .856$	$F(2, 99.73) = 1.09$, $p = .341$	$F(2, 101.05) = .38$, $p = .683$	$F(2, 97.68) = 1.85$, $p = .162$
Lang * OS	$F(2, 82.87) = 2.14$, $p = .123$	$F(2, 99.72) = .54$, $p = .586$	$F(2, 101.06) = .36$, $p = .697$	$F(2, 97.68) = .88$, $p = .417$
Cond * Lang * OS	$F(2, 82.35) = .57$, $p = .565$	$F(2, 99.72) = .32$, $p = .723$	$F(2, 101.04) = .44$, $p = .641$	$F(2, 97.67) = 1.14$, $p = .323$

Note. *$p < .05$, **$p < .01$.

DISCUSSION

Writing can be a challenging skill to master (Barca et al., 2007), so that even for skilled writers, producing an orthographically accurate word string can sometimes be demanding (Bourdin & Fayol, 2002).

Knowledge of two or more languages could be an additional challenge for accurate writing since differences in the letter–sound mappings of the two coactivated languages might produce interference (e.g., Escamilla, 2006; Gildersleeve-Neumann et al., 2009). In this study, we aimed to: 1) examine whether non-selective coactivation effects were evident in cross-linguistic orthographically inconsistent segments in a writing production task; and 2) investigate the time course of lexical and sublexical activation in order to conceptualize bilingual writing production as a cascaded interacting process (e.g., Bonin, et al., 2015; Delattre, et al., 2006) or as a discrete serial type of processing (e.g., Muscalu & Smiley, 2018). With this purpose, we asked bilinguals to perform a writing to dictation typewriting task in their L1 and L2, and we introduced between-language orthographic incongruences (polyvalent graphemes) to index coactivation. We looked at accuracy and writing times to the first letter of the word, and to the accuracy and times for the rest of the word as a way of indexing lexical and sublexical coactivation. Although, we used the dictation task instead of translation and the blocked design instead of intermixing languages across trials to avoid the direct activation of the non-intended language, it could still be argued that the use of both languages in the same experimental session could have enhanced language coactivation. However, recent studies have shown that language coactivation occurs even under very stringent single-language contexts, and even when language use is limited to the dominant language (Shook & Marian, 2019; Bobb et al., 2020). In the following subsections, we will discuss the evidence regarding language coactivation, the time course of lexical and sublexical activation, and finally, some issues regarding language differences.

Language coactivation in written production

Regarding the question of whether language coactivation occurs in bilingual written production, our results showed evidence supporting the presence of cross-linguistic orthographic effects in bilingual typing. Thus, for the English–L2 block, the retrieval of the first keystroke, and the time to write the rest of the word were faster in response to congruent than to incongruent stimuli. In addition, participants committed fewer errors with congruent stimuli than with incongruent stimuli. Importantly, these differences were not evident in the monolingual groups, indicating that these effects were not an artifact due to an inappropriate selection of the experimental materials. Hence, these results clearly suggest that language coactivation is also present in bilingual typing production (Muscalu & Smiley, 2018). Overall, this pattern provides evidence supporting the assumption that language coactivation influences the two typewriting loops proposed by Logan and Crump (2011): the outer loop related to the generation of a lexical and graphemic representation (first key performance), and the inner loop related to keystroke production (rest of the word performance). In our study, the incongruent condition was based on the orthographic difference in a critical polyvalent grapheme between Spanish and English, so the results suggested that the letters of both languages might be coactivated and influence the two loops of writing.

However, the obtained pattern also suggested that these orthographic coactivation effects are asymmetrical and different for L1 and L2. Thus, whereas L2 typing showed congruency effects in first letter latency and rest of the word latency and ACC, congruency effects in L1 were only observed in typing latencies for rest of the word. This differential pattern suggests that, similar to spoken production, L1 might be less susceptible to language coactivation than L2 (Kroll et al., 2010). Thus, the greater susceptibility to coactivation effects for L2 was evident in the lexical and sublexical measures for the English block (L2) where there were differences between congruent and incongruent words in ACC and/or RTs, whereas coactivation was only evident in reaction times to sublexical processes (rest of the word) for the Spanish block (L1). Note that participants in this experiment were late bilinguals and dominant in Spanish. Hence, the differences between L1 and L2 could be explained in terms of changes in the associative relationship between languages depending on proficiency and AoA (Blumenfeld & Marian, 2007; Silverberg & Samuel, 2004). Thus, lexical access in L1 seems to be more resistant to sublexical influences from L2, supporting the assumption of some models that L1 has direct access to meaning, whereas L2 seems to require L1 mediation (Kroll & Stewart, 1994). Both the revised hierarchical model (RHM; Kroll & Stewart, 1994) and the BIA+ (Dijkstra & Van Heuven, 2002) postulate that L2 words are directly connected to their L1 translation equivalents in less proficient bilinguals (Duyck & Warlop, 2009; Witzel & Forster, 2012), thus increasing the effect of coactivation in L2 in comparison with L1. Thus, it is possible that these differential language effects and the possible mediation of L1 over L2 might be reduced in experiments involving early bilinguals immersed in dual contexts (English–Spanish environment) (see van Hell & Tanner, 2012 for more details about the modulation of L2 proficiency during cross-language coactivation).

The first key latency indexing speed of lexical access was critically different for L1 and L2. Thus, while latencies to L2 showed a clear polyvalent grapheme congruency effect, this effect was not evident in L1. This suggests that L1 and L2 are activated in parallel during L2 generation of a lexical representation for writing (outer loop;

Logan & Crump, 2011), and that specific incongruences between L1 and L2 slow down this process. This effect is similar to the orthographic similarity effect shown by Muscalu and Smiley (2018) where orthographically similar words (cognates) facilitated first-letter performance, but it is important to note that, in our study, the polyvalent grapheme effect was sublexical in nature, and different from the lexical cognate effects in their experiment. Interestingly, in our experiment, this L2 effect was evident in RTs, and not in ACC, suggesting that the presence of incongruent graphemes interfered with and slowed down the generation of the lexical information needed for correctly typing the first letter of the word. The fact that a sublexical variable such as the presence of incongruent polyvalent graphemes was evident in a lexical measure such as first key latency suggests that the outer and inner loops are connected so that the access to the lexical representation (outer loop) is affected by the orthographic sublexical inconsistencies between languages (for a more encapsulated view of the two loops in skilled typewriting see Logan and Crump, 2011).

Regarding the rest of the word, the presence of incongruences slowed down typing responses, although these inconsistencies only led to erroneous responses when the bilinguals typed in their L2 language. This pattern suggests again that the two languages of the bilingual are coactivated during actual implementation of the typing response (inner loop), although the selection of the appropriate graphemes was correctly performed in L1. In contrast, the stronger activation of L1 while writing in L2 was not always correctly solved leading to an increase in erroneous L2 writing responses. According to various typing models, all the letters in a word are activated in parallel and sequenced by a competitive process of inhibitory connections to allow the execution of the correct pulse (Crump & Logan, 2010; Rumelhart

& Norman, 1982; Snyder et al., 2014). Thus, errors in L2 incongruent condition might be due to failures in lateral inhibition processes needed to reduce the activation of alternative competitive graphemes (Rumelhart & Norman, 1982), in this case, the graphemes of the non-used language.

Thus, interference effects of the incongruent condition (polyvalent graphemes) support the idea that inconsistent L1 and L2 orthographic representations slow down the typing of words (Bonin et al., 2001; Dijkstra & Van Heuven, 2002). In general, orthographically inconsistent segments are written more slowly and with less precision than orthographically congruent segments (Defior, et al., 2009; Kreiner & Gough, 1990; Mulatti & Job, 2003) even when the inconsistency is cross-linguistic. Importantly, although our analysis of OS had to be taken with caution (it was not planned in advance, and it included an unequal number of items across conditions), it showed that the polyvalent grapheme effect was independent of overall orthographic similarity. It suggests that the effect of orthographic congruency was not restricted to highly similar cognates. The effect was evident even when the overlap between languages was minimal (Conrad et al., 2014).

In addition, the results of this a-posteriori analysis replicated the OS effects obtained in previous studies (Comesaña et al., 2012; Dijkstra, et al., 2010; Duyck et al., 2007; Schwartz et al., 2007; Van Assche et al., 2011) as well as the results of Muscalu and Smiley (2018) in their writing experiments. That is, for first key latencies (lexical), we found that a high similarity between languages facilitated performance, whereas for rest of the word (sublexical), high similarity produced interfering effects, with longer times for high than for low OS between languages. Despite the differences between our study and the study by Muscalu and Smiley, that included differences in the tasks (writing to dictation vs. translation task), modality of presentation of the stimuli (visual and auditory vs. auditory), and time parameters (participants could not start writing until the word presentation had ended), the pattern of OS effects was very similar in both studies. However, as we will next discuss, the fact that we introduced a sublexical manipulation (polyvalent graphemes) that had an effect in a lexical measure (first key) thus made our interpretation of the time course of lexical and sublexical variables differ from the serial account proposed by Muscalu and Smiley (2018).

Time course of lexical and sublexical processing in bilingual writing

The fact that L2 congruency effects were evident from the very beginning of lexical access (during first key production) and extended to rest of the word suggests that L2 lexical and sublexical orthographic representations are automatically activated from the very beginning of the writing process as proposed by cascade models (Dijkstra et al., 2010; Pattamadilok et al., 2009; Perre et al., 2009). Thus, regarding the time course of lexical and sublexical activation, our results indicate that the onset of writing is delayed when phonological–orthographic inconsistencies appear (Sadat et al., 2014), thus evidencing sublexical influences during lexical processing. This pattern supports the assumption of cascade models of spoken (e.g., Navarrete & Costa, 2005; Sternberg, 2001) and written (Bonin, 2001; Delattre et al., 2006) production, as applied to bilingual L2 processing.

Studies on spoken word production and word comprehension have already shown evidence of the early influence of orthographic information (Dich, 2011; Dijkstra et al., 2010; Frost & Ziegler, 2007; Grainger, 2018; Hallé et al., 1999; Pattamadilok et al., 2007; Perre, et al., 2009; Seidenberg & Tanenhaus, 1979; Ventura et al., 2004; Ziegler et al., 2004; Ziegler et al., 2008). In fact, previous evidence has shown that the position of the manipulated sublexical elements may influence the time for lexical access in reading tasks (diverging letter effect; Mulatti et al., 2007). Thus, our results extend the evidence of interactions between lexical and sublexical levels in reading and naming to bilingual writing production. Theoretical proposals assume that orthographic knowledge "contaminates" phonology during the process of learning to read and write, thus altering the very nature of phonological representations (Muneaux & Ziegler, 2004; Ziegler & Goswami, 2005) and creating unstable lexical representations. The idea is that orthographically consistent words develop better and more detailed phonological representations than inconsistent words in the course of learning to read, and this, in turn, creates more stable lexical representations (Caplan et al., 1995; Hickok & Poeppel, 2000; Petersson et al., 2000; Scott & Wise, 2004). Note that the different pattern that we obtained for L1 does not necessarily mean that lexical and sublexical processing in L1 proceeds in a discrete serial manner, but, as suggested above, that L1 written production is less vulnerable to orthographic incongruences due to language coactivation and that, therefore, our indexes of lexical and sublexical processing might not be able to capture these processes and their interaction during L1 writing. Future studies with other manipulations might shed some further light on this issue.

Language differences

In our study, the bilinguals made more specific errors in Spanish than in English. During the typing task, the participants could generate both non-specific typographical spelling errors (caused by erroneous finger movements by pressing adjacent keys) and specific cognitive errors (caused by specific orthographic features; Kukich, 1992). We observed that, relative to the type of errors, bilinguals made more errors with letters with polyvalent Spanish graphemes than with any other type of letter. This pattern is probably due to the different orthography–phonology mapping between the two languages (Rapp et al., 2002). English is an opaque language, with many phonographic and orthographic inconsistencies that would encourage lexical processing (following the orthographic depth hypothesis; Katz & Frost, 1992). Therefore, in this case, the diversity of inconsistent grapheme-phoneme mappings would induce a more generalized type of error, which could affect different graphemes. In contrast, Spanish is a more transparent language with fewer inconsistencies that encourage phonological–orthographic processing (Seymour et al., 2003). Thus, more specific errors, affecting the critical polyvalent graphemes are to be expected. Also, different degrees of consistency between phonology and orthography may lead to different strategies when developing lexical representations, with less specific phonological–orthographic processing in opaque languages (Ziegler & Goswami, 2005).

In sum, the current study was the first exploring the proposal of two-loop of typewriting (Logan & Crump, 2011) in bilingual typing production involving a single-language task (writing to dictation). An inconsistency in the orthographic representation between languages appeared to affect the inner loop in L1 and L2 typing production. If a bilingual had to type a word with inconsistent polyvalent graphemes between languages, the inconsistency of the key mapping and, therefore, of the orthographic representation hindered performance with more errors, and resulted in longer RTs in writing rest of the word. However, the outer loop related to the generation of the word–lexical representation only was affected in the L2 language block; the interference caused by the orthographic inconsistency spread from one loop to the other in the weakest language. Although the results of the present study show a clear pattern, it is not without limitations. First, this is the first study aiming at exploring the effect of orthographic incongruence between languages due to the presence of critical polyvalent graphemes during writing. One of the advantages of the polyvalent phoneme manipulation is that the presence of orthographic inconsistency is very specific and affects individual phoneme–grapheme mappings; however, the interaction of this specific inconsistency with more global orthographic similarity effects was not directly manipulated, and although *a posteriori* analysis suggested that they are independent, future research should include orthogonal manipulations of the two variables. Second, our study included highly proficient late L2 learners, and their coactivation pattern might differ from that for early bilinguals. Future studies should include different groups of bilinguals for a deeper understanding of the dynamics in which two languages interact during writing production.

Additionally, despite the usefulness of our experimental paradigm to study lexical and sublexical processing during typing production (Muscalu & Smiley, 2018), our writing to dictation task might also have some limitations. First, although we tried to solve the possible overlap between comprehension and production in our procedure by delaying the participants' typing response to the appearance of a space bar, it is still possible that difficulties in comprehension might affect the first letter typing response. In addition, our sublexical latency measure (rest of the word) was the average of the times from first key to the end of the word typing response, and therefore, tracking the performance of individual graphemes was not possible. This might be important since the presence of visually presented information on the screen as writing proceeded might have been used as feedback to correct possible errors, and it might have influenced the final typing response. Future research tracking individual letter typing and exploring the role of visual feedback is needed to clarify this issue. In addition, this study focused on the impact of orthographic congruence between languages as a sublexical property. Future research should also focus on the role of phonology in language coactivation during written production.

Finally, this study focused on typewriting while writing production involves typewriting and handwriting. Although some research indicates similar processing (Pinet et al., 2016; Yamaguchi & Logan, 2014), future research should also directly compare the pattern of orthographic activation in typing and handwriting production.

CONCLUSIONS

Writing and typing can be complex competences to master, and the production of an orthographically accurate text can be difficult, especially in a second language with all the difficulties associated with the parallel coactivation of two languages which may facilitate but also hinder language selection (Costa, et al., 2003; Poulisse & Bongaerts, 1994). Our findings add to other attempts to conceptualize the processing architecture underlying writing production in the bilingual population. The findings of our study, which included cross-linguistic polyvalent graphemes in a writing to dictation task, showed that the cross-linguistic orthographic effects in bilingual writing production resulted in better performance for between-language congruent spelling than for incongruent spelling, supporting the idea of a unified orthographic lexicon (Dijkstra & Van Heuven, 2002). Words with inconsistent spellings across languages were typed slower and with more errors, even in a task in which only one language was employed, although these errors were especially evident in the English L2 block. This pattern reflects that the non-used language (Spanish) orthography was hindering the selection of the correct spelling of the word (e.g., garaJe instead of the correct spelling garage), so that orthographic inconsistencies between languages may make the already difficult writing processes even more difficult for bilingual writers.

In addition, our results showed that orthographic retrieval effects are evident from the very beginning of L2 lexical access, suggesting a cascade-type of processing for writing production (Olive, 2014). When a bilingual participant is typing in L2, the presence of orthographic incongruences between languages introduces difficulties in the generation of the lexical representation of the to-be-written word. Thus, conflicting information at the sublexical level makes access to the word representation more difficult.

APPENDIX 1

Selected targets and their respective translations for each experimental condition in both language blocks (Spanish and English). The words (Congruent and Incongruent columns) were included in a dictation task, so the translation column is referred to as non-required language.

Spanish block (L1)				English block (L2)			
Congruent	*translation*	Incongruent	*translation*	Congruent	*translation*	Incongruent	*translation*
cuer**v**o	ra**v**en	beren**j**ena	auber**g**ine	e**v**il	mal**v**ado	clo**v**er	tré**b**ol
ba**b**ero	**bib**	**h**uérfano	**ø**orphan	dan**g**er	peli**g**ro	sur**g**eon	ciru**j**ano
bala	**b**ullet	**h**ielo	**ø**ice	**b**oat	**b**arco	**j**elly	**g**elatina
guía	**gu**ide	go**b**ierno	go**v**ernment	a**mb**ush	e**mb**oscada	fe**v**er	fie**b**re
yate	**y**acht	pa**z**	pea**c**e	**h**awk	**h**alcón	**g**inger	**j**engibre
i**m**perio	e**m**pire	circu**n**ferencia	circu**m**ference	**h**iccup	**h**ipo	voi**c**e	vo**z**
ára**b**e	ara**b**ic	pasa**j**ero	passen**g**er	sla**v**ery	escla**v**itud	advanta**g**e	venta**j**a
fá**b**ula	fa**b**le	**ø**arpa	**h**arp	ali**v**e	vi**v**o	so**v**ereign	so**b**erano
bici	**b**ike	ra**z**ón	rea**s**on	an**g**le	án**g**ulo	mo**b**ile	mó**v**il
octu**b**re	octo**b**er	actri**z**	actre**ss**	**b**east	**b**estia	**ø**ability	**h**abilidad
banco	**b**ench	espon**j**a	spon**g**e	pri**c**e	pre**c**io	gene**v**a	gine**b**ra
dro**g**a	dru**g**	**v**enda**j**e	**b**anda**g**e	**b**ottle	**b**otella	homa**g**e	homena**j**e
bar**b**acoa	**b**ar**b**ecue	**j**irafa	**g**iraffe	**v**ine**g**ar	**v**ina**g**re	endi**v**e	endi**b**ia
mo**ns**truo	mo**ns**ter	**b**uitre	**v**ulture	ti**g**er	ti**g**re	**v**arnish	**b**arniz
bilin**g**ue	bilin**g**ual	co**n**ciencia	co**ns**cience	a**mb**ulance	a**mb**ulancia	ja**v**elin	ja**b**alina
triân**g**ulo	trian**g**le	**ø**alucinación	**h**allucination	pen**g**uin	pin**g**üino	**g**arden	**j**ardín
tur**q**uesa	tur**q**uoise	go**b**ernador	go**v**ernor	**bib**le	**bib**lia	do**z**en	do**c**ena
mo**v**imiento	mo**v**ement	mensa**j**e	messa**g**e	**g**ender	**g**énero	folia**g**e	folla**j**e
her**b**í**v**oro	her**b**i**v**orous	lengua**j**e	langua**g**e	**g**enius	**g**enio	i**m**migration	i**n**migración
zona	**z**one	diálo**g**o	dialo**gu**e	ner**v**e	ner**v**io	**z**ero	**c**ero
violencia	**v**iolence	**ø**armónica	**h**armonica	**b**arrier	**b**arrera	circu**m**stance	circu**n**stancia
ni**v**el	le**v**el	i**n**migrante	i**m**migrant	**h**ori**z**on	**h**ori**z**onte	tra**m**	tra**n**vía
jungla	**j**ungle	camufla**j**e	camoufla**g**e	distan**c**e	distan**c**ia	**z**ebra	**c**ebra
mar**g**en	mar**g**in	gara**j**e	gara**g**e	e**x**cuses	e**x**cusas	catalo**gu**e	catálo**g**o
vaini**ll**a	**v**ani**ll**a	sabota**j**e	sabota**g**e	cara**v**an	cara**v**ana	bron**z**e	bron**c**e

Note. Bold letters indicate the polyvalent graphemes present in selected words and in their translations.

CHAPTER 5.

THE INFLUENCE OF CROSS-LINGUISTIC SIMILARITY AND LANGUAGE BACKGROUND ON WRITING TO DICTATION

ABSTRACT

This study used a word dictation task to examine the influence of a variety of factors on word writing production: cognate status (cognate vs. non-cognate words), orthographic (OS) and phonological similarity (PS) within the set of cognate words, and language learning background (late bilinguals [LBs] with academic literacy and formal instruction in English and Spanish, and heritage speakers [HSs] with academic literacy and formal instruction only in English).

Both accuracy and reaction times for the first key pressed by participants (indicating lexical access), and the time required to type the rest of the word after the first keypress (indicating sublexical processing) were assessed. The results revealed an effect of PS on the dictation task particularly for the first keypress. That is, cognates with high PS were processed faster than cognates with low PS. In contrast to reading studies in which PS only revealed a significant effect when the OS between languages was high (O+P+ vs. O+P-), in the dictation to writing task the phonology had a more general effect across all conditions, regardless of the level of OS. On the other hand, OS tended to be more influential for typing the rest of the word. This pattern is interpreted as indicating the importance of phonology (and PS in cognates) for initial lexical retrieval when the input is aural. In addition, the role of OS and PS during coactivation was different between groups probably due to the participants' linguistic learning environment. Concretely, HSs were found to show relatively lower OS effects, which is attributed to the greater emphasis on spoken language in their Spanish language learning experiences, compared to the formal education received by the LBs. Thus, the study demonstrates that PS can influence lexical processing of cognates, as long as the task demands specifically require phonological processing, and that variations in language learning experiences also modulate lexical processing in bilinguals.

Keywords. Bilingual writing, writing to dictation, language coactivation, orthographic/phonological similarity, heritage speakers.

Iniesta, A., Rossi, E., Bajo, M. T., & Paolieri, D. (2021). The Influence of Cross-Linguistic Similarity and Language Background on Writing to Dictation. *Frontiers in Psychology*, 4280. doi: 10.3389/fpsyg.2021.679956

INTRODUCTION

A central question in bilingual research has been to determine how bilinguals manage the use of words from different languages (Costa & Sebastián-Gallés, 2014; Kroll et al., 2013). There is evidence that bilinguals co-activate their two languages, even in single language contexts (e.g., Van Hell & Dijkstra, 2002; Hoshino & Kroll, 2008; Macizo, 2016; Marian & Spivey, 2003; Van Heuven et al., 1998; Von Studnitz & Green, 2002) and that this parallel coactivation may facilitate (Costa et al., 2000; Christoffels et al., 2007; Lemhöfer et al., 2008; Voga & Grainger, 2007) or hinder access to intended words (Gollan et al., 2005; Ivanova & Costa, 2008). Under the assumption that the two languages are coactivated ("non-selective" activation of the two languages; Dijkstra & Van Heuven, 2002), a key question is whether bilingual language coactivation is modulated at different linguistic levels (e.g., lexical, orthographic, phonological) depending on the linguistic tasks (i.e., reading, speaking, writing). Critically, one question that is untapped in the literature is how these various levels of coactivation and control thereof vary for different bilingual populations with diverse language experiences.

Orthographic processing has been the focus of most bilingual word recognition studies (e.g., Casaponsa et al., 2014; Hoversten et al., 2017; Van Heuven et al., 1998; Van Kesteren et al., 2012). The cross-linguistic influence of the two bilingual orthographic codes has been strongly supported by experimental evidence using cognate words. Cognate words are words that have the same meaning and form representation in two or more languages (e.g., “chocolate” in English, is translated as “chocolate” in Spanish). Behavioral studies using different experimental tasks (lexical decision, word recognition, naming, translation) have demonstrated that cognate words are processed faster than non-cognates (words with different lexical representations between languages, i.e., “bed” in English and “cama” in Spanish). This evidence comes from studies in which the words were presented in the visual (e.g., Costa et al., 2000; Dijkstra et al., 1999; Hoshino & Kroll, 2008; Peeters et al., 2013) and the auditory modalities (Andras et al., 2022; Bowers et al., 2000; Woutersen et al., 1995). Cognate facilitation has also been reported in spoken word production studies (Costa et al., 2005; see also Muscalu & Smiley, 2018 for typing). Thus, most models of bilingual language processing assume that both languages are coactivated and include predictions for the role of cognate words during word recognition (e.g., Bilingual Interactive Activation BIA+ model, Dijkstra & Van Heuven, 2002) and word production (e.g., The revised hierarchical model – RHM, Kroll et al., 2010).

However, hypotheses regarding the processing of non-identical but similar cognates are not completely clear (Dijkstra et al., 2010). Cognate facilitation seems to be greater for identical cognates than non-identical cognates (Comesaña et al., 2015; Guasch et al., 2017) with larger cognate-facilitation effects for words with greater orthographic similarity (OS) (Dijkstra et al., 2010). Importantly, cognate words do not only differ in terms of OS between languages, but also in the degree of phonological overlap across languages. Recent models, such as the Bilingual Spelling in Alphabetic Systems (BAST) model (Tainturier, 2019) propose that the strength of coactivation is mediated by the degree of orthographic and phonological similarity (PS) between the two languages. However, the combined contributions of OS and PS have received little attention.

Most studies focusing on the interplay between OS and PS have been conducted using reading paradigms using strings of letters on the screen (Comesaña et al., 2012; Schwartz et al., 2007). The fact that the presented input is orthographic can undermine the possible role of phonology on language processing. According to cognitive models of reading (e.g., the dual-route model of reading; Coltheart et al., 2001) a visual stimulus may be decoded through the orthography to phonology conversion (OPC) system where a mapping between graphemes and phonemes occurs (letter-sound correspondence rules). Thus, during silent reading, phonology is activated, but its activation is delayed with respect to the first orthographic analysis. As such, in these kind of reading tasks processing may be biased towards orthographic decoding. Conversely, writing production paradigms, and especially the writing to dictation task, can provide a useful tool to study the role of phonology and its interplay with orthography. In a writing to dictation task the first input is phonological (phonology to orthography conversion [POC] system), due to words that are presented by auditory modality (e.g., the dual-route of spelling; Houghton & Zorzi, 2003) and therefore, orthographic activation occurs later than phonological activation (See Figure 11).

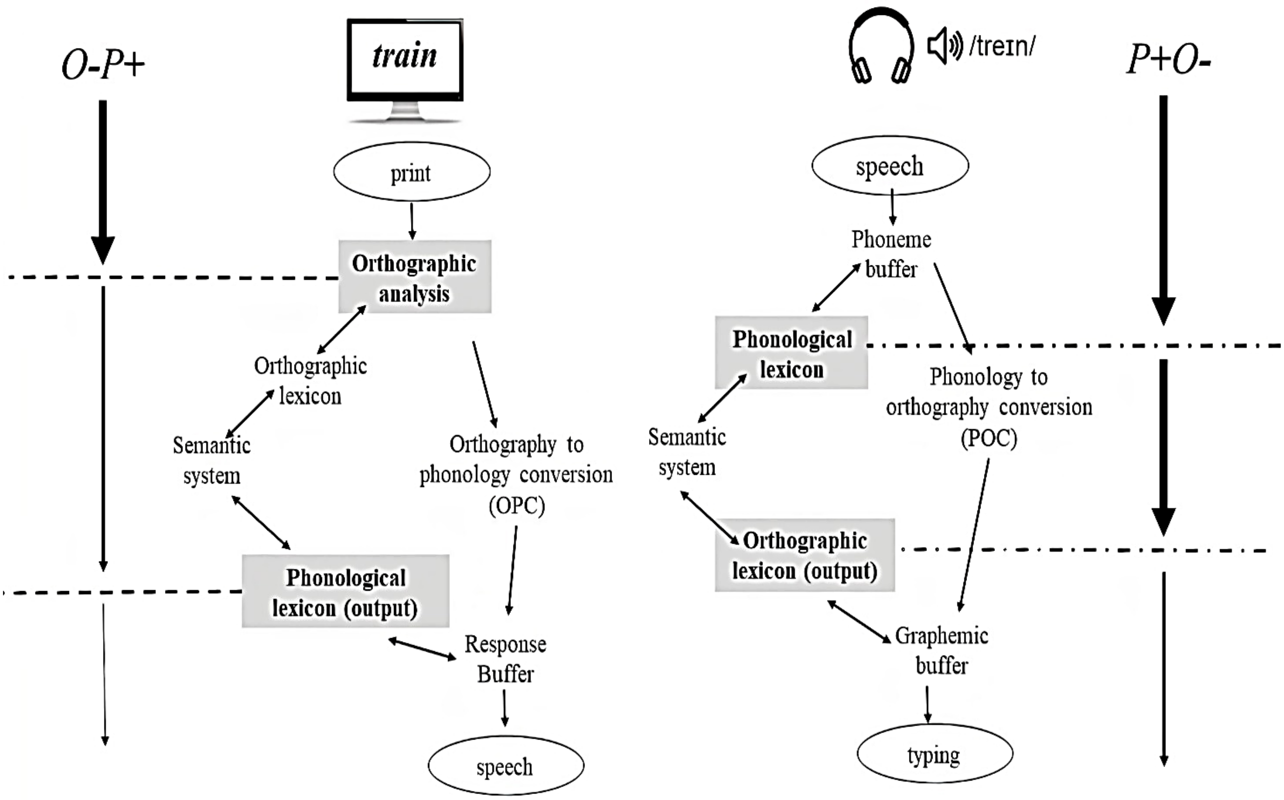


Figure 11. Reading vs. dictation to writing differences. In reading, the input is a string of letters, so the first analysis is orthographic. In the low OS condition, the representations of the two languages greatly differ, and therefore, they compete for selection. This orthographic analysis may act as a filter for cross-linguistic competition reducing the spread of activation so that non-target phonological information receives minimal activation (in the figure the thickness of the left arrow is reduced as the processing progresses to represent this idea). On the contrary, in writing to dictation (current study), the input is auditory, so the first analysis is phonological. In this context, phonology has a direct impact on performance since there is not an orthographic filter to reduce the spread of activation to the non-target phonology (in the figure the thickness of the right arrow is regular before and after the phonological filter). POC = phonology to orthography conversion system, OPC = orthography to phonology conversion system.

An effective approach to study the interplay of OS and PS could be the orthogonal manipulation of both variables. Comesaña et al., (2012) divided the cognate condition into four experimental conditions depending on the degree of orthographic and phonological similarity: O+P+ (*bomba*-BOMB), O+P- (*cometa*-COMET), O-P+ (*dança*-DANCE), and O-P- (*laço-LACE*), where the sign "+" indicates high overlap between languages, and the sign "-" indicates low overlap. Twenty-four Portuguese-English bilinguals performed a silent reading task including cognate and non-cognate words during a masked priming paradigm. Participants had to press the space bar to proceed to the next word (i.e., a self-paced reading task). Overall, performance (reaction times) was better for non-cognates than for cognates. Phonological effects were also present but they depended on the degree of orthographic similarity. Thus, cognates with high PS were read faster than cognates with low PS, but these differences were restricted to the high OS conditions (O+P+ vs. O+P-). For low OS cognates the effect of phonology disappeared. In another study, Schwartz et al., (2007) asked English-Spanish bilinguals to read aloud cognates and non-cognates in both languages in two counterbalanced blocks. The orthogonal manipulation of orthographic and phonological similarity was also included: O+P+ (*hospital*-HOSPITAL), O+P- (*genuino*-GENUINE), O-P+ (*noción*-NOTION), and O-P- (*músculo*-MUSCLE). Reading latencies were slower for cognates relative to non-cognates, suggesting an interference effect (from the onset of stimulus presentation to the onset of articulation). In addition, cognate words with high orthographic and phonological similarity (O+P+) were named faster than cognates with high orthographic similarity but low phonological overlap (O+P-). However, there was no difference between O-P+ and O-P-. That is, when the OS between languages was low, there was no PS effect (faster responses for high PS cognates than for low

PS cognates). Therefore, the coactivation of phonology seems to be OS-dependent (Orthographic Autonomy hypothesis; Rapp & Caramazza, 1997). Only when the OS between languages was high was the phonology activated. Importantly, this pattern of results was observed both in the L2 (Spanish block) and in the L1 (English block). Hence, cross-language influences were evident during reading in the weaker L2 but also in the stronger L1.

The goal of the current study is to investigate the role of cognate status in bilingual writing production using a writing to dictation task in which a phonological analysis is mandatory. Specifically, we (1) compared performance (reaction time and accuracy) for cognate and non-cognate words in a typing paradigm, and (2) examined the effect of orthographic and phonological coactivation in writing performance. To our knowledge, this study is the first to test the effect of orthographic and phonological activation across languages during a writing to dictation task. The critical materials included in this experiment consisted of cognate and non-cognate words (extracted from Schwartz et al., 2007). We included also the orthogonal manipulation of OS and PS: O+P+; O+P-; O-P+; O-P-. Following previous studies investigating bilingual word recognition, we expected that the cognate facilitation effect (e.g., Costa et al., 2005; Dijkstra, et al., 2010; Hoshino & Kroll, 2008; Lemhöfer et al., 2008) would be modulated by orthography, and more importantly also by the phonological overlap across languages. As in Schwartz et al. (2007), we expected that O+P+ would be typed faster than O+P- cognates, as evidence that phonological information is processed. However, in contrast to previous results, we also expected differences when the orthographic forms of cognates were different (O-P+ vs. O-P-), due to the differences between experimental tasks (See Figure 11). Different from reading studies in which the phonology only has an effect in high

OS conditions, in our writing to dictation task we predicted that the phonology would have an effect for high OS as well as for low OS conditions (significant differences between P+ and P-). In writing to dictation, the first input is phonological, so the phonological processing precedes orthographic processing, and therefore, the phonology would have a direct impact on performance. In this case, the phonological processing would be relatively independent of the orthographic overlap.

In addition to variations in the type of task, phonological and orthographic coactivation may also be dependent on the previous language experience of the bilingual participants. Previous studies have shown that the relationship between L1 and L2 is influenced by L2 competence and by the language learning background (Dijkstra et al., 2010; Kroll et al., 2006). Language experience is characterized by high variability on a range of factors related to language exposure and use (Anderson et al., 2018; Green & Abutalebi, 2015). The nature of the input received during learning has important consequences on language processing (Fricke et al., 2019; Kroll et al., 2018) and language outcomes (Byers-Heinlein, 2013; Place & Hoff, 2011). The quantity, and even more important, the quality of the input are strong predictors of the language development in bilinguals (Gathercole & Thomas, 2009). In this context, it is fundamental to consider differences between naturalistic and classroom settings (Rothman & Guijarro-Fuentes, 2010). It is well known that L2 learners in a classroom setting receive considerably less oral input than in a naturalistic setting (and of course than native speakers). Qualitative differences in input during learning might serve to explain some asymmetries between L2-learners in classroom and naturalistic environments.

The learning background might be especially relevant when examining bilingual writing because writing competence might differ depending on whether L1 or L2 was formally acquired at school, or whether it was learned and used at home where verbal/auditory input exceeds visual/written exposure. These differences could have an important impact on the interplay of orthographic and phonological processing.

In order to address this critical question, we included two groups of English-Spanish bilinguals with different language learning backgrounds: native English speakers who were Spanish learners (late bilinguals [LBs] with formal education in Spanish) and Spanish heritage speakers (HSs) who had acquired English and Spanish at an early age in the household but did not receive a formal education in Spanish. Both groups of participants were immersed in an English dominant context and immersed in English education.

The selection of these two groups provides the opportunity for examining the effects of phonological and orthographic coactivation in cognate writing production by English-Spanish bilinguals, who have different background experiences in one of their languages, experience with academic literacy and formal instruction in Spanish and English (LBs) vs. experience with academic literacy and formal instruction just in English (HSs) (Carrasco-Ortiz et al., 2019). L1 acquisition is normally characterized by being homogeneous, systematic and complete. However, the L1 acquisition in the HSs could be unstable and incomplete (Montrul, 2008; Polinsky, 2008). As HSs learn their minority language (L1) at home, and at the same time they are immersed in a majority language (L2) context (Benmamoun et al., 2013), they receive mainly oral/phonological input during L1-learning (in a naturalistic environment).

In contrast, L2 learners are exposed to formal education of reading and writing, but also to oral inputs in an instructed context (e.g., Hyltenstam & Abrahamsson, 2003; Paradis, 2004). Given the higher exposure to oral/phonological input in HSs in comparison with L2 learners, HSs are throughto have a phonological advantage (Chang et al., 2011; Gor, 2014). In addition, studies have also pointed out difficulties in orthographic knowledge in HSs (Elola & Mikulski, 2016) especially during writing tasks (Montrul, 2013). These described differences across bilingual speakers made it possible to expect stronger phonological effects in the HSs than in LBs (faster responses for cognates with high PS than for cognates with low PS), especially during English writing, in which the influence of Spanish phonology is expected. In addition, stronger orthographic effects were expected for LBs relative to HSs, especially during English writing due to their greater familiarity with Spanish orthography. Note that "stronger phonological effects" means higher differences between P+ and P- conditions. On the contrary, "stronger orthographic effects" means higher differences between O+ and O- conditions.

METHOD

Participants

Forty-eight bilingual students from the University of Florida (USA) participated in the study in exchange for partial course credit. One participant was excluded because he reported Central Auditory Processing Disorder (CAPD). The remaining 47 participants reported normal hearing and normal vision, and they did not report any language or neurological deficits. All participants were able to type using their 10 fingers. They were classified into two experimental groups: 23 LBs and 24 HSs. Both groups were immersed in an English dominant context and they had been educated in the United States.

As data analysis was implemented as mixed-effect regression analysis, we checked if our observations were enough for this type of analysis. Brysbaert and Stevens (2018) recommend "at least 1.600-word observations per condition (e.g., 40 participants, 40 stimuli)". In the current study, observations from 47 participants (23 LBs and 24 HSs), and from 208 words (104 cognates vs. 104 non-cognates) were included. This resulted in 2392 observations for the LBs, and 2496 observations for the HSs in each condition. However, some of these observations were excluded from analysis due to the data trimming performed to eliminate outliers (see Results section). Despite this, we had enough observations, with 2104 observations remaining in the LBs (and 2170 for non-cognates), and 2242 observations in the HSs (and 2238 for non-cognates). This estimation is similar to the ones reported previous studies (Comesaña et al., 2012; Schwartz et al., 2007).

To determine their language dominance and background experiences (experience with academic literacy and formal instruction) all participants completed the Language Experience and Proficiency Questionnaire (LEAP-Q; Marian et al., 2007) for both languages, Spanish and English. Table 5 summarizes the language use and exposure data and the proficiency level of the participants.

The LEAP-Q data show that the LBs were exposed to English earlier than the HSs (age of first exposure [AoA], $t\ (45) = -4.541$, $p<.001$) because they were born into an English-speaking country/family and context. In addition, LBs spent more years in an English-speaking country, $t\ (45) = 2.016$, $p= .049$, and LBs spent more years living in a familiar English environment, $t\ (45) = 2.177$, $p=.035$ than HSs. Importantly, the difference in years of exposure to school context in English was not significant, $t\ (45) = 1.716$, $p = .093$. Importantly, the difference in the self-assessed English skills was not significant (Speaking, Understanding and Reading; all $ps > .05$). In order to explore the instructed context of English learning, we analyzed the specific item *Reading contribution to learning* (See the question 4 in the LEAP-Q questionnaire: “Please mark how much the following factors contributed to you English/Spanish learning”). The participants rated this item on a scale of 1 to 10. Low scores indicate that reading has contributed little to their learning. This score reflects the degree of formal language education in one language, which is throughto be an important requirement for correct learning of orthography (Iniesta et al., 2021). The differences between groups were not significant; $t\ (45) = -.030$, $p = .976$.

Conversely, HSs were exposed earlier to Spanish (AoA) than LBs ($t\ (45) = 8.467$, $p < .001$) because they were born into a Spanish-speaking family. In addition, HSs lived longer than LBs in a Spanish-speaking country ($t\ (45) = -3.408$, $p = .001$), and familiar Spanish environment ($t\ (45) = -31.287$, $p < .001$). Overall, HSs presented greater exposure to Spanish. However, the difference with respect to years of exposure to school context in Spanish was not significant ($t\ (45) = .767$, $p = .447$). The difference in the self-assessed Spanish skills was significant for Speaking ($t\ (45) = -2.193$, $p = .034$) and Understanding ($t\ (45) = -2.484$, $p = .017$). The HSs scored higher on these scales, as expected. However, in the skill more related to formal use of language, Reading ($t\ (45) = .404$, $p = .688$), there were no differences between groups. As for English, we explored the *Reading contribution to learning* for Spanish revealing that HSs had a significantly lower score ($t\ (45) = 2.024$, $p = .048$).

In addition to the self-rated questionnaire, participants also completed a formal standardized test in Spanish for writing and spelling (PROESC- Batería de Evaluación de Los Procesos de Escritura, Cuetos, Ramos, & Ruano, 2002). As part of PROESC, participants completed the ruled-orthography subtest consisting of a pen and paper writing to dictation task of 25 words that included a Spanish spelling rule (Chacón, 1997). For example, in Spanish all verbs that end in -aba (i.e., cantaba), are spelled with "b" instead of "v". In addition, all words that end in -aje (chantaje), are spelled with "j" instead of "g". In addition, participants completed a silent efficiency reading test (TECLE- Test de Eficiencia Lectora, Marin & Carrillo, 1999) including an orthographic decision subtest in which there were sentences with one word missing. Participants had to select the correct word, among 4 options that included semantic, spelling and phonological distractors, which included subtle letter changes. In 3 minutes, the participant had to solve the maximum number of sentences as possible among a total of 64 sentences. A good knowledge of spelling is necessary to select the correct option. The results showed better accuracy in word writing in PROESC for the LBs (mean = 22.43; SD = 1.87) than the HSs (mean = 20.83; SD = 2.91) out of 25 words in total, $t\,(45) = 2.228$, $p = .031$. Additionally, the LBs were more accurate in the TECLE than the HSs (LBs: mean = 35.74; SD =7.06; HSs: mean = 31.96; SD = 5.20); $t\,(45) = 2.095$, $p = .042$.

These results confirmed that, despite the higher speaking and understanding abilities that HSs reported for Spanish in the self-reported questionnaire, no differences in reading skills were evidenced (the fact that in HSs the superiority in speaking and understanding was not extended to reading could indicate the lower skills with the formal aspect of Spanish). Additionally, the LBs had higher orthographic knowledge of Spanish than the HSs in formal standardized test. This provides support to the assumption that HSs might be biased toward phonology, and that they might have more difficulties with the more formal aspects of Spanish (including orthographic rules), due to their informal learning background.

Table 5.

Mean scores (with standard deviation in parenthesis) for English and Spanish language experience in the LBs and HSs.

Language version		ENGLISH (L1/majority language)			SPANISH (L2/minority language)		
		LBs (N=23)	HSs (N=24)		LBs (N=23)	HSs (N=24)	
LEAP-Q items				*p*			*p*
AoA		.74 (.91)	2.71 (1.87)	**	10.69 (3.61)	.92 (1.32)	**
Years of exposure	Country	19.91 (1.16)	18.71 (2.62)	*	.13 (.62)	6.08 (8.35)	**
	Family	19.65 (1.99)	16.54 (6.57)	*	.87 (2.41)	19.45 (1.59)	**
	School	17.95 (2.94)	16.50 (2.87)		4.56 (5.01)	3.33 (5.94)	
Self-assessed capacity (from 1 to 10)	to speak	9.69 (.55)	9.54 (.77)		6.30 (1.22)	7.08 (1.21)	*
	to understand	9.60 (.78)	9.71 (.55)		7.35 (1.26)	8.25 (1.22)	*
	to read	9.65 (.57)	9.66 (.63)		7.26 (1.54)	7.08 (1.47)	
Reading contribution to learning		8.89 (1.42)	8.71 (1.49)		7.35 (2.27)	5.87 (2.69)	*
Spanish Writing and Spelling tests							
PROESC					22.43 (1.87)	20.83 (2.91)	*
TECLE					35.74 (7.06)	31.96 (5.20)	*

Note. * $p < .05$, ** $p < .01$; AoA = age of acquisition; LBs = late bilinguals; HSs = Heritage Speakers.

Materials

A total of 208 words in English and their Spanish translations were selected (extracted from Schwartz et al., 2007). English and Spanish items were presented in two independent blocks. Each language block (Spanish or English) was comprised of 104 cognates and 104 non-cognates. Schwartz et al. (2007) classified them according to the OS score (Van Orden et al., 1988; Yates et al., 2003). If the OS was higher than 0.3, this word was classified as cognate. The conditions were matched in logarithmic lexical frequency and the number of letters (Guasch et al., 2013), age of acquisition (AoA; Alonso et al., 2015; Kuperman et al., 2012), concreteness (Brysbaert et al., 2014; Duchon et al., 2013), and orthographic and phonological neighbors (Marian et al., 2012). English/Spanish cognates and non-cognates were presented aurally. The experimental material was read by a female Puerto Rican Spanish-English bilingual. The material was recorded using a Shure SM57 microphone on a Marantz Solid State Recorder PMD670 (Valdés-Kroff et al., 2019). The recorded items were then isolated using a script implemented in PRAAT software (version 5.3.16; Boersma & Weenink, 2012) employing *TextGrids* for segmentation and labeling. In addition, the script added 50 ms of silence at the beginning and 500 ms at the end of each word by default, and it resampled the words so that they were at 44.1 kHz in monoaural. It also rescaled and equated the loudness of the files. Table 6 shows descriptive statistics for the experimental material.

Table 6.

Characteristics of the experimental stimuli (mean scores with standard deviations in parenthesis).

	Within-language variables						
	Frequency	Letters	Concreteness	AoA	PN	ON	Audio
English block							
Non-cognates	1.41 (.47)	6.09 (1.26)	3.92 (1.10)	6.53 (2.01)	6.93 (6.99)	4.01 (5.21)	647 (144)
Cognates	1.42 (.48)	5.94 (1.41)	3.69 (1.01)	6.95 (2.25)	5.48 (7.59)	3.50 (4.11)	667 (124)
Statistics	*t* (206) =.188, *p*= .851	*t* (206) =-.837, *p*=.404	*t* (206) = -1.531, *p*= .127	*t* (206) = 1.43, *p*=.154	*t* (206) = -1.42, *p*= .157	*t* (206) = -.779, *p*=.437	*t* (206) = 1.08, *p*=.203
O+P+	1.50 (.46)	6.11 (1.51)	3.91 (.91)	6.98 (1.47)	5.75 (7.68)	3.35 (3.95)	700 (150)
O+P-	1.35 (.48)	5.87 (1.49)	3.53 (.97)	7.02 (2.67)	5.13 (8.62)	4.03 (4.45)	632 (89)
O-P+	1.43 (.34)	5.89 (.87)	3.80 (1.24)	7.24 (2.04)	4.53 (5.25)	3.36 (2.26)	698 (112)
O-P-	1.41 (.61)	5.88 (1.58)	3.56 (.93)	6.62 (2.61)	6.30 (6.93)	3.84 (4.51)	652 (127)
Statistics	*F* (3, 104) = .433, *p*= .729	*F* (3, 104) = .171, *p*= .916	*F* (3, 104) = .910, *p*= .439	*F* (3, 104) = .299, *p*= .826	*F* (3, 104) = .232, *p*= .874	*F* (3, 104) = .722, *p*= .541	*F* (3, 104) = 1.897, *p*= .204
Spanish block							
Non-cognates	1.37 (.47)	6.65 (1.72)	4.98 (1.42)	5.28 (2.35)	3.15 (4.45)	2.89 (3.42)	663 (142)
Cognates	1.37 (.54)	6.27 (1.53)	4.74 (.98)	5.85 (3.06)	3.10 (3.88)	2.66 (3.26)	673 (128)
Statistics	*t* (206) =-1.211, *p*= .227	*t* (206) =-1.648, *p*=.101	*t* (206) = -1.21, *p*= .232	*t* (206) = .702, *p*=.484	*t* (206) = -.074, *p*= .941	*t* (206) = -.492, *p*=.623	*t* (206) = .516, *p*=.607
O+P+	1.48 (.42)	6.35 (1.59)	4.87 (.91)	5.90 (2.16)	2.96 (3.13)	2.71 (2.59)	698 (146)
O+P-	1.39 (.64)	6.16 (1.55)	4.73 (1.14)	5.40 (3.70)	2.53 (3.23)	2.53 (2.78)	657 (119)
O-P+	1.27 (.55)	6.21 (1.03)	4.73 (1.11)	6.43 (2.55)	2.94 (3.09)	1.52 (1.64)	651 (111)
O-P-	1.42 (.48)	6.58 (2.13)	4.62 (.89)	5.56 (2.86)	3.11 (3.88)	2.61 (3.23)	680 (132)
Statistics	*F* (3, 104) = .573, *p*= .634	*F* (3, 104) = .335, *p*= .800	*F* (3, 104) = .227, *p*= .877	*F* (3, 104) = .550, *p*= .649	*F* (3, 104) = .757, *p*= .521	*F* (3, 104) = 1.496, *p*= .220	*F* (3, 104) = .747, *p*= .526

Note. AoA = Age of Acquisition; PN = Phonological Neighbors; ON = Orthographic Neighbors; Audio = Audio duration; + = high similarity; - = low similarity

As in Schwartz et al., (2007), the cognates condition also included the orthogonal manipulation of OS and PS including high (+) and low (-) similarity: O+P+ (n=28); O+P- (n=31); O-P+ (n=19); O-P- (n=26). If the OS was greater than .70 the cognate word was classified as high similarity condition. Otherwise, was classified as low similarity. The PS was calculated subjectively using the following procedure. Pairs of cognate words were auditorily presented to the participants (English monolinguals). The pairs were recorded and spoken by two fluent bilinguals with each member of the pair spoken by a different bilingual. Participants (n = 29) rated the phonological similarity of cognate pairs on a Likert scale from 1 (no similarity) to 7 (very similar). If the PS was greater than 4 the cognate word was classified as high similarity. Otherwise, it was classified as low similarity (we report norming that were conducted and reported by Schwartz et al., 2007). Table 7 shows the OS and PS for each condition. Also see Table 6 for the information about frequency, number of letters, age of acquisition, concreteness and neighbors relative to these four experimental conditions.

Table 7.

Orthographic and Phonological similarity across experimental conditions (mean scores with standard deviations in parenthesis)

	Cross-linguistic variables	
	OS	PS
Non-cognates	.14 (.09)	-
Cognates	.74 (.23)	-
Statistics	$t(206) = 24.21, p = .000$	
(1) O+P+	.92 (.12)	5.31 (.91)
(2) O+P-	.88 (.13)	2.84 (.67)
(3) O-P+	.50 (.13)	5.02 (.71)
(4) O-P-	.54 (.17)	2.84 (.73)
Statistics	$F(3, 104) = 60.45, p = .000$	$F(3, 104) = 81.34, p = .000$
Post-hoc comparisons 1 *vs.* 2	$t(57) = .931, p = .356$	$t(57) = 11.87, p = .000$
1 *vs.* 3	$t(45) = 11.11, p = .000$	$t(45) = 1.209, p = .233$
1 *vs.* 4	$t(52) = 9.27, p = .000$	$t(52) = 10.91, p = .000$
2 *vs.* 3	$t(48) = 9.84, p = .000$	$t(48) = -10.82, p = .000$
2 *vs.* 4	$t(55) = 8.406, p = .000$	$t(55) = -.005, p = .996$
3 *vs.* 4	$t(43) = -.963, p = .341$	$t(43) = 9.96, p = .000$

Note. OS = Orthographic similarity; PS = Phonological similarity. We report norming that were conducted and reported by Schwartz et al., 2007. Data from non-cognates words was not available in the original research.

Procedure

After signing the consent form, participants in both groups performed the writing to dictation task in two independent blocks (Spanish and English). The order of presentation was counterbalanced between participants. The items were randomized (the four conditions of cognates and the condition of non-cognates). Each block began with 8 practice trials, followed by the experimental block, with 208 trials in each language. We included a break in the middle of each block, with a duration adaptable to the needs of the participant. The writing to dictation task was conducted on a computer using E-prime version 3.0 (Psychology Software Tools, Pittsburgh, PA). Participants wore headphones to listen to the stimuli, and used a standard QWERTY keyboard to type words. Each trial (see Figure 12) started with a fixation point (1) which remained on the screen until the auditory stimulus was presented. As soon as the audio terminated, a position bar (2) appeared on the screen indicating that the participants could start to write. Typing was not enabled until the appearance of this position bar. Participants were instructed to type as quickly and accurately as possible. The responses appeared on the screen at the same time as participants were writing.

Importantly, language coactivation in cognate words could be evidenced as facilitation or interference depending on whether coactivation occurs at a lexical or sublexical level (Iniesta et al., 2021; Muscalu & Smiley, 2018), or depending on whether coactivation occurs in a more initial and central process (lexical retrieval), or in a more posterior or peripheral process (Purcel et al., 2011). For this reason, the reaction time (RT) and accuracy (ACC) of the typing response were collected in two different temporal moments associated with lexical and sublexical processing (see Iniesta et al., 2021, and

Muscalu & Smiley, 2018 for a similar procedure): from the offset of the stimulus to the first keypress (first key performance) (3) and from the first keypress to the press of the Space Bar key (rest of the word performance) (4). These two measures have been associated with lexical and sublexical processing respectively, and therefore allowed us to pinpoint the time course and level of linguistic analysis at which our effects occurred. Considering that the experiment was carried out with an English keyboard, the participants received explicit instructions not to write the diacritical marks during the Spanish block. In addition, one word included a "ñ" grapheme. The participants were instructed to press the key adjacent to the "l", which would be the natural position of the ñ on a Spanish keyboard. Between trials, there was a black screen for 1000 ms (5).

Between the English and Spanish blocks of the writing to dictation task, participants completed the LEAP-Q questionnaire (Marian et al., 2007) for both languages (Spanish and English), and the two Spanish assessment tests (PROESC and TECLE, see the participants section, for more information). Overall, the experimental session lasted approximately 60 minutes. The study was conducted in accordance with the ethical standards approved by the University of Florida Institutional Review Board (IRB): Protocol #2019-02427.

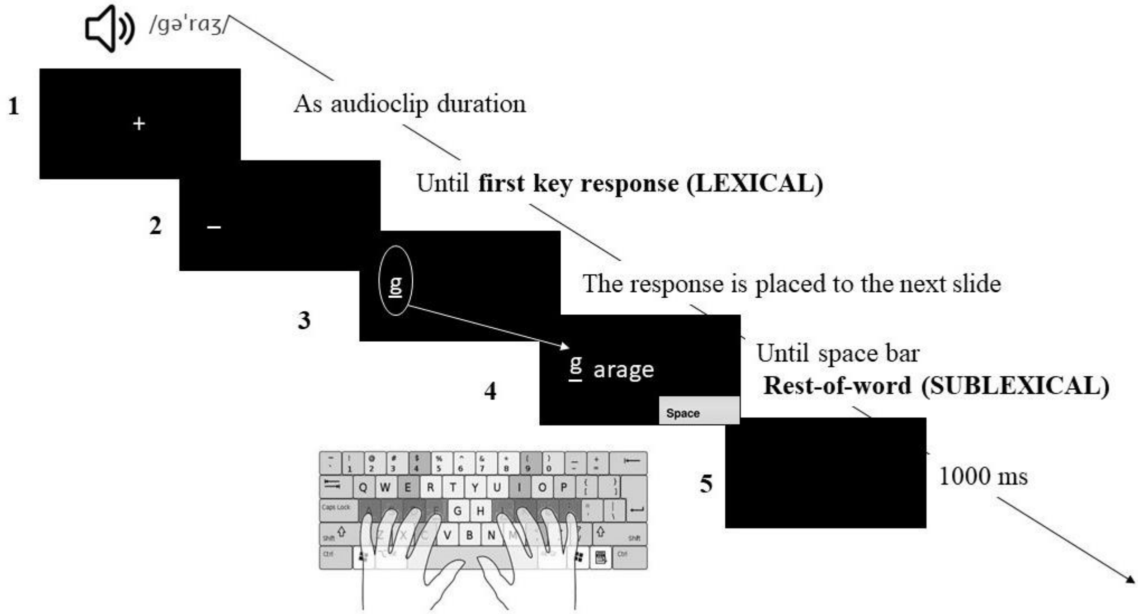


Figure 12. An example of an experimental trial. Participants typed the whole word. The first keypress (first key response-lexical) as well the latency of the rest of the word (rest-of-word response-sublexical) were recorded. /gəˈrɑʒ/ represents the phonetic transcription of garage following the Carnegie Mellon University Pronouncing Dictionary. The numbers 1 to 5 have been associated with the description of the procedure in the main text. Point 3 (the response is placed to the next slide) refers to the programming aspect. We used the [response.RESP] E-prime attribute to automatically register the participant's response from the previous slide (lexical latency) and to continue recording the participant's response until the end (sublexical latency), but participants were unaware of this feature of the display and perceived their typing as continuous.

RESULTS

For the writing to dictation task, the ACC, and the RTs for correct responses were calculated for each participant and condition for the first keystroke and the rest of the word separately. Response times above or below 2.5 SD from each participant's mean were eliminated from the analysis (first key performance: 3.31 % [English] / 4.39 % [Spanish] of the items of the LBs and 3.92 % [English] / 4.49 % [Spanish] from the HSs; rest of the word performance: 4.15 % [English] / 4.87 % [Spanish] of the items of the LBs and 4.88 % [English] / 5.58 % [Spanish] from the HSs). Accuracy was determined based on a strict criterion for correct (1) vs. incorrect (0) scores. Clear typographical errors were also considered as correct (e.g., helic***q***opter. In this case the key "q" is not necessary and it is not surrounding any target key). In the same way, errors derived from accentuation in Spanish were also considered correct. Although the instructions explicitly indicated not to type the accent-marks, some participants made mistakes trying to type them, and we also considered these words as correctly typed (e.g., m**^**aquina, the Spanish word for machine). Note that there were only 8 observations in this special situation.

Following previous studies two independent analyses were conducted to explore (Comesaña et al., 2012; Schwartz et al., 2007): 1) the *overall effect of language and cognate status* in the performance of both groups of participants, and 2) *the impact of OS and PS in cognates.*

A mixed-model analysis was performed using the R lme4 package (R Core Team, 2017; Bates et al., 2015) and including the function with a "Kenward-Roger" modification for F-tests (Halekoh &

Højsgaard, 2014) in order to include the random effects in the analysis (Luke, 2017). The model for the first analysis (overall effect of language and cognate status) was conducted with Group (LBs vs. HSs), Language (English vs. Spanish) and Condition (Cognates vs. non-cognates) as fixed factors and Participants and Items as random effects for *first key* and *rest of the word* performances. For the second analysis (the impact of OS and PS) the model included Group (LBs vs. HSs), Language (English vs. Spanish), OS (+ vs. -) and PS (+ vs. -) as fixed factors and Participants and Items as random effects both for *first key* and *rest of the word* performances. Participants and Items were included as random intercepts, random slopes were not included. When a two-way interaction was found, a post-hoc t-test using Tukey's multiple comparison correction was implemented using the R function *lsmeans*. When a three-way interaction (or above) was significant, a new model exploring this specific interaction was performed, also including participants and items as random effects. Finally, p-values were reported by the *anova* function of the LmerTestR-package.

1) The overall effect of language and cognate status

Table 8 summarizes the results (RTs and ACC) obtained in the writing to dictation task as a function of Group (LBs vs. HSs), Language (English vs. Spanish) and Condition (cognates vs. non-cognates).

Table 8.

Mean scores (with standard errors in parenthesis) in the writing to dictation for the overall effect of language and cognate status in each participant group (analysis 1).

		FIRST KEY				REST OF WORD			
		English		Spanish		English		Spanish	
		LBs	HSs	LBs	HSs	LBs	HSs	LBs	HSs
RTs	Cognates	643	713	764	744	1182	1325	1318	1550
		(29.8)	(29.3)	(29.8)	(29.3)	(58.1)	(57.3)	(58.0)	(57.3)
	Non-cognates	562	635	753	768	1085	1254	1549	1852
		(31.3)	(30.9)	(31.4)	(31.0)	(63.2)	(62.4)	(63.3)	(62.6)
ACC	Cognates	.944	.946	.943	.956	.832	.817	.868	.841
		(.009)	(.009)	(.009)	(.008)	(.019)	(.018)	(.019)	(.018)
	Non-cognates	.966	.971	.924	.944	.898	.884	.829	.812
		(.010)	(.010)	(.010)	(.010)	(.021)	(.021)	(.022)	(.022)

First Key Performance

Latency. For *first key* latencies (RTs), the main effect of Language was significant, F (1, 478.9) = 76.38, p <.001. Responding in English (mean = 638 ms) was faster than responding in Spanish (mean = 757 ms). The main effect of Condition was also significant, F (1, 349.4) = 3.95, p = .047. Cognates were responded to slower (mean = 716 ms) than non-cognates (mean = 679 ms).

The interaction between Group and Language was also significant (F (1, 17185.1) = 51.54, p<.001). For both groups the differences between Spanish and English were significant (LBs: t (17182.3) = -10.67, SE = 14.6, p<.001; HSs: t (17186.4) = -5.66, SE = 14.5, p<.001), but the magnitude of the differences was greater in the LBs (Spanish: 759 – English: 602 = 157 ms) than in the HSs (Spanish 756 – English: 674 = 82 ms). The interaction between Language and Condition was also significant (F (1, 478.8) = 9.93, p = .002) with cognates being slower (mean = 678 ms) than the non-cognates (mean = 598 ms; t (477.2) = 3.48, SE = 23.0, p<.001) in the English block.

However, these differences were not significant in the Spanish block (mean of cognates = 754 ms; mean of non-cognates = 760 ms; t (475.2) = -.26, SE = 23.1, p = .791). No other main effects or interactions were significant (all ps > 0.05).

Accuracy. For *first key* accuracy there was a main effect of Group, F (1, 46.3) = 4.25, p = .045, with higher accuracy for HSs (mean = .954) than for LBs (mean = .944). The main effect of Language was also significant, F (1, 492.7) = 4.22, p = .040, such that accuracy in English (mean = .957) was higher than in Spanish (mean = .942).

A Group x Language interaction was also significant, F (1, 18076.1) = 5.35, p= .021. For LBs, the difference between English (mean = .955) and Spanish (mean = .945) was significant (t (18072.3) = 2.74, SE = .008, p = .006), whereas for HSs, it was not (English mean = .959; Spanish mean = .950; t (18072.8) = 1.09, SE = .007, p = .272). The Language x Condition interaction was also significant, F (1, 492.7) = 6.79, p =.009, showing that for the English block, cognates (mean = .945) were less accurate than non-cognates (mean = .969), t (491.1) = -1.989, SE = .012, p = .046. In contrast, for the Spanish block, the difference between cognates and non-cognates was not significant (cognates mean = .949, non-cognates mean = .934; t (490.8) = 1.19, SE = .013, p = .232). No other main effects or interactions were significant (all ps > 0.05).

Rest of the Word Performance

Latency. Regarding the RTs of the *rest of the word*, there was a main effect of Group, F (1, 46.9) = 10.79, p = .002. LBs (mean = 1284 ms) showed faster responses than the HSs (mean = 1495 ms). There was also a main effect of Language, F (1, 428.8) = 124.66, p<.001. The responses in English (mean = 1211 ms) were faster than Spanish (mean = 1567 ms). Similarly, the main effect of Condition was significant, *F* (1, 354.2) = 4.107, *p* = .043. Cognates (1344 ms) were typed faster than non-cognates (1435 ms).

The interaction between Group and Language, *F* (1, 15244.1) = 38.35, *p*<.001, was also significant. For both groups the differences between Spanish and English were significant (LB: *t* (15238.1) = -9.05, SE = 33.1, *p*<.001; HS: *t* (15245.3) = -12.44, SE = 33.1, *p*<.001). However, the magnitude of the difference was greater for the HSs (Spanish 1701 – English: 1289 = 412 ms) than for the LBs (Spanish: 1434 – English: 1134 = 300 ms). The interaction between Group x Condition was also significant, *F* (1,15242.3) = 7.17, *p* = .007. Thus, for LBs, there were no differences between cognates (mean = 1250 ms) and non-cognates (mean = 1357 ms; *t* (15241.6) = -1.46, SE = 46.0, *p* = .143), whereas these differences were significant in the HSs (mean of cognates = 1437 ms; mean of non-cognates = 1553 ms; *t* (15239.4) = -2.51, SE = 46, *p* = .012). The interaction between Language and Condition was also significant, *F* (1, 428.6) = 30.37, *p*<.001, such that in the English block, there were no differences between cognates (mean = 1254 ms) and non-cognates (mean = 1169 ms; *t* (427.3) = 1.52, SE =55.2, *p* = .128), whereas in the Spanish block, cognates (mean = 1434 ms) were faster than non-cognates (mean = 1701 ms; *t* (428.4) = -4.83, SE = 55.3, *p*<.001). The three-way interaction was not significant (Group x Language x Condition, *F* (1, 15242.5) = 1.61, *p* = .204).

Accuracy. For *rest of the word* accuracy no main effects were significant; Group, *F* (1, 46.5) = 2.25, *p* = .139; Language, *F* (1, 443.9) = 1.90, *p* = .168; Condition, *F* (1, 363.1) = .63, *p* =.427.

However, the Language x Condition interaction was significant, *F* (1, 443.9) = 11.53, *p*<.001. In the English block, cognates (mean =

.824) were less accurate than non-cognates (mean = .891), t (442.6) = -2.618, SE = .025, p = .008, whereas the differences in the Spanish block were not significant (cognates mean = .854, non-cognates mean = .821; t (443.7) = 1.315, SE = .025, p = .188). No other interactions were significant (all ps > 0.05).

Summary of the language and cognate status analysis

The *first key* responses were slower for Spanish (L2) than for English (L1), although this effect was modulated by subtle differences in language experience (e.g., LBs were slower in Spanish than in English to a greater extent than the HSs. In addition, LBs were more accurate in English than in Spanish, but these language differences in accuracy were not present in HSs). In addition, both groups showed similar patterns of cognate effects, with cognate interference being evident in English (L1), but absent in Spanish (L2), in latency and accuracy. For the *rest of the word*, response times differed for language, group and condition: Responses were slower for Spanish (L2) than for English (L1), although this effect was modulated by the differences in language experience (e.g., HSs were slower in Spanish than in English to a greater extent than the LBs). Writing cognate words was faster than writing non-cognate words, but this facilitatory effect showed some nuanced relations with language (only present in Spanish when looking at response times). Importantly, the group-by-condition interaction indicated that the facilitatory effect was only present for the HSs. However, in English (L1), writing cognates was less accurate than writing non-cognate words in both groups, revealing a similar cognate interference effect to that found for the first key.

2) The impact of orthographic (OS) and phonological similarity (PS) in cognates

Figure 13 (for latency) and Figure 14 (for accuracy) summarize the results obtained in the writing to dictation task in relation to a new analysis including 4 factors: Group (LBs vs. HSs), Language (English vs. Spanish), OS (High vs. Low) and PS (High vs. Low) within the cognate condition. In addition, a summary of statistics has been included in Table 9 (main effects and interactions).

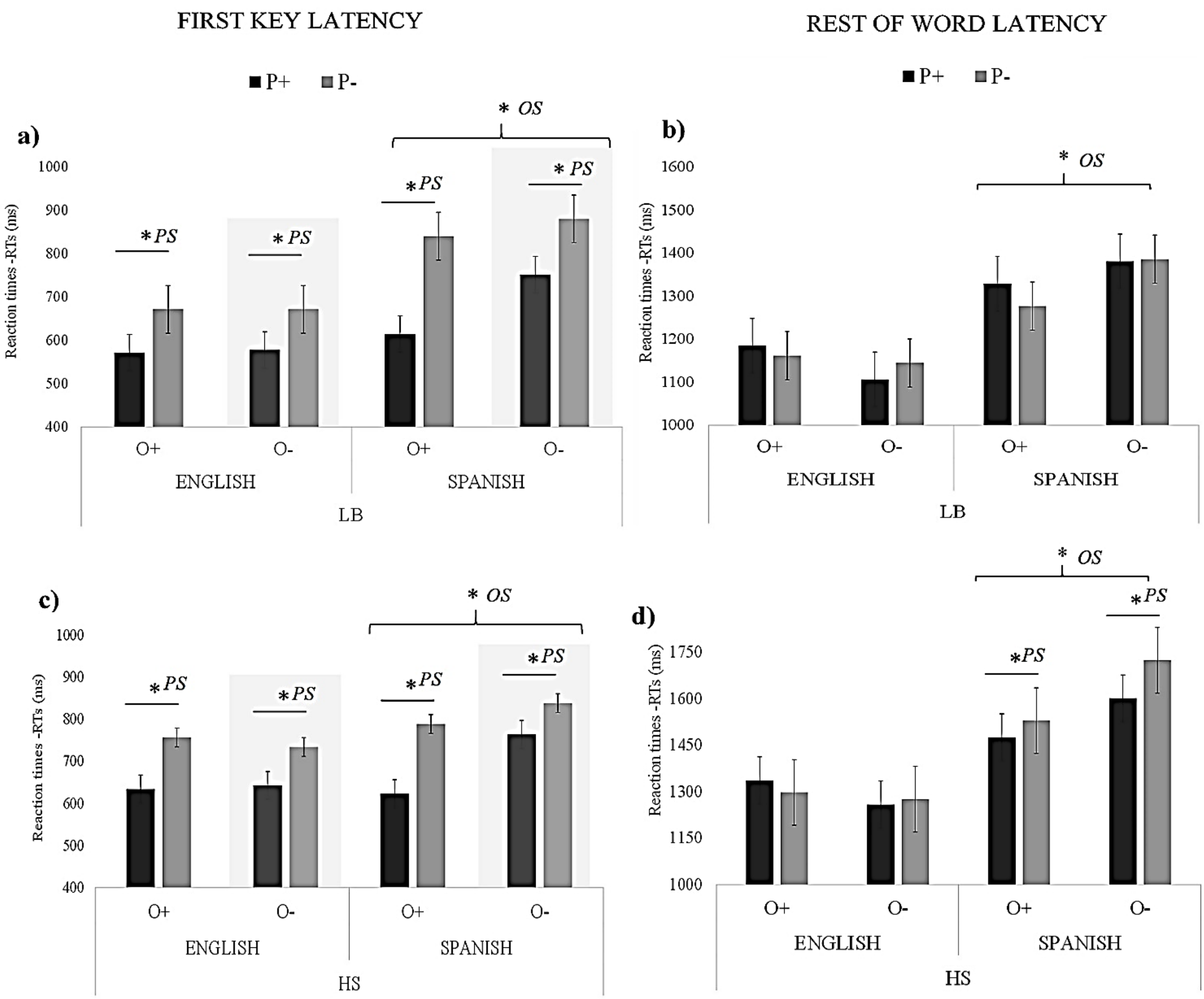


Figure 13. Visual representation of OS and PS latency results for the cognate condition (milliseconds): a) LBs first key b) LBs rest of the word; c) HSs first key; d) HSs rest of the word. Asterisks next to PS indicate significant effects of phonology, and asterisks next to OS indicate significant effects of orthography.

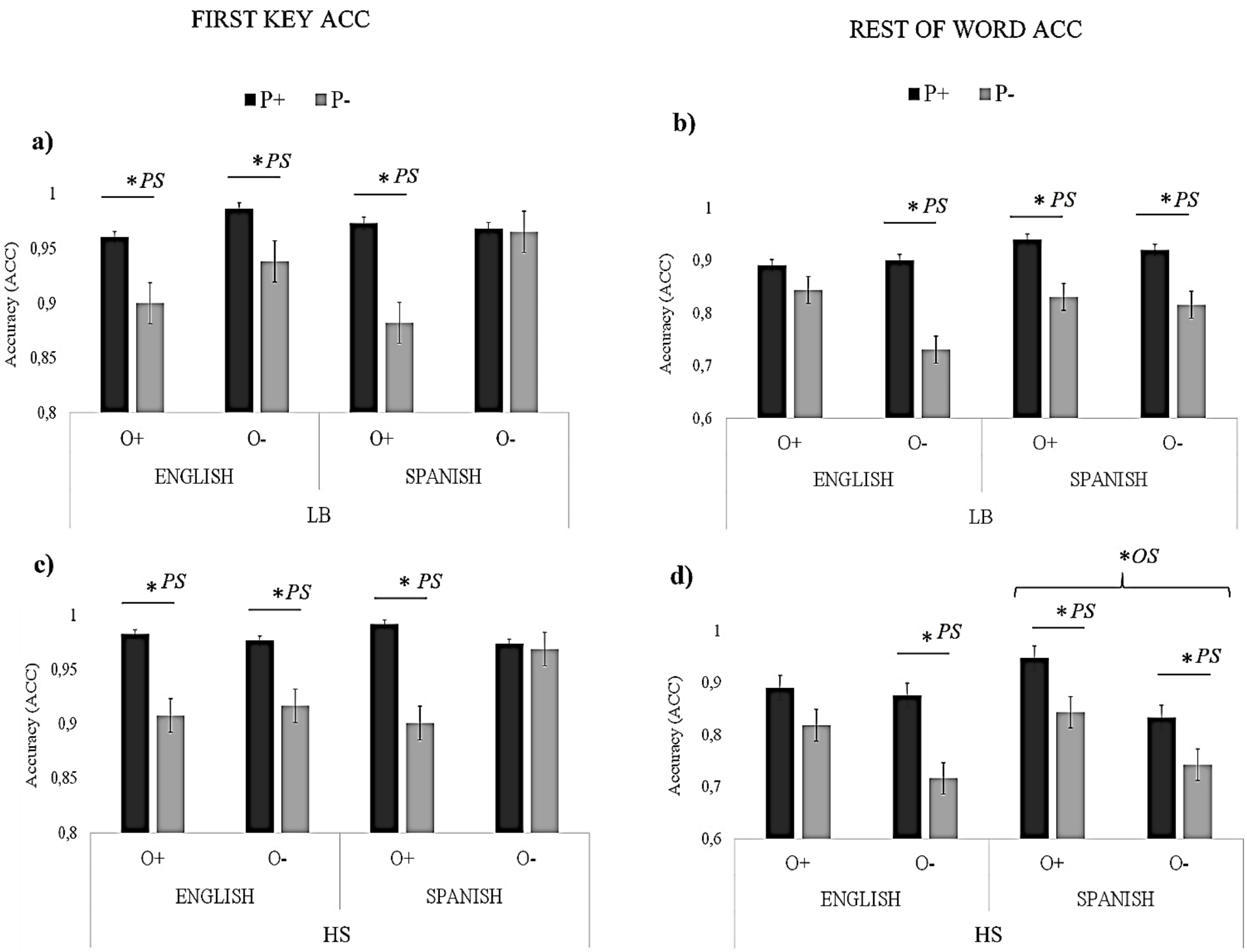


Figure 14. Visual representation of OS and PS accuracy results for the cognate condition (proportion of correct responses): a) LBs first key b) LBs rest of the word; c) HSs first key; d) HSs rest of the word. Asterisks next to PS indicate significant effects of phonology, and asterisks next to OS indicate significant effects of orthography.

Table 9.

Summary of results (main effects and interactions) of the OS and PS in the cognate words condition (analysis 2).

	FIRST KEY		REST OF THE WORD	
Effects	LATENCY	ACC	LATENCY	ACC
Group	*F*(1, 47)= .42, *p*= .515	*F*(1, 48)= 1.44, *p*= .235	**F(1, 46.9)= 8.02, p= .006***	**F(1, 47)= 4.63, p= .036***
Lang	**F(1, 1684)= 57.02, p<.001****	*F*(1, 1665.2)= .85, *p*=.358	**F(1, 2505)= 86.21, p<.001****	**F(1, 3426.8)= 4.57, p=.032***
OS	*F*(1, 155.3)= 2.65, *p*= .105	*F*(1, 158.3)= 2.85, *p*= .093	*F*(1, 157.2)= .33, *p*= .565	*F*(1, 161.3)= 3.68, *p*= .056
PS	**F(1, 155.3)= 20.91, p<.001****	**F(1, 158.3)= 14.18, p<.001****	*F*(1, 157.2)= .06, *p*=.806	**F(1, 161.3)= 12.22, p<.001****
*Group*Lang*	**F(1, 8613.1)= 30.34, p<.001****	*F*(1, 9079.3)= 1.81, *p*=.179	**F(1, 7663.3)= 13.66, p<.001****	*F*(1, 9069.8)= 2.23, *p*=.136
*Group*OS*	*F*(1, 8613.4)= .01, *p*= .898	**F(1, 9079.7)= 6.94, p= .008***	*F*(1, 7662.1)= 2.15, *p*= .143	**F(1, 9069.5)= 14.58, p< .001****
*Group*PS*	*F*(1, 8613.6)= 2.23, *p*= .135	*F*(1, 9080.2)= .70, *p*= .403	*F*(1, 7662.5)= 3.19, *p*= .074	*F*(1, 9069.5)= .01, *p*= .905
*Lang*OS*	**F(1, 1683.6)= 11.30, p<.001****	*F*(1, 1665.2)= 1.04, *p*=.309	**F(1, 2502.8)= 10.47, p=001***	*F*(1, 3426.6)= .09, *p*=.759
*Lang*PS*	*F*(1, 1683.5)= 2.86, *p*=.091	*F*(1, 1665.1)= .84, *p*=.359	*F*(1, 2504.2)= .42, *p*=.516	*F*(1, 3426.5)= .16, *p*=.686
*OS*PS*	*F*(1, 155.3)= 1.07, *p*=.302	*F*(1, 158.3)= 3.01, *p*=.085	*F*(1, 157.2)= .24, *p*=.622	*F*(1, 161.3)= .611, *p*=.436
*Group*Lang*OS*	*F*(1, 8613)= .28, *p*= .597	*F*(1, 9079.5)= .95, *p*= .329	*F*(1, 7662.2)= 2.49, *p*= .114	**F(1, 9069.5)= 10.56, p= .001***
*Group*Lang*PS*	**F(1, 8613)= 4.61, p= .032***	*F*(1, 9079)= .49, *p*= .485	**F(1, 7662.4)= 6.15, p= .013***	*F*(1, 9069.9)= .37, *p*= .539
*Group*OS*PS*	*F*(1, 8613.3)= .09, *p*= .755	*F*(1, 9079.1)= .01, *p*= .963	*F*(1, 7662.4)= .01, *p*= .941	*F*(1, 9069.7)= .71, *p*= .399
*Lang*OS*PS*	*F*(1, 1683.6)= 1.85, *p*=.173	**F(1, 1665.2)= 6.36, p=.012***	*F*(1, 2504.1)= .01, *p*=.965	**F(1, 3426.6)= 5.58, p=.018***
*Group*Lang*OS*PS*	*F*(1, 8613)= .23, *p*= .631	*F*(1, 9079.9)= .01, *p*= .936	*F*(1, 7662.2)= .02, *p*= .889	*F*(1, 9069.7)= .31, *p*= .578

Note. Lang = language; OS = Orthographic similarity; PS= Phonological similarity; * p < .05, ** p < .01

First Key Performance

Latency. Regarding the latency (RTs) of the *first key*, the main effect of Language was significant. The responses in English (mean = 658 ms) were faster than in Spanish (mean = 763 ms). The main effect of PS was also significant. Cognates with high PS (mean = 648 ms) were typed faster than of cognates with low PS (mean = 773 ms).

The interaction between Group and Language was significant. The differences between Spanish and English were significant in both groups (LBs: t (8612.6) = -9.23, SE = 16.1, p<.001; HSs: t (8610.3) = -3.86, SE = 15.9, p<.001), but the magnitude of the differences was greater in the LBs (Spanish: 772 – English: 623 = 149 ms) than in the HSs (Spanish 754 – English: 692 = 22 ms). The interaction between Language and OS was also significant, indicating that in the English block there were no significant differences between cognates with high OS (mean = 659 ms) and cognates with low OS (mean = 657 ms; t (1680.9) = .07, SE =30.7, p = .945), whereas in the Spanish block these differences were significant (mean of cognates with high OS = 717 ms; mean of cognates with low OS = 808 ms; t (1681.7) = - 2.97, SE = 30.7, p = .002).

The three-way interaction between Group, Language and PS was also significant. In order to explore this interaction, we performed a specific model (Language * PS) for each group separately. Here, we wanted to examine the interaction between Language and PS separately for the LBs and the HSs in order to examine the PS effect in each language, across the two language background profiles. The analysis performed in the LBs indicated a main effect of Language (F (1, 1797.2) = 51.01, p <.001), and PS (F (1, 149.28) = 20.73, p =.003). In addition, the Language x PS interaction was significant, F (1, 1796.97) = 9.75, p = .002. During the English version of the task, cognates with high PS (mean = 591 ms) were typed faster than of cognates with low PS (mean = 672 ms), t (1793.45) = -2.85, SE= 34.6, p = .043. During the Spanish version of the task, cognates with high PS (mean = 662 ms) were also typed faster than of cognates with low PS (mean = 853 ms), t (1789.7) = -5.51, SE = 34.7, p <.001. Although in both languages there were differences between conditions, the magnitude of the differences was greater in Spanish (191 ms) than in English (81 ms). In HSs, there was a main effect of Language, F (1, 2839.1) = 9.68, p = .002. The responses in English (mean = 631 ms) were faster than in Spanish (mean = 757 ms). The main effect of PS was also significant, F (1, 148.85) = 18.44, p <.001. Thus, cognates with high PS (mean = 627 ms) were typed faster than cognates with low PS (mean = 762 ms) but the Language x PS interaction was not significant (F (1, 2838.04) = 1.49, p =.22). No other interactions were significant.

Accuracy. Regarding the accuracy (ACC) of the *first key*, the main effect of PS was significant. The accuracy of cognates with high PS (mean = .977) was higher than of cognates with low PS (mean = .922).

The Group x OS interaction was also significant. In the LBs, the difference between cognates with high OS (mean = .929) and cognates with low OS (mean = .964) was significant (t (9076.8) = -2.36, SE = .015, p = .018), but in the HSs was not significant (O+ mean = .946; O- mean = .959; t (9075.4) = -.882, SE = .015, p = .377).

The three-way interaction between Language, OS and PS was also significant. In order to explore the interaction, we performed a specific model (OS*PS) for each language separately. Here, we wanted to examined the interaction between OS and PS separately for each language in order to examine the interplay of OS and PS effect in each language. In the analysis performed in the English block, there was a main effect of PS, $F(1, 92.01) = 6.74$, $p = .011$. The accuracy of cognates with high PS (mean = .984) was higher than of cognates with low PS (mean = .928). However, the main effect of OS $F(1, 92.01) = 1.10$, $p = .296$, and the OS x PS interaction $F(1, 92.01) = .20$, $p = .65$, were not significant. The analysis performed in the Spanish block indicated that there was no main effect of OS, $F(1, 100.98) = .1.941$, $p = .166$, but the main effect for PS $F(1, 100.99) = 7.84$, $p = .006$, and OS x PS interaction were significant $F(1, 100.89) = 3.93$, $p = .048$. This interaction indicated that in the high OS condition, there were differences between the P+ (mean = .977) and P- (mean = .873) conditions; $t(100.34) = 3.622$, SE = .028, $p < .001$. However, the difference between P+ (mean = .965) and P- (mean = .946) in the low OS condition was not significant; $t(100.48) = 0.573$, SE = .033, $p = .567$.

Rest of the Word Performance

Latency. Regarding the latency (RTs) for the *rest of the word*, the main effects of Group, and Language were significant, indicating that the responses in the LBs (mean = 1246 ms) were faster than in the HSs (mean = 1438 ms), and that the responses in English (mean = 1221 ms) were faster than those in Spanish (mean = 1463 ms).

The interaction between Group and Language was significant. Differences between Spanish and English were significant for both groups (LBs: $t(7661.8) = -6.630$, SE = 29.2, $p<.001$; HSs: $t(7662.8) = -9.944$, SE = 29.2, $p<.001$), but the magnitude of the differences was greater in the HSs (Spanish: 1583 – English: 1293 = 290 ms), than in the LBs (Spanish 1343 – English: 1150 = 193 ms). The interaction between Language and OS was also significant, indicating that the cognates with high OS were typed faster than cognates with low OS, but only in Spanish (O+ mean = 1403 ms; O- mean = 1523 ms; t (2489.3) = -2.963, SE = 80.1, p = .038). In English there were no differences (O+ mean = 1245 ms; O- mean = 1195 ms; t (2493.5) = 1.012, SE = 81.4, p = .472).

The three-way interaction between Group, Language and PS was also significant. To explore this interaction, we performed a specific model (Language*PS) for each group separately. Here, we wanted to examined the interaction between language and PS separately for the LBs and the HSs in order to examine the PS effect in each language, across the two language background profiles. The analysis in the LBs indicated that there was a main effect of Language (F (1, 3003.7) = 46.22, p <.001), indicating that the responses in English (mean = 1163 ms) were faster than those in Spanish (mean = 1331 ms). The main effect of PS (F (1, 152.46) = 0.08, p = .772), and the Language x PS interaction (F (1, 3003.22) =0.02, p =.874) were not significant. The analysis for the HSs showed a main effect of Language (F (1, 3003.7) = 66.17, p <.001), indicating that the responses in English (mean = 1316 ms) were faster than those in Spanish (mean = 1553 ms). However, the main effect of PS was not significant (F (1, 155.43) = 0.36, p = .545). The Language x PS interaction was significant (F (1, 3361.4.22) = 3.74, p =.039), so that in the English block, the difference between cognates with high PS (mean = 1314 ms) and cognates with low PS (mean = 1319 ms) was not significant, t (3002.3) = -0.069, SE = 78.2, p = .999, whereas in the Spanish block the difference between cognates with high PS (mean = 1512 ms) and cognates with low PS (mean = 1615 ms) was significant, t (7664.1) = -2.55, SE = 77.9, p = .019.

Accuracy. Regarding the ACC of the *rest of the word*, the main effect of Group was significant, with higher accuracy for the LBs (mean

= .858) than for the HSs (mean = .833). The main effect of Language was also significant, indicating higher ACC in Spanish (mean = .858), than in English (.833). The main effect of PS was also significant. The accuracy of cognates with high PS (mean = .899) was higher than of cognates with low PS (mean = .792).

The Group x OS interaction was significant, so that in the LBs, the difference between cognates with high OS (mean = .875) and cognates with low OS (mean = .841) was not significant (t (9067.7) = 1.097, SE = .034, p = .273), whereas this difference was significant for the HSs (O+ mean = .874; O- mean = .791; t (9068.5) = 2.661, SE = .031, p = .008).

The three-way interaction between Group, Language and OS was significant. To explore this interaction, we performed a specific model (Language x OS) for each group separately. The analysis in the LBs indicated that there was a main effect of Language, F (1, 1664.11) = 5.05, p = .024), indicating higher ACC in Spanish (mean = .870), than in English (.835). The main effect of OS (F (1, 160.24) = 2.21, p = .138), and the Language x OS interaction were not significant (F (1, 1664.08) = 1.28, p =.257. The analysis for the HSs showed that the main effect of Language was not significant, (F (1, 1740.22) = .08, p = .768), however, the main effect of OS (F (1, 161.08) = 6.81, p = .009), and Language x OS interaction were significant (F (1,1740.08) = 3.77, p =.05). The interaction indicated that in the English block the difference between cognates with high OS (mean = .851) and cognates with low OS (mean = .796) was not significant; t (1738.7) =1.499, SE = .037, p = .438), whereas in the Spanish block this difference was significant (O+ mean = .887; O- mean = .769; t (1736.5) = 3.198, SE = .037, p = .008).

The three-way interaction between Language, OS and PS was significant. We explored this interaction by a specific model (OS x PS) for each language separately. The analysis in the English block showed no main effect of OS, $F(1,103.69) = .62$, $p = .431$, but the main effect of PS $F(1,103.69) = 10.84$, $p = .001$, and the OS x PS interaction were significant, $F(1,103.69) = 4.32$, $p = .023$. This interaction indicated that for the high OS condition, there were no differences between the high PS (mean = .919) and the low PS (mean = .840) conditions; $t(102.6) = 1.375$, SE = .057, $p = .515$. However, there were differences between high PS (mean = .917) and low PS (mean = .740) in the low OS condition; $t(101.7) = 3.163$, SE = .066, $p = .008$. The analysis in the Spanish block showed main effects of OS, $F(1,102.85) = 6.20$), $p = .014$, with higher accuracy for cognates with high OS (mean = .868) than for cognates with low OS (mean = .799). The main effect of PS was also significant, $F(1,102.85) = 6.78$, $p = .012$, so that accuracy in cognates with high PS (mean = .871) was higher than in cognates with low PS (mean = .777). The OS x PS interaction was not significant, $F(1, 102.85) = .336$, $p = .563$. No other effects or interactions reached significance.

Summary of the OS and PS analysis

The results indicated that for the *first key*, the effect of the PS was present in the two languages and for the two groups (i.e., participants processed high PS cognates faster than low PS cognates), although PS effects were stronger for the HSs than LBs. In LBs the PS effect was stronger in Spanish than in English. OS had an effect in the Spanish block (i.e., participants processed high OS cognates faster than low OS cognates) but this effect interacted with PS. That is, the difference between P+ and P- conditions was significant only for the high OS condition. In English there was no effect of OS.

For the *rest of the word*, the effect of PS in reaction time was restricted to Spanish in the HSs. However, in Spanish it was present for accuracy (cognates with high PS had a better performance than cognates with low PS), but in English depended on OS (in cognates with high OS, there were no differences between P+ and P-. However, in low OS cognates, the accuracy was higher for P+ than P- cognates). Regarding the accuracy, the effect of OS depended on group and language, so that for the HSs the effect appeared in Spanish, but not in English, whereas in the LBs, the effect was not evident. OS tended to be more influential for typing the rest of the word than the first key (which was more influenced by PS).

DISCUSSION

The main goal of this study was to investigate language coactivation and the role of cognate status during bilingual writing using a writing to dictation task. More specifically, we investigated the relative contributions of the profile of participants' language backgrounds by testing two bilingual populations: LBs (L1: English; L2: Spanish) and HSs (Majority language: English; Minority language: Spanish) which were both immersed in an English dominant context, but differed in the level of formal literacy received in Spanish. The main goal was to analyze performance during typing of cognate and non-cognate words and examine how different degrees of orthographic similarity (OS) and phonological similarity (PS) in cognates affected writing times and accuracy. Importantly, from a theoretical standpoint, it is not completely clear how non-identical but similar cognates are lexically represented, what the role of orthographic and phonological similarity is in shaping these representations, especially when bilingualism is modulated by more or less exposure to formal education in one language. Moreover, previous experiments on cognate similarity have used reading tasks with visual presentations which may have obscured the role of phonological similarity. Critically, here we use a writing to dictation task in which words were orally presented but orthographically implemented, therefore providing a tool to unveil the role of both phonological and orthographic similarities. In addition, and very key to this study, the use of writing could also unveil possible differences in the nature of language coactivation for bilinguals with different language experiences. In the following subsections, we will discuss the reported results to examine the influence of cognate status, the impact of OS and PS in language coactivation, and the diversity of language and learning backgrounds on the current task.

The consequences of coactivation in writing to dictation: The overall effect of cognate status

The results of our experiment shed some light on the nature of cognate effects during a writing to dictation task. Previous studies have shown that cognates are "special" because they share more semantic, orthographic and phonological characteristics between languages than non-cognates (Voga & Grainger, 2007). Cognate facilitation effects have been widely reported in bilinguals and reflect language coactivation in reading, visual word recognition (e.g., Dijkstra et al., 2010; Lemhöfer & Dijkstra, 2004; Peeters et al., 2013), and in translation (Muscalu & Smiley, 2018). In the present experiment, cognate effects were also modulated by the language experience of the bilingual and the language in which the writing task was performed. More specifically, cognate facilitation was only present in HSs while processing in the minority language (Spanish), providing evidence of coactivation with the majority language (English). However, the results demonstrated an unexpected cognate interference effect in English (L1/majority language) with cognates being less accurate and slower than non-cognates in both groups.

Although cognate interference is not a common finding, some previous studies have found a similar effect (Comesaña et al., 2012; Dijkstra et al., 2010; Muscalu & Smiley, 2018; Schwartz et al., 2007). Critically, in all of them non-identical cognates were included as experimental material suggesting that the degree of OS and PS in cognates may have an important impact during word processing. The Bilingual Spelling in Alphabetic Systems theory (BAST; Tainturier, 2019) has proposed that the strength of coactivation is mediated by the degree of OS and PS between the two languages, so the relative proportion of high and low similarity cognates can modulate the resulting facilitation vs. interference effects. Importantly, in the present study, cognates with high orthographic and phonological similarity (O+P+) were intermixed with cognates with low OS or PS (O-P+ and O+P-) and cognates with low OS and PS (O-P-). The fact that low similarity cognates represented one third of the cognate stimuli might have masked the expected cognate facilitation effect. Thus, cognates are generally expected to produce coactivation of the two languages, and in turn facilitation, but the salient change in the code/representation (orthographic or phonological) of non-identical cognates may have produced competition and impaired their processing. At this point, competition between the two language representations would trigger lateral inhibition in order to reduce interference and select the appropriate representation (for a similar interpretation see Comesaña et al. 2012). Because non-cognates produce much weaker between language coactivation than cognate words, competition between representations would also be weaker for non-cognates relative to cognates (even for low similarity cognates). The role of inhibition when selecting among lexical competitors has also been proposed by others (Borragan et al., 2018). In line with this interpretation, previous research has found larger error monitoring effects and higher recruitment of brain regions dedicated to control while processing non-identical cognates relative to control words (Declerck et al., 2017; Peeters et al., 2019).

In addition, our results showed that the interference effect was found in the L1/majority language in both LBs and HSs, replicating previous production studies which showed a reversed dominance effect, exemplified by more intrusion errors in the dominant language (Gollan et al., 2014; Gollan & Goldrick, 2016; Li & Gollan, 2018). In this direction, some studies have pointed out that language processing in the L1/majority language could be largely mediated by an automatic process of orthography to phonology conversions, while processing in the L2 is more attentionally demanding (Plat, Lowie, & de Bot, 2018). We propose that the manipulated similarities and differences in phonology and orthography in the current study might have directly affected the phonology to orthography conversion (POC). Since the L1/majority language is mediated by automatic processes, it is easier to observe interference effects. On the contrary, during L2/minority language, processing is more demanding, and therefore the interference effect is reduced. The fact that interference occurs for HSs in the majority language (English) even though Spanish is their L1 may suggest that the regulatory processes are dependent on language experience and proficiency.

The nature of language coactivation: The role of PS and OS

The strength of language coactivation is mediated by the degree of orthographic and phonological similarity between languages

(Tainturier, 2019). Nevertheless, orthographic processing has been the focus of most studies (e.g., Casaponsa et al., 2014; Hoversten, et al., 2017; Muscalu & Smiley, 2018; Peeters et al., 2013; Van Kesteren et al., 2012), reporting in a general larger cognate-facilitation effects with greater OS (Dijkstra et al., 2010). Crucially, cognates can also vary in the degree of phonological similarity (PS) across languages. However, the role of PS and the interaction of PS with OS have received little to no attention. Very few studies have explored the interplay of PS and OS during word processing and most have relied on a reading task in which orthographic processing is imperative (Comesaña et al., 2012; Schwartz et al., 2007). For example, previous studies have demonstrated that the positive effect of PS (i.e., faster RTs for cognates with high PS than cognates with low PS) was mediated by the OS (Comesaña et al., 2012; Schwartz et al., 2007). In those studies, the PS effects only emerged in high OS conditions (i.e., the response in O+P+ condition was faster than the responses in O+P- condition). However, there were no differences between high and low PS in cognates with low OS (there were no differences between O-P+ and O-P-). In other words, if common orthographic L1/L2 nodes map onto different phonological L1/L2 nodes, it can create confusion, slowing down the processing of the word (Dijkstra et al., 1999; Dijkstra & Van Heuven, 2002; Doctor & Klein, 1992; Schwartz et al., 2007).

The absence of PS effects in low OS conditions reported in previous studies has been explained by the Orthographic Autonomy hypothesis which proposes that written production is not dependent on spoken production, and therefore not dependent on phonological information (Rapp & Caramazza, 1997). In reading, orthographic retrieval is mandatory, and the coactivation of language nodes would be mediated by OS. In addition, in the O- condition, the coactivated representations compete for selection, and inhibition would be triggered to achieve successful processing (in the Comesaña and colleagues' and in the Schwartz and colleagues' studies). This first orthographic filter would reduce the spread of activation to phonology (See Figure 11 in which the arrows on the left represent the reduction of spread in the O- condition). As mentioned, phonological processing in reading is delayed with respect to orthographic processing because the stimuli are visually presented and mapping of orthography to phonology only occurs after orthographic analyses have taken place. However, writing production paradigms, and especially writing to dictation tasks, can be key to study the role of phonology because these tasks involve phonological input and orthographically oriented responses, such that phonological processing is mandatory (Obligatory Phonological Mediation hypothesis; Geschwind, 1969).

Contrary to previous studies, the results of our writing to dictation task showed a general PS effect in the first key latency and accuracy in most conditions of the experiment. In the first key latency analysis, the PS effect (faster RTs for cognates with high PS than cognates with low PS) was present for both groups (LBs and HSs) in English (L1/majority language) and Spanish (L2/minority language), suggesting primacy of phonological processing facilitating the access to the lexical representations of the words. The first filter would therefore be phonological, so in the low OS condition, phonological information would continue to be processed, because the first filter, in this case, did not reduce the spread of activation to phonology (See Figure 11, specifically see the arrows on the far right).

In contrast, PS effects for the rest of the word, although present in accuracy, were not present in LBs and it interacted with OS in HSs (in Spanish). This pattern suggests that the role of phonology is smaller as the time course progresses and the influence of orthography gains relevance. The fact that the OS effect was more consistently found in Spanish than in English in the rest of the word analyses suggests that the way the words are processed in each language could be different (i.e., after the first key). Performance on the rest of the word in the writing task has been attributed to sublexical processing (Iniesta et al., 2021; Muscalu & Smiley, 2018). Dual route theories of reading propose that transparent orthographies such as Spanish rely on phoneme to grapheme processing, contrary to deeper languages such as English which uses direct access to lexical representations (Orthographic Depth Hypothesis; Frost, 1994; 2012). So, the OS, which is a sublexical characteristic, would more directly affect sublexical processing (the POC system) than lexical processing explaining the greater role of OS in Spanish.

In sum, differences in the time-course of orthographic and phonological activation during reading vs. writing to dictation tasks explain the differences in the impact of OS and PS. The Bilingual Interactive Activation BIA+ model (Dijkstra & Van Heuven, 2002) introduces the "temporal delay assumption" to explain that under some conditions, cross-linguistic phonological, orthographic and/or semantic effects may be absent due to task demands. Reading requires orthographic activation prior to phonological activation, and therefore the late phonological activation would not affect response times (Brysbaert et al., 2002). However, during a writing to dictation task, the phonological processing precedes activation of orthographic information, and therefore the phonology may directly impact the performance. The fact that phonological processing occurs early in writing to dictation explain the generalized PS effects in all experimental conditions (faster responses for cognates with high PS than for cognates with low PS).

Following previous studies, we decided to use OS and PS as dichotomous variables to directly compare reading and writing to dictation (Comesaña et al., 2012; Schwartz et al., 2007). However, the threshold used to classify cognates as high or low similarity is somewhat arbitrary, and future research in this field should consider OS and PS as continuous variables.

The role of the learning environment in language coactivation

In our experiment, we included two groups of bilinguals: LBs and HSs. We hypothesized that the relationship between the L1 and the L2 could be influenced by their linguistic learning background (Dijkstra et al., 2010; Kroll et al., 2006). More specifically, differences in literacy and exposure to writing and reading between the two groups might modulate the coactivation effects and the relative roles of OS and PS in L1 and L2 processing. The two groups did not differ in the LEAP-Q measures for English (L1/majority language): there were no differences in the years of schooling in an English context, nor in their self-assessed language skills for speaking, understanding and reading, nor in their Reading contribution to learning measure which reflects L1 formal learning and regulates learning at school (Iniesta et al., 2021). For Spanish however (L2/minority language), the LEAP-Q highlighted significant differences in the self-assessed skills in speaking and understanding with HSs scoring higher than LBs. Critically, in skills that were more related to formal language use, like reading, there were no group differences, and additionally, HSs showed a lower score for the score Reading contribution to learning. In addition, and in accordance with previous studies (Elola & Mikulski, 2016), scores in the Spanish tests showed worse performance for HSs than LBs (PROESC and TECLE). Hence, even though the years of exposure to Spanish were greater in the HSs, they showed more orthographic difficulties in Spanish than the LBs, presumably due to the fact that their input during learning was mainly phonological, resulting in a less accumulated literacy practice (see the weaker links hypothesis; Gollan et al., 2008).

In the same direction of PROESC and TECLE, the HSs showed worse performance in the writing to dictation task (relative to LBs), specifically in the latency of the rest of the word performance. This suggests that the HSs might have greater difficulties in sublexical processing, where the orthographic form retrieval is especially important. In addition, analysis of the RTs showed an interaction between Group and Language. This interaction indicated that both groups were faster in English than Spanish, but the magnitude of the difference was greater for the LBs than for the HSs when looking at the first key performance (lexical access), and the magnitude of the difference was greater for the HSs than the LBs when considering the rest of the word performance (sublexical processing). Again, this pattern suggests that the HSs might have more difficulties retrieving the word form in both languages (English and Spanish) although these difficulties become more evident during writing production in the minority language, presumably due to less accumulated practice as a result of their learning background (see also Gollan et al., 2008).

Regarding the OS and PS between languages, there were subtle differences between groups. In the RTs analysis of the first key (lexical) latency, the results showed a Group x Language x PS interaction. Even though there were significant differences between high PS and low PS in both groups and both languages (Spanish and English), the magnitude of the difference was higher in Spanish in the LBs (cognates with high PS were typed faster than cognates with low PS). A possible interpretation of this effect is that when LBs type the first key in

Spanish, the English phonology is more coactivated than when they are typing in English and Spanish is coactivated. In contrast, for HSs there were no magnitude differences between languages for phonology. There were no accuracy differences while processing O+ and O- cognates for the first key, suggesting that for HSs the sensitivity to the OS is reduced in both languages. This pattern supports previous studies that show phonological advantages for HSs relative to LBs (Chang et al., 2011; Gor, 2014), but also orthographic disadvantages (Elola & Mikulski, 2016).

In sum, these results add to the current literature on bilingual language coactivation by demonstrating that the language learning environment, especially formal exposure to reading and writing in a given language, can not only modulate proficiency but also affect how the languages are coactivated and how they interact.

CONCLUSIONS

The present study provides evidence that language coactivation during writing production in L1 and L2 is modulated by OS, but also, and more important, by PS across languages. Writing to dictation involves phonology from the very early processing stages so that PS contributes to facilitating access to the lexical representation of the words. Hence, contrary to previous studies on reading, the PS effects were very pervasive during lexical access (first key latency, [i.e., participants process cognates with high PS faster than cognates with low PS]), although they showed modulation with orthography during the implementation of writing while typing the rest-of-the-word (sublexical processing). In contrast, the effect of OS was not extensively evident during lexical access (first key), and it had a more important role during the sublexical processing (rest of the word). In addition, the results provide evidence about the impact of literacy differences for orthographic and phonological coactivation during writing production (in this case, the acquisition of the Spanish L2/minority language).

To conclude, the interplay of OS and PS underlying cross-linguistic influence in bilinguals seems to be dependent on the relative order in which orthographic and phonological processing occurs, and this pattern can be modulated by the task that bilinguals are performing and by the language learning environment of the bilinguals. Commonly, bilingual competence is conceptualized as a continuum. In this continuum, the study of HSs is especially important because it allows for an exploration of how different cultural, linguistic, and educational contexts influence language learning and the relationship between languages.

CHAPTER 6.

TRANSFER EFFECTS FROM LANGUAGE PROCESSING TO THE SIZE OF THE ATTENTIONAL WINDOW: THE IMPACT OF ORTHOGRAPHIC TRANSPARENCY

ABSTRACT

The consistency between letters and sounds varies across languages, and it is associated with different reading mechanisms; while transparent orthographies use mostly phonological processing, lexical processing is more used in opaque orthographies. This study aimed to extend this idea to writing to dictation. For that purpose, we evaluated whether the use of different types of processing (lexical vs. phonological) has a differential impact on local windowing attention: phonological (local) processing in a transparent language (Spanish) and lexical (global) processing of an opaque language (English). Spanish and English monolinguals (Experiment 1) and Spanish–English bilinguals (Experiment 2) performed a writing to dictation task in Spanish or/and English followed by a global-local task. A correlational analysis showed that the response times (RTs) from the Spanish writing to dictation task correlated with word length, whereas the RTs from the English writing to dictation task correlated with word frequency and age of acquisition, respectively, as evidence of phonological and lexical processing. In addition, after a Spanish task, participants more efficiently processed local information, which resulted in both the benefit of global congruent information (monolinguals and bilinguals) and the reduced cost of incongruent global information (was more evident in monolinguals). Additionally, the results showed that bilinguals adapt their attentional processing depending on the language context.

Keywords. Transparency, lexical, phonological, local attention, writing, bilingualism

Iniesta, A., Bajo, M.T., Rivera, M., & Paolieri, D. (under review). Transfer effects from language processing to the size of the attentional window: the impact of orthographic transparency. *British Journal of Psychology*.

INTRODUCTION

Reading and spelling have been studied extensively in order to understand how people identify, process, and decode different types of words or strings of letters. Several theories have been proposed to explain the mechanism of reading (e.g., Grainger & Jacobs, 1996; McClelland & Rumelhart, 1981; Rayner et al., 2012; Treiman & Kessler, 2014), most of them within the framework of the dual-route cascaded (DRC) model of word identification (Coltheart, 1978; Coltheart et al., 1979; 2001). According to the DRC model, reading and spelling are processed by two pseudo-independent routes. The non-lexical-phonological route involves mapping between graphemes and phonemes, which makes the correct pronunciation of regular words and non-words possible. In contrast, the lexical route involves retrieval of word forms from long-term memory (Grainger & Ziegler, 2011), which permits recognition and pronunciation of familiar and irregular words (e.g., Coltheart et al., 2001).

DRC models (Coltheart et al., 2001) have also been extended to writing (Ellis & Young, 1988) and applied to explanations of data from writing to dictation tasks (Bonin & Méot, 2002; Delattre et al., 2006; Rapp et al., 2002). Thus, writing would be based on two parallel routes: the non-lexical route, which uses phoneme-to-grapheme correspondences for letter-by-letter word processing, and the lexical route, which retrieves the spelling of the word from the orthographic lexicon directly before starting to write. Although empirical studies testing the hypothesis of the model to writing are still scarce (Brown & Ellis, 1994; Houghton & Zorzi, 2003; Olson & Caramazza, 1994), a number of studies have provided support for it. Thus, dissociations between the two writing processing routes have been reported for patients with acquired central dysgraphia (Barry, 1994; Behrmann & Bub, 1992; Goodman & Caramazza, 1986; Tainturier & Rapp, 2000), with a double dissociation between lexical dysgraphia (Hatfield & Patterson, 1983) and phonological dysgraphia (Shallice, 1981).

Similar to reading, different linguistic variables seem to affect writing production (e.g., Norton et al., 2007). On the one hand, the phonological route is influenced by word regularity (e.g., Delattre et al., 2006; Rapp et al., 2002) or word length (Burani et al., 2007). Thus, differential patterns of brain activation for regular and irregular word spelling have been pointed out (Henry et al., 2007; Palmis et al., 2019; Rapcsak & Beeson, 2004). On the other hand, the lexical route is more sensitive to lexical factors such as word frequency, age of acquisition (AoA), or concreteness (Bonin, 2004; Bonin et al., 2002; Burani et al., 2007). Overall, these effects have been taken as evidence of dual processing in writing to dictation (Bonin & Meót, 2002; Delattre et al., 2006).

In reading, some evidences for DRC models comes from comparisons between languages varying in orthographic depth. One dimension for between-language variation that has been observed in reading is the regularity of the grapheme-phoneme correspondence (Frost et al., 1987). In opaque or deep orthographies such as English or French, the majority of the words have ambiguous grapheme-phoneme relations, with many graphemes having more than one pronunciation. In contrast, in transparent or shallow orthographies such as Italian or Spanish, words have simple grapheme-phoneme relations with very consistent pronunciations (Seymour et al., 2003). In this line, reading studies have shown that the type of processing might be language-dependent (Orthographic Depth Hypothesis; Frost, 1994; 2012; Frost et al., 1987; Katz & Frost, 1992). Transparent orthographies engage mostly phonological processing because the very few existing grapheme-morpheme inconsistencies do not require retrieval of the word from the lexicon. In contrast, deep orthographies involve many words that do not follow regular phonological-orthographical rules, and lexical processing is essential to retrieve the correct pronunciation of the words (Bolger et al., 2005; Glushko, 1979; Seidenberg & McClelland, 1989; Seymour et al., 2003; Ziegler & Goswami, 2005). Supporting these assumptions, studies focusing on phonological awareness or lexical access abilities have shown that they are modulated by the transparency of the language (Frost, 1994; Frost et al., 1987; Ziegler et al., 2010). Thus, in transparent languages, phonological awareness is acquired and automatized faster than in opaque languages (see Goswami et al., 2005; Patel et al., 2004). Conversely, performance in the rapid automated naming task (a standard measure of lexical access) performance is faster and becomes more stable in opaque than in transparent languages (e.g., Caravolas et al., 2012; Moll et al., 2014).

The orthographic depth hypothesis (Frost, 1994; Frost et al., 1987) has also been supported by experiments using event-related potentials (ERPs). Thus, the specific component (N320) related to grapheme-phoneme conversion appears more consistently in transparent orthographies (Proverbio et al., 2004; Simon et al., 2006), while components related to lexical integration (N400) are more evident in opaque orthographies (Koester et al., 2007).

From another theoretical perspective, the Psycholinguistic Grain Size theory (PGST, Ziegler & Goswami, 2005) proposes that languages with opaque orthographies are associated with coarser-grain coding, which includes whole words rather than letters in the processing window. In contrast, transparent orthographies are associated with finer-grain coding and with smaller processing windows (Grainger & Ziegler, 2011). i.e., differences in processing (lexical *vs.* phonological) lead to a differential processing grain (coarse *vs.* fine) which could also have an impact on the attentional windowing (words *vs.* letters) (see Figure 15). Using eye-tracking measures, readers of orthographically opaque languages have been shown to use larger orthographic sequences for analysis than readers of transparent orthographies who use smaller reading units (Rau et al., 2014; Rau et al., 2015). In addition, cross-linguistic data have shown that the number of visual elements that people can process simultaneously is associated with reading speed in opaque languages, while in transparent languages, this association is not observed (Awadh, et al., 2016; Lallier et al., 2018).

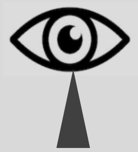
PSYCHOLOGICAL GRAIN SIZE THEORY			
Transparency	Reading strategy	Visual attention modulation	Processing mode
Deep/Opaque	Lexical	 *orange*	Word
Shallow/Transparent	Phonological	 *naranja*	Phoneme

Figure 15. The Psycholinguistic Grain Size Theory. The representation of the reading strategies and the modulation of the processing mode (visual attention) depends on the orthographic transparency and the grain size used during reading (adapted from Lallier & Carreiras, 2018).

Recently, Franceschini et al. (2020) observed an interesting association between language processing (lexical or phonological) and attentional window (global or local) using Italian regular (phonological processing) and irregular words (lexical processing) and a perceptual priming paradigm. They included in their procedure the global-local task (Navon 1977). The prototypical global-local task consists in a large letter (or geometric figure) composed of small letters (or geometric figures) and the participants have to identify the large (global task) or small element (local task) depending on the instructions. In their procedure, they asked participants to respond to global or local features composing the Navon global-local task (Navon 1977), before performing a reading aloud task including regular and irregular words and pseudowords. Their results showed that after the local-attention task, reading irregular words was significantly slower than reading regular words. In contrast, reading pseudowords was not affected by the previous performance of the local (or global) task after the global attentional condition. This pattern indicated that local attentional processing selectively impaired subsequent global-lexical processing of irregular words, suggesting that the type of processing (global-local) induced by the attentional task transferred to a subsequent linguistic task. The transfer of local/global processing from attentional to linguistic tasks and vice-versa suggests that dual local/global processing might be a general dimension that affect other cognitive domains. In fact, compositional-local processing versus holistic-global processing have also been proposed in number processing (e.g., Nuerk et al., 2011), syntactic processing (McClelland & Patterson, 2002; Pinker & Ullman, 2002), and creativity (Zmigrod et al., 2015) among others.

Our aim here is to explore whether this dimension can also be extended to writing. Similar to reading, writing has also been assumed to vary with the orthographic depth of the language of writing. Hence, it has been associated with lexical mechanisms in opaque orthographies and mostly sublexical mechanisms in transparent languages. However, there is no specific data supporting this assumption, and it is critical to carry out cross-linguistic research in this direction (Miceli & Costa, 2014). Studies on the relationship between attentional windowing and writing processes in transparent and opaque orthographies can be used to generate evidence supporting the orthographic depth hypothesis in writing. It is important to note that attentional windowing in addition to modulate the linguistic processing (Franceschini et al., 2020) can also be modulated by language transparency (Adelman et al., 2010; Awadh, et al., 2016; Lallier et al., 2018; Marzouki & Grainger, 2014; Rau et al., 2014; 2015).

The main objective of our two experiments was to directly explore whether the use of transparent or opaque language during a writing task would have an impact on the attentional windowing. First, we wanted to test whether writing is modulated by lexical or phonological variables depending on the depth of the language involved. Second, we planned to investigate whether the type of processing during writing (phonological or lexical) would have an impact on the grain of the processing size of attentional patterns (Awadh et al., 2016; Grainger & Ziegler, 2011; Rau et al. 2015). In doing this, we aimed to extend the evidence from reading theories (orthographic depth hypothesis and the psycholinguistic grain size theory) to word writing production in monolinguals (Experiment 1), and bilinguals (Experiment 2). Thus, in Experiment 1, we used a between-group design to explore whether monolingual speakers of two languages differing in transparency transfer the processing grain from writing to attention. In Experiment 2, we used a within-participants design to explore the transfer from the processing grain in writing to attention in the two languages of English/Spanish bilinguals. Recent studies support the idea that bilinguals adapt their processing to the opacity/transparency of the language they are using (Buetler et al., 2014; Rau et al., 2015), so exploring bilinguals in each language could be also an interesting approach to test the orthographic depth hypothesis in writing, and the transfer of writing to attention.

EXPERIMENT 1: SPANISH AND ENGLISH MONOLINGUALS

To address these issues, we asked to monolingual participants to carry out a writing to dictation task and then perform a visual attention task. In order to explore the effect of language transparency, English and Spanish monolingual groups were addressed considering English as an opaque orthography, and Spanish as a transparent orthography. The writing to dictation task has shown high sensitivity to linguistic variables (Bonin et al., 2015). Thus, we expected to find evidence of lexical or phonological processing in the writing to dictation task depending on the language transparency. We anticipated that frequency, age of acquisition, and concreteness would have an effect when the dictation task was in English (an opaque orthography), since these variables are considered evidence of lexical processing (Bonin et al., 2004). In contrast, we expected that these effects would not be evident in transparent orthographies (Spanish), where phonological effects such as word length and orthographic neighbors should be evident (Burani et al., 2007).

Our second focus was on transfer effects from the linguistic to the attentional task. Thus, once we tested whether different types of processing emerge as a consequence of language transparency, we explored the relationship between language transparency and attentional windowing. We hypothesized that phonological processing in a transparent orthography (Spanish) would activate local attentional processing, while global processing would be induced by lexical processing in an opaque orthography (English).

We explored these hypotheses by looking at the pattern of facilitation and interference effects when participants performed the global-local attentional task (Navon, 1981). Facilitation refers to faster times when the local and global features are congruent (i.e., a big H composed of small Hs or a big S composed of small Ss) relative to a neutral condition (a big H or S composed of small circles). Interference refers to slower times responding to incongruent conditions (a big H composed of small *s*'s or vice versa) than to the neutral condition. We focused our predictions on the facilitation and interference effects during the local task, since results have shown that global processing is prevalent in this task effects (Navon, 1977; 1981). Thus, global processing seems to be a necessary first stage in perception, while local processing is vulnerable to contextual effects. In addition, previous studies have shown not transfer effects between language processing and global attention (Franceschini et al., 2020). Therefore, we expected that, when participants performed the local tasks after the Spanish writing task, thus inducing phonological processing and smaller grain sizes, we would find more efficient local processing with a possible reduction of facilitation and interference effects from global information. In contrast, when the attentional local task was performed after English (lexical processing and larger grain size), we would find less facilitation and greater interference than when it was performed in Spanish. This indicated that processing in English promotes global processing with the consequence of producing greater facilitation when the preferred global information is congruent with the local information and greater interference when global information is incongruent with the local information.

METHOD

Participants

Twenty-two Spanish monolinguals from the University of Granada (Spain, mean age: 22.05, *SD*: 3.22) and 23 English monolinguals from Pennsylvania State University (USA; mean age: 23.56, *SD*: 3.29) were recruited for this study. All participants had normal or corrected to normal vision and hearing abilities, and they did not show any language or neurological impairments. They all signed consent forms according to the protocol approved by the Ethical Committee at the University of Granada.

Materials

Global-Local Task

We created an adapted version of the classical global-local task (Navon 1977). Participants were presented with a large letter composed of small letters, and they were instructed to respond to the large (global task) or small letter (local task) immediately before a presentation. All conditions (congruent, incongruent, and neutral) were constructed by combining three different letters: H, S, and O. In the congruent condition, the large and small letters were the same (e.g., S letter composed of small S letters). In the incongruent condition, the large letter was composed of different small letters (e.g., H letter composed of small S letters). In the neutral condition, the large letter (H or S) was formed by small circles in the global task. For the local task, a large circle was composed of small H or S letters. Each participant received 72 trials in the global tasks and 72 trials in the local task; that is, there were 24 congruent trials, 24 incongruent trials, and 24 neutral trials within each task. The order of blocks and conditions within the blocks was randomized (Soriano et al., 2018).

Writing to dictation task

The participants carried out a writing to dictation task, with words presented aurally with an emotionally neutral tone. The words were recorded in mono, 26 bits with a frequency of 44,100 Hz and filtered from environmental sounds. A total of 178 nouns words in English and Spanish were included in two separate blocks (see Table 10 for descriptive analysis of experimental material). English and Spanish logarithmic frequencies and length (number of letters) were computed using the NimTools (Guaschet al., 2013). English AoA was extracted from Kuperman et al.'s (2012) ratings, and Spanish AoA was extracted from subjective norms (Alonso et al., 2014). English concreteness was searched in the word lemmas rating (Brysbaert et al., 2014) and Spanish concreteness in the EsPal database (Duchon et al., 2013). CLEARPOND (Marian et al., 2012) was used to acquire orthographic neighbor information.

Table 10.

Characteristics of the Experimental Stimuli

Blocks	Frequency	Length	AoA	Concreteness	Neighbors	OS	NLD
English	1.017	6.438	7.415	4.051	2.932	0.471	0.496
	(0.567)	(1.637)	(2.609)	(1.140)	(4.355)	(0.194)	(0.211)
Spanish	1.033	6.842	7.019	4.29	2.112	0.471	0.510
	(0.636)	(1.851)	(2.201)	(1.188)	(3.369)	(0.211)	(0.211)

Note. Mean scores with *SD* in parentheses. Frequency= Logarithmic frequency; AoA = age of acquisition; OS = orthographic similarity; NLD = normalized Levensthein distance.

As expected, there were no significant differences between language blocks in frequency, $t(89) = -.170$, $p = .865$; length, $t(89) = -1.628$, $p = .107$; AoA, $t(89) = -1.04$, $p = .301$; concreteness, $t(89) = -1.55$, $p = .126$; or number of neighbors, $t(89) = -1.35$, $p = .182$. We also controlled the orthographic similarity (OS; van Orden & Goldinger, 1994) and normalized Levensthein distance (NLD; Levenshtein, 1966; Schepenset al., 2012) between the selected words and their translation. OS and NLD were computed using NimTools (Guasch et al., 2013). The *t*-test performed showed no significant differences between language blocks, t (89) = –.001, p = .999 (OS); t (89) = .43, p = .671 (NLD).

Procedure

Each participant performed the experiment individually. The monolingual participants were asked to perform the dictation task in their native languages. After the dictation task, participants were asked to perform the global-local task. Thus, for each participant, the experiment consisted of two main tasks that proceeded sequentially: 1) the dictation task in Spanish or English (depending of the group) and 2) the global-local task. All the tasks were performed in individual sessions that lasted less than 40 minutes.

The writing to dictation task was programmed on E-Prime version 2.0. Each trial started with a fixation point that remained on the screen until the audio stimulus finished. The target word was presented orally through headphones. When the audio finished, the participant had to write the target word as rapidly and as accurately as possible. The participants were instructed to press the space bar when they finished writing. Each language block began with 10 practice trials and 89 experimental words.

Writing times and accuracy were collected from the onset of the stimulus to the first keypress (first key performance) in order to study the influence of the linguistic factors previously mentioned (frequency, length, AoA, concreteness, and orthographic neighbors). The time required to type the first key has been associated with access to the lexical representations (see Iniesta et al., 2021; Muscalu & Smiley, 2018).

The global-local task was also administered via E-Prime version 2.0 (Psychology Software Tools, Pittsburgh, PA, USA). Participants were shown a series of global letters that were composed of local letters. At the start of each trial, participants were presented with an instruction cue at the center of the screen for 500 ms indicating if they should respond to the large or small letter. This consisted of a screen with the instructions to respond to either the "large" global letter or to the "small" local letters of the global-local stimulus (Courier New, 18-point size). Immediately after instructions, a single stimulus was presented in the center of the computer screen (with a dimension of 7 x 4 cm) until the participant's response. The participants were sitting 65 cm from the screen. At this distance, the local letters had a vertical visual angle of 0.5 degrees. Large letters subtended a vertical visual angle of 10 degrees (Kimchi, 2015). Participants were reminded at the beginning of each block to identify the target letter by making the keypress corresponding to "H" or "S." They were prompted to answer as rapidly as possible but trying not to make mistakes. The participants received 10 practice trials before the experimental task.

RESULTS

Writing to dictation task

First, we analyzed the first key response times (RTs) and accuracy in the writing to dictation task to investigate whether the performance was modulated by lexical and/or phonological variables. Data trimming was implemented when the RTs were at 2.5 *SD* above or below the mean of the participants in each group (3.31% from the

Spanish monolingual group and 3.12% from the English monolingual group). Then, correlational analyses were performed for each group (Spanish and English monolinguals), including lexical frequency, AoA, and concreteness as evidence of lexical processing (Bonin et al., 2004), and the number of letters (length) and orthographic neighbors as evidence of phonological processing (Burani et al., 2007).

Table 11 includes Pearson correlations between the variables for the two data sets (writing to dictation performance and linguistic variables). In the English monolingual group, the RT was negatively associated with Frequency, $r = -.323$, $p = .002$, and positively associated with AoA, $r = .255$, $p = .016$. ACC was associated only with frequency, $r = -.224$, $p = .035$. In contrast, in the Spanish monolingual group, RT was associated with word length, $r = .289$, $p = .006$. No significant correlations were observed with ACC.

Table 11.

Correlation among linguistic variables and writing to dictation performance in each monolingual group

	Spanish		English	
	RT	ACC	RT	ACC
Frequency	–.107	.180	–.323**	–.224*
Length	.289**	.124	–.098	–.075
AoA	.004	–.110	.255*	.033
Concreteness	.192	–.032	.091	.085
Neighbors	.034	.143	–.064	–.106

Note. *$p < .05$, **$p < .01$.

In addition, we also implemented Bayesian Pearson correlations (Love et al., 2015) to test for the robustness of the significant correlations (length, frequency, and AoA; see Table 12) (Love et al., 2015).

Table 12.

Bayesian Factor Analysis of the critical correlations in both monolingual groups

Correlations	Spanish Group	English Group
RT – Length	BF_{10} 5450	BF_{10} 0.199
Evidence for H1. Robustness check	*strong**	*no evidence*
RT – Frequency	BF_{10} 0.216	BF_{10} 14.43
Evidence for H1. Robustness check	*no evidence*	*moderate**
RT – Age of Acquisition (AoA)	BF_{10} *0.133*	BF_{10} *4.591*
Evidence for H1. Robustness check	*no evidence*	*moderate**

**Note*: A Bayes factor above 3 is considered to be *moderate* evidence, and a Bayes factor above 10 is considered to be *strong* evidence for the alternative hypothesis (Lee & Wagenmakers, 2014).

Global-Local Task

Data trimming was implemented so that RTs at 2.5 *SD* above or below the mean were eliminated from the analysis. The cut-off was done for each participant of each group independently (3.65% of the items were discarded in the Spanish monolingual group, and 3.17% in the English monolingual group).

The RT data of each type of trial during the local task in the Spanish monolingual group (congruent [*M* = 859.37 ms; *SD* = 32.19], incongruent [*M* = 926.89 ms; *SD* = 41.46] and neutral [*M* = 922.04 ms; *SD* = 34.10] trials) and in the English monolingual group (congruent [*M* = 784.97 ms; *SD* = 38.52], incongruent [*M* = 844.75 ms; *SD* = 36.33] and neutral [*M* = 792.85 ms; *SD* = 34.95] trials) were computed in both facilitation and interference indexes (Soriano et al., 2018). See Appendix 2-table A (pp. 194) for complete latency and accuracy data (M and SD). The analysis was conducted separately for each index (facilitation and interference) (see Figure 16). The information about global task were included in the Appendix 2-table B (pp. 194) for information only, since the global task is less vulnerable to local effects (Navon, 1977; 1981) and the global task did not transfer to reading in previous experiments (Franceschini et al., 2020).

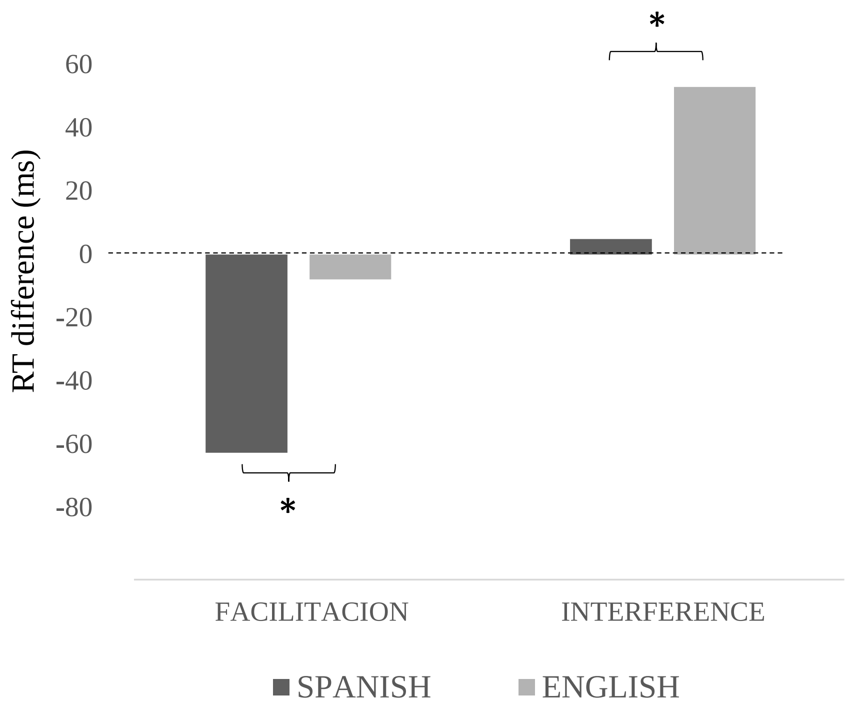


Figure 16. Facilitation and interference indexes from Monolingual Groups. The facilitation index (the difference between congruent and neutral trials) and interference index (the difference between incongruent and neutral trials) was obtained in the local task in both Spanish and English monolingual groups.

Facilitation Index. The analyses conducted on the RT difference between congruent and neutral trials showed larger facilitation after Spanish (M = –62.66 ms) than after English (M = –7.88 ms), $t\,(43) = -3.532$, $SE = 28.02$, $p = .002$, $d = -0.953$.

Interference Index. The analyses conducted on the RT differences between incongruent and neutral trials showed smaller interference in Spanish (M = 4.85 ms) than in English (mean = 51.89 ms), $t\,(43) = -2.587$, $SE = 24.17$, $p = .016$, $d = -0.771$.

DISCUSSION

In the Experiment 1, we aimed to explore whether the type of processing (local-phonological or global-lexical) induced by the use of a transparent or opaque language during a writing to dictation task transferred to a subsequent attentional task, thus biasing attention toward local features. With this aim, we asked to the Spanish and English monolingual participants to perform a global-local task after a writing to dictation task.

We first performed a correlational analysis in order to explore the effect of some linguistic variables in the English and Spanish writing tasks (Norton et al., 2007). The results showed a clear dissociation between languages: performance (RTs) in the Spanish monolinguals correlated with the number of letters (word length), whereas performance in the English monolinguals correlated with word frequency and age of acquisition. Since word length effects are usually interpreted as the result of phonological processing (Burani et al., 2007) and frequency and age of acquisition as the result of lexical processing (Bonin et al., 2004), our results support the assumption that language transparency bias processing toward phonological (local) or lexical (global) processing.

In addition, we calculated both facilitation and interference indexes to evaluate the possible effect of the language of the writing task over the attentional task. The analysis of facilitation and interference on the local task yielded significantly greater facilitation from Spanish than from English writing. Spanish participants showed that, after the writing task, congruent global information facilitated performance in the local attention task more than the English monolinguals after English writing. The differences between languages also extended to the pattern of interference so that after Spanish writing the interference from incongruent information was smaller than after English writing.

Although this pattern did not exactly fit our expectations, our results can still be interpreted as supporting our hypothesis. Thus, more efficient processing of local information after practicing local (phonological) processing in the Spanish block might have permitted our Spanish participants to use congruent global information to facilitate performance, while avoiding to increase greater interference by incongruent global information when processing local information. This very efficient local processing after the Spanish block contrasts with the seemingly more difficult processing after the English block where our English participants could not use the congruent global information to facilitate performance. However, the incongruent global information impaired their performance, which made that their local attention was inefficient using the global information. The transfer from processing Spanish words (local bias) to the local visual attention was evidenced not only by the larger facilitation effect in the local tasks, but also by smaller interference in this task. Overall, the type of processing influenced the size of the attentional window (e.g., Awadh et al., 2016; Grainger & Ziegler, 2011; Rau et al. 2015).

EXPERIMENT 2: SPANISH-ENGLISH BILINGUALS

Bilinguals are readers and writers of two or more languages that might differ in their level of transparency. Recent studies support the idea that bilinguals adapt their processing to the opacity/transparency of the language they are using (Buetler et al., 2014; Rau et al., 2015) so that they use a coarser-grain process when using the language with deeper orthography (e.g., English) and a finer-grain process when using the language with shallower orthography (e.g., Spanish) (Lallier & Carreiras, 2018). For example, in a study by Lallier et al. (2014), bilingual children showed an advantage in reading words over pseudowords when they were presented in their opaque language (French). However, this difference was not evident in their shallower language (Spanish), suggesting that the children were using a finer-grain reading strategy.

Similarly, an eye-tracking study with bilingual children of German (transparent) and French (opaque) showed that the location of the first fixation over the presented words was closer to the beginning of the words when reading in a transparent language than in an opaque language, suggesting again that the reading strategy is modulated by the language transparency, with smaller grains (more local) in transparent languages and larger grains (more global) in opaque languages (De León Rodríguez et al., 2015). Thus, different degrees of language transparency elicit different attentional processing windows (Lallier et al., 2016), which impacts the pattern of eye movements (Mishra, 2009). This ability to adapt the reading strategy in bilinguals depending on the language in use has also been supported by neural data (Buetler et al., 2014; Das et al., 2011; Jamal et al., 2012; Tierney & Nelson, 2009; see also Oliver et al., 2017).

The aim of Experiment 2 was to seek further evidence about the transfer effects from differential language processing (writing to dictation) depending the opacity/transparency of the language over the attention task (global-local task). We aimed to replicate the pattern of language effects obtained in Experiment 1, but in this experiment, language was manipulated within participants because participants were bilinguals of opaque-transparent (English and Spanish) orthographies, and the effects after processing in a transparent orthography and after processing in an opaque orthography could be explored in the same participants.

Importantly, we expected that bilingual participants would be able to adapt their processing styles to the transparency of the language used for the writing task, which would, in turn, be reflected in their attentional type of processing (e.g., De León Rodríguez et al., 2015). Thus, we expected that, when participants performed the linguistic task in Spanish, we would find evidence of local efficiency that we found in Spanish monolinguals (Experiment 1), while performing the writing to dictation task in English would result in an inefficient local processing, replicating the English monolinguals (Experiment 1).

METHOD

Participants

Twenty-three bilingual students (mean age: 21.5, *SD*: 4.43) from the University of Granada (Spain) participated in the study. They were native Spanish speakers, with high proficiency in English. They had obtained an official English qualification in the previous two years before the present experiment (Level B2) and participated in the experiment in exchange for partial course credits. The data of these participants were extracted from previous research whose objective was to study orthographic coactivation in bilingual writing production. All participants were exposed to English more than 11 years (*M* = 13.14), and their self-rating proficiency was greater than 7 for understanding (*M* = 8.05), speaking (*M* = 7.41), and reading (*M* = 7.77) in English assessed by Language Experience and Proficiency Questionnaire (LEAP-Q; Marian et al., 2007). All participants had normal or corrected to normal vision and hearing abilities, and they did not show any language or neurological impairments. They all signed consent forms according to the protocol approved by the Ethical Committee at the University of Granada.

Material and Procedure

Participants in the bilingual group were asked to complete the global-local letter task and the writing to dictation task as well as the monolinguals of the Experiment 1. After the dictation task, participants were asked to perform the global-local task. However, in this experiment the dictation task was composed of two blocks (Spanish and English) that were administered separately and counterbalanced across participants. Thus, for each participant, the experiment consisted of a number of tasks that proceeded sequentially: 1) the dictation task in either Spanish or English; 2) the global-local task; 3) a new dictation task in the alternative language (Spanish or English); and 4) the global-local task. All the tasks were performed in individual sessions that lasted less than one hour. The materials were the same as in the Experiment 1.

RESULTS

Writing to dictation task

As in Experiment 1, the first key response times (RTs) and accuracy in the writing to dictation task were analyzed in order to investigate the effects of lexical and/or phonological variables on writing performance. Data trimming was implemented when the RTs were at 2.5 *SD* above or below the mean of the participant in each language block (3.15% of the items from the Spanish block, 3.54% from the English block). Then, correlational analyses were performed for each language block (bilinguals-English block and bilinguals-Spanish block), including lexical frequency, number of letters, AoA, orthographic neighbor, and concreteness. As mentioned, the effects of frequency, AoA and concreteness have been considered evidence of lexical processing (Bonin et al., 2004), while the effects of length and orthographic neighbors have been considered evidence of phonological processing (Burani et al., 2007).

Table 13 includes Pearson correlations between the variables for the two data sets (writing to dictation performance and linguistic variables). The RT of the English block was negatively associated with frequency, $r = -.461$, $p < .001$, and positively associated with AoA, $r = .274$, $p = .009$. Accuracy (ACC) for the English block was positively associated only with frequency, $r = .233$, $p = .028$. In contrast, RT in the Spanish block was associated with word Length, $r = .393$, $p < .001$. All the other correlations were not significant.

Table 13

Correlation among linguistic variables and writing to dictation performance in each language block in the bilingual group

	Spanish (L1)		English (L2)	
	RT	ACC	RT	ACC
Frequency	–.123	.197	–.461**	.233*
Length	.393**	.052	–.131	–.045
AoA	–.098	.094	.274**	–.150
Concreteness	.145	–.083	.174	–.203
Neighbors	.163	.120	–.060	.113

Note. *p < .05, **p < .01.

In addition, we also implemented Bayesian Pearson correlations (Love et al., 2015) to test the relation between RTs to the first key and length, frequency, and AoA because they are theoretically critical for our arguments (Love et al., 2015; See Table 14). For these analyses, we used JASP software (JASP Team, 2019) and the default Cauchy prior width of 0.707, and the default Beta prior width of 1 in the Bayes factor robustness check.

Table 14.

Bayesian Factor Analysis of the theoretically critical correlations in bilinguals

Correlations	Spanish Block	English Block
RT – Length	BF_{10} 165.2	BF_{10} 0.275
Evidence for H1. Robustness check	*strong**	*no evidence*
RT – Frequency	BF_{10} 0.254	BF_{10} 3467
Evidence for H1. Robustness check	*no evidence*	*strong**
RT – Age of Acquisition (AoA)	BF_{10} *0.200*	BF_{10} *4.697*
Evidence for H1. Robustness check	*no evidence*	*moderate**

Note. A Bayes factor above 3 is considered to be *moderate* evidence, and a Bayes factor above 10 is considered to be *strong* evidence about an alternative hypothesis (Lee & Wagenmakers, 2014).

Global-Local Task

Similar to the writing to dictation task, data trimming was implemented so that RTs at 2.5 *SD* above or below the mean were eliminated from the analysis. The cut-off was done for each language block independently (5.16% of the items were discarded after the Spanish block, and 3.02% after the English block).

Following the data processing of the monolingual experiment (Experiment 1), the RT data of each type of trial during the local task after the Spanish-L1 block (congruent [M = 720.94 ms; SD = 36.27], incongruent [M = 811.46 ms; SD = 53.86] and neutral [M = 780.80 ms; SD = 43.92] trials) and after the English-L2 block (congruent [M = 818.85 ms; SD = 32.61], incongruent [M = 869.72 ms; SD = 32.04] and neutral [M = 827.73 ms; SD = 29.81] trials) were computed in both facilitation and interference indexes (Soriano et al., 2018). See the Appendix 2-table A (pp. 194) for complete latency and accuracy data (M and SD). The facilitation index was defined as the RT difference between the congruent condition and the neutral condition. Similar to Experiment 1, the analysis was conducted separately for each index (facilitation and interference) (see Figure 17). The information about global task were included in the Appendix 2-table B (pp. 194) for information only, since the global task is less vulnerable to local effects (Navon, 1977, 1981) and there were not transfer effects between language processing and global attention (Franceschini et al., 2020).

Facilitation Index. The analyses conducted with the RT differences between congruent and neutral trials in the bilingual group showed greater facilitation when participants performed the local task after the Spanish block (M = –59.86 ms) than after the English block (M = –8.88 ms), $t(22) = –3.639$, SE = 26.29, p = .001, d = –0.759.

Interference Index. The analyses conducted on the RT differences between incongruent and neutral trials showed no differences when participants performed the local task after the Spanish block (*M* = 30.65 ms) or after the English block (*M* = 41.99 ms), *t* (22) = –.153, *SE* = 16.56, *p* = .880, *d* = –0.032.

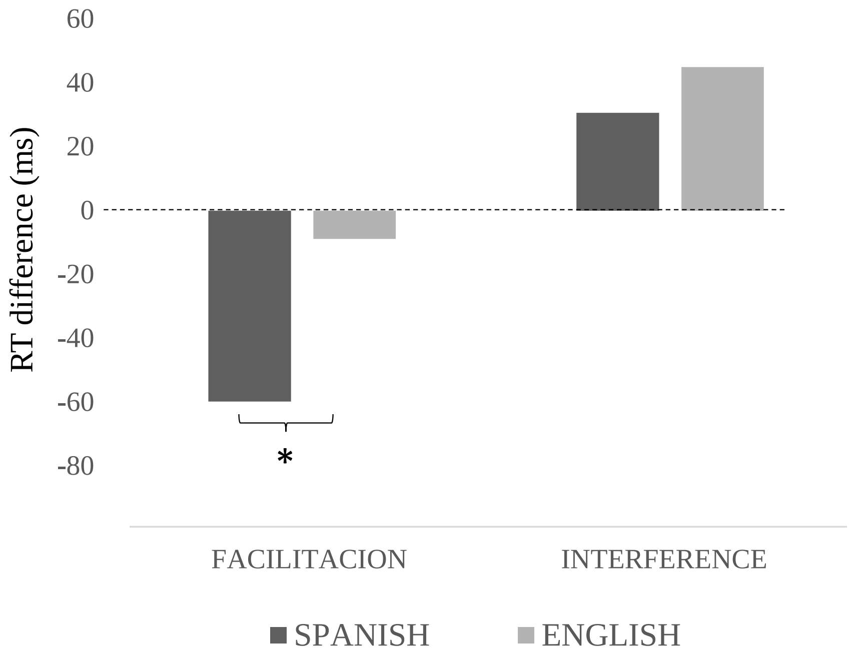


Figure 17. Facilitation and interference indexes from Bilingual Group. Facilitation index (the difference between congruent and neutral trials) and interference index (the difference between incongruent and neutral trials) were obtained in the local task after the Spanish or the English writing to dictation task block in the bilingual group.

DISCUSSION

Results of Experiment 2 replicated in part those from Experiment 1. The results of the correlational analysis replicated the dissociation between languages found in monolinguals (Exp. 1) and extended the results to the bilingual population. Thus, the writing times for the Spanish block correlated with word length, presumably as a consequence of the predominant phonological type of processing (Burani et al., 2007), and the writing performance of the English block correlated with word frequency and age of acquisition, presumably as a consequence of the more lexical type of processing (Bonin et al., 2004).

The pattern of transfer between the linguistic writing to dictation task and the attention task replicated, in part, across both experiments. Thus, the results of Experiment 2 showed higher local efficacy after the Spanish block than after the English block. As we expected, according with the Experiment 1 analyses of facilitation and interference on the local task yielded significantly greater facilitation from Spanish than from English writing. However, interference effects were similar for both languages. Thus, more efficient processing of local information after practicing local (phonological) processing in the Spanish block might have permitted our bilingual participants to use congruent global information to facilitate performance in greater extent than after English block, where there was no facilitation.

In contrast to Experiment 1, this local efficiency to use the global information to facilitate the performance after Spanish was not accompanied with smaller interference during local processing. Thus, in this experiment, our bilingual participants were not able to reduce the interference from global information after the Spanish block as they showed similar global interference effects after the English than the Spanish block when processing local information.

The fact that interference effects were similar after the Spanish than after the English block were somewhat unexpected, since more efficient local processing should produce both greater facilitation from congruent global information and smaller interference from incongruent information. However, we found differences in facilitation and not in interference. One possible reason may lie in the fact that our participants were bilinguals since co-activation of their two languages might have mitigated possible language differences in facilitation and interference effects. Bilinguals are known to co-activate their two languages even while processing only one of them (Marian & Spivey, 2003; Paolieri et al., 2010; Van Hell & Dijkstra, 2003), and it is possible that this co-activation acts at different processing levels. Since we were interested in exploring whether our results reflected the flexibility of the bilinguals or were due to general transfer from language to attention, we decided to replicate the study with two groups of monolingual participants with English and Spanish as their mother languages.

GENERAL DISCUSSION

According to the orthographic depth hypothesis, reading and writing in transparent orthographies are mainly performed through the use of the phonological processing route, in contrast to opaque orthographies that make extensive use of lexical processing (Frost, 1994; Frost et al., 1987; Katz & Baldasare, 1983; Turvey et al., 1984). In Experiments 1 and 2, we used a writing to dictation task in Spanish (transparent orthography) or English (opaque orthography) followed by a global-local task to evaluate if language transparency biased processing toward phonological/lexical processing in writing and to capture the possible influence of language in the processing of an attention task. First, we will discuss the results of the writing to dictation task and the evidence of different types of processing (lexical vs. phonological) depending on the degree of language transparency;

and second, we will discuss the influence of language in local attention. Finally, we will address the results of the bilingual participants and the ability to adapt their processing mode depending on the language transparency.

Evidence in the writing to dictation task

According to the assumptions of some reading processing theories (orthographic depth hypothesis and psychological grain size theory), the writing to dictation task would be performed differently depending on the transparency of the target language (opaque vs. transparent). The results of correlational analyses between lexical and phonological variables and writing performance indicated a clear dissociation between Spanish and English. Thus, word length correlated with performance on the Spanish writing to dictation task in both Spanish monolinguals and bilinguals, and word frequency and age of acquisition correlated with performance in the English writing to dictation task in both English monolinguals and bilinguals. Importantly, this dissociation was found with classical correlational approaches, but also when using Bayesian Pearson correlations (Love et al., 2015). The pattern of effects of these critical variables on the writing to dictation task is important since they have been previously used as a way of exploring reading processes in alphabetic scripts (Norton et al., 2007). Thus, sublexical processing in orthography-phonology conversion systems is modulated by word length (Burani et al., 2007), while lexical processing is associated with frequency and age of acquisition (Bonin et al., 2004).

The dual-route architecture of processing has also been extended to writing (Bonin & Méot, 2002; Delattre et al., 2006; Ellis & Young, 1988; Rapp et al., 2002). Our cross-linguistic study provides important evidence for this theoretical account, extending it to writing to dictation processing.

Transfer to the Global-Local Letter Task

In order to evaluate the possible attentional modulation depending on the language used in the writing task, we included a global-local letter task (Navon, 1977), and we calculated two indexes: a facilitation index indicating faster processing associated with congruent information and an interference index indicating the additional time required for processing conflicting information. We hypothesized that phonological processing in a transparent orthography (Spanish) would activate local attentional processing, while global processing would be induced by lexical processing in an opaque orthography (English). Results indicated that, when the local task was performed after the writing to dictation in Spanish, in which phonological processing is mainly used, global information facilitated local attention more than when the task was performed after the English task in both monolinguals and bilinguals. This suggests that, after a Spanish task, participants (Spanish monolinguals and bilinguals in the Spanish block) more efficiently processed local information so that they used the context only if it benefitted performance (benefit of global congruent information). In addition, participants after Spanish writing more efficiently avoided large interference effects from incongruent global information, although suppression of global interference was more evident in monolinguals (Experiment 1) than in bilinguals (Experiment 2), suggesting some language processing differences between the two groups. In contrast, after the English task, participants (English monolinguals and bilinguals in the English block) were less efficient in the local task as they were not able to benefit from the context and were hindered by the incongruent global context.

The pattern of transfer effects from the language in use (English or Spanish in the writing to dictation task) to the attentional task (local or global) can be explained in part from the orthographic depth and grain size hypothesis. Results of the local attention task support the idea that the grain of attentional processing is affected by language transparency. Transparent orthographies are assumed to use smaller processing windows based on fine-grained phonological features that bias attention toward local features. Thus, after the Spanish task, participants processed the local information needed to perform the local task in a more efficient way so that they were able to benefit from congruent information and avoid interference from incongruent information. In contrast, when participants performed the local task after English writing, global bias produced less efficient processing in the local task. Opaque orthographies are assumed to use a greater processing grain mainly based on lexical knowledge (e.g., Ziegler & Goswami, 2005) that will bias attention toward global features. This global bias produced by the English writing task will hinder the processing of the information needed to perform the local task, and this will result in interference from incongruent information and a lack of facilitation of congruent information. Interestingly, this pattern was evident in monolinguals (Experiment 1) and bilinguals (Experiment 2). Hence, the language differences for the local task can be easily interpreted as suggesting that, after Spanish, local processing is enhanced and proceeds more efficiently.

Although Experiments 1 (monolinguals) and 2 (bilinguals) showed similar patterns of facilitation from congruent global information, they differed in the pattern of interference effects from incongruent global information. Thus, bilingual participants (Experiment 2) showed similar interference effects from incongruent global information when performing the local task after English or Spanish writing (although there was a tendency to reduce this effect after Spanish writing). In contrast, monolingual participants showed significantly smaller interference after Spanish writing than English writing. Although the source of this differential effect is not completely clear, it might have to do with cross-language influences in bilinguals. Numerous studies have provided evidence that linguistic properties of the non-intended language affect the production of the intended language at the lexical and phonological levels (Colomé, 2001; Hermans et al., 1998; Macizo & Bajo, 2006; Paolieri et al., 2010), and therefore it is possible that co-activation of the two languages during writing mitigates the effect of the grain size of the language in use and consequently the strength of the transfer effects from the language to the visual attention task. Because the pattern of interferences was not as predicted, and our explanation is somewhat speculative, further research should be directed toward exploring this hypothesis.

Despite these nuances, our results show that phonological processing during the Spanish writing to dictation task, in which the words were decoded in smaller units (phonemes) (e.g., Coltheart et al., 2001), was transferred to the visual attention task and produced higher local attention efficacy. Thus, the differences in grain size between transparent and opaque orthographies had an impact on attentional windowing (Franceschini, et al., 2013; Goswami, 2015; Lallier et al., 2014; Lobier et al., 2013; Onochie-Quintanilla et al., 2017; Valdois et al., 2014). The differential pattern regarding local attention efficacy in both languages is compatible with the idea of differential processing depending on language transparency underlying written production (Brown & Loosemore, 1994; Houghton

& Zorzi, 2003; Olson & Caramazza, 1994). This different style of processing affected the windowing or grain sizes (De León Rodríguez et al., 2015; Grainger & Ziegler, 2011), and it was reflected in visual attention patterns (Awadh et al., 2016; Grainger & Ziegler, 2011; Rau et al. 2015) captured with the global-local task.

The role of visual attention in reading and writing continues to be the subject of debate (Goswami, 2015), despite the importance of visual attentional skills in literacy acquisition and in reading speed. Visual attention has been shown to be a predictor of academic skills (Lobier et al., 2013; Onochie-Quintanilla et al., 2017; Valdois et al., 2014), and a deficit in visual span has been identified as one of the problems in dyslexia (e.g., Franceschini et al., 2013; Lallier et al., 2014). Evidence for the relationship between global-local attention and phonological and lexical processing has been previously offered by Franceschini et al. (2020), who used the global-local task to bias the grain of attention and explore the influence of lexical and phonological processing within language. Thus, our study is the first extension of the dynamic interaction between language and attention across languages in a writing production task in monolingual and bilingual participants.

Is Language Processing Modulated by the Transparency of the Orthography in Which They Are Written?

Our results supported the bilingual ability to adapt or modulate the processing routes depending on the language opacity (grain size accommodation hypothesis; Lallier & Carreiras, 2018). That is, participants in the bilingual group replicated the pattern of frequency and AoA vs. frequency impact over the performance along with the local attention efficacy of the monolingual groups. This pattern provide support to the idea of flexible changes between lexical and sublexical strategies during writing to adapt to the language in use by bilinguals (Sheriston et al., 2016) and suggests that bilinguals distribute their visual attention depending on whether they are writing in an opaque or deep orthography; the size of the attentional window seems to vary depending on the grain required to process the language (Ans et al., 1998; Buetler et al., 2014; Lallier et al., 2014; Perry et al., 2010; Rau et al., 2015).

The bilingual capacity to adapt the processing mode depending on the context has been noted in previous research with natural speech showing that bilinguals can operate either in a bilingual or monolingual mode (e.g., Olson, 2016). Hasselmo (1970) noted that English-Swedish bilinguals could alternate among different "modes" of speaking: monolingual-mode, English-Swedish, and Swedish-English. The idea of multiple "language modes" was extensively conceptualized by Grosjean (1997, 2001, 2008), with the assumption that bilinguals can move along a continuum from a monolingual to a bilingual model of processing during speech production (Kaushanskaya & Marian, 2007) with the point in the continuum depending on psychological and linguistic factors (Grosjean, 2001).

CONCLUSIONS

The differential effects of the linguistic variables (length, frequency, and AoA) in the Spanish vs. English writing to dictation performance support the idea that different types of processing (phonological vs. lexical) depend on the degree of transparency, extending the reading evidence concerning writing to dictation production. In addition, the differential patterns of local efficacy in a subsequent visual attention task led us to conclude that the experience with different languages (with different transparencies) modulates the attentional windowing used during processing, thus further supporting the assumptions concerning reading processing made by the DRC model of word identification and by psychological grain size theory to writing production in monolingual and bilingual populations.

The results of the current study are in line with a previous study (Iniesta et al., 2021) that showed differences in English and Spanish writing to dictation in bilinguals. During a writing to dictation task that included words with polyvalent graphemes (a sublexical/phonological manipulation in which one phonological representation has two orthographic specifications, for example, / b /for both the graphemes v and b), the participants made more specific errors during Spanish than English writing. That is, during the English block that follows a more lexical type of processing, the inconsistent grapheme-phoneme mappings induced a more generalized type of error (the errors were distributed across all possible letters composing the word). In contrast, during the Spanish block (phonological processing), the type of error was more specific, in the sense that the errors were mainly present on the polyvalent grapheme.

APPENDIX 2

Table A. Performance in Local trials of Global-Local letter task. Mean response times (RT in milliseconds) and percentages of hits (Accuracy-ACC) were obtained from monolinguals and from each language block in the bilingual group.

	MONOLINGUALS				BILINGUALS			
	Spanish monolingual		English monolingual		Spanish block		English block	
	RT	ACC	RT	ACC	RT	ACC	RT	ACC
Local Task								
Congruent	859.37	.99	784.97	.97	720.94	.98	818.85	.98
	(32.19)	(.01)	(38.52)	(.01)	(36.27)	(.01)	(32.61)	(.01)
Incongruent	926.89	.92	844.75	.96	811.46	.92	869.72	.93
	(41.46)	(.01)	(36.33)	(.01)	(53.86)	(.01)	(32.04)	(.02)
Neutral	922.04	.99	792.85	.99	780.80	.96	827.73	.98
	(34.10)	(.00)	(34.95)	(.00)	(43.92)	(.01)	(29.81)	(.01)

Table B. Performance in Global trials of Global-Local letter task. Mean response times (RT in milliseconds) and percentages of hits (Accuracy-ACC) were obtained from monolinguals and from each language block in the bilingual group.

	MONOLINGUALS				BILINGUALS			
	Spanish monolingual		English monolingual		Spanish block		English block	
	RT	ACC	RT	ACC	RT	ACC	RT	ACC
Global Task								
Congruent	843.17	.98	788.90	.96	751.42	.97	795.85	.99
	(31.70)	(.01)	(40.51)	(.01)	(47.30)	(.01)	(30.26)	(.01)
Incongruent	965.19	.85	896.48	.93	827.33	.88	907.39	.86
	(40.99)	(.02)	(48.61)	(.01)	(59.10)	(.02)	(39.38)	(.02)
Neutral	864.54	.96	781.12	.96	770.04	.95	786.75	.97
	(32.98)	(.01)	(39.58)	(.01)	(51.85)	(.01)	(29.33)	(.01)

PART III

GENERAL DISCUSSION AND CONCLUSIONS

CHAPTER 7.

THEORETICAL IMPLICATIONS AND CONCLUSIONS

Given the expansion of bilingualism in education and in contemporary society, and the impact of writing in our lives, we focused this dissertation on the bilingual writing process. Our main aim was to explore the consequences of bilingualism on written language production. A long psycholinguistic tradition focusing on spoken language production has helped conceptualize the organization of the bilingual system. One of the most remarkable findings has been undoubtedly the phenomenon of language coactivation (Costa et al., 1999; Dijkstra et al., 2005; Kroll et al., 2008; Marian & Spivey, 2003; Sadat et al., 2015) as a starting point to explore mechanisms of language selection and control in bilingualism.

Unfortunately, writing has scarcely been studied, and some assumptions have been generalized to writing from spoken language and reading studies without specific evidence. However, writing is a multifaceted construct with associated comprehension and revision processes (e.g., Hayes & Olinghouse, 2015), and multiple methodological approaches to its study. In this dissertation, we decided to study the mechanisms and processes underlying the writing of isolated words as a first step to understanding other, more complex forms of written language production, such as the writing of sentences or texts (see Perret & Olive, 2019).

The central task employed in all the experiments included in this dissertation was writing to dictation because it is especially suited to exploring the dynamics of lexical and sublexical processing (Bonin et al., 2015). It also provides the opportunity to explore the organization of the bilingual system when the input is phonological, the least investigated input modality in this field.

As a result of the bias toward spoken language and reading research, few theoretical models have been proposed specifically for written language production, and even fewer for bilingual writing. Thus, the theoretical approach with a greater focus on the processes taken place during bilingual writing was the theory of bilingual spelling in alphabetic systems (BAST) proposed by Tainturier (2019); however, the predictions and assumptions included in the BAST model come mostly from spoken language or reading studies, and therefore, there is a need to test these predictions in specific writing paradigms. With this aim, the empirical work of this dissertation was directed at analyzing written language production in bilinguals with a focus on language coactivation and the time course of activation through the lexical and sublexical levels of processing in the bilingual language system.

In this chapter, we have summarized the most relevant findings of the three studies included in this dissertation and the theoretical implications of the results for bilingualism and writing. In the following subsections, we will discuss the evidence regarding language coactivation, the time course of lexical and sublexical activation, and the influence of four main modulators: language proficiency, the interplay of orthographic and phonological similarities in the input from the two languages, learning background and linguistic experience, and language transparency.

THE NATURE OF THE LANGUAGE COACTIVATION

The BAST model, based on previous bilingual spoken language production research, assumes that the two languages of the bilingual are coactivated. Hence, our first empirical study was intended to evaluate this assumption by using a writing-to-dictation task and manipulating interlanguage orthographic inconsistencies. The results of our experiments support the presence of language coactivation at both the lexical and sublexical levels. At the sublexical level, in Study 1 (Chapter 4), we found a cross-linguistic orthographic effect in Spanish-English bilinguals. We took advantage of the presence of polyvalent graphemes in Spanish to introduce words with sublexical congruent versus incongruent representations in the two languages in a writing-to-dictation task. The results showed faster responses, as well as more accurate responses in L2, for congruent words in comparison with incongruent words. The fact that the two conditions were equal in terms of relevant lexical variables, and that monolinguals did not show differences between conditions, led us to interpret the bilinguals' differences as evidence of language coactivation in bilingual typing production (Muscalu & Smiley, 2018). Writing duration has been linked with sublexical processing, and it is assumed to be implemented "after" lexical and POC processing. In our study, language coactivation hindered the retrieval of the graphemic representation when the English/Spanish orthographic representations were incongruent, and it facilitated the retrieval of the graphemic representation when the orthographic representations were congruent. Hence, the pattern of interference and facilitation supports the hypothesis that sublexical language coactivation, as indexed by the consistency or inconsistency between L1 and L2 orthographic representations, has an impact on typing (Bonin et al., 2001; Dijkstra & van Heuven, 2002). Importantly, the congruency effect was not restricted to word-translation pairs with high OS. The effect was present even in words with minimal overlap between translations.

Study 2 (Chapter 5) extended the evidence of language coactivation to the lexical level by showing cognate interference effects in L1 writing. In this experiment, we used the writing-to-dictation task to include Spanish/English cognates and non-cognates. The results indicated that the latency performance was slower and less accurate for cognates. The latency performance, or writing latency, has been linked with lexical access and selection, and therefore the finding of cognate interference in initiating the writing-to-dictation task suggests that the coactivation of representations with similar interlanguage orthographic and phonological representations seems to impair lexical selection. Interference effects have been reported in several previous reading studies as evidence of language coactivation (Comesaña et al., 2012; Dijkstra et al., 2010; Schwartz et al., 2007). Therefore, our studies extend the results of these studies to written language production and support the idea that lexical coactivation also occurs in bilingual writing.

Taken together, Studies 1 and 2 provide evidence of cross-linguistic influence at the lexical and sublexical levels and support the notion of non-specific language selection in writing. Additionally, the evidence of interference for graphemically incongruent words (Study 1) and cognates (Study 2) during written language production not only supports the assumption that target and non-target representations compete for selection at the lexical and sublexical levels, but also that language selection engages cognitive mechanisms to control the interference between languages during writing (Green & Abutalebi, 2013).

TIME COURSE OF LEXICAL AND SUBLEXICAL ACTIVATION

A second important assumption of the BAST model is that the spreading of activation (Collins & Loftus, 1975; Costa et al., 2000; Dell, 1986; Levelt et al., 1999) is cascaded in nature. That is, the activation is assumed to spread top-down between lexical and POC and graphemic sublexical levels but also bottom-up from the lower sublexical to the upper lexical levels. However, previous results in typing that used a translation task found evidence in favor of modular and discrete activation (Muscalu & Smiley, 2018). This modular activation would be in agreement with the predictions of the psychomotor model of writing (Kandel et al., 2011; van Galen, 1991) and the two-loop theory of typewriting (Logan & Crump, 2011), which conceptualize processing as hierarchical, where the output of each stage serves as input for the subsequent stage.

To explore the dynamic interaction between lexical and sublexical processing, we used the writing-to-dictation task with the assumption that writing latency is an index of lexical processing, whereas writing duration constitutes an index of sublexical processing (Muscalu & Smiley, 2018). In this context, the latency performance is critical to assess whether activation proceeds discretely or in a cascade. In Study 1, we introduced an orthographic congruency as a sublexical manipulation, whereas in Study 2, a cognate versus non-cognate lexical manipulation was introduced in parallel with the sublexical features OS and PS. If processing was discrete and modular, and lexical access was independent and prior to sublexical retrieval, lexical latency would not show orthographic congruency or sublexical features. In support of the assumption of cascade models (Dijkstra et al., 2010; Pattamadilok et al., 2009; Perre et al., 2009), the results of our Studies 1 and 2 showed congruency and OS and PS effects from the very beginning of L2 lexical access, that is, during latency, and therefore, they extend the monolingual evidence indicating that sublexical features influence lexical processing (e.g., Bonin et al., 2001; Delattre et al., 2006) to bilingual L2 written processing.

As we will further discuss in the next section, the absence of an orthographic congruency effect on L1 for latency (Study 1) does not necessarily mean a discrete and unidirectional relationship between the lexical and sublexical levels in L1. Lexical access in L1 might be fast and, once established, less vulnerable to sublexical interference from polyvalent graphemes than lexical access in L2, which might be slower and therefore sensible to the interfering sublexical orthographic activation present in other parts of the words. The fact that in our Study 2 latency and lexical performance was modulated by the PS and by the OS of the cognates suggests that this might be the case since sublexical features were very clearly modulating the lexical effect. Overall, the patterns found in both Studies 1 and 2 supported cascade processing in the central processes of writing itself.

LANGUAGE DOMINANCE AND THE TIME COURSE OF LEXICAL AND SUBLEXICAL PROCESSES

One of the criticisms of the BAST model is that its predictions are restricted to highly proficient balanced bilinguals, whereas many bilingual studies have shown that L2 proficiency is a relevant factor that modulates language coactivation (Van Hell & Tanner, 2012). Hence, in our studies, we included unbalanced high proficiency bilinguals with a dominant L1 and a weaker L2.

The relevance of this factor was evident in our studies since both Studies 1 and 2 revealed asymmetric orthographic congruency and cognate effects for L1 and L2. Thus, in Study 1, L2 typing showed orthographic congruency effects in first-letter latency and in writing duration, whereas for L1 congruency effects were only observed in writing duration. This differential pattern suggests that lexical and sublexical processing inL1 might be less susceptible to the consequences of language coactivation than in L2, extending similar findings in spoken language production (Kroll et al., 2010) to writing. This asymmetric pattern might be explained by the differential lexical and sublexical time courses for L1 relative to L2. Thus, it is possible that lexical access in L1 is faster than in L2, and that once accessed, it is not susceptible to sublexical incongruencies from the rest of the word. In contrast, slower access to L2 lexical representations might cause more susceptibility to sublexical interference from the rest of the word, with these incongruences feeding back to the lexical representations in a moment in which they have not been completely accessed and established.

Similarly, in Study 2, there was also evidence of L1 and L2 asymmetries in the pattern of cognate facilitation and interference. In the dominant L1, cognate interference (cognates typed slower than non-cognates) was evident in the responses to latency, but they were not evident for the rest of the word, whereas the weaker L2 showed no cognate effects in the responses to latency that turned to facilitation for the rest of the word. The presence of cognate interference in the bilinguals' dominant language replicates previous studies on spoken language production and reading showing similar cognate interference in the dominant language (Comesaña et al., 2012; Gollan et al., 2014; Gollan & Goldrick, 2016; Li & Gollan, 2018; Schwartz et al., 2007), which again extends it to written language production.

The fact that Study 2 shows cognate effects in L1 for lexical latency responses is not necessarily in contradiction with the results from Study 1, where congruency effects only had lexical effects present in L2. Note that the two manipulations are different in nature (sublexical in Study 1 and lexical in Study 2), and the asymmetrical effect can also be due to faster lexical access for L1 relative to L2. Hence, it is possible that fast activation of non-identical cognates in L1 produced interference effects when accessing the lexical information needed for first-key responses. Once interference is resolved and lexical information is well established, sublexical incongruencies no longer have an effect on sublexical processing, suggesting again that lexical information is faster and less vulnerable in L1 than in L2. In contrast, in L2, cognates did not have an effect on latency responses, but they did when typing the rest of the word, suggesting that lexical processing might still be taking place at this later moment. Some studies have pointed out that language processing in L1 could be largely mediated by automatic processes, while processing in L2 is more attentionally demanding (Plat et al., 2018). Thus, the interference in Study 1 did not affect L1 lexical processing because it was much lower than the interference generated in Study 2 (sublexical versus lexical + sublexical), which was controlled during L2 lexical processing, as it occurs under greater attentional control. Further research should be directed toward gathering further evidence for this explanation.

Therefore, taken together, results from Studies 1 and 2 seem to suggest that L1 has a more stable lexical representation and more automatic access than L2, and that it might be more resistant to bottom-up coactivation effects.

LANGUAGE COACTIVATION AND CONTROL IN NON-IDENTICAL COGNATES

The BAST model predicts that the strength with which the representations are coactivated depends on the similarity or overlap between representations in terms of OS and PS between languages. Similar to previous studies (Comesaña et al., 2012; Schwartz et al., 2007), we manipulated PS and OS in the cognate condition.

Although the processing of non-identical but similar cognates is not completely clear (Dijkstra et al., 2010), the degree of similarity seems to modulate the strength of coactivation (Dijkstra et al., 2010). Perfect cognates are generally expected to produce coactivation of the two languages and, in turn, facilitation. However, inconsistencies between target-word translation representations, whether orthographic or phonological, may produce competition for selection, and the need for control mechanisms to reduce this competition, which in turn may slow down processing (see Comesaña et al., 2012). Because non-cognates produce weaker coactivation than cognates, competition between representations would also be weaker for non-cognates than for cognates, even for low similarity cognates. The interaction between OS, PS, coactivation strength, interference, and cognitive control is shown in Figure 18. The role of inhibition in lexical selection has been proposed in different contexts (e.g., Borragan et al., 2018; Broersma et al., 2016; Filippi et al., 2014). Indeed, studies have shown larger error-monitoring effects and higher recruitment of brain regions dedicated to control while processing non-identical cognates relative to control words (Declerck et al., 2017; Peeters et al., 2019).

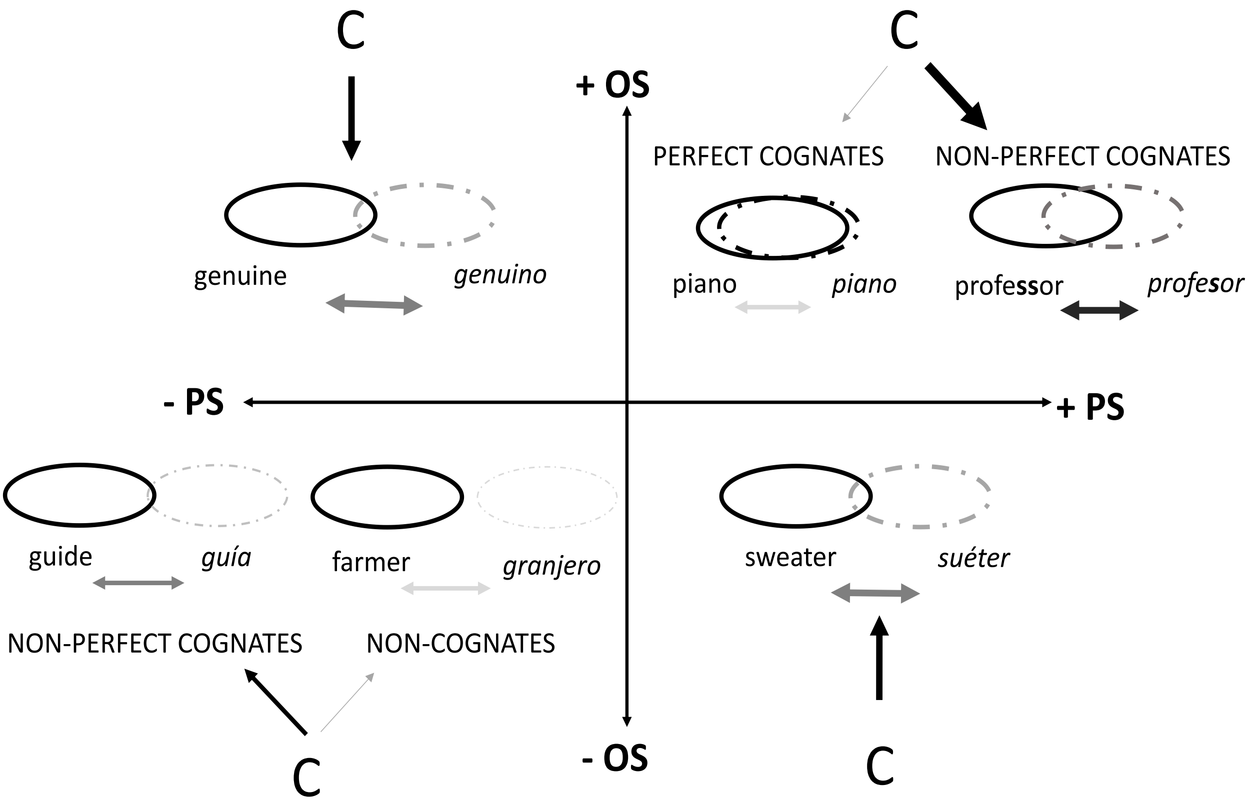


Figure 18. The interaction between OS, PS, coactivation, and interference strength, and cognitive control. The upper right box illustrates the case of perfect and non-perfect cognates. Although the strength at which the non-target language is coactivated is greater for perfect cognates, there would be no interference between languages, and therefore no need to apply control. On the other hand, in non-perfect cognates, language coactivation will produce interference, and therefore, greater need for control. The bottom box illustrates the comparison between non-perfect and non-cognates: Coactivation in non-perfect cognates leads to greater interference, and therefore, greater control. In contrast, in non-cognates the coactivation is less, and the interference is lower, therefore, the need for control is lower as well. Note. C = cognitive control; + = high similarity; - = low similarity; circle overlapping = strength of coactivation; horizontal arrows = strength of interference; arrows coming from the C = degree of cognitive control applied; color gradient from black to gray = from greater to lesser strength.

However, OS and PS seem to have differential effects on competition and language selection. Previous studies based on silent reading have demonstrated that the effects of PS were mediated by OS (Comesaña et al., 2012; Schwartz et al., 2007). That is, the PS had an effect on performance only when the OS was high. However, there was no PS effect when the OS was low. In other words, it was only when the L1 and L2 representations were highly similar orthographically that the phonology activated, indicating that the OS is the key to activating the phonological information. The absence of PS effects in low OS conditions has been explained by the orthographic autonomy hypothesis, which defends that the orthography is activated directly from the lexical-semantic system without phonological activation so that the linguistic output is not affected by PS (Miceli et al., 1997; Rapp & Caramazza, 1997; Rapp et al., 1997).

However, the results of the writing-to-dictation task in Study 2 showed a general PS effect. Cognates with high PS were processed faster than cognates with low PS, and this effect appeared in most conditions of the experiment. That is, in this task, the PS was not mediated by OS, suggesting the primacy of phonological processing in facilitating access to the lexical representations. This pattern provides support to the obligatory phonological mediation hypothesis (Rapp & Caramazza, 1994) and its assumption that the activation of phonological information is mandatory.

The different results in reading versus writing to dictation led us to conclude that the properties of the experimental tasks (reading and writing) might modulate the role of phonology and orthography. In reading, the input is a string of letters, so the first analysis is orthographic. Additionally, while the phonology is activated, its activation is delayed with respect to the first orthographic analysis. On the contrary, in writing to dictation, the input is auditory, so the first analysis is phonological. Hence, in written language production, differences in the time course of orthographic and phonological analysis can modulate the relative impact of OS and PS.

The idea of temporal delay assumption was introduced in the bilingual interactive activation (BIA+) model (Dijkstra & Van Heuven, 2002) to explain that task demands can modulate cross-linguistic phonological and/or orthographic influences. Reading requires orthographic activation prior to phonological activation; therefore, late phonological activation would not affect response times (Brysbaert et al., 2002). However, during a writing-to-dictation task, phonological processing precedes the activation of orthographic information; therefore, phonology may directly impact performance. Because these are only hypotheses, further research should explore the dependence and independence of PS and OS in a larger variety of writing tasks, (e.g., the copy task where the orthographic analysis is prior to the phonological one). Overall, our results seem to support the assumption that the temporal delay in the activation of different features (phonological and orthographical) have an impact on writing.

THE INFLUENCE OF THE LEARNING CONTEXT AND THE LANGUAGE BACKGROUND

The BAST model did not take into account the modulating effect that the learning context and the language background may have on L1 and L2 language processing, despite the larger number of previous studies showing the important impact of these factors in L1 and L2 language processing and control (Byers-Heinlein, 2013; Fricke et al., 2019; Iverson et al., 2003; Kroll et al., 2018; Mechelli et al., 2004;

Newman et al., 2002; Place & Hoff, 2011; Zirnstein et al., 2019). in particular, the strength of phonological and orthographic coactivation seems to be dependent on the context of learning (Jacobs et al., 2016).

One of the most important characteristics of the context of learning is the setting in which the language was learned. Clearly, naturalistic and classroom settings provide very different types of input during learning (Rothman & Guijarro-Fuentes, 2010). It is well known that in a naturalistic setting, the input is mostly oral and phonological, in comparison to classroom settings, where the input is mostly written and orthographic. This differential input is critical when considering writing processes, and for this reason, in Study 2, we decided to compare a group of LBs with academic literacy and formal instruction in Spanish and English with a group of HSs with academic literacy and formal instruction just in one of their languages (English). For the last group, Spanish was inherited by family interactions without formal learning (Carrasco-Ortiz et al., 2019).

Interestingly, our results showed that even though the years of exposure to Spanish were greater for HSs than for LBs, the former showed more difficulty in retrieving the orthographic representations of the Spanish words (Elola & Mikulski, 2016). This greater difficulty was evident in several aspects of the results; first, the HSs had worse performance on Spanish tests used to assess orthographic knowledge (i.e., PROESC and TECLE); second, and relative to LBs, the HSs showed slower and less accurate performance in rest of the word of the writing-to-dictation task, indicating more difficult sublexical processing (note that rest of the word is usually associated with sublexical retrieval). Hence, HSs seem to have greater difficulties in sublexical processing, where orthographic retrieval is especially important. Finally, although both groups showed higher processing speed in English (their dominant language) in writing to dictation, the magnitude of the language differences was larger for HSs than LBs in writing duration, where their performance was especially slow in Spanish. The overall pattern suggests that HSs might have more difficulties than LBs in retrieving the word form during written language production in the minority language. According to the weaker links hypothesis, our results suggest that reduced practice with a language due to the learning background influences accessibility to this language (Gollan et al., 2008).

Another interesting difference between the LBs and HSs was the more consistent PS effects for the HSs compared to the LBs. This difference might signal a greater relevance of phonological processing for the HSs, which was especially evident in the writing duration performance (sublexical retrieval). This pattern is interesting if one considers the time course of phonological and orthographic processing in the writing-to-dictation task. Because phonological analysis is prior to orthographic analysis, the phonological effects should be evident in latency, before the orthographic effects, which should be more evident later, in writing duration. Whereas this pattern was evident in LB latency analysis, phonological effects for HSs were evident during the entire course of processing. OS had differential effects on the rest of the word latencies for both groups, but LBs were able to control the interference, as low similarity between languages seems to have reduced processing speed but not accuracy, whereas HSs seemed to have more difficulties controlling it, and low similarity appears to have reduced both processing speed and accuracy. This pattern supports other studies attributing phonological advantages to HSs (Chang et al., 2011; Gor, 2014), but these are coupled with some orthographic impairments (Elola & Mikulski, 2016).

On the whole, these results confirm that the language-learning environment, especially formal exposure to formal instruction in reading and writing and to spoken interactions, can modulate the relative roles of OS and PS in L1 and L2 processing and the impact of these variables in language coactivation during writing to dictation.

THE INFLUENCE OF ORTHOGRAPHIC TRANSPARENCY

One of the central points in the BAST model is the differential processing proposed for deeper versus shallower orthographies. Based on the evidence indicating processing differences for transparent and opaque orthographies in reading tasks (Frost, 1994; 2012; Katz & Frost, 1992), the BAST model assumes that, in writing, transparent orthographies would also rely on POC processing, whereas deep orthographies would primarily rely on lexical processing. Hence, similar to reading, processing in writing is dependent on the regularity of the grapheme–phoneme correspondence (Frost et al., 1987; Ziegler & Goswami, 2005).

To test these predictions in written language production in Study 3 (Chapter 6), we compared two orthographies (Spanish and English) that fall on opposite ends of the transparency–opacity continuum. The results of this study showed critical interlanguage dissociation in the impact of lexical and sublexical variables during written language production. Thus, variables such as word length correlated with Spanish writing performance, whereas word frequency and AoA correlated with performance in English writing. Since word frequency and AoA are considered to be the result of lexical processing (Bonin et al., 2004) and word length is considered to reflect sublexical processing (Burani et al., 2007), our results support the notion that language transparency influences language processing during writing to dictation.

The BAST model also adopts some assumptions from PGST (Ziegler & Goswami, 2005). That is, the model assumes that language transparency also determines the attentional window for lexical and phonological processing. Accordingly, orthographic depth would modulate the size of the visual grain used during processing (Franceschini et al., 2021; Perry et al., 2010), so that transparent orthographies like Spanish, which rely on phonological processing, would be associated with a smaller processing window, while opaque orthographies like English, which rely on lexical processing, would be associated with a larger processing window. However, this theory of reading is still controversial in monolingual studies, and there is no supportive evidence in writing tasks. The role of visual attention in reading and writing continues to be the subject of debate (Goswami, 2015), despite the importance of visual attentional skills in literacy acquisition and processing speed.

In Study 3, we evaluated the assumptions of PGST by investigating transfer effects from a language writing task to a visual attention task, the global-local letter task (Navon, 1977), as a function of language transparency. Our results pointed out that after performing the writing-to-dictation task in Spanish, where phonological processing is extensively used, local attention was more efficiently performed than after writing in English. Thus, the results indicated that after a linguistic Spanish task, participants were more efficient in processing the local information, so that they only used the global context if it facilitated processing and ignored it when it hindered processing.

Transparent orthographies are assumed to use smaller processing windows based on fine-grained phonological features that bias attention toward local features. Thus, after the Spanish task, participants processed the visual information needed to perform the local-global task in a more efficient way so that they were able to benefit from global congruent information and avoid interference from global incongruent information during the local task. In contrast, when participants performed the local task after English writing, global bias produced less efficient processing in the local task.

Considering the influence of phonological and lexical processing in the attentional window during processing, the question that remained was whether bilinguals adapt their grain size to the transparency of each language (Buetler et al., 2014; Rau et al., 2015) or accommodate their processing into a hybrid grain size (Lallier & Carreiras, 2018) during writing. To explore the bilinguals' changes in grain size depending on the transparency of each language, Spanish-English bilinguals performed the writing-to-dictation task in both languages. We explored the transfer effects from lexical versus phonological differential language processing depending on the opacity or transparency of the language over the global-local attention task.

Our results showed that bilinguals were able to adapt their processing modes depending on the opacity of the language involved. That is, we replicated the frequency and AoA effects found with monolinguals for the Spanish writing-to-dictation task and the word length effect found for monolinguals in the English writing-to-dictation task with our bilingual sample. In addition, transfer effects and local attention efficacy being dependent on language transparency was also replicated for the bilingual group after the Spanish and English blocks. The results provide support to the idea of flexible changes in processing strategies during writing to adapt to the language in bilinguals (Sheriston et al., 2016) and suggest that bilinguals can adapt the attentional window depending on language transparency (Ans et al., 1998; Buetler et al., 2014; Perry et al., 2010; Rau et al., 2015).

However, in Study 3, the results of the bilingual group did not exactly replicate the monolingual pattern. Thus, bilinguals were not able to reduce interference from global information after the Spanish block when processing local information. After writing to dictation in Spanish, they achieved facilitation but could not solve the global information interference, showing lower efficiency than the Spanish monolinguals. Despite this pattern, we maintain that bilinguals adapt (e.g., Olson, 2016) their attentional window to the transparency of the language in use, but they also have to deal with the consequences of language coactivation, and this might obscure the effects (Marian & Spivey, 2003; Paolieri et al., 2010; Van Hell & Dijkstra, 2003). The coactivated English lexical global representations during phonological processing in Spanish writing to dictation would be incongruent at some points with the highly congruent phonological-lexical outputs in Spanish. Therefore, as the results indicated, bilinguals can use the global lexical congruent information from Spanish to facilitate the local processing, but the global lexical incongruent information to the coactivated English also impaired local processing.

FINAL CONCLUSIONS

Overall, this dissertation aimed to conceptualize the processing architecture underlying written language production in the bilingual population, specifically during writing to dictation. Because of the complexity of mastering writing and typing skills, the expansion of bilingualism in education and in contemporary society, and the impact of writing in our lives, we believe that it is especially relevant to understand the impact of bilingualism on writing processing. For our theoretical and empirical work, we focused on the writing of isolated words as a first step to approaching more complex levels, such as writing sentences and texts.

The results reported in this dissertation support the assumption that language coactivation is also present during written language production, so that when a Spanish-English bilingual writes a word in Spanish, both its lexical and sublexical representations from English are coactivated, and vice versa. We have also shown that, similar to reading or spoken language production, language coactivation may facilitate, but also hinder, language selection. Our results also suggest that processing in writing is not encapsulated and composed of independent modules. The linguistic representational levels seem to be interconnected, with activation flowing bidirectionally between the POC lexical and graphemic sublexical levels. That is, when a bilingual writes a Spanish word and its translation has incongruent letters (e.g., garage and garaje), this simple incongruency can impair language selection, even at the lexical level, resulting in slower production and larger susceptibility to errors.

Additionally, in our studies, we explored four possible modulators of cross-linguistic influences. First, we focused on language proficiency. The idea of bilingualism as native-like competence in two or more languages has been criticized and challenged by several researchers. Understanding bilingualism as the use of two languages in daily life with different proficiency levels opens the question of whether the consequences of coactivation are the same for the dominant L1 and the weaker L2. In line with previous evidence, this dissertation supports the notion that L1 lexical representations are more stable and resistant to activation from sublexical interfering information than L2 lexical representations.

Second, we explored interlanguage similarities in terms of orthography (OS) and phonology (PS). The results indicated that OS, and, most importantly, PS, mediated the strength with which the representations are coactivated, and the effect of PS seems to be independent of OS. Cognates with high PS were processed faster than cognates with low PS, supporting the primacy of phonological processing and the obligatory phonological mediation hypothesis in writing to dictation, although this primacy seemed to vary depending on the task and the input modality. Our results support the idea that the temporal delay of the processes involved in the task influences the activation of phonology and orthography. For example, in reading where the input is a string of letters, the first analysis is orthographic and, consequently, phonology activation seems to be dependent on OS (Comesaña et al., 2012; Schwartz et al., 2007). But in writing to dictation, where the input is auditory, the first analysis is phonological, and, consequently, the activation of phonology seems to be predominant.

The dynamics of the activation between phonological and orthographic representations also seem to vary depending on the context of learning and the quality and quantity of the input. The results show that differences in literacy and exposure to writing and reading might modulate the coactivation effects and the relative roles of OS and PS in L1 and L2 processing. Heritage speakers showed more orthographic difficulties in Spanish and, in turn, a bias toward phonological information during processing. Exposure to naturalistic contexts during learning but without access to formal classroom settings—a situation very extended in HSs—leads to phonological advantages (Chang et al., 2011; Gor, 2014), as well as orthographic impairments (Elola & Mikulski, 2016). The accumulated literacy practice seems to impact language processing (Gollan et al., 2008).

Finally, we explored whether orthographic transparency modulated writing performance. Our results extend the evidence accumulated from reading studies to writing-to-dictation processing. That is, our experiment clearly indicated that, in writing, processing is also dependent on the regularity of the grapheme–phoneme correspondences (Frost et al., 1987; Ziegler & Goswami, 2005). Therefore, writing to dictation in transparent orthographies relies predominantly on POC sublexical processing, whereas writing to dictation in deep orthographies relies more on lexical processing.

These differences can be attributed to differences in the attentional window used during writing (Ziegler & Goswami, 2005). Language transparency has an impact on the attentional windowing underlying differential lexical versus phonological processing. Our results showed that phonological processing during writing to dictation in a transparent orthography, in which the words were decoded in smaller units, was transferred to the attentional window, showing more efficient local attention. Our results also supported the idea that bilinguals are able to adapt the attentional window to the features of the language in use and use strategies that are appropriate for the degree of opacity or transparency of the language they are using while also dealing with the coactivation of the non-target orthography, which might also influence the size of the attentional window.

All the results and conclusions of this dissertation have been summarized visually in Figure 19.

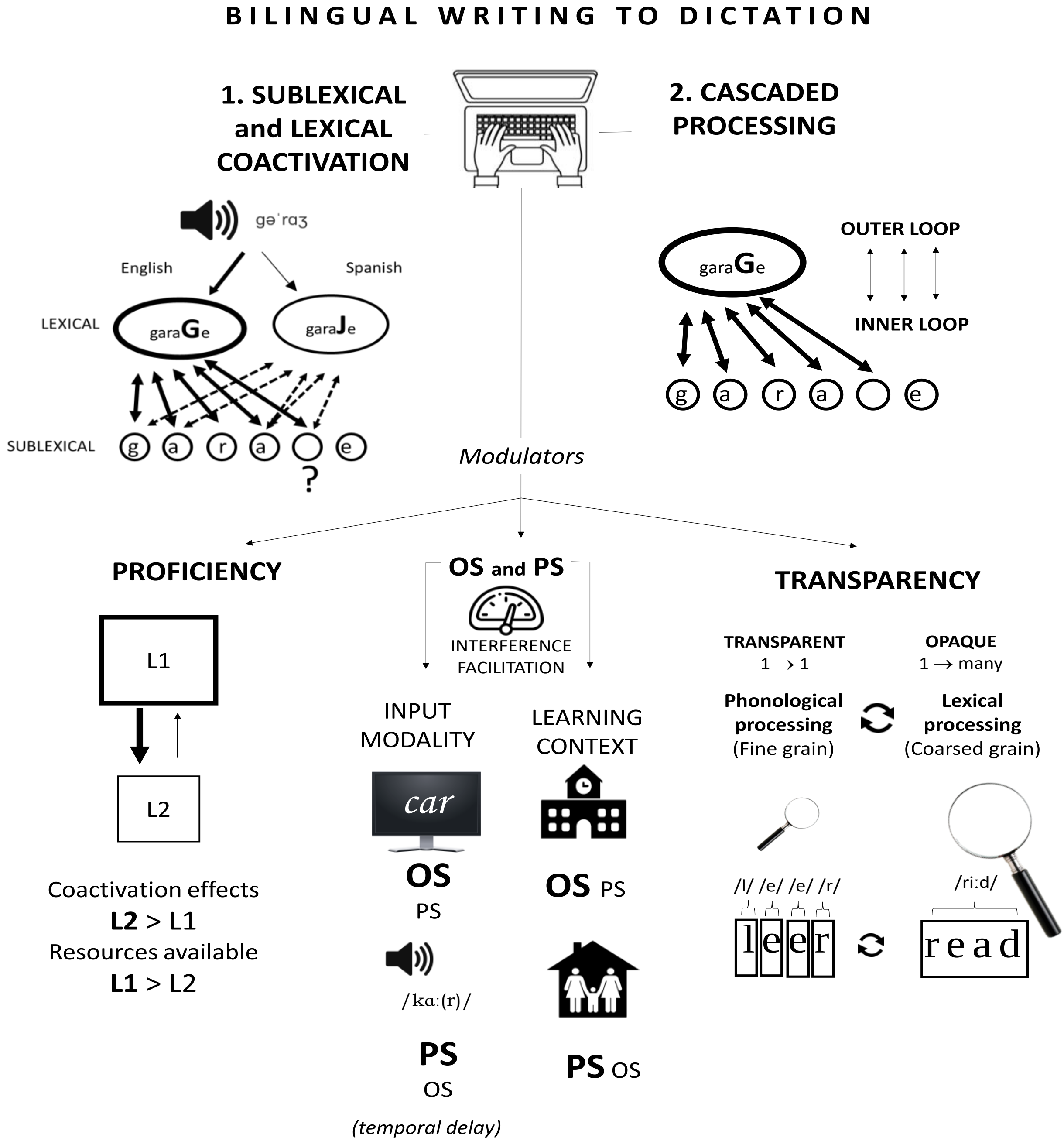


Figure 19. Results of the dissertation. OS = orthographic similarity; PS = phonological similarity.

CHAPTER 8.

FUTURE RESEARCH QUESTIONS

In this dissertation, we explored language coactivation effects in written language production and the modulatory effect that orthographic and phonological interlanguage similarities, learning background, and language transparency have on language coactivation during writing processing. However, there is still much work to be done on bilingual writing, and some of our results have opened doors to new questions to be addressed by future research. In this section, we briefly elaborate on some of these open questions and new ideas for future directions.

First, the idea of temporal delay assumption needs to be more fully investigated (Dijkstra & Van Heuven, 2002) in the context of the role of phonological and orthographic activation during writing. Previous studies focusing on reading comprehension have indicated that the activation of phonological information was mediated by OS (Comesaña et al., 2012; Schwartz et al., 2007). These studies supported the orthographic autonomy hypothesis, which proposes that written language production is not dependent on spoken language production and, therefore, not dependent on phonological information (Rapp & Caramazza, 1997). Contrary to previous studies, the results of our writing-to-dictation task showed a general PS effect in the lexical latency and accuracy in most conditions of the experiment.

We explained the differences between reading and writing to dictation in terms of the temporal course of phonological and orthographic activation and different input modalities (visual versus auditory). Phonological processing in reading is delayed with respect to orthographic processing because the stimuli are visually presented, and the mapping of orthography to phonology only occurs after orthographic analyses have taken place; therefore, late phonological activation would not affect response times (Brysbaert et al., 2002). However, writing-to-dictation tasks involve phonological input and orthographically oriented responses, such that phonological processing is mandatory (Geschwind, 1969). During a writing-to-dictation task, phonological processing precedes activation of orthographic information, and, therefore, phonology may directly impact performance. If we are correct, and it depends on the temporal delay in phonological or orthographic analysis, other writing tasks should yield a pattern similar to that of reading. Specifically, in copying tasks, where the input is a string of letters, and therefore the first analysis is orthographic, we should find that phonological activation is again OS dependent. Further research should be directed to replicating the condition of Study 2 (Chapter 5), but with a copy paradigm.

Surely the most promising line of research is one that explores the role of transparency in the processing of writing (Study 3; Chapter 6). The results found in our dissertation have expanded the horizons for exploring different orthographies following the opacity–transparency continuum (Liu & Cao, 2016; Perfetti & Dunlap, 2008) and to explore these effects in bilinguals with different linguistic combinations. It also opens the door to the use of global and local attentional inductions prior to writing to study the effects on writing processing (see Franceschini et al., 2021). This project is already in progress, in collaboration with the Brain Language and Bilingualism Lab (University of Florida). At the moment, we are in an initial phase of data collection on monolingual speakers of various orthographies to map various points of the opacity–transparency continuum (i.e., Italian, English, French, Norwegian, Portuguese, Dutch, Japanese, Turkish, and German).

As we discussed previously in this dissertation, writing is a multifaceted construct with associated comprehension and revision processes. We decided to address writing from a dual vision of online processing (Muscalu & Smiley, 2018) in which writing latency was considered a measure of lexical processing and writing duration was considered an index of sublexical retrieval. However, this approach has some limitations that open the door to other processes related to writing that would be important to explore in future studies. Figure 20 displays the overlap between comprehension and revision, two important processes that also take place during writing to dictation, which we would like to explore further in future research.

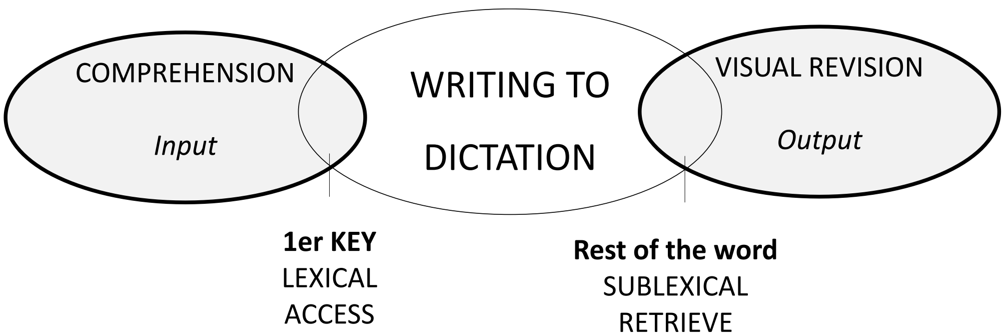


Figure 20. Overlapping between writing to dictation and adjacent processes such as comprehension and revision.

Although not specifically related to writing, language comprehension and revision have been extensively studied in bilingualism (e.g., Blumenfeld & Marian, 2007; Dijksta & Van Heuven, 2002; Grainger et al., 2010; Guash et al., 2017; Marian & Spivey, 2003; Morales et al., 2016; Van Heuven & Dijkstra, 2010). However, these processes have been scarcely studied in relation to typing, even though revision might be especially engaged in this context. Error detection is one of the main mechanisms underlying the expansion of the mental lexicon and the creation of a stable orthographic lexicon, which are critical for correct reading and writing (Horowitz-Kraus & Breznitz, 2008; Wanzek et al., 2006). Error monitoring is considered an executive function involving part of the brain's learning circuitry (Falkenstein et al., 1991).

Error monitoring is germane for typing when considering different processing levels. Typing production is assumed to be composed of two distinct processing levels (see Chapter 1; two-loop theory of typewriting [Logan & Crump, 2011]): the outer loop underlying lexical access and the inner loop underlying sublexical retrieval and the conversion to motor outputs. It has been proposed that each loop monitors different types of errors. That is, the outer loop depends on feedback from the final result of the typing action, the output on the screen, while the inner loop relies on somatosensory feedback from the fingers and is unaffected by the screen output. Although the loops have been proposed to be independent of each other, our results showed cross-linguistic effects between these two levels, with lexical (from Study 2 [Chapter 5]) and sublexical effects (from Study 1 [Chapter 4]) not only in writing latency (outer), but also in the rest of the word (inner). It would be especially relevant to explore how bilingualism and coactivation modulate error-monitoring processes in each loop separately.

For this line, we propose assessing the ability of bilinguals to monitor their errors explicitly using a Likert scale after each word to measure the monitoring performance and implicitly through the error-related negativity electrophysiological component during the performance of a writing-to-dictation task that includes non-perfect cognates. High demand for conflict monitoring has been assumed for bilinguals, underlying the continuous management of cross-linguistic activations (Marian & Spivey, 2003; Martin et al., 2009; Wu & Thierry, 2013). In this sense, larger error monitoring effects and higher activation of control regions have been found during non-identical cognate processing related to non-cognates (Acheson et al., 2012; Declerck et al., 2017; Peeters et al., 2019). Indeed, they have more intrusions due to coactivation, but they self-correct more, which is evidence of the use of error monitoring (Li & Gollan, 2018).

To explore monitoring in the two typing loops, two conditions might be included: with and without visual feedback. That is, half of the participants' responses will appear on the screen, so the error feedback will be visual, directly exploring the outer loop. The other half of the responses will not appear on the screen, so the feedback will only be kinesthetic, directly exploring the inner loop. We expect that the presentation of the output on the screen would increase the interference effect on non-perfect cognates but would also increase the resources applied during error monitoring. However, intrusion errors due to coactivation would be less detected by kinesthetic feedback and, consequently, error detection in the inner loop would be less efficient.

Finally, we are particularly interested in the child population as a focus for future research. Approximately half of a typical school day is composed of writing activities (Ratzon et al., 2007). In addition, the dual route model (Rapp & Fischer-Baum, 2015; Tainturier & Rapp, 2001) and its assumptions of lexical and POC sublexical differential processing are especially relevant in the context of reading and writing acquisition. The development and specialization of the ventral and dorsal pathways underlying lexical and phonological processing have been related to experience (Perani et al., 2011; Vandermosten et al., 2015). Prior to the onset of reading, both pathways seem to be related to phonological processing, that is, when children are progressing from a partial to full alphabetic phase (Frith, 1985). Thus, when children are learning to read and write, they are assumed to use a sublexical strategy: reading the letters of words one by one. The structural development of the ventral white matter network and its involvement in reading have been shown to change in two developmental stages: formal reading instruction (pre-reading children) and after two years of reading instruction (early reading children) (Vanderauweraa et al., 2018).

Hence, it is very relevant to identify the consequences of bilingualism in the development of writing and the influence of the two routes in understanding language coactivation. We aim to explore the orthographic congruency effect between language (Study 1) as an index of the development of the phonological pathway; the performance of perfect cognates (Study 2) as an index of the development of the lexical pathway; and the reduction of the differences between perfect cognates and non-perfect cognates as evidence for the specialization of the lexical pathway (see Bosma et al., 2019) in three groups of children immersed in a Spanish-English bilingual program. Specifically, we aim to assess a group of children at the outset of learning to write, where most teaching strategies will be phonological and POC (i.e., second graders, 7–8 years old). We also plan to assess a second group of children at the beginning of the development of the lexical pathway and its specialization (i.e., fourth graders; 9–10 years old). Finally, we will assess a third group of children with longer experience with the use of the two processing pathways (i.e., sixth graders, 11– 2 years old). In this way, we will be mapping the development of lexical and phonological pathways in parallel as proficiency increases. Furthermore, it would be highly relevant to study these language coactivation phenomena in children with learning difficulties (i.e., children with dyslexia), in which lexical and/or sublexical processing and POC are impaired (Ramus et al., 2013).

CAPÍTULO 9.

RESUMEN Y CONCLUSIONES

En el mundo actual hablar varios idiomas se ha convertido en la norma más que ser una excepción (Graddol, 2004; Grosjean, 1992). En el mundo se hablan más de ocho mil idiomas (UNESCO, 2021), y la mitad de la población mundial es bilingüe o multilingüe, y muchos más están en proceso de serlo (Bhatia & Ritchie, 2014; Grosjean, 2010). Además, los países europeos con una fuerte tradición monolingüe en sus sistemas educativos, han ido implementado progresivamente los programas de educación bilingüe con el fin de promover las competencias bilingües/multilingües en las escuelas regulares (p. ej., el aprendizaje integrado de contenidos y lenguas - AICLE). Cada vez hay más puestos de trabajo que requieren hablar y escribir en varios idiomas con una competencia elevada (Keirstead et al., 2016). Poder hablar varios idiomas tiene obviamente importantes beneficios comunicativos, sociales, culturales y profesionales que son innegables. Sin embargo, tiene algunas consecuencias sobre el procesamiento lingüístico (p. ej., Kroll et al., 2015) que es imprescindible conocer y caracterizar.

El descubrimiento más importante y más replicado en los últimos 30 años en el campo del bilingüismo es que todas las lenguas se activan simultáneamente (p. ej., Kroll & Dussias 2013). Es decir, cuando los bilingües están hablando, leyendo o comprendiendo un mensaje en una lengua, las representaciones de la lengua que no se están utilizando se activan en paralelo, aunque la persona no sea consciente de ello. Este fenómeno ha sido denominado coactivación de lenguas (Costa et al., 1999; Dijkstra et al., 2005; Kroll et al., 2008; Marian & Spivey, 2003; Sadat et al., 2015).

El conocimiento actual sobre la producción lingüística en bilingües es considerable; sin embargo, este conocimiento proviene principalmente de estudios sobre el lenguaje hablado (p. ej., Butterworth & Hadar, 1989; Dell, 1986; Garrett, 1975; Kuipers & Thierry, 2010; Levelt, 1989). Dada la relevancia de la escritura en contextos escolares, profesionales y sociales (Bazerman, 2009; Graham et al., 2006), es importante entender también cómo la coactivación bilingüe afecta a la activación y selección en diferentes niveles lingüísticos durante la escritura. Desgraciadamente la escritura no se ha estudiado ampliamente, y se han generalizado algunas asunciones desde estudios sobre producción oral y comprensión lectora a la escritura sin evidencia específicas que las respalden.

Decidimos estudiar los mecanismos y procesos que subyacen a la escritura de palabras aisladas como un primer paso para comprender otras formas más complejas de producción escrita como la escritura de oraciones o textos (Perret & Olive, 2019). Además, se utilizó como tarea principal, la escritura al dictado al ser una modalidad de la escritura que está muy presente en nuestro día a día, especialmente en los ámbitos educativo y laboral. Además, la escritura al dictado es la tarea más sensible a la información subléxica (Bonin et al., 2015), por lo que se ha propuesto como la más apropiada para explorar la dinámica léxica y subléxica. Además, ofrece la oportunidad de explorar el procesamiento bilingüe ante un input fonológico, es decir, cuando se reciben los estímulos de forma auditiva, una modalidad que posiblemente haya sido menos explorada que la visual.

Concretamente, en nuestros experimentos utilizamos la tarea de escritura mecanografiada. La mecanografía se está convirtiendo en la forma predominante de escribir y se ha señalado como un procedimiento relevante para explorar la producción escrita (Pinet et al., 2016).

El objetivo principal de esta tesis fue analizar en profundidad la PRODUCCIÓN ESCRITA en bilingües, explorando el fenómeno de la coactivación de lenguas, y el curso temporal de la activación a través del sistema lingüístico bilingüe, concretamente entre el nivel léxico (la representación completa de la palabra que quieres escribir) y subléxico (la recuperación de segmentos fonológicos/ortográficos específicos de la palabra a escribir). Sin embargo, bilingüismo y lenguaje son dos constructos muy heterogéneos, y son muchos los factores que pueden estar influyendo en el fenómeno de coactivación. En esta tesis exploramos tres posibles moduladores de la coactivación en la escritura; el papel de la competencia, la similitud entre lenguas en términos de ortografía y fonología, y la transparencia del lenguaje en relación con la coactivación del lenguaje durante la escritura a través de tres estudios principales que conforman la presente tesis.

Para explorar el procesamiento léxico y subléxico asumimos la visión dual introducida por Muscalu & Smiley (2018). De esta forma los bilingües tenían que escribir palabras que se presentaban auditivamente, y se monitorizaba su ejecución (tiempos de escritura en milisegundos, y aciertos y errores) en dos momentos temporales diferentes. El primer momento temporal considerado fue el tiempo de latencia o “primera tecla” que consistía en el tiempo transcurrido entre la presentación del estímulo y la primera pulsación. La latencia ha sido interpretada como un índice de acceso y selección a nivel léxico (p. ej. he escuchado y tengo que escribir la palabra “coche”). El segundo momento temporal considerado fue la duración total de la palabra o "resto de la palabra" que consistía en el tiempo transcurrido entre la primera pulsación y el final de la palabra. Este tiempo ha sido interpretado como un índice de recuperación de la información subléxica (p. ej., la recuperación de segmentos ortográficos específicos: c-o-c-h-e).

En este capitulo vamos a presentar los objetivos y la descripción de los tres estudios que componen esta tesis que fueron diseñados para responder a diferentes preguntas, para terminar con una visión general de los resultados que encontramos en cada uno de ellos.

OBJETIVOS Y DESCRIPCIÓN DE LOS EXPERIMENTOS

En el primer estudio de esta tesis titulado "Coactivación de la escritura bilingüe: procesamiento léxico y subléxico en una tarea de dictado de palabras" exploramos los fenómenos de coactivación en el nivel subléxico, y el curso temporal y consecuencias de esta coactivación en el nivel léxico, en bilingües con alto dominio en dos lenguas, pero no equilibrados, es decir, con un mayor dominio en la lengua materna (L1; español) que en la segunda lengua (L2; inglés).

Para explorar la coactivación a nivel subléxico, aprovechamos las características ortográficas del español y del inglés y la presencia de grafemas polivalentes en el español para crear dos condiciones experimentales y compararlas entre sí. Los grafemas polivalentes son aquellos que tienen dos representaciones ortográficas para un solo fonema (b/v; j/g; h/no h; q/c; z/c; ll/y; gu/g; x/s; m/n en estructura consonante-vocal-consonante). La tarea consistió en un dictado de palabras ortográficamente congruentes en su representación de los grafemas polivalentes entre lenguas (p. ej., la "g" en inglés y español como en sur**g**ery-ciru**g**ía), e incongruentes (p. ej., la "v" en inglés y la "b" en español como en go**v**ernor–go**b**ernador). Exploramos las diferencias entre estas condiciones en la duración total de la palabra ("resto de la palabra") debido a que se consideraba el índice de recuperación subléxica.

Además, exploramos si esas diferencias se observaban también en la latencia de escritura (primera tecla), con el fin de comprobar si la activación fluye a través del sistema lingüístico en forma de cascada, de manera que el procesamiento subléxico pueda empezar antes de que la selección léxica haya terminado (Caramazza, 1997; Dell, 1986; Navarrete & Costa, 2005; Rapp & Goldrick, 2000; Starreveld & La Heij, 1996). Si el procesamiento es en cascada deben observar efectos de congruencia e incongruencia también en la primera tecla. Por el contrario, si la activación fluyese de forma discreta o modular (Garrett, 2000; Laver, 1980; Levelt, 1989; Levelt et al., 1999), de forma que el output de cada etapa fuese el input de la siguiente (Kandel et al., 2011; Logan & Crump 2011; Muscalu & Smiley, 2018; van Galen, 1991), esperaríamos encontrar que los efectos de congruencia en incongruencia serían evidentes en el resto-de la-palabra, pero no en la primera tecla.

En el segundo estudio de esta tesis titulado "La influencia de la similitud lingüística y de los antecedentes lingüísticos en la escritura al dictado" exploramos el impacto de la similitud ortográfica y fonológica entre lenguas en la coactivación de lenguas durante la escritura al dictado en dos poblaciones con diferentes contextos lingüísticos durante el aprendizaje. El primer grupo estaba compuesto por hablantes nativos de inglés, que habían empezado a estudiar español durante la adolescencia, o la universidad y por tanto su contexto de aprendizaje del español había sido en un contexto formal (denominados bilingües tardíos). El segundo grupo estaba compuesto por hablantes que habían adquirido el español a una edad temprana en el hogar, por simple exposición familiar, pero nunca habían recibido educación formal de esta lengua (denominados hablantes de herencia). Ambos grupos de participantes estaban inmersos en un contexto dominante en inglés y en una educación en inglés (Florida).

El contexto lingüístico puede tener consecuencias en el procesamiento del lenguaje (Fricke et al., 2019; Kroll et al., 2018) y en el nivel de dominio alcanzado (Byers-Heinlein, 2013; Place & Hoff, 2011). En este contexto es fundamental tener en cuenta las diferencias entre los entornos naturalistas y los del aula (Rothman & Guijarro-Fuentes, 2010). En un entorno naturalista/familiar el input es mayoritariamente oral/fonológico, en comparación con los entornos de aula donde el input es mayoritariamente escrito/ortográfico.

Un procedimiento utilizado para explorar la interacción de la similitud ortográfica y fonológica entre lenguas es la manipulación ortogonal de estas dos variables que dé lugar a cuatro condiciones experimentales que pueden ser comparadas entre si (Comesaña et al., 2012; Schwartz et al., 2007): O+P+ (hospital-HOSPITAL), O+P- (genuino-GENUINO), O-P+ (noción-NOTION), y O-P- (músculo-MUSCLE). Así tenemos palabras con alta o baja similitud tanto ortográfica como fonológica, y palabras con alta similitud en uno de los parámetros, pero bajo en el otro y viceversa, pudiendo explorar los efectos diferenciales que tienen la ortografía y la fonología en el procesamiento. En esta dirección, la llamada hipótesis de mediación fonológica obligatoria (Rapp & Caramazza, 1994), propone que la activación de la información fonológica automática, por lo que la ejecución se vería afectada principalmente por la similitud fonológica entre lenguas. Por el contrario, la llamada hipótesis de la autonomía ortográfica (Miceli et al., 1997; Rapp & Caramazza, 1997; Rapp et al., 1997) defiende que la ortografía se activa directamente desde el sistema léxico-semántico sin activación fonológica, y por tanto, el la similitud ortográfica entre lenguas tendría un mayor efecto sobre la ejecución. La mayoría de los estudios de lectura centrados en la interacción entre las similitudes fonológica y ortográfica (Comesaña et al., 2012; Schwartz et al., 2007) han mostrado que la coactivación de la fonología parece ser dependiente de la ortografía (hipótesis de la autonomía ortográfica); solo cuando la similitud ortográfica entre lenguas era alta se activaba la fonología. Sin embargo, era necesario explorar el papel de la fonología en la escritura, especialmente en la escritura al dictado, donde el procesamiento fonológico es primordial.

En el tercer y último estudio de esta tesis titulado "Transferencia del procesamiento lingüístico al tamaño de la ventana atencional: el impacto de la transparencia ortográfica" exploramos el impacto de la transparencia ortográfica. Las ortografías pueden diferir en cuanto a la coherencia de la relación entre grafemas y fonemas y viceversa (Schmalz et al., 2015). En algunas ortografías, como el español y el italiano, a cada sonido le corresponde una única letra (relación 1:1). Por tanto, la consistencia interna es muy alta y son consideradas ortografías transparentes. Sin embargo, en ortografías como el inglés o el francés la relación entre letras y sonidos es más complicada, y para un mismo sonido hay varias opciones (relación 1: varias). Por tanto, la consistencia interna es más baja, y son consideradas ortografías opacas (Ziegler et al., 1997).

Algunas teorías en lectura defienden que la transparencia ortográfica modula el tipo de procesamiento lingüístico empleado (p. ej., la hipótesis de la Profundidad Ortográfica; Frost, 1994; 2012; Katz

& Frost, 1992). De esta forma, las ortografías transparentes se basan en mayor medida en el procesamiento fonológico, letra a letra, debido a la alta consistencia interna. Sin embargo, en ortografías opacas en las que hay muchas inconsistencias, el procesamiento léxico es esencial (Bolger et al., 2005; Glushko, 1979; Seidenberg & McClelland, 1989; Seymour et al., 2003; Ziegler & Goswami, 2005). Para explorar el predominio del procesamiento léxico frente al fonológico durante la escritura (o viceversa), se exploraron algunas propiedades lingüísticas. Concretamente, la frecuencia, la edad de adquisición y la concreción de las palabras se consideran propiedades léxicas de las palabras (Bonin et al., 2004), por lo que se esperaba que tendrían efecto cuando la tarea de dictado se realizara en inglés (la ortografía opaca). Por el contrario, la longitud de la palabra y los vecinos ortográficos de las palabras se consideran propiedades subléxicas/fonológicas (Burani et al., 2007), y que, por tanto, deberían tener efectos cuando la tarea de dictado se realizara en español (la ortografía transparente). Nuestros resultados mostraron el patrón esperado en apoyo de la hipótesis de la transparencia ortográfica y su papel en la escritura.

Por otra parte, la teoría de la fineza de grano (Ziegler & Goswami, 2005) propone que las diferencias en términos de consistencia hacen que el tamaño de la ventana de procesamiento sea diferente. Es decir, las lenguas con ortografías transparentes están asociadas a una codificación de grano más fino, es decir, una ventana de procesamiento más pequeña (que incluye letras en lugar de palabras completas en la ventana de procesamiento), mientras que las lenguas con ortografías opacas se asocian con una codificación de grano grueso, o una ventana de procesamiento más grande (que incluye palabras enteras en lugar de letras en la ventana de procesamiento) (Grainger & Ziegler, 2011; Ziegler & Goswami, 2005). Para explorar la influencia del procesamiento léxico y fonológico en la ventana de procesamiento se administró la tarea Global-Local (Navon, 1977) después de que los participantes monolingües y bilingües realizaran la tarea de dictado en cada una de las lenguas de nuestros estudios (español, transparente vs. inglés, opaca). La tarea global-local permite explorar si el procesamiento léxico o fonológico facilita o interfiere la información global o local en la realización de la tarea de atención visual (Tarea Global-Local).

RESULTADOS

En resumen, y tomados de forma global, los resultados de los experimentos que compone la tesis apoyan el fenómeno de la coactivación de lenguas durante la producción de la escritura. Así, cuando un bilingüe español-inglés está escribiendo una palabra en español, se coactivan tanto sus representaciones léxicas como subléxicas del inglés, y viceversa. Como se muestra en nuestros experimentos, durante el proceso de escritura, esta coactivación puede facilitar, pero también dificultar la ejecución. Además, estos experimentos también muestran que el procesamiento en la escritura parece no estar encapsulado, sino compuesto por módulos independientes. Los niveles de representación lingüística están interconectados entre sí y el procesamiento subléxico puede influir el acceso y la selección a nivel léxico. Es decir, cuando un bilingüe está escribiendo una palabra en español y su traducción tiene letras incongruentes (p. ej., gara**g**e y gara**j**e), esta simple incongruencia puede dificultar la selección de la lengua incluso en el nivel léxico, dando lugar a una ralentización de la producción y a una mayor susceptibilidad a los errores.

En la tesis también exploramos factores que podrían modular la coactivación de lenguas durante la escritura. El primer factor modulador que exploramos fue la competencia lingüística. En nuestra investigación entendemos el bilingüismo como el uso de dos lenguas en la vida cotidiana, aunque el bilingües tenga diferentes niveles de competencia. Esta forma de entender el bilingüismo abre la puerta a cuestionar si las consecuencias de la coactivación son similares para la lengua dominante – L1 y para la lengua más débil -L2. En línea con las evidencias anteriores, esta tesis apoya que las representaciones léxicas de la L1 son más estables (Kroll et al., 2010) y más resistentes a la coactivación subléxica. Además, se observó que hay más recursos disponibles durante el procesamiento de la L1 para controlar la interferencia a nivel léxico.

El segundo modulador explorado fue la similitud entre lenguas. Los resultados señalaron que la similitud ortográfica entre lenguas, pero sobre todo la fonológica, y en menor medida la ortográfica median la fuerza de la coactivación. Nuestros resultados mostraron que, a mayor similitud, mayores efectos de coactivación, con un menor tiempo empleado durante el procesamiento de palabras similares entre lenguas. El efecto de similitud fonológica fue general; las palabras con alta similitud fonológica se procesaron más rápido que las palabras con baja similitud fonológica, y este efecto no fue dependiente de la similitud ortográfica. Estos resultados apoyan la primacía del procesamiento fonológico sobre el ortográfico en la escritura al dictado. Este último, cobra mayor relevancia en una fase más tardía del procesamiento, durante la recuperación de la información subléxica.

La supremacía de la fonología sobre la ortografía durante el procesamiento parece variar según la tarea y la modalidad de entrada del input lingüístico (i. e., forma de presentación). Nuestros resultados apoyan la asunción del retraso temporal (modelo BIA+; Dijkstra & Van Heuven, 2002). Así, por ejemplo, en el procesamiento de la lectura donde el input es una cadena de letras, el primer análisis es ortográfico y en consecuencia la activación de la fonología parece depender de la similitud ortográfica, de forma que no se activa cuando la ortografía es más diferente entre lenguas (Comesaña et al., 2012; Schwartz et al., 2007). Sin embargo, en la escritura al dictado donde el input es auditivo, el primer análisis es fonológico y en consecuencia la activación de la fonología parece ser predominante.

La dinámica de la activación fonológica y ortográfica parece variar también en función del contexto de aprendizaje y de la calidad y cantidad del input. Los resultados señalan que las diferencias en la alfabetización y la exposición a la escritura y la lectura podrían modular los efectos de la coactivación y el papel relativo de la ortografía y fonología en el procesamiento de la L1 y la L2. Los hablantes de herencia mostraron más dificultades ortográficas en español, mostrando un sesgo hacia la información fonológica durante el procesamiento. La exposición a contextos naturalistas durante el aprendizaje, pero sin acceso a entornos formales/de clase (situación muy extendida en los hablantes de herencia) conducen a ventajas fonológicas (Chang et al., 2011; Gor, 2014), pero también a las dificultades ortográficas (Elola & Mikulski, 2016). La práctica acumulada con una determinada lengua parece tener un impacto sobre el procesamiento del lenguaje (Gollan et al., 2008).

Finalmente, exploramos el efecto de la transparencia ortográfica sobre el procesamiento lingüístico durante la escritura. Nuestros resultados extienden la evidencia acumulada en los estudios de lectura a la escritura al dictado. Es decir, el modo de procesamiento depende de la regularidad de las correspondencias grafema-fonema (Frost et al., 1987; Ziegler & Goswami, 2005). Así, la escritura al dictado en ortografías transparentes se basa predominantemente en el procesamiento fonológico. Sin embargo, la escritura al dictado en ortografías opacas se basa más en el procesamiento léxico.

Estas diferencias pueden atribuirse a las diferencias en la ventana atencional utilizada durante la escritura (PGST; Ziegler & Goswami, 2005). La transparencia de la lengua influye en la ventana atencional que subyace al procesamiento diferencial léxico vs. fonológico. Nuestros resultados muestran que el procesamiento fonológico (durante la escritura al dictado en una ortografía transparente) en la que las palabras fueron decodificadas en unidades más pequeñas, se trasladó a la ventana atencional mostrando una mayor eficacia de la atención local. Además, nuestros resultados apoyan la idea de que los bilingües son capaces de adaptar la ventana atencional y sus estrategias de procesamiento durante la escritura en función de la opacidad de la lengua que están utilizando, y esa adaptación deben hacerla en un contexto en que la coactivación de la ortografía no utilizada también afecta la ventana atencional.

Los resultados de esta tesis aportan evidencias importantes que ayudan en la teorización del sistema lingüístico bilingüe, en este caso, a la base de la escritura, una habilidad con un gran impacto en nuestra vida social, educativa y laboral. El hecho de conocer varias lenguas hace que mientras escribimos una palabra, por ejemplo, en español, las representaciones del inglés tanto léxicas como subléxicas están activas también influyendo en nuestra escritura, tanto facilitando la recuperación de las palabras cuando son congruentes, como interfiriéndola cuando son incongruentes. Sin embargo, esta coactivación de lenguas no es algo estático y generalizado para todas las personas. Esta coactivación parece ser modulada por algunos factores o características propios del hablante, de su contexto, y de la lengua que usa durante la escritura. Es decir, encontramos evidencias de que los efectos de coactivación se vieron modulados por: el grado de competencia en cada lengua, del contexto de aprendizaje de cada lengua, de la similitud entre lenguas, y de la transparencia de la mismas. Todos los resultados y conclusiones de esta tesis se han resumido visualmente en la figura 21.

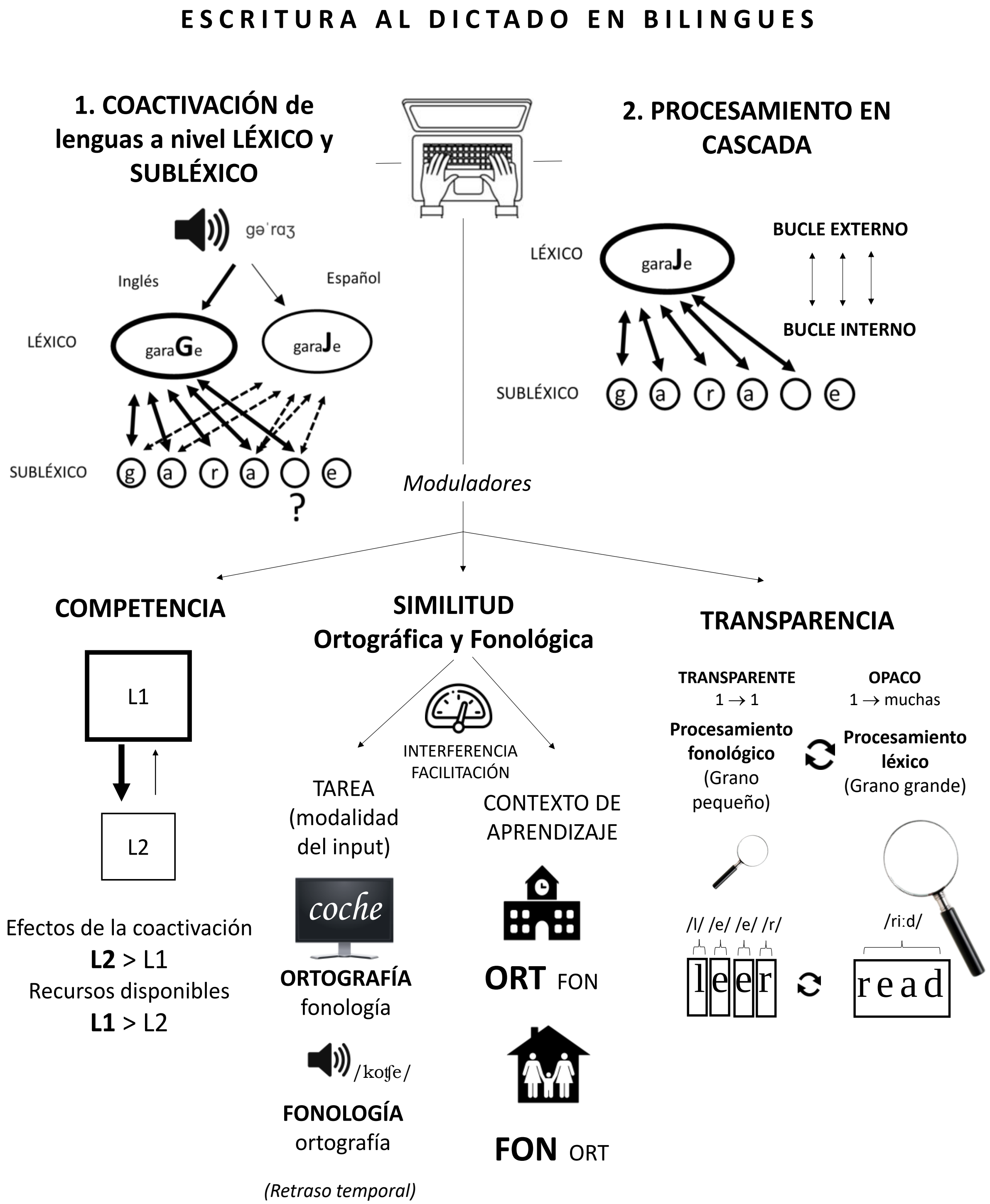


Figura 21. Resultados de la tesis. ORT = ortografía; FON = fonología.

REFERENCES

Abutalebi, J., & Green, D. W. (2008). Control mechanisms in bilingual language production: Neural evidence from language switching studies. *Language and cognitive processes, 23*, 557-582. doi: 10.1080/01690960801920602

Acheson, D. J., Ganushchak, L. Y., Christoffels, I. K., & Hagoort, P. (2012). Conflict monitoring in speech production: Physiological evidence from bilingual picture naming. *Brain and language, 123*, 131-136. doi: 10.1016/j.bandl.2012.08.008

Adelman, J. S., Marquis, S. J., & Sabatos-DeVito, M. G. (2010). Letters in words are read simultaneously, not in left-to-right sequence. *Psychological Science, 21,*1799–1801. doi: 10.1177/0956797610387442

Adesope, O. O., Lavin, T., Thompson, T., & Ungerleider, C. (2010). A systematic review and meta-analysis of the cognitive correlates of bilingualism. *Review of Educational Research, 80*, 207-245. doi: 10.3102/0034654310368803

Afonso, O. (2014). *Phonological Processing during Handwriting of Isolated Words*. Doctoral Dissertation, Universidad de La Laguna

Afonso, O., & Álvarez, C. J. (2019). Measuring writing durations in handwriting research: what do they tell us about the spelling process?. In *Spelling and Writing Words* (pp. 151-162). Brill.

Afonso, O., Álvarez, C. J., & Kandel, S. (2014). Effects of grapheme-to-phoneme probability on writing durations. *Memory & cognition, 43*, 579-592. doi: 10.3758/s13421-014-0489-8

Afonso, O., Álvarez, C. J., Martínez, C., & Cuetos, F. (2019). Writing difficulties in Alzheimer’s disease and mild cognitive impairment. *Reading and Writing, 32*, 217-233. doi: 10.1007/s11145-017-9813-6

Alonso, M., Díez, E., & Fernandez, A. (2014). Subjective age-of-acquisition norms for 4.640 verbs in Spanish. *Behavior Research Methods*, *48*, 1337-1342. doi: 10.3758/s13428-015-0675-z

American Academy of Arts and Sciences. (2017). America’s languages: Investing in language education for the 21st century. Cambridge, MA: American Academy of Arts & Sciences.

Anderson, J. A. E., Mak, L., Keyvani Chahi, A., & Bialystok, E. (2018). The language and social background questionnaire: Assessing degree of bilingualism in a diverse population. *Behavior Research Methods, 50*, 250–263. doi: 10.3758/s13428-017-0867-9

Andras, F., Rivera, M., Dussias, P.E., Bajo, M.T., Paolieri, D. (2022). Cognate facilitation effect during auditory comprehension of L2: a visual world eye-tracking study. *International Journal of Bilingualism.* doi: 10.1177/13670069211033359

References

Ans, B., Carbonnel, S., & Valdois, S. (1998). A connectionist multiple-trace memory model for polysyllabic word reading. *Psychological review*, *105*, 678-723. doi: 10.1037/0033-295x.105.4.678-723

Applebee, A. N., & Langer, J. A. (2011). " EJ" Extra: A Snapshot of Writing Instruction in Middle Schools and High Schools. *The English Journal, 100,* 14-27.

Awadh, F. H., Phénix, T., Antzaka, A., Lallier, M., Carreiras, M., & Valdois, S. (2016). Cross-language modulation of visual attention span: an Arabic-French-Spanish comparison in skilled adult readers. *Frontiers in psychology*, *7*, 307. doi: 10.3389/fpsyg.2016.00307

Barnett, A. L., & Prunty, M. (2021). Handwriting difficulties in developmental coordination disorder (DCD). *Current Developmental Disorders Reports, 8,* 6-14. doi: 10.1007/s40474-020-00216-8

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language, 68,* 255-278. doi:10.1016/j.jml.2012.11.001.

Barry, C. (1994). Spelling routes (or roots or rutes). In G. D. A. Brown & N. C. Ellis (Eds.), *Handbook of spelling: Theory, process and intervention* (pp. 27–49). Chichester, U.K.: Wiley.

Barry, C., & De Bastiani, P. (1997). Lexical priming of nonword spelling in the regular orthography of Italian. In *Spelling* (pp. 185-203). Springer, Dordrecht.

Bates, D., Mächler, M., Bolker, B., Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software, 67*, 1–48. doi: 10.18637/jss.v067.i01.

Baus, C., Costa, A., & Carreiras, M. (2013). On the effects of second language immersion on first language production. *Acta psychologica, 142*, 402-409. doi: 10.1016/j.actpsy.2013.01.010

Baxter, D. M., & Warrington, E. K. (1987). Transcoding sound to spelling: Single or multiple sound unit correspondence? *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior, 23*, 11–28. doi: 10.1016/S0010-9452(87)80016-3

Bayram, F., Rothman, J., Iverson, M., Kupisch, T., Miller, D., Puig-Mayenco, E., & Westergaard, M. (2017). Differences in use without deficiencies in competence: passives in the Turkish and German of Turkish heritage speakers in Germany. *International Journal of Bilingual Education and Bilingualism, 22,* 919-939. doi: 10.1080/13670050.2017.1324403

Bazerman, C. (2009). Genre and cognitive development. In C. Bazerman, A. Bonini, D. Figueiredo (eds.), *Genre in a changing world: Perspectives on writing* (pp. 279-294). Fort Collins, Colorado: The WAC Clearinghouse and Parlor Press.

Beatty-Martínez, A. L., Navarro-Torres, C. A., Dussias, P. E., Bajo, M. T., Guzzardo Tamargo, R. E., & Kroll, J. F. (2020). Interactional context mediates the consequences of bilingualism for language and cognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 46,* 1022-1047. doi: 10.1037/xlm0000770

Beauvois, M. F., & Dérouesné, J. (1981). Lexical or orthographic agraphia. *Brain: a journal of neurology, 104*, 21–49. doi: 10.1093/brain/104.1.21

Beeson, P. M., Rewega, M. A., Vail, S., & Rapcsak, S. Z. (2000). Problem-solving approach to agraphia treatment: Interactive use of lexical and sublexical spelling routes. *Aphasiology, 14*, 551-565. doi: 10.1080/026870300401315

Behrmann, M., & Bub, D. (1992). Surface dyslexia and dysgraphia: Dual routes, single lexicon. *Cognitive Neuropsychology, 9*, 209 251. doi: 10.1080/02643299208252059

Benmamoun, E., Montrul, S., & Polinsky, M. (2013). Heritage languages and their speakers: Opportunities and challenges for linguistics. *Theoretical linguistics, 39*, 129-181. doi: 10.1515/tl-2013-0009

Bhatia, T. K., & Ritchie, W. C. (Eds.). (2014). *The handbook of bilingualism and multilingualism*. John Wiley & Sons.

Bialystok, E. (2017). The bilingual adaptation: How minds accommodate experience. *Psychological Bulletin, 143*, 233–262. doi: 10.1037/bul0000099

Bialystok, E., Craik, F., & Luk, G. (2008). Cognitive control and lexical access in younger and older bilinguals. *Journal of Experimental Psychology: Learning, memory, and cognition, 34*, 859-873. doi: 10.1037/0278-7393.34.4.859

Bierman, K. L., Domitrovich, C. E., Nix, R. L., Gest, S. D., Welsh, J. A., Greenberg, M. T., Blair, C., Nelson, K. E., & Gill, S. (2008). Promoting academic and social-emotional school readiness: the head start REDI program. *Child development*, *79*, 1802–1817. doi: 10.1111/j.1467-8624.2008.01227.x

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child development*, *78*, 647–663. doi: 10.1111/j.1467-8624.2007.01019.x

Bloomfield, L. (1933). *Language*. New York: Holt, Rinehart & Winston.

Blumenfeld, H. K., & Marian, V. (2007). Constraints on parallel activation in bilingual spoken language processing: Examining proficiency and lexical status using eye-tracking. *Language and cognitive processes, 22*, 633-660. doi: 10.1080/01690960601000746

Bobb, S. C., & Wodniecka, Z. (2013). Language switching in picture naming: What asymmetric switch costs (do not) tell us about inhibition in bilingual speech planning. *Journal of Cognitive Psychology, 25*, 568–585. doi: 10.1080/20445911.2013.792822

Bobb, S. C., Von Holzen, K., Mayor, J., Mani, N., & Carreiras, M. (2020). Co-activation of the L2 during L1 auditory processing: An ERP cross-modal priming study. *Brain and language, 203*, 104739. doi: 10.1016/j.bandl.2019.104739

Bock, K., & Levelt, W. (1994). Language production: Grammatical encoding. In M. A. Gernsbacher (Ed.), *Handbook of psycholinguistics* (pp. 945–984). Academic Press.

Boersma, P., & Weenink, D. (2012). Praat: Doing phonetics by computer [Computer software]. *Amsterdam: Institute of Phonetic Sciences*.

Bolger, D. J., Perfetti, C. A., & Schneider, W. (2005). Cross-cultural effect on the brain revisited: universal structures plus writing system variation. *Human brain mapping*, *25*, 92–104. doi: 10.1002/hbm.20124

Bonin, P., & Fayol, M. (2000). Writing words from pictures: What representations are activated, and when?. *Memory & Cognition, 28*, 677-689. doi: 10.3758/bf03201257

Bonin, P., & Méot, A. (2002). Writing to dictation in real time in adults: What are the determinants of written latencies? In S. P. Shohov (Ed.), *Advances in psychology research* (pp. 139–165). Nova Science Publishers.

Bonin, P., Barry, C., Méot, A., & Chalard, M. (2004). The influence of age of acquisition in word reading and other tasks: A never ending story?. *Journal of Memory and language, 50*, 456-476. doi: 10.1016/j.jml.2004.02.001

Bonin, P., Chalard, M., Méot, A., & Fayol, M. (2002). The determinants of spoken and written picture naming latencies. *British Journal of Psychology*, *93*, 89-114. doi: 10.1348/000712602162463

Bonin, P., Collay, S., Payola, M., & Méot, A. (2005). Attentional strategic control over nonlexical and lexical processing in written spelling to dictation in adults. *Memory & Cognition*, *33*, 59-75. doi: 10.3758/bf03195297

Bonin, P., Fayol, M., & Gombert, J. E. (1998). An experimental study of lexical access in the writing and naming of isolated words. *International Journal of Psychology, 33*, 269–286. doi: 10.1080/002075998400312

Bonin, P., Fayol, M., & Gombert, J.E. (1997). Role of phonological and orthographic codes in picture naming and writing: An interference paradigm study. *Current Psychology of Cognition, 16*, 299-324.

Bonin, P., Méot, A., Lagarrigue, A., & Roux, S. (2015). Written object naming, spelling to dictation, and immediate copying: Different tasks, different pathways?. *Quarterly Journal of Experimental Psychology, 68*, 1268-1294. doi: 10.1080/17470218.2014.978877

Bonin, P., Méot, A., Laroche, B., Bugaiska, A., & Perret, C. (2019). The impact of image characteristics on written naming in adults. *Reading and Writing, 32*, 13-31. doi: 10.1007/s11145-017-9727-3

Bonin, P., Peereman, R., & Fayol, M. (2001). Do phonological codes constrain the selection of orthographic codes in written picture naming?. *Journal of memory and language, 45*, 688-720. doi: 10.1006/jmla.2000.2786

Bonin, P., Roux, S., Barry, C., & Canell, L. (2012). Evidence for a limited-cascading account of written word naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 1741-1758. doi: 10.1037/a0028471

Borragan, M., Martin, C. D., De Bruin, A., & Duñabeitia, J. A. (2018). Exploring different types of inhibition during bilingual language production. *Frontiers in psychology*, *9*, 2256. doi: 10.3389/fpsyg.2018.02256

Bosma, E., Blom, E., Hoekstra, E., & Versloot, A. (2019). A longitudinal study on the gradual cognate facilitation effect in bilingual children's Frisian receptive vocabulary. *International Journal of Bilingual Education and Bilingualism, 22,* 371-385. doi: 10.1080/13670050.2016.1254152

Bosse, M. L., Valdois, S., & Tainturier, M. J. (2003). Analogy without priming in early spelling development. *Reading and Writing, 16*, 543-572. doi: 10.1023/A:1025883815395

Boukadi, M., Davies, R. A. I., & Wilson, M. A. (2015). Bilingual lexical selection as a dynamic process: Evidence from Arabic-French bilinguals. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale, 69*, 297–313. doi: 10.1037/cep0000063

Bourdin, B., & Fayol, M. (2002). Even in adults, written production is still more costly than oral production. *International Journal of Psychology*, *37*, 219-227. doi: 10.1080/00207590244000070

Bowers, J. S., Mimouni, Z., & Arguin, M. (2000). Orthography plays a critical role in cognate priming: Evidence from French/English and Arabic/French cognates. *Memory & Cognition, 28*, 1289–1296. doi: 10.3758/BF03211829

Braver, T. S. (2012). The variable nature of cognitive control: a dual mechanisms framework. *Trends in cognitive sciences, 16*, 106-113. doi: 10.1016/j.tics.2011.12.010

Broersma, M., Carter, D., & Acheson, D. (2016). Cognate Costs in Bilingual Speech Production: Evidence from Language Switching. *Frontiers in Psychology*, *7*. doi: 10.3389/fpsyg.2016.01461

Broos, W. P., Duyck, W., & Hartsuiker, R. J. (2018). Are higher-level processes delayed in second language word production? Evidence from picture naming and phoneme monitoring. *Language, Cognition and Neuroscience, 33*, 1219-1234. doi: 10.1080/23273798.2018.145 7168

Brown, G. D., & Ellis, N. C. (Eds.). (1994). *Handbook of spelling: Theory, process and intervention.* Wiley.

Brysbaert, M. & Stevens, M. (2018). Power Analysis and Effect Size in Mixed Effects Models: *A Tutorial. Journal of Cognition, 1*, 1–20. doi: 10.5334/joc.10.

Brysbaert, M., Van Wijnendaele, I., & Duyck, W. (2002). On the temporal delay assumption and the impact of non-linguistic context effects. *Bilingualism: Language and Cognition, 5*, 199-201. doi: 10.1017/S1366728902213012

Brysbaert, M., Warriner, A., & Kuperman, V. (2014). Concreteness ratings for 40 thousand generally known English word lemmas. *Behavior Research Methods*, *46*, 904-911. doi: 10.3758/s13428-013-0403-5

Buchwald, A., & Rapp, B. (2003). The orthographic representation of consonant–vowel status: Evidence from two cases of acquired dysgraphia. *Brain and Language, 87*, 120-121. doi: 10.1016/S0093-934X(03)00228-1

Buetler, K. A., de León Rodríguez, D., Laganaro, M., Müri, R., Spierer, L., & Annoni, J. M. (2014). Language context modulates reading route: an electrical neuroimaging study. *Frontiers in Human Neuroscience, 8*, 83. doi: 10.3389/fnhum.2014.00083

Burani, C., Arduino, L. S., & Barca, L. (2007). Frequency, not age of acquisition, affects Italian word naming. *European Journal of Cognitive Psychology, 19*, 828-866. doi: 10.1080/09541440600847946

Butterworth, B., & Hadar, U. (1989). Gesture, speech, and computational stages: A reply to McNeill. *Psychological Review*, *96*, 168-174. doi: 10.1037/0033-295x.96.1.168

Byers-Heinlein, K. (2013). Parental language mixing: Its measurement and the relation of mixed input to young bilingual children's vocabulary size. *Bilingualism: Language and Cognition, 16,* 32–48. doi: 10.1017/S1366728912000120

Byers-Heinlein, K., Burns, T. C., & Werker, J. F. (2010). The roots of bilingualism in newborns. *Psychological science, 21*, 343-348. doi: 10.1177/0956797609360758

Canseco-Gonzalez, E., Brehm, L., Brick, C. A., Brown-Schmidt, S., Fischer, K., & Wagner, K. (2010). Carpet or Cárcel: The effect of age of acquisition and language mode on bilingual lexical access. *Language and Cognitive Processes, 25*, 669-705. doi: 10.1080/01690960903474912

Caplan, D., Rochon, E., & Waters, G. (1995). Articulatory and phonological determinants of word length effects in span tasks. *The Quarterly Journal of Experimental Psychology Section A*, *45*, 177-192. doi: 10.1080/14640749208401323

Caramazza, A. (1988). Some aspects of language processing revealed through the analysis of acquired aphasia: The lexical system. *Issues in reading, writing and speaking, 11,* 395-421. doi: 10.1146/annurev.ne.11.030188.002143

Caramazza, A. (1997). How many levels of processing are there in lexical access? *Cognitive Neuropsychology, 14*, 177–208. doi: 10.1080/026432997381664

Caravolas, M. (2004). Spelling Development in Alphabetic Writing Systems: A Cross-Linguistic Perspective. *European Psychologist, 9*, 3–14. doi: 10.1027/1016-9040.9.1.3

Caravolas, M., Lervåg, A., Mousikou, P., Efrim, C., Litavsky, M., Onochie-Quintanilla, E., Salas, N., Schöffelová, M., Defior, S., Mikulajová, M., Seidlová-Málková, G., & Hulme, C. (2012). Common patterns of prediction of literacy development in different alphabetic orthographies. *Psychological science*, *23*, 678–686. doi: 10.1177/0956797611434536

Carrasco-Ortiz, H., Amengual, M., & Gries, S. T. (2019). Cross-language effects of phonological and orthographic similarity in cognate word recognition: the role of language dominance. *Linguistic Approaches to Bilingualism, 11*, 389-417. doi: 10.1075/lab.18095.car

Casado, A., Palma, A., & Paolieri, D. (2017). The Influence of Sex Information on Gender Word Processing. *Journal of Psycholinguistic Research, 47*, 557-583. doi: 10.1007/s10936-017-9546-3

Casaponsa, A., Carreiras, M., & Duñabeitia, J. A. (2014). Discriminating languages in bilingual contexts: the impact of orthographic markedness. *Frontiers in psychology, 5*, 424. doi: 10.3389/fpsyg.2014.00424

Cenoz, J., Hufeisen, B., & Jessner, U. (2003). Why investigate the multilingual lexicon?. In *The multilingual lexicon* (pp. 1-9). Springer, Dordrecht.

Chacón,T. (1997). *Ortografía española.* Madrid: UNED.

Chang, C. B., Yao, Y., Haynes, E. F., & Rhodes, R. (2011). Production of phonetic and phonological contrast by heritage speakers of Mandarin. *The Journal of the Acoustical Society of America, 129*, 3964-3980. doi: 10.1121/1.3569736

Christoffels, I. K., Firk, C., & Schiller, N. O. (2007). Bilingual language control: An event-related brain potential study. *Brain research, 1147*, 192-208. doi: 10.1016/j.brainres.2007.01.137

Chua, S. M., & Rickard Liow, S. J. (2014). The locus of word frequency effects in skilled spelling-to-dictation. *Quarterly Journal of Experimental Psychology, 67*, 1720-1741. doi: 10.1080/17470218.2013.868915

Cohen, J. (1977). *Statistical power analysis for the behavioral sciences* (Rev. ed.). Hillsdale, NJ, US: Lawrence Erlbaum Associates, Inc.

Colheart, M. (1978). Lexical access in simple reading tasks. En G. Underwood (Ed.), *Strategies of information processing.* Londres: Academic Press

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82*, 407–428. doi: 10.1037/0033-295X.82.6.407

Colomé, À. (2001). Lexical activation in bilinguals' speech production: Language-specific or language-independent? *Journal of Memory and Language, 45*, 721–736. doi: 10.1006/jmla.2001.2793

Colomé, À., & Miozzo, M. (2010). Which words are activated during bilingual word production?. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *36*, 96-109. doi: 10.1037/a0017677

Coltheart, M., Besner, D., Jonasson, J. T., & Davelaar, E. (1979). Phonological Encoding in the Lexical Decision Task. *Quarterly Journal of Experimental Psychology*, *31*, 489–507. doi: 10.1080/14640747908400741

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and parallel-distributed-processing approaches. *Psychological review, 100*, 589-608. doi: 10.1037/0033-295X.100.4.589

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: a dual route cascaded model of visual word recognition and reading aloud. *Psychological review, 108*, 204-256. doi: 10.1037/0033-295X.108.1.204

Comesaña, M., Ferré, P., Romero, J., Guasch, M., Soares, A. P., & García-Chico, T. (2015). Facilitative effect of cognate words vanishes when reducing the orthographic overlap: The role of stimuli list composition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41,* 614 –635. doi: 10.1037/xlm0000065

Comesaña, M., Sánchez-Casas, R., Soares, A. P., Pinheiro, A. P., Rauber, A., Frade, S., & Fraga, I. (2012). The interplay of phonology and orthography in visual cognate word recognition: An ERP study. *Neuroscience letters, 529*, 75-79. doi: 10.1016/j.neulet.2012.09.010

Commission on Language Learning. (2017). *America's languages: Investing in language education for the 21st century*. Cambridge, MA: American Academy of Arts and Sciences.

Conrad, M., Alvarez, C. J., Afonso, O., & Jacobs, A. M. (2014). Sublexical modulation of simultaneous language activation in bilingual visual word recognition: The role of syllabic units. *Bilingualism, 18*, 696- 712. doi:10.1017/S1366728914000443

Cossu, G., Shankweiler, D., Liberman, I. Y., Katz, L., & Tola, G. (1988). Awareness of phonological segments and reading ability in Italian children. *Applied Psycholinguistics, 9,* 1–16. doi: 10.1017/S0142716400000424

Costa, A. (2005). Lexical Access in Bilingual Production. In J. F. Kroll & A. M. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 289-307). New York, NY, US: Oxford University Press.

Costa, A., & Caramazza, A. (1999). Is lexical selection in bilingual speech production language-specific? Further evidence from Spanish–English and English–Spanish bilinguals. *Bilingualism: Language and cognition*, *2*, 231-244. doi: 10.1017/S1366728999000334

Costa, A., & Sebastián-Gallés, N. (2014). How does the bilingual experience sculpt the brain?. *Nature Reviews Neuroscience*, *15*, 336-345. doi: 10.1038/nrn3709.

Costa, A., Albareda, B., & Santesteban, M. (2008). Assessing the presence of lexical competition across languages: Evidence from the Stroop task. *Bilingualism: Language and Cognition, 11,* 121–131. doi: 10.1017/S1366728907003252

Costa, A., Calabria, M., Marne, P., Hernandez, M., Juncadella, M., Gascon-Bayarri, J., Rene, R. (2012). On the parallel deterioration of lexico-semantic processes in the bilinguals' two languages: Evidence from Alzheimer's disease. *Neuropsychologia, 50*, 740-753. doi: 10.1016/j.neuropsychologia.2012.01.008

Costa, A., Caramazza, A., & Sebastian-Galles, N. (2000). The cognate facilitation effect: implications for models of lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 1283-1296. doi: 10.1037//0278-7393.26.5.1283

Costa, A., Colomé, A., Gómez, O., & Sebastian-Gallés, N. (2003). Another look at cross-language competition in bilingual speech: Lexical and phonological factors. *Bilingualism: Language and Cognition, 6,* 167–179. doi:10.1017/S1366728903001111

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection? *Journal of Memory and Language, 41*, 365–397. doi: 10.1006/jmla.1999.2651

Costa, A., Santesteban, M., & Caño, A. (2005). On the facilitatory effects of cognate words in bilingual speech production. *Brain and language, 94*, 94-103. doi: 10.1016/j.bandl.2004.12.002

Cuetos, F. (1991). *Psicología de la escritura: diagnóstico y tratamiento de los trastornos de la escritura.* Madrid: Escuela Española

Cuetos, F., & Labos, E. (2001). The autonomy of the orthographic pathway in a shallow language: Data from an aphasic patient. *Aphasiology, 15*, 333-342. doi: 10.1080/02687040042000313

Cuetos, F., Ramos, J. & Ruano, E. (2002). *PROESC. Batería de evaluación de los procesos de escritura.* Madrid: TEA.

Damian, M. F., Dorjee, D., & Stadthagen-Gonzalez, H. (2011). Long-term repetition priming in spoken and written word production: Evidence for a contribution of phonology to handwriting. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*, 813-826. doi:10.1037/a0023260

Das, T., Padakannaya, P., Pugh, K. R., & Singh, N. C. (2011). Neuroimaging reveals dual routes to reading in simultaneous proficient readers of two orthographies. *Neuroimage*, *54*, 1476-1487. doi: 10.1016/j.neuroimage.2010.09.022

De Bot, K. (1992). A Bilingual Production Model Levelt's 'Speaking' Model Adapted. *Applied Linguistics, 13,* 1-24. doi: 10.1093/applin/13.1.1

de León Rodríguez, D., Buetler, K. A., Eggenberger, N., Preisig, B., Schumacher, R., Laganaro, M., ..., Müri, R. (2015). The modulation of reading strategies by language opacity in early bilinguals: an eye movement study. *Bilingualism 19*, 1–11. doi: 10.1017/S1366728915000310

De Smedt, F., Van Keer, H., & Merchie, E. (2016). Student, teacher and class-level correlates of Flemish late elementary school children's writing performance. *Reading and Writing, 29,* 833–868. doi:10.1007/s11145-015-9590-z

Deane, P., Odendahl, N., Quinlan, T., Fowles, M., Welsh, C., & Bivens-Tatum, J. (2008). Cognitive models of writing: Writing proficiency as a complex integrated skill. ETS Research Report Series, *2008*, 1-36. doi: 10.1002/j.2333-8504.2008.tb02141.x

Declerck, M. (2020). What about proactive language control? *Psychonomic Bulletin & Review, 27*, 24–35. doi: 10.3758/s13423-019-01654-1

Declerck, M., & Philipp, A. M. (2015). A review of control processes and their locus in language switching. *Psychonomic bulletin & review, 22*, 1630-1645. doi: 10.3758/s13423-015-0836-1

Declerck, M., Lemhöfer, K., & Grainger, J. (2017). Bilingual language interference initiates error detection: Evidence from language intrusions. *Bilingualism: Language and Cognition*, *20*, 1010-1016. doi: 10.1017/S1366728916000845

Defior, S., Jiménez-Fernández, G., & Serrano, F. (2009). Complexity and lexicality effects on the acquisition of Spanish spelling. *Learning and Instruction, 19*, 55-65. doi: 10.1016/j.learninstruc.2008.01.005

Delattre, M., Bonin, P., & Barry, C. (2006). Written spelling to dictation: Sound-to-spelling regularity affects both writing latencies and durations. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 32,* 1330–1340. doi: 10.1037/0278-7393.32.6.1330

Dell, G. S. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review, 93*, 283–321. doi: 10.1037/0033-295X.93.3.283

Dell, G. S. (1988). The retrieval of phonological forms in production: Tests of predictions from a connectionist model. *Journal of memory and language, 27*, 124-142. doi: 10.1016/0749-596X(88)90070-8

Dell, G. S. (1986). A Spreading-Activation Theory of Retrieval in sentence production. *Psychological Review*, *93*, 283-321. doi: 10.1037/0033-295X.93.3.283

Desmet, T., & Duyck, W. (2007). Bilingual language processing. *Language and linguistics compass, 1,* 168-194. doi: 10.1111/j.1749-818X.2007.00008.x

Dijkstra, T. (2005). Bilingual Visual Word Recognition and Lexical Access. In J. F. Kroll & A. M. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 179–201). Oxford University Press.

Dijkstra, T. O. N., Wahl, A., Buytenhuijs, F., Van Halem, N., Al-Jibouri, Z., De Korte, M., & Rekké, S. (2019). Multilink: a computational model for bilingual word recognition and word translation. *Bilingualism: Language and Cognition, 22*, 657-679. doi: 10.1017/S1366728918000287

Dijkstra, T., & van Heuven, W. J. B. (2002). The Architecture of the Bilingual Word Recognition System: From Identification to Decision. *Bilingualism: Language and Cognition, 5*, 175-197. doi: 10.1017/s1366728902003012

Dijkstra, T., Grainger, J., & van Heuven, W. J. B. (1999). Recognition of cognates and interlingual homographs: The neglected role of phonology. *Journal of Memory and Language, 41*, 496–518. doi: 10.1006/jmla.1999.2654

Dijkstra, T., Miwa, K., Brummelhuis, B., Sappelli, M., & Baayen, H. (2010). How cross-language similarity and task demands affect cognate recognition. *Journal of Memory and language, 62*, 284-301. doi: 10.1016/j.jml.2009.12.003

Doctor, E. A., & Klein, D. (1992). Phonological processing in bilingual word recognition. In R. J. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 237–252). Amsterdam, Netherlands: Elsevier Science.

Duchon, A., Perea, M., Sebastián-Gallés, N., Martí, A., & Carreiras, M. (2013). EsPal: One-stop shopping for Spanish word properties. *Behavior Research Methods, 45*, 1246-1258. doi: 10.3758/s13428-013-0326-1

Duyck, W., & Warlop, N. (2009). Translation priming between the native language and a second language: New evidence from Dutch-French bilinguals. *Experimental Psychology, 56*, 173-179. doi: 10.1027/1618-3169.56.3.173

Duyck, W., Van Assche, E., Drieghe, D., & Hartsuiker, R. J. (2007). Visual word recognition by bilinguals in a sentence context: evidence for nonselective lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 663-679. doi: 10.1037/0278-7393.33.4.663

Elley, W. (1991). Acquiring Literacy in a Second Language: The effect of book-based programs. *Language Learning, 41*, 375-411. doi: 10.1111/j.1467-1770.1991.tb00611.x

Elley, W. B., & Mangubhai, F. (1983). The impact of reading on second language learning. *Reading Research Quarterly, 19*, 53-67. doi: 10.2307/747337

Ellis, A. W. (1988). Modelling the writing process. In *This paper is based on a talk given at the Jan 1984 conference on Perspectives in Cognitive Neuropsychology*. Lawrence Erlbaum Associates, Inc.

Ellis, A.W., & Young, A.W. (1988). *Human cognitive neuropsychology*. Hove, UK: Lawrence Erlbaum Associates Ltd

Elola, I., & Mikulski, A. M. (2016). Similar and/or different writing processes? A study of Spanish foreign language and heritage language learners. *Hispania, 99*, 87-102. doi: 10.1353/hpn.2016.0000

Erdfelder, E., Faul, F., & Buchner, A. (1996). G-POWER: A general power analysis program. *Behavior Research Methods, Instruments, & Computers*, *28*, 1-11. doi: 10.3758/bf03203630

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*, 363–406. doi: 10.1037/0033-295X.100.3.363

Escamilla, K. (2006). Semilingualism Applied to the literacy behaviors of spanish-speaking emerging bilinguals: Bi-illiteracy or emerging biliteracy?. *Teachers College Record, 108*, 2329-2353. doi: 10.1111/j.1467-9620.2006.00784.x

Fay, N., Ellison, M., & Garrod, S. (2014). Iconicity: From sign to system in human communication and language. *Pragmatics & Cognition, 22*, 244-263. doi: 10.1075/pc.22.2.05fay

Feldman, L., Dale, R., & van Rij, J. (2019). Lexical and Frequency Effects on Keystroke Timing: Challenges to a Lexical Search Account From a Type-To-Copy Task. *Frontiers In Communication, 4*. doi: 10.3389/fcomm.2019.00017

Fenyvesi, A. (2005). *Hungarian language contact outside Hungary: Studies on Hungarian as a minority language* (Vol. 20). John Benjamins Publishing.

Festman, J. (2013). The complexity-cost factor in bilingualism. *Behavioral and Brain Sciences, 36*, 355-356. doi: 10.1017/S0140525X12002579

Filippi R., Karaminis T., Thomas M. S. C. (2014). Language switching in bilingual production: empirical data and computational modelling. *Bilingualism: Language and Cognition, 17*, 294–315. doi: 10.1017/S13667289130

Finkbeiner, M., Gollan, T. H., & Caramazza, A. (2006). Lexical access in bilingual speakers: What's the (hard) problem? *Bilingualism: Language and Cognition, 9*, 153–166. doi: 10.1017/S1366728906002501

Franceschini, S., Bertoni, S., Puccio, G., Mancarella, M., Gori, S., & Facoetti, A. (2020). Local perception impairs the lexical reading route. *Psychological Research, 85,* 1-9. doi: 10.1007/s00426-020-01326-z

Franceschini, S., Gori, S., Ruffino, M., Viola, S., Molteni, M., & Facoetti, A. (2013). Action video games make dyslexic children read better. *Current biology, 23,* 462– 466. doi: 10.1016/j.cub.2013.01.044

Francis, W. N., & Kucëra, H. (1982). Computational analysis of present day American English. Providence, RI: Brown University Press.

Fricke, M., Zirnstein, M., Navarro-Torres, C. A., & Kroll, J. F. (2019). Bilingualism reveals fundamental variation in language processing. *Bilingualism: Language and Cognition, 22*, 200–207. doi: 10.1017/S1366728918000482

Frost, R. (1994). Prelexical and postlexical strategies in reading: Evidence from a deep and a shallow orthography. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*, 116. doi: 10.1037//0278-7393.20.1.116

Frost, R. (2012). Towards a universal model of reading. *Behavioral and brain sciences, 35,* 263-279. doi: 10.1017/S0140525X11001841

Frost, R., Katz, L., & Bentin, S. (1987). Strategies for visual word recognition and orthographical depth: a multilingual comparison. *Journal of Experimental Psychology: Human Perception and Performance, 13,* 104-115. doi: 10.1037//0096-1523.13.1.104

Frost, R., Ziegler, J.C. (2007). Speech and spelling interaction: the interdependence of visual and auditory word recognition. In: Gaskell, M.G. (Ed.), *The Oxford Handbook of Psycholinguistics* (pp. 107–118). Oxford University Press, Oxford.

Gagné, C. L., & Spalding, T. L. (2014). Typing time as an index of morphological and semantic effects during English compound processing. *Lingue e linguaggio, 13*, 241-262. doi: 10.1418/78409

Gagné, C. L., & Spalding, T. L. (2016). Effects of morphology and semantic transparency on typing latencies in english compound and pseudocompound words. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 42*, 1489–1495. doi: 10.1037/xlm0000258

Garrett, M. (2000). Remarks on the architecture of language processing systems. In Y. Grodzinsky, L. P. Shapiro, & D. Swinney (Eds.), *Language and the brain: Representation and processing* (pp. 31–69). Academic Press.

Garrett, M. F. (1975). The analysis of sentence production. In G. H. Bower (Ed.), *The psychology of learning and motivation* (pp. 133-177). New York: Academic Press.

Gathercole, V. C. M., & Thomas, E. M. (2009). Bilingual first-language development: Dominant language takeover, threatened minority language take-up. *Bilingualism: Language and Cognition, 12*, 213–237. doi: 10.1017/S1366728909004015

Gentner, D. R. (1987). Timing of skilled motor performance: Tests of the proportional duration model. *Psychological Review, 94*, 255-276. doi: 10.1037/0033-295X.94.2.255

Gildersleeve-Neumann, C. E., Peña, E. D., Davis, B. L., & Kester, E. S. (2009). Effects on L1 during early acquisition of L2: Speech changes in Spanish at first English contact. *Bilingualism: Language & Cognition, 12*, 259 – 272. doi: 10.1017/S1366728908003994

Glushko, R. J. (1979). The organization and activation of orthographic knowledge in reading aloud. *Journal of Experimental Psychology: Human Perception and Performance, 5,* 674–691. doi: 10.1037/0096-1523.5.4.674

Gollan, T. H., & Acenas, L. A. R. (2004). What is a TOT? Cognate and translation effects on tip-of-the-tongue states in Spanish-English and tagalog-English bilinguals. Journal of Experimental Psychology: *Learning, Memory, and Cognition, 30*, 246. doi: 10.1037/0278-7393.30.1.246

Gollan, T. H., & Ferreira, V. S. (2009). Should I stay or should I switch? A cost–benefit analysis of voluntary language switching in young and aging bilinguals. Journal of Experimental Psychology: Learning, Memory, and Cognition, 35, 640-665. doi: 10.1037/a0014981

Gollan, T. H., & Kroll, J. F. (2001). Bilingual lexical access. In B. Rapp (Ed.), *The handbook of cognitive neuropsychology: What deficits reveal about the human mind* (pp. 321-345). New York, NY, US: Psychology Press.

Gollan, T. H., Montoya, R. I., Cera, C., & Sandoval, T. C. (2008). More use almost always means a smaller frequency effect: Aging, bilingualism, and the weaker links hypothesis. *Journal of memory and language, 58*, 787-814. doi: 10.1016/j.jml.2007.07.001

Gollan, T. H., Montoya, R. I., Fennema-Notestine, C., & Morris, S. K. (2005). Bilingualism affects picture naming but not picture classification. *Memory & cognition, 33,* 1220-1234. doi: 10.3758/BF03193224

Gollan, T. H., Schotter, E. R., Gomez, J., Murillo, M., & Rayner, K. (2014). Multiple levels of bilingual language control: Evidence from language intrusions in reading aloud. *Psychological science, 25*, 585-595. doi: 10.1177/0956797613512661

Gollan, T.H., & Goldrick, M. (2016). Grammatical constraints on language switching: Language control is not just executive control. *Journal of Memory and Language, 90*, 177-199. Doi: 10.1016/j.jml.2016.04.002

Gollan, T.H., Fennema-Notestine, C, Montoya, R.I. & Jernigan, T.L. (2007). The bilingual effect on Boston Naming Test performance. *Journal of the International Neuropsychological Society, 13,* 197-208. doi: 10.1017/S1355617707070038

Goodman, R. A., & Caramazza, A. (1986). Aspects of the spelling process: Evidence from a case of acquired dysgraphia. *Language and Cognitive Processes*, *1*, 263-296. doi: 10.1080/01690968608404678

Gor, K. (2014). Raspberry, not a car: context predictability and a phonological advantage in early and late learners' processing of speech in noise. *Frontiers in psychology, 5,* 1449. doi: 10.3389/fpsyg.2014.01449

Goswami, U. (2015). Sensory theories of developmental dyslexia: three challenges for research. *Nature Reviews Neuroscience, 16*, 43-54. doi: 10.1038/nrn3836

Goswami, U., Ziegler, J. C., & Richardson, U. (2005). The effects of spelling consistency on phonological awareness: A comparison of English and German. *Journal of experimental child psychology, 92*, 345-365. doi: 10.1016/j.jecp.2005.06.002

Graddol, D. (2004). The Future of Language. *Science, 304*, 1329–1331. doi: 10.1126/science.1096546

Graham, S. (2019). Changing How Writing Is Taught. *Review of Research in Education, 43*, 277–303. doi: 10.3102/0091732X18821125

Graham, S., Struck, M., Santoro, J. & Berninger, V. (2006). Dimensions of Good and Poor Handwriting Legibility in First and Second Graders: Motor Programs, Visual–Spatial Arrangement, and Letter Formation Parameter Setting. *Developmental Neuropsychology, 29*, 43-60. doi: 10.1207/s15326942dn2901_4

Grainger, J. (2018). Orthographic processing: A 'mid-level' vision of reading: The 44th Sir Frederic Bartlett Lecture. *Quarterly Journal of Experimental Psychology*, *71*, 335-359. doi: 10.1080/17470218.2017.1314515

Grainger, J., & Jacobs, A. M. (1996). Orthographic processing in visual word recognition: A multiple read-out model. *Psychological Review, 103*, 518–565. doi: 10.1037/0033-295X.103.3.518

Grainger, J., & Ziegler, J. C. (2011). A dual-route approach to orthographic processing. *Frontiers in psychology, 2*, 54. doi: 10.3389/fpsyg.2011.00054

Grasso, S. M., Peña, E. D., Bedore, L. M., Hixon, J. G., & Griffin, Z. M. (2018). Cross-linguistic cognate production in Spanish–English bilingual children with and without specific language impairment. *Journal of Speech, Language, and Hearing Research, 61*, 619-633. doi: 10.1044/2017_JSLHR-L-16-0421

Green, D. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition*, *1*, 67-81. doi: 10.1017/s1366728998000133

Green, D. W., & Abutalebi, J. (2013). Language control in bilinguals: The adaptive control hypothesis. *Journal of cognitive psychology, 25*, 515-530. doi: 10.1080/20445911.2013.796377

Green, D. W., & Abutalebi, J. (2015). Language control and the neuroanatomy of bilingualism: In praise of variety. *Language, Cognition and Neuroscience, 31*, 340-344. doi: 10.1080/23273798.2015.1084428.

Green, P., & MacLeod, C. J. (2016). SIMR: an R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution, 7,* 493-498. doi: 10.1111/2041-210X.12504

Grosjean, F. (1992). Another view of bilingualism. In R. J. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 51–62). North-Holland.

Grosjean, F. (1997). Processing mixed language: Issues, findings, and models. *Tutorials in bilingualism: Psycholinguistic perspectives*, (pp. 225-254).

Grosjean, F. (2001). The Bilingual's Language Modes. In J. L. Nicol (Ed.), *Explaining linguistics. One mind, two languages: Bilingual language processing* (p. 1–22). Blackwell Publishing.

Grosjean, F. (2008). *Studying bilinguals*. Oxford University Press.

Grosjean, F. (2010). *Bilingual: Life and reality*. Harvard University Press

Grundy, J. G., & Timmer, K. (2017). Bilingualism and working memory capacity: A comprehensive meta-analysis. *Second Language Research, 33*, 325-340. doi: 10.1177/0267658316678286

Guasch, M., Boada, R., Ferré, P., & Sánchez-Casas, R. (2012). NIM: A Web-based Swiss army knife to select stimuli for psycholinguistic studies. *Behavior Research Methods*, *45*, 765-771. doi: 10.3758/s13428-012-0296-8

Guasch, M., Ferre, P., & Haro, J. (2017). Pupil dilation is sensitive to the cognate status of words: further evidence for non-selectivity in bilingual lexical access. *Bilingualism: Language and Cognition, 20*, 49-54. doi: 10.1017/S1366728916000651

Guinet, E., & Kandel, S. (2010). Ductus: A software package for the study of handwriting production. *Behavior research methods, 42*, 326-332. doi: 10.3758/BRM.42.1.326

Hafiz, F., & Tudor, I. (1990). Graded readers as an input medium in L2 learning. *System*, *18*, 31-42. doi: 10.1016/0346-251x(90)90026-2

Hakuta, K. (2009). 'Bilingualism'. In: Adelman, G. & Smith, B.H. (eds). *Encyclopedia of Neuroscience.* (3rd edition). Elsevier.

Halekoh, U., & Højsgaard, S. (2014). A Kenward-Roger Approximation and Parametric Bootstrap Methods for Tests in Linear Mixed Models – TheRPackagepbkr test. *Journal of Statistical Software*, *59*. doi: 10.18637/jss.v059.i09

Hallé, P., Best, C., & Levitt, A. (1999). Phonetic vs. phonological influences on French listeners' perception of American English approximants. *Journal of Phonetics*, *27*, 281-306. doi: 10.1006/jpho.1999.0097

Hanulová, J., Davidson, D. J., & Indefrey, P. (2011). Where does the delay in L2 picture naming come from? Psycholinguistic and neurocognitive evidence on second language word production. *Language and cognitive processes, 26*, 902-934. DOI: 10.1080/01690965.2010.509946

Hartanto, A., & Yang, H. (2016). Disparate bilingual experiences modulate task-switching advantages: A diffusion-model analysis of the effects of interactional context on switch costs. *Cognition, 150*, 10-19. doi: 10.1016/j.cognition.2016.01.016

Hasselmo, N. (1970). Code-switching and modes of speaking. In G. Gilbert (ed.), *Texas studies in bilingualism* (pp. 179-210). Berlin: Walter de Gruyter.

Hatfield, F. M., & Patterson, K. E. (1983). Phonological spelling. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 35*, 451–468. doi: 10.1080/14640748308402482

Haugen, E. (1953). The Norwegian language in America: A study in bilingual behavior. *Vol. 1: The bilingual community; Vol. II. The American dialects of Norwegian.* Bloomington: Indiana University Press.

Hayes, J. R., & Olinghouse, N. G. (2015). Can cognitive writing models inform the design of the common core state standards?. *The elementary school journal, 115*, 480-497. doi: 10.1086/681909

Henderson, E., & Beers, J. (1980). *Developmental and cognitive aspects of learning to spell: A reflection of word knowledge*. Newark, DE: International Reading Association.

Henry, M. L., Beeson, P. M., Stark, A. J., & Rapcsak, S. Z. (2007). The role of left perisylvian cortical regions in spelling. *Brain and language*, *100*, 44-52. doi: 10.1016/j.bandl.2006.06.011

Hermans, D. (2000). Word production in a foreign language (Doctoral dissertation, [Sl: sn]).

Hermans, D. (2004). Between-language identity effects in picture-word interference tasks: A challenge for language-nonspecific or language-specific models of lexical access?. *International Journal of Bilingualism, 8,* 115-125. doi: 10.1177/13670069040080020101

Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: Can speakers prevent interference from their first language?. *Bilingualism: language and cognition, 1,* 213-229. doi: 10.1017/S1366728998000364

Hickok, G., & Poeppel, D. (2000). Towards a functional neuroanatomy of speech perception. *Trends in Cognitive Sciences*, *4*, 131-138. doi: 10.1016/s1364-6613(00)01463-7

Hier, D. B., & Mohr, J. P. (1977). Incongruous oral and written naming: Evidence for a subdivision of the syndrome of Wernicke's aphasia. *Brain and language, 4,* 115-126. doi: 10.1016/0093-934x(77)90010-4

Hoff, E., Core, C., Place, S., Rumiche, R., Señor, M., & Parra, M. (2012). Dual language exposure and early bilingual development. *Journal of child language, 39,* 1-27. doi: 10.1017/S0305000910000759

Hofslundsengen, H., Hagtvet, B. E., & Gustafsson, J. E. (2016). Immediate and delayed effects of invented writing intervention in preschool. *Reading and writing, 29*, 1473-1495. doi: 10.1007/s11145-016-9646-8

Hoshino, N., & Kroll, J. F. (2008). Cognate effects in picture naming: Does cross-language activation survive a change of script? *Cognition, 106*, 501–511. doi: 10.1016/j.cognition.2007.02.001

Houghton, G., & Zorzi, M. (2003). Normal and impaired spelling in a connectionist dual-route architecture. *Cognitive Neuropsychology, 20*, 115–162. doi: 10.1080/02643290242000871

Hoversten, L. J., Brothers, T., Swaab, T. Y., & Traxler, M. J. (2017). Early processing of orthographic language membership information in bilingual visual word recognition: Evidence from ERPs. *Neuropsychologia, 103*, 183-190. doi: 10.1016/j.neuropsychologia.2017.07.026

Hyltenstam, K., & Abrahamsson, N. (2003). Age of onset and ultimate attainment in near-native speakers of Swedish as a second language. In K. Fraurud & K. Hyltenstam (Eds.), *Multilingualism in global and local perspectives* (pp. 319–340). Sweden: Centre for Research on Bilingualism and Rinkeby Institute of Multilingual Research, Stockholm University

Iniesta, A., & Serrano, F. (2020). Writing intervention: an integrated program for Primary School children. *Journal of Psychologists and Counsellors in Schools, 30*, 1-9. doi: 10.1017/jgc.2019.35

Iniesta, A., Paolieri, D., Serrano, F., & Bajo, M. (2021). Bilingual writing coactivation: Lexical and sublexical processing in a word dictation task. *Bilingualism: Language and Cognition,* 1-16. doi:10.1017/S1366728921000274

Ivanova, I., & Costa, A. (2008). Does bilingualism hamper lexical access in speech production?. *Acta psychologica, 127*, 277-288. doi: 10.1016/j.actpsy.2007.06.003

Iverson, P., Kuhl, P. K., Akahane-Yamada, R., Diesch, E., Kettermann, A., & Siebert, C. (2003). A perceptual interference account of acquisition difficulties for non-native phonemes. *Cognition, 87*, 47-57. doi: 10.1016/S0010-0277(02)00198-1

Jacobs, A., Fricke, M., & Kroll, J. F. (2016). Cross-language activation begins during speech planning and extends into second language speech. *Language learning, 66*, 324-353. doi: 10.1111/lang.12148

Jamal, N. I., Piche, A. W., Napoliello, E. M., Perfetti, C. A., & Eden, G. F. (2012). Neural basis of single-word reading in Spanish-English bilinguals. *Human brain mapping, 33*, 235–245. doi: 10.1002/hbm.21208

Janssen, N., Schirm, W., Mahon, B. Z., & Caramazza, A. (2008). Semantic interference in a delayed naming task: evidence for the response exclusion hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34*, 249 –256. doi: 10.1037/0278-7393.34.1.249

Jared, D., & Seidenberg, M. S. (1990). Naming multisyllabic words. *Journal of Experimental Psychology: Human Perception and Performance, 16*, 92–105. doi: 10.1037/0096-1523.16.1.92

Jared, D., & Szucs, C. (2002). Phonological activation in bilinguals: Evidence from interlingual homograph naming. *Bilingualism: Language and Cognition, 5*, 225-239. doi: 10.1017/S1366728902003024

Kandel, S., & Perret, C. (2015). How does the interaction between spelling and motor processes build up during writing acquisition?. *Cognition, 136*, 325-336. doi: 10.1016/j.cognition.2014.11.014

Kandel, S., Alvarez, C., & Vallée, N. (2006). Syllables as processing units in handwriting production. *Journal of Experimental Psychology: Human Perception and Performance, 32,* 18–31. doi: 10.1037/0096-1523.32.1.18

Kandel, S., Lassus-Sangosse, D. & Grosjacques, G. & Perret, C. (2018). The impact of developmental dyslexia and dysgraphia on movement production during word writing. In B. Rapp & McCloskey, M. (Eds.), *Developmental Dysgraphia*, (pp. 155-188). New York, London: Taylor & Francis.

Kandel, S., Peereman, R., & Ghimenton, A. (2013). Further evidence for the interaction of central and peripheral processes: the impact of double letters in writing English words. *Frontiers in psychology, 4,* 729. doi: 10.3389/fpsyg.2013.00729

Kandel, S., Peereman, R., Ghimenton, A., & Perret, C. (2019). Letter coding affects movement production in word writing: an English–Italian cross-linguistic study. *Reading and Writing, 32*, 95-114. doi: 10.1007/s11145-017-9756-y

Kandel, S., Peereman, R., Grosjacques, G., & Fayol, M. (2011). For a psycholinguistic model of handwriting production: Testing the syllable-bigram controversy. *Journal of Experimental Psychology: Human Perception and Performance, 37,* 1310-1322. doi: 10.1037/a0023094

Karayayla, T., & Schmid, M. S. (2017). First language attrition as a function of age at onset of bilingualism: First language attainment of Turkish–English bilinguals in the United Kingdom. *Language Learning, 69*, 106-142. doi: 10.1111/lang.12316

Katz, L., & Baldasare, J. (1983). Syllable coding in printed-word recognition by children and adults. *Journal of Educational Psychology, 75*, 245–256. doi: 10.1037/0022-0663.75.2.245

Katz, L., & Frost, R. (1992). The reading process is different for different orthographies: The orthographic depth hypothesis. In R. Frost & L. Katz (Eds.), *Advances in psychology. Orthography, phonology, morphology, and meaning* (pp. 67–84). North-Holland.

Kaushanskaya, M., & Marian, V. (2007). Bilingual language processing and interference in bilinguals: Evidence from eye tracking and picture naming. *Language Learning, 57*, 119-163. doi: 10.1111/j.1467-9922.2007.00401.x

Keirstead, J., Mehta, S., Webb, S., Silveira, L., & Khikhol, H. (2016). *English at Work: Global analysis of language skills in the workplace.* Cambridge English Language Assessment, Cambridge.

Kempen, G., & Vosse, T. (1989). Incremental syntactic tree formation in human sentence processing: A cognitive architecture based on activation decay and simulated annealing. *Connection Science, 1,* 273-290. doi: 10.1080/09540098908915642

Kimchi, R. (2015). The perception of hierarchical structure. In J. Wagemans (Ed.), *Oxford handbook of perceptual organization* (pp. 129–149). Oxford: Oxford University Press.

Klaus, J., Lemhöfer, K., & Schriefers, H. (2018). The second language interferes with picture naming in the first language: Evidence for L2 activation during L1 production. *Language, Cognition and Neuroscience, 33*, 867-877. doi: 10.1080/23273798.2018.1430837

Klein, E., & Martohardjono, G. (2009). *Understanding the student with interrupted formal education (SIFE): A study of SIFE skills, needs and achievement (Phase II).* New York: New York City Department of Education.

Koester, D., Gunter, T. C., & Wagner, S. (2007). The morphosyntactic decomposition and semantic composition of German compound words investigated by ERPs. *Brain and language, 102*, 64-79. doi: 10.1016/j.bandl.2006.09.003

Kreiner, D. S., & Gough, P. B. (1990). Two ideas about spelling: Rules and word-specific memory. *Journal of Memory and Language, 29*, 103-118. doi:10.1016/0749-596X(90)90012-O

Kroll, J. F., & de Groot, A. M. B. (1997). Lexical and Conceptual Memory in the Bilingual: Mapping Form to Meaning in Two Languages. In A. M. B. De Groot, & J. F. Kroll (Eds.), Tutorials in Bilingualism: Psycholinguistic Perspectives (pp. 169-199). Mahwah, NJ: Lawrence Erlbaum Publishers.

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connection between bilingual memory representations. *Journal of Memory and Language, 33*, 149–174. doi: 10.1006/jmla.1994.1008

Kroll, J. F., Bobb, S. C., & Wodniecka, Z. (2006). Language selectivity is the exception, not the rule: Arguments against a fixed locus of language selection in bilingual speech. *Bilingualism: Language and Cognition, 9*, 119–135. doi: 10.1017/S1366728906002483

Kroll, J. F., Dussias, P. E., & Bajo, M. T. (2018). Language use across international contexts: Shaping the minds of L2 speakers. *Annual Review of Applied Linguistics, 38*, 60-79. doi: 10.1017/S0267190518000119

Kroll, J. F., Dussias, P. E., Bice, K., & Perrotti, L. (2015). Bilingualism, mind, and brain. *Annual Review of Linguistics, 1*, 377-394. doi: 10.1146/annurev-linguist-030514-124937

Kroll, J. F., Dussias, P. E., Bogulski, C. A., & Kroff, J. R. V. (2012). Juggling two languages in one mind: What bilinguals tell us about language processing and its consequences for cognition. In *Psychology of learning and motivation* (pp. 229-262). Academic press.

Kroll, J. F., Gullifer, J. W., & Rossi, E. (2013). The multilingual lexicon: The cognitive and neural basis of lexical comprehension and production in two or more languages. *Annual review of applied linguistics, 33*, 102. doi: 10.1017/S0267190513000111

Kroll, J. F., Van Hell, J. G., Tokowicz, N., & Green, D. W. (2010). The Revised Hierarchical Model: A critical review and assessment. *Bilingualism: Language and Cognition, 13*, 373-381. Doi:10.1017/S136672891000009X

Kroll, J., Bobb, S., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *Acta Psychologica*, *128*, 416-430. doi: 10.1016/j.actpsy.2008.02.001

Kroll, J., van Hell, J., Tokowicz, N., & Green, D. (2010). The Revised Hierarchical Model: A critical review and assessment. *Bilingualism: Language and Cognition*, *13*, 373-381. doi: 10.1017/s136672891000009x

Kühnen, U., & Oyserman, D. (2002). Thinking about the self-influences thinking in general: Cognitive consequences of salient self-concept. *Journal of Experimental Social Psychology*, *38*, 492-499. doi: 10.1016/S0022-1031(02)00011-2

Kuipers, J., & Thierry, G. (2010). Event-related brain potentials reveal the time-course of language change detection in early bilinguals. *Neuroimage*, *50*, 1633-1638. doi: 10.1016/j.neuroimage.2010.01.076

Kukich, K. (1992). Technique for automatically correcting words in text. *ACM Computing Surveys*, *24*, 377-439. doi: 10.1145/146370.146380

Kuperman, V., Stadthagen-Gonzalez, H., & Brysbaert, M. (2012). Erratum to: Age-of-acquisition ratings for 30,000 English words. *Behavior Research Methods*, *45*, 900-900. doi: 10.3758/s13428-013-0348-8

Kupisch, T., & Rothman, J. (2016). Terminology matters! Why difference is not incompleteness and how early child bilinguals are heritage speakers. *International Journal of Bilingualism, 22,* 564-582. doi: 10.1177/1367006916654355

La Heij, W. (2005). Selection Processes in Monolingual and Bilingual Lexical Access. In J. F. Kroll & A. M. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 289–307). Oxford University Press.

Lagrou, E., Hartsuiker, R. J., & Duyck, W. (2011). Knowledge of a second language influences auditory word recognition in the native language. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*, 952-965. doi: 10.1037/a0023217.

Lallier, M., & Carreiras, M. (2018). Cross-linguistic transfer in bilinguals reading in two alphabetic orthographies: The grain size accommodation hypothesis. *Psychonomic bulletin & review, 25*, 386-401. doi: 10.3758/s13423-017-1273-0

Lallier, M., & Valdois, S. (2012). "Sequential versus simultaneous processing deficits in developmental dyslexia" in *Dyslexia-a comprehensive and international approach*. eds. T. Wydell and L. Fern-Pollak (InTech).

Lallier, M., Abu Mallouh, R., Mohammed, A. M., Khalifa, B., Perea, M., & Carreiras, M. (2018). Does the visual attention span play a role in reading in Arabic?. *Scientific Studies of Reading*, *22*, 181-190. doi: 10.1080/10888438.2017.1421958

Lallier, M., Valdois, S., Lassus-Sangosse, D., Prado, C., & Kandel, S. (2014). Impact of orthographic transparency on typical and atypical reading development: evidence in French-Spanish bilingual children. *Research in developmental disabilities*, *35*, 1177–1190. doi: 10.1016/j.ridd.2014.01.021

Lambert, E., & Quémart, P. (2019). Introduction to the special issue on the dynamics of written word production: Methods, models and processing units. *Reading and Writing: An Interdisciplinary Journal, 32*, 1–12. doi: 10.1007/s11145-018-9929-3

Lambert, E., Alamargot, D., Larocque, D., & Caporossi, G. (2011). Dynamics of the spelling process during a copy task: Effects of regularity and frequency. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale, 65*, 141. doi: 10.1037/a0022538

Lashley, K. S., (1951). The problem of serial order in behavior. In L. A. Jeffress (ed.), *Cerebral Mechanisms in Behavior*. Oxford, United Kingdom: Bobbs-Merrill.

Laver, J. (1980). Monitoring systems in the neurolinguistic control of speech production. In: V. A. Fromkin (Ed.), *Errors in linguistic performance: Slips of the tongue, ear, pen, and hand.* New York: Academic Press.

Leacox, L., Wood, C., Sunderman, G., & Schatschneider, C. (2016). Young Spanish-English language learners' cognate facilitation on picture naming. *Contemporary Issues in Communication Science and Disorders, 43*, 115-128. doi: 10.1044/cicsd_43_S_115

Lee, M. D., & Wagenmakers, E.-J. (2014). *Bayesian cognitive modeling: A practical course.* Cambridge University Press. doi: 10.1017/CBO9781139087759

Lehtonen, M., Soveri, A., Laine, A., Järvenpää, J., De Bruin, A., & Antfolk, J. (2018). Is bilingualism associated with enhanced executive functioning in adults? A meta-analytic review. *Psychological bulletin, 144*, 394-425. doi: 10.1037/bul0000142

Lemhöfer, K., & Dijkstra, T. (2004). Recognizing cognates and interlingual homographs: Effects of code similarity in language-specific and generalized lexical decision. *Memory & Cognition, 32*, 533-550. doi: 10.3758/BF03195845

Lemhöfer, K., Spalek, K., & Schriefers, H. (2008). Cross-language effects of grammatical gender in bilingual word recognition and production. *Journal of Memory and Language, 59,* 312-330. doi: 10.1016/j.jml.2008.06.005

Levelt, W. (2002). Picture naming and word frequency: Comments on Alario, Costa and Caramazza, Language and Cognitive Processes, 17, 299-319. *Language and Cognitive Processes, 17*(6), 663-671. doi: 10.1080/01690960143000443

Levelt, W. J. M. (1989). *Speaking: From intention to articulation.* The MIT Press.

Levelt, W. J., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and brain sciences, 22,* 1-38. doi: 10.1017/s0140525x99001776

Levelt, W., Schriefers, H., Vorberg, D., Meyer, A., Pechmann, T., & Havinga, J. (1991). The time course of lexical access in speech production: A study of picture naming. *Psychological Review, 98,* 122-142. doi: 10.1037/0033-295x.98.1.122

Levenshtein, V. I. (1966). Binary codes capable of correcting deletions, insertions and reversals. *Soviet Physics Doklady, 10*, 707-710.

Levy, B. J., McVeigh, N. D., Marful, A., & Anderson, M. C. (2007). Inhibiting your native language: The role of retrieval-induced forgetting during second-language acquisition. *Psychological Science, 18*, 29-34. doi: 10.1111/j.1467-9280.2007.01844.x

Li, C., & Gollan, T. H. (2018). Cognates interfere with language selection but enhance monitoring in connected speech. *Memory & Cognition, 46*, 923-939. doi: 10.3758/s13421-018-0812-x

Li, C., & Gollan, T. H. (2021). Language-switch costs from comprehension to production might just be task-switch costs. *Bilingualism: Language and Cognition,* 1-12. doi: 10.1017/S13667 28921001061

Libben, M. R., & Titone, D. A. (2009). Bilingual lexical access in context: evidence from eye movements during reading. *Journal of Experimental Psychology: Learning, memory, and cognition, 35,* 381-390. doi: 10.1037/a0014875

Linck, J. A., Hoshino, N., & Kroll, J. F. (2008). Cross-language lexical processes and inhibitory control. *The mental lexicon, 3*, 349-374. doi: 10.1075/ml.3.3.06lin

Linck, J. A., Kroll, J. F., & Sunderman, G. (2009). Losing access to the native language while immersed in a second language: Evidence for the role of inhibition in second-language learning. *Psychological science, 20,* 1507-1515. doi: 10.1111/j.1467-9280.2009.02480.x

Liu, H., & Cao, F. (2016). L1 and L2 processing in the bilingual brain: A meta-analysis of neuroimaging studies. *Brain and language, 159*, 60-73. doi: 10.1016/j.bandl.2016.05.013

Lobier, M., & Valdois, S. (2015). Visual attention deficits in developmental dyslexia cannot be ascribed solely to poor reading experience. Nature Reviews Neuroscience, 16(4, 225-225. doi: 10.1038/nrn3836-c1

Lobier, M., Dubois, M., & Valdois, S. (2013). The role of visual processing speed in reading speed development. *PLoS One, 8*. doi: 10.1371/journal.pone.0058097

Logan, G. D., & Crump, M. J. (2010). Cognitive illusions of authorship reveal hierarchical error detection in skilled typists. *Science, 330*, 683-686. doi: 10.1126/science.1190483

Logan, G. D., & Crump, M. J. (2011). Hierarchical control of cognitive processes: The case for skilled typewriting. In *Psychology of learning and motivation* (Vol. 54, pp. 1-27). Academic Press.

Love J., Selker R., Marsman M., Jamil T., Dropmann D., Verhagen A.J., Ly A., Gronau Q.F., Smira M., Epskamp S., Matzke D., Wild A., Rouder J.N., Morey R.D., Wagenmakers, E.-J. (2015). JASP (Version 0.7) [Computer software].

Luke, S.G. (2017). Evaluating significance in linear mixed-effects models in R. *Behavior Research Methods, 49,* 1494-1502. doi: 10.3758/s13428-016-0809-y

MacArthur, C. A., & Graham, S. (2016). Writing research from a cognitive perspective. In C. A. MacArthur, S. Graham, & J. Fitzgerald (Eds.), *Handbook of writing research* (pp. 24–40). The Guilford Press.

MacDonald, M. C. (2013). How language production shapes language form and comprehension. *Frontiers in psychology, 4*, 226. doi: 10.3389/fpsyg.2013.00226

Macizo, P. (2016). Phonological coactivation in the bilinguals' two languages: Evidence from the color naming task. *Bilingualism: Language and Cognition, 19*, 361–375. doi: 10.1017/S136672891500005X

Macizo, P., & Bajo, M. (2006). Reading for repetition and reading for translation: do they involve the same processes?. *Cognition, 99*, 1-34. doi: 10.1016/j.cognition.2004.09.012

MacKay, I. R. (1987). *Phonetics: The science of speech production*. Little Brown and Company.

Macnamara, J. (1967). The bilingual's linguistic performance—a psychological overview. *Journal of social issues, 23*, 58-77. doi: 10.1111/j.1540-4560.1967.tb00576.x

Maggio, S., Lété, B., Chenu, F., Jisa, H., & Fayol, M. (2012). Tracking the mind during writing: Immediacy, delayed, and anticipatory effects on pauses and writing rate. *Reading and Writing, 25,* 2131-2151. doi: 10.1007/s11145-011-9348-1

Mahon, B. Z., Costa, A., Peterson, R., Vargas, K. A., & Caramazza, A. (2007). Lexical selection is not by competition: a reinterpretation of semantic interference and facilitation effects in the picture-word interference paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 503-535. doi: 10.1037/0278-7393.33.3.503

Marian, V., & Spivey, M. (2003). Competing activation in bilingual language processing: Within-and between-language competition. *Bilingualism: Language and Cognition, 6,* 97-115. doi:10.1017/S1366728903001068

Marian, V., Bartolotti, J., Chabal, S., & Shook, A. (2012). CLEARPOND: Cross-Linguistic Easy-Access Resource for Phonological and Orthographic Neighborhood Densities. *Plos ONE, 7*, e43230. doi: 10.1371/journal.pone.0043230

Marian, V., Blumenfeld, H., & Kaushanskaya, M. (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing Language Profiles in Bilinguals and Multilinguals. *Journal of Speech, Language, and Hearing Research*, *50*, 940-967. doi: 10.1044/1092-4388(2007/067)

Marín, J., & Carrillo, M. (1999). *Test colectivo de Eficacia Lectora (TECLE).* Manuscrito no publicado. Departamento de Psicología Básica y Metodología. Universidad de Murcia.

Martín, M., Macizo, P., & Bajo, T. (2010). Time course of inhibitory processes in bilingual language processing. *British Journal of Psychology*, *101*, 679-693. doi: 10.1348/000712609x480571

Marzouki, Y., & Grainger, J. (2014). Effects of stimulus duration and inter-letter spacing on letter-in-string identification. *Acta Psychologica, 148,* 49–55. doi: 10.1016/j.actpsy.2013.12.011

Mason, B., & Krashen, S. (1997). Extensive reading in English as a foreign language. *System*, *25*, 91-102. doi: 10.1016/s0346-251x(96)00063-2

McClelland, J. L., & Patterson, K. (2002). Rules or connections in past-tense inflections: What does the evidence rule out? *Trends in Cognitive Sciences, 6*, 465–472. doi: 10.1016/S1364-6613(02)01993-9

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: I. An account of basic findings. *Psychological Review, 88*, 375–407. doi: 10.1037/0033-295X.88.5.375

McRae, K., Jared, D., & Seidenberg, M. S. (1990). On the roles of frequency and lexical access in word naming. *Journal of memory and language, 29,* 43-65. doi: 10.1016/0749-596X(90)90009-O

Mechelli, A., Crinion, J. T., Noppeney, U., O'Doherty, J., Ashburner, J., Frackowiak, R. S., & Price, C. J. (2004). Structural plasticity in the bilingual brain. *Nature, 431*, 757-757.

Miceli, G., & Costa, V. (2014). The role of lexical and sublexical orthography in writing: Autonomy, interactions, and neurofunctional correlates. In P.E. Nathan (Series Ed.) & M. Goldrick, V. Ferreira, & M. Miozzo (Vol. Eds.), *Oxford library of psychology. The Oxford handbook of language production* (pp. 358–378). New York, NY: Oxford.

Miceli, G., Benvegnù, B., Capasso, R., & Caramazza, A. (1997). The independence of phonological and orthographic lexical forms: Evidence from aphasia. *Cognitive Neuropsychology, 14*, 35-69. doi: 10.1080/026432997381619

Mishra, R. K. (2009). Interaction of language and visual attention: evidence from production and comprehension. *Progress in Brain Research, 176*, 277-292. doi: 10.1016/S0079-6123(09)17616-1

Misra, M., Guo, T., Bobb, S. C., & Kroll, J. F. (2012). When bilinguals choose a single word to speak: Electrophysiological evidence for inhibition of the native language. *Journal of Memory and Language, 67*, 224–237. doi: 10.1016/j.jml.2012.05.001

Moll, K., Ramus, F., Bartling, J., Bruder, J., Kunze, S., Neuhoff, N., ... & Landerl, K. (2014). Cognitive mechanisms underlying reading and spelling development in five European orthographies. *Learning and instruction, 29*, 65-77. doi: 10.1016/j.learninstruc.2013.09.003

Montrul, S. (2008). *Incomplete Acquisition in Bilingualism. Re-examining the Age Factor.* Amsterdam: John Benjamins.

Montrul, S. (2011). Morphological errors in Spanish second language learners and heritage speakers. *Studies in Second Language Acquisition, 33*, 163-192. doi: 10.1017/S0272263110000720

Montrul, S. (2013). *El bilingüismo en el mundo hispanohablante*. John Wiley & Sons.

Montrul, S. (2016). Age of onset of bilingualism effects and availability of input in first language attrition. In E. Nicoladis & S. Montanari (Eds.), *Bilingualism across the lifespan: Factors moderating language proficiency* (pp. 141–161). American Psychological Association.

Montrul, S. A. (2012). Is the heritage language like a second language?. *Eurosla Yearbook, 12*, 1-29. doi: 10.1075/eurosla.12.03mon

Morales, L., Paolieri, D., Cubelli, R., & Bajo, M. T. (2014). Transfer of Spanish grammatical gender to English: Evidence from immersed and non-immersed bilinguals. *Bilingualism: Language and Cognition, 17*, 700-708. doi: 10.1017/S1366728914000017

Morford, J. P., Wilkinson, E., Villwock, A., Piñar, P., & Kroll, J. F. (2011). When deaf signers read English: Do written words activate their sign translations?. *Cognition, 118*, 286-292. doi: 10.1016/j.cognition.2010.11.006

Morsella, E., & Miozzo, M. (2002). Evidence for a cascade model of lexical access in speech production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*, 555–563. doi: 10.1037/0278-7393.28.3.555

Mulatti, C., & Job, R. (2003). Lettura di parole “straniere” in italiano: Effetto della regolarità e della posizione dell’irregolarità [Reading foreign words in Italian:

Regularity effect and effect of irregularity position]. *Giornale Italiano di Psicologia, 30*, 883-893.

Mulatti, C., Peressotti, F., & Job, R. (2007). Zeading and reazing: Which is faster? The position of the diverging letter in a pseudoword determines reading time. *Quarterly Journal of Experimental Psychology, 60*, 1005–1014. doi: 10.1080/17470210600847842

Muneaux, M., & Ziegler, J. C. (2004). Locus of orthographic effects in spoken word recognition: Novel insights from the neighbor generation task. *Language and Cognitive Processes, 19*, 641-660. doi: 10.1080/01690964440000052

Muscalu, L., & Smiley, P. (2018). The illusory benefit of cognates: Lexical facilitation followed by sublexical interference in a word typing task. *Bilingualism: Language and Cognition*, *22*, 848-865. doi: 10.1017/s1366728918000792

Navarrete, E., & Costa, A. (2005). Phonological activation of ignored pictures: Further evidence for a cascade model of lexical access. *Journal of Memory and Language*, *53*, 359-377. doi: 10.1016/j.jml.2005.05.001

Navarrete, E., Mahon, B. Z., & Caramazza, A. (2010). The cumulative semantic cost does not reflect lexical selection by competition. *Acta Psychologica, 134*, 279–289. doi: 10.1016/j.actpsy.2010.02.009

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive psychology, 9*, 353-383. doi: 10.1016/0010-0285(77)90012-3

Navon, D. (1981). The forest revisited: More on global precedence. *Psychological Research, 43*, 1–32. doi: 10.1007/BF00309635

Neuroscript. (2018). *MovAlyzeR*. http://www.neuroscript.net/movalyzer.php. Accessed June 2020.

Newman, A. J., Bavelier, D., Corina, D., Jezzard, P., & Neville, H. J. (2002). A critical period for right hemisphere recruitment in American Sign Language processing. *Nature neuroscience, 5*, 76-80. doi: 10.1038/nn775

Nichols, E. S., Wild, C. J., Stojanoski, B., Battista, M. E., & Owen, A. M. (2020). Bilingualism affords no general cognitive advantages: a population study of executive function in 11,000 people. *Psychological Science, 31*, 548-567. doi: 10.1177/0956797620903113

Nikula, T., Dalton-Puffer, C., Llinares, A., & Lorenzo, F. (2016). More than content and language: The complexity of integration in CLIL and bilingual education. In *Conceptualising integration in CLIL and multilingual education* (pp. 1-26). Multilingual Matters.

Norman, D. A., & Shallice, T. (1980). Attention to action: Willed and automatic control of behaviour. In M. Gazzaniga (Ed.), *Cognitive Neuroscience: A Reader* Blackwell.

Norton, E. S., Kovelman, I., & Petitto, L. A. (2007). Are there separate neural systems for spelling? New insights into the role of rules and memory in spelling from functional magnetic resonance imaging. *Mind, Brain, and Education*, *1*, 48-59. doi: 10.1111/j.1751-228X.2007.00005.x

Nottbusch, G., Grimm, A., Weingarten, R., & Will, U. (2005). Syllabic sructures in typing: Evidence from deaf writers. *Reading and Writing, 18*, 497-526. doi: 10.1007/s11145-005-3178-y

Nuerk, H.-C., Moeller, K., Klein, E., Willmes, K., & Fischer, M. H. (2011). Extending the mental number line: A review of multi-digit number processing. *Zeitschrift für Psychologie/Journal of Psychology, 219*, 3–22. doi: 10.1027/2151-2604/a000041

O'Grady, W., Lee, O. S., & Lee, J. (2008). Practical and Theoretical Issues in the Study of Heritage Language Acquisition. *Heritage Language Journal, 8*, 315–332. doi: 10.46538/hlj.8.3.2

Olive, T. (2014). Toward a parallel and cascading model of the writing system: A review of research on writing processes coordination. *Journal of Writing Research*, *6*, 173-194. doi: 10.17239/jowr-2014.06.02.4

Oliver, M., Carreiras, M., & Paz-Alonso, P. M. (2017). Functional dynamics of dorsal and ventral reading networks in bilinguals. *Cerebral Cortex*, *27*, 5431-5443. doi: 10.1093/cercor/bhw310

Olson, A., & Caramazza, A. (1994). Representation and connectionist models: The NETspell experience. In G. A. Brown & N. C. Ellis (Eds.), *Handbook of normal and disturbed spelling development: Theory, process and intervention* (pp. 337-364). New York: Wiley.

Olson, D. J. (2016). The role of code-switching and language context in bilingual phonetic transfer. *Journal of the International Phonetic Association*, *46*, 263-285. doi: 10.1017/S0025100315000468

Onochie-Quintanilla, E., Defior, S., & Simpson, I. C. (2017). Visual multi-element processing as a pre-reading predictor of decoding skill. *Journal of Memory and Language*, *94*, 134-148. doi: 10.1016/j.jml.2016.11.003

Ooi, S. H., Goh, W. D., Sorace, A., & Bak, T. H. (2018). From Bilingualism to Bilingualisms: Bilingual experience in Edinburgh and Singapore affects attentional control differently. *Bilingualism: Language and Cognition, 21*, 867–879. doi: 10.1017/S1366728918000020

Paap, K. R., & Greenberg, Z. I. (2013). There is no coherent evidence for a bilingual advantage in executive processing. *Cognitive psychology, 66*, 232-258. doi: 10.1016/j.cogpsych.2012.12.002

Paap, K. R., & Noel, R. W. (1991). Dual-route models of print to sound: Still a good horse race. *Psychological research, 53*, 13-24. doi: 10.1007/BF00867328

Paap, K. R., Myuz, H. A., Anders, R. T., Bockelman, M. F., Mikulinsky, R., & Sawi, O. M. (2017). No compelling evidence for a bilingual advantage in switching or that frequent language switching reduces switch cost. *Journal of Cognitive Psychology, 29*, 89-112. doi: 10.1080/20445911.2016.1248436

Palmis, S., Velay, J. L., Fabiani, E., Nazarian, B., Anton, J. L., Habib, M., ... & Longcamp, M. (2019). The impact of spelling regularity on handwriting production: A coupled fMRI and kinematics study. *Cortex*, *113*, 111-127. doi: 10.1016/j.cortex.2018.11.024

Paolieri, D., Cubelli, R., Macizo, P., Bajo, T., Lotto, L., & Job, R. (2010). Grammatical gender processing in Italian and Spanish bilinguals. *Quarterly Journal of Experimental Psychology, 63*, 1631-1645. doi: 10.1080/17470210903511210

Paradis, J. (2004). The relevance of specific language impairment in understanding the role of transfer in second language acquisition. *Applied Psycholinguistics 25*, 67 – 82. doi: 10.1017/S0142716404001043

Paradis, J., Nicoladis, E., Crago, M., & Genesee, F. (2011). Bilingual children's acquisition of the past tense: A usage-based approach. *Journal of child language, 38*, 554-578. doi: 10.1017/S0305000910000218

Patel, T. K., Snowling, M. J., & de Jong, P. F. (2004). A Cross-Linguistic Comparison of Children Learning to Read in English and Dutch. *Journal of Educational Psychology, 96,* 785–797. doi: 10.1037/0022-0663.96.4.785

Pattamadilok, C., Morais, J., Ventura, P., & Kolinsky, R. (2007). The locus of the orthographic consistency effect in auditory word recognition: Further evidence from French. *Language and Cognitive Processes*, *22*, 700-726. doi: 10.1080/01690960601049628

Pattamadilok, C., Perre, L., Dufau, S., & Ziegler, J. (2009). On-line Orthographic Influences on Spoken Language in a Semantic Task. *Journal of Cognitive Neuroscience*, *21*, 169-179. doi: 10.1162/jocn.2009.21014

Pearson, B. Z. (2007). Social factors in childhood bilingualism in the United States. *Applied psycholinguistics, 28*, 399-410. doi: 10.1017/S014271640707021X

Peeters, D., Dijkstra, T., & Grainger, J. (2013). The representation and processing of identical cognates by late bilinguals: RT and ERP effects. *Journal of Memory and Language, 68*, 315-332. doi: 10.1016/j.jml.2012.12.003

Peeters, D., Vanlangendonck, F., Rueschemeyer, S. A., & Dijkstra, T. (2019). Activation of the language control network in bilingual visual word recognition. *Cortex, 111*, 63-73. doi: 10.1016/j.cortex.2018.10.012

Perani, D., Saccuman, M. C., Scifo, P., Anwander, A., Spada, D., Baldoli, C., ... & Friederici, A. D. (2011). Neural language networks at birth. *Proceedings of the National Academy of Sciences, 108*, 16056-16061. doi: 10.1073/pnas.1102991108

Perfetti, C. A., & Dunlap, S. (2008). Learning to read: General principles and writing system variations. In *Learning to read across languages* (pp. 25-50). Routledge.

Perre, L., Pattamadilok, C., Montant, M., & Ziegler, J. (2009). Orthographic effects in spoken language: On-line activation or phonological restructuring?. *Brain Research*, *1275*, 73-80. doi: 10.1016/j.brainres.2009.04.018

Perret, C., & Olive, T. (2019). *Spelling and writing words: theoretical and methodological advances.* Brill.

Perry, C., Ziegler, J. C., & Zorzi, M. (2010). Beyond single syllables: Largescale modeling of reading aloud with the Connectionist Dual Process (CDP++) model. *Cognitive Psychology, 61*, 106–151. doi: 10.1016/j.jml.2016.09.003

Petersson, K., Reis, A., Askelöf, S., Castro-Caldas, A., & Ingvar, M. (2000). Language Processing Modulated by Literacy: A Network Analysis of Verbal Repetition in Literate and Illiterate Subjects. *Journal of Cognitive Neuroscience*, *12*, 364-382. doi: 10.1162/089892900562147

Philipp, A. M., Gade, M., & Koch, I. (2007). Inhibitory processes in language switching: Evidence from switching language-defined response sets. *European Journal of Cognitive Psychology, 19*, 395-416. doi: 10.1080/09541440600758812

Pinet, S., Ziegler, J. C., & Alario, F. X. (2016). Typing is writing: Linguistic properties modulate typing execution. *Psychonomic bulletin & review, 23*, 1898-1906. doi: 10.3758/s13423-016-1044-3

Pinker, S., & Ullman, M. T. (2002). The past and future of the past tense. *Trends in Cognitive Sciences, 6*, 456–463. doi: 10.1016/S1364-6613(02)01990-3

Place, S., & Hoff, E. (2011). Properties of dual language exposure that influence 2-year-olds' bilingual proficiency. *Child development, 82*, 1834-1849. doi: 10.1111/j.1467-8624.2011.01660.x

Planton, S., Jucla, M., Roux, F. E., & Démonet, J. F. (2013). The "handwriting brain": a meta-analysis of neuroimaging studies of motor versus orthographic processes. *Cortex, 49*, 2772-2787. doi: 10.1016/j.cortex.2013.05.011

Plat, R., Lowie, W., & de Bot, K. (2018). Word naming in the L1 and L2: A dynamic perspective on automatization and the degree of semantic involvement in naming. *Frontiers in psychology, 8*, 2256. doi: 10.3389/fpsyg.2017.02256

Polinsky M. (2006). Incomplete acquisition: American Russian. *Journal of Slavic Linguistics, 14,* 191-262.

Polinsky, M. (2011). Reanalysis in adult heritage language: A case for attrition. *Studies in Second Language Acquisition, 33*, 305–328. doi: 10.1017/S027226311000077X

Polinsky, M. (2018). Bilingual children and adult heritage speakers: The range of comparison. *International Journal of Bilingualism, 22,* 547-563. doi: 10.1177/1367006916656048

Poplack, S. (1980). Sometimes i'll start a sentence in spanish y termino en español: toward a typology of code-switching1. *Linguistics*, *18*, 581-618. doi: 10.1515/ling.1980.18.7-8.581

Poulisse, N., & Bongaerts, T. (1994). First language use in second language production. *Applied linguistics, 15*, 36-57. doi: 10.1093/applin/15.1.36

Proverbio, A. M., Vecchi, L., & Zani, A. (2004). From orthography to phonetics: ERP measures of grapheme-to-phoneme conversion mechanisms in reading. *Journal of cognitive neuroscience, 16,* 301-317. doi: 10.1016/j.brainres.2006.05.071

Purcell, J., Turkeltaub, P. E., Eden, G. F., & Rapp, B. (2011). Examining the central and peripheral processes of written word production through meta-analysis. *Frontiers in psychology, 2*, 239. doi: 10.3389/fpsyg.2011.00239

Qu, Q., & Damian, M. F. (2016). Orthographic effects in spoken word recognition: Evidence from Chinese. *Psychonomic Bulletin & Review, 24,* 901-906. doi: 10.3758/s13423-016-1164-9

Ramus, F., Marshall, C. R., Rosen, S., & Van Der Lely, H. K. (2013). Phonological deficits in specific language impairment and developmental dyslexia: Towards a multidimensional model. *Brain, 136*, 630-645. doi: 10.1093/brain/aws356

Rapcsak, S. Z., & Beeson, P. M. (2004). The role of left posterior inferior temporal cortex in spelling. *Neurology*, *62*, 2221-2229. doi: 10.1212/01.WNL.0000130169. 60752.C5

Rapp, B., & Caramazza, A. (1994). The dissociation of grammatical categories in the spoken vs. written production of a single patient. *Reports of the Cognitive Neuropsychology Laboratory*.

Rapp, B., & Caramazza, A. (1997). From graphemes to abstract letter shapes: Levels of representation in written spelling. *Journal of Experimental Psychology: Human Perception and Performance, 23,* 1130–1152. doi: 10.1037/0096-1523.23.4.1130

Rapp, B., & Fischer-Baum, S. (2015). Uncovering the cognitive architecture of spelling. In *The handbook of adult language disorders* (pp. 75-102). Psychology Press.

Rapp, B., & Goldrick, M. (2000). Discreteness and interactivity in spoken word production. *Psychological Review*, *107*, 460-499. doi: 10.1037/0033-295x.107.3.460

Rapp, B., Epstein, C., & Tainturier, M. (2002). The integration of information across lexical and sublexical processes in spelling. *Cognitive Neuropsychology*, *19*, 1-29. doi: 10.1080/0264329014300060

Ratiu, I., & Azuma, T. (2015). Working memory capacity: Is there a bilingual advantage? *Journal of Cognitive Psychology, 27*, 1–11. doi: 10.1080/20445911.2014.976226

Ratzon, N. Z., Efraim, D., & Bart, O. (2007). A short-term graphomotor program for improving writing readiness skills of first-grade students. *The American Journal of Occupational Therapy, 61*, 399-405. doi: 10.5014/ajot.61.4.399

Rau, A. K., Moeller, K., & Landerl, K. (2014). The transition from sublexical to lexical processing in a consistent orthography: An eye-tracking study. *Scientific Studies of Reading, 18*, 224-233. doi: 10.1080/10888438.2013.857673

Rau, A. K., Moll, K., Snowling, M. J., & Landerl, K. (2015). Effects of orthographic consistency on eye movement behavior: German and English children and adults process the same words differently. *Journal of Experimental Child Psychology, 130*, 92-105. doi: 10.15496/publikation-4866

Rayner, K., & Clifton, C., Jr. (2009). Language processing in reading and speech perception is fast and incremental: Implications for event-related potential research. *Biological Psychology, 80*, 4–9. doi: 10.1016/j.biopsycho.2008.05.002

Rayner, K., Pollatsek, A., Ashby, J., & Clifton Jr, C. (2012). *Psychology of reading.* Psychology Press.

Roberts, P. M., & Deslauriers, L. (1999). Picture naming of cognate and non-cognate nouns in bilingual aphasia. *Journal of Communication Disorders, 32*, 1–23. doi: 10.1016/S0021-9924(98)00026-4

Roberts, P. M., Garcia, L. J., Desrochers, A., & Hernandez, D. (2002). English performance of proficient bilingual adults on the Boston Naming Test. *Aphasiology, 16*, 635-645. doi: 10.1080/02687030244000220

Roelofs, A. (1997). Syllabification in speech production: Evaluation of WEAVER. *Language and Cognitive Processes, 12*, 657-694. doi: 10.1080/016909697386655

Roelofs, A., & Verhoef, K. (2006). Modeling the control of phonological encoding in bilingual speakers. *Bilingualism: Language and Cognition, 9*, 167–176. doi: 10.1017/S1366728906002513

Roeltgen, D. P., & Heilman, K. M. (1984). Lexical agraphia. Further support for the two-system hypothesis of linguistic agraphia. *Brain: a journal of neurology, 107*, 811–827. doi: 10.1093/brain/107.3.811

Roeser, J., De Maeyer, S., Leijten, M., & Van Waes, L. (2021). Modelling typing disfluencies as finite mixture process. *Reading and Writing*, *August*, 1-26. doi: 10.1007/s11145-021-10203-z

Rønneberg, V., & Torrance, M. (2019). Cognitive predictors of shallow-orthography spelling speed and accuracy in 6th grade children. *Reading and Writing, 32*, 197-216. doi: 10.1007/s11145-017-9751-3

Rosário, P., Högemann, J., Núñez, J. C., Vallejo, G., Cunha, J., Rodríguez, C., & Fuentes, S. (2019). The impact of three types of writing intervention on students' writing quality. *PloS one, 14,* e0218099. doi: 10.1371/journal.pone.0218099

Rothman, J. (2009). Understanding the nature and outcomes of early bilingualism: Romance languages as heritage languages. *International journal of bilingualism, 13*, 155-163. doi: 10.1177/1367006909339814

Rothman, J., & Guijarro-Fuentes, P. (2010). Input quality matters: Some comments on input type and age-effects in adult SLA. *Applied linguistics, 31*, 301-306. doi: 10.1093/applin/amq004

Roux, S., & Bonin, P. (2012). Cascaded processing in written naming: Evidence from the picture–picture interference paradigm. *Language and Cognitive Processes, 27*, 734–769. doi: 10.1080/01690965.2011.580162

Roux, S., McKeeff, T. J., Grosjacques, G., Afonso, O., & Kandel, S. (2013). The interaction between central and peripheral processes in handwriting production. *Cognition, 127*, 235-241. doi: 10.1016/j.cognition.2012.12.009

Rumelhart, D. E., & Norman, D. A. (1982). Simulating a skilled typist: A study of skilled cognitive-motor performance. *Cognitive Science, 6*, 1–36. doi: 10.1207/s15516709cog0601_1

Runnqvist, E., Strijkers, K., Sadat, J., & Costa, A. (2011). On the temporal and functional origin of L2 disadvantages in speech production: A critical review. *Frontiers in Psychology, 2*, 379. doi: 10.3389/fpsyg.2011.00379

Sadat, J., Martin, C. D., Alario, F. X., & Costa, A. (2012). Characterizing the bilingual disadvantage in noun phrase production. *Journal of Psycholinguistic Research, 41*, 159-179. doi: 10.1007/s10936-011-9183-1

Sadat, J., Martin, C., Costa, A., & Alario, F. (2014). Reconciling phonological neighborhood effects in speech production through single trial analysis. *Cognitive Psychology*, *68*, 33-58. doi: 10.1016/j.cogpsych.2013.10.001

Sadat, J., Martin, C., Magnuson, J., Alario, F., & Costa, A. (2015). Breaking Down the Bilingual Cost in Speech Production. *Cognitive Science, 40,* 1911-1940. doi: 10.1111/cogs.12315

Sandoval, T. C., Gollan, T. H., Ferreira, V. S., & Salmon, D. P. (2010). What causes the bilingual disadvantage in verbal fluency? The dual-task analogy. *Bilingualism: Language and Cognition, 13*, 231–252. doi: 10.1017/S1366728909990514

Santesteban, M., & Schwieter, J. W. (2020). *Lexical selection and competition in bilinguals*. In R. R. Heredia & A. B. Cieślicka (Eds.), *Bilingual lexical ambiguity resolution* (p. 126–156). Cambridge University Press. doi: 10.1017/9781316535967.007

Savage, G. R., Bradley, D. C., & Forster, K. I. (1990). Word frequency and the pronunciation task: The contribution of articulatory fluency. *Language and cognitive processes, 5,* 203-236. soi: 10.1080/01690969008402105

Scaltritti, M., Arfe, B., Torrance, M., & Peressotti, F. (2016). Typing pictures: Linguistic processing cascades into finger movements. *Cognition, 156,* 16-29. doi: 10.1016/j.cognition.2016.07.006

Scaltritti, M., Peressotti, F., & Miozzo, M. (2017). Bilingual advantage and language switch: What's the linkage?. *Bilingualism: Language and Cognition, 20*, 80-97. doi: 10.1017/S1366728915000565

Schepens, J., Dijkstra, T., & Grootjen, F. (2012). Distributions of cognates in Europe as based on Levenshtein distance. *Bilingualism: Language and Cognition*, *15*, 157-166. doi: 10.1017/s1366728910000623

Schmalz, X., Marinus, E., Coltheart, M., & Castles, A. (2015). Getting to the bottom of orthographic depth. *Psychonomic bulletin & review, 22,* 1614-1629. doi: 10.3758/s13423-015-0835-2

Schwartz, A. I., Kroll, J. F., & Diaz, M. (2007). Reading words in Spanish and English: Mapping orthography to phonology in two languages. *Language and Cognitive processes, 22,* 106-129. doi: 10.1080/01690960500463920

Scontras, G., Polinsky, M., & Fuchs, Z. (2018). In support of representational economy: Agreement in heritage Spanish. *Glossa: A journal of general linguistics, 3*, 1-29. doi: 10.5334/gjgl.164

Scott, S., & Wise, R. (2004). The functional neuroanatomy of prelexical processing in speech perception. *Cognition*, *92*, 13-45. doi: 10.1016/j.cognition.2002.12.002

Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming. *Psychological review, 96*, 523-568. doi: 10.1037//0033-295X.96.4.523.

Seidenberg, M. S., & Tanenhaus, M. K. (1979). Orthographic effects on rhyme monitoring. *Journal of Experimental Psychology: Human Learning and Memory, 5*, 546-554. doi: 10.1037/0278-7393.5.6.546

Seymour, P. H. K., Aro, M. & Erskine, J. M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology, 94*, 143– 174. doi: 10.1348/000712603321661859

Shallice, T. (1981). Phonological agraphia and the lexical route in writing. *Brain: a journal of neurology, 104*, 413-429. doi: 10.1093/brain/104.3.413

Shao, Z., Janse, E., Visser, K., & Meyer, A. S. (2014). What do verbal fluency tasks measure? Predictors of verbal fluency performance in older adults. *Frontiers in psychology, 5,* 772. doi: 10.3389/fpsyg.2014.00772

Shen, X. R., Damian, M. F., & Stadthagen-Gonzalez, H. (2013). Abstract graphemic representations support preparation of handwritten responses. *Journal of Memory and Language, 68*, 69–84. doi: 10.1016/j.jml.2012.10.003

Sheriston, L., Critten, S., & Jones, E. (2016). Routes to Reading and Spelling: Testing the Predictions of Dual-Route Theory. *Reading Research Quarterly, 51*, 403-417. doi: 10.1002/rrq.143

Shook, A., & Marian, V. (2019). Covert co-activation of bilinguals' non-target language: Phonological competition from translations. *Linguistic approaches to bilingualism, 9*, 228-252. doi: 10.1075/lab.17022.sho

Shook, A., & Marian, V. (2019). Covert co-activation of bilinguals' non-target language: Phonological competition from translations. *Linguistic approaches to bilingualism, 9*, 228-252. doi: 10.1075/lab.17022.sho

Silverberg, S., & Samuel, A. G. (2004). The effect of age of second language acquisition on the representation and processing of second language words. *Journal of memory and language, 51*, 381-398. doi: 10.1016/j.jml.2004.05.003

Simon, G., Bernard, C., Lalonde, R., & Rebaï, M. (2006). Orthographic transparency and grapheme–phoneme conversion: An ERP study in Arabic and French readers. *Brain research, 1104*, 141-152. doi: 10.1016/j.brainres.2006.05.071

Smits, E., Martensen, H., Dijkstra, T., & Sandra, D. (2006). Naming interlingual homographs: Variable competition and the role of the decision system. *Bilingualism: Language and Cognition, 9*, 281-297. doi: 10.1017/S136672890600263X

Snyder, K. M., Ashitaka, Y., Shimada, H., Ulrich, J. E., & Logan, G. D. (2014). What skilled typists don't know about the QWERTY keyboard. *Attention, Perception, & Psychophysics, 76*, 162-171.

Snyder, K. M., Logan, G. D., & Yamaguchi, M. (2015). Watch what you type: The role of visual feedback from the screen and hands in skilled typewriting. *Attention, Perception, & Psychophysics, 77*, 282-292. doi: 10.3758/s13414-014-0756-6

Sorace, A. (2011). Pinning down the concept of "interface" in bilingualism. *Linguistic approaches to bilingualism, 1,* 1-33. doi: 10.1075/lab.1.1.01sor

Soriano, M. F., Ibáñez-Molina, A. J., Paredes, N., & Macizo, P. (2018). Autism: hard to switch from details to the whole. *Journal of abnormal child psychology, 46*, 1359-1371. doi: 10.1007/s10802-017-0384-4

Starreveld, P. A., & La Heij, W. (1996). Time-course analysis of semantic and orthographic context effects in picture naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22*, 896-918. doi: 10.1037/0278-7393.22.4.896

Sternberg, S. (2001). Separate modifiability, mental modules, and the use of pure and composite measures to reveal them. *Acta Psychologica, 106,* 147-246. doi: 10.1016/s0001-6918(00)00045-7

Strijkers, K., Costa, A., & Thierry, G. (2010). Tracking lexical access in speech production: electrophysiological correlates of word frequency and cognate effects. *Cerebral cortex, 20*, 912-928. doi: 10.1093/cercor/bhp153

Stuss, D. T. (2011). Functions of the frontal lobes: relation to executive functions. *Journal of the international neuropsychological Society, 17*, 759-765. doi: 10.1017/S1355617711000695

Sullivan, M. D., Poarch, G. J., & Bialystok, E. (2018). Why is lexical retrieval slower for bilinguals? Evidence from picture naming. Bilingualism, 21, 479-488. doi: 10.1017/S1366728917000694.

Sun-Alperin, M. K., & Wang, M. (2008). Spanish-speaking children's spelling errors with English vowel sounds that are represented by different graphemes in English and Spanish words. *Contemporary Educational Psychology, 33*, 932-948. doi: 10.1016/j.cedpsych.2007.12.005

Tainturier, M. J. (2019). BAST: A Theory Of Bilingual Spelling In Alphabetic Systems. In *Spelling and Writing Words* (pp. 67-92). Brill.

Tainturier, M. J., Bosse, M. L., Roberts, D. J., Valdois, S., & Rapp, B. (2013). Lexical neighborhood effects in pseudoword spelling. *Frontiers in psychology, 4*, 862. doi: 10.3389/fpsyg.2013.00862

Tainturier, M.-J., & Rapp, B. (2001). The spelling process. In B. Rapp (Ed.), *Handbook of cognitive neuropsychology: What deficits reveal about the human mind* (pp. 263–289). Philadelphia, PA: Psychology Press.

Team, R. C. (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Templeton, S. (1998). Explorations in developmental spelling: Foundations for learning and teaching phonics, spelling, and vocabulary. *The Reading Teacher, 52*, 222-242

Thierry, G., & Wu, Y. J. (2007). Brain potentials reveal unconscious translation during foreign-language comprehension. *Proceedings of the National Academy of Sciences, 104*, 12530-12535. doi: 10.1073/pnas.0609927104

Tierney, A.L., & Nelson, C.A. (2009). Brain Development and the Role of Experience in the Early Years. *Zero to three, 30*, 9-13.

Timmer, K., Costa, A., & Wodniecka, Z. (2021). The source of attention modulations in bilingual language contexts. *Brain and language, 223*, 105040. doi: 10.1016/j.bandl.2021.105040

Treiman, R., & Kessler, B. (2014). *How children learn to write words*. Oxford University Press.

Trueswell, J., Tanenhaus, M., & Garnsey, S. (1994). Semantic influences on parsing: Use of thematic role information in syntactic disambiguation. *Journal of Memory and Language, 33*, 285-318. doi: 10.1006/jmla.1994.1014

Turvey, M. T., Feldrnan, L. B., & Lukatela. G. (1984). The Serbo-Croatian orthography constrains the reader to a phonologically analytic strategy. In L. Henderson (Ed.), *Orthographies and reading*. London: Erlbaurn.

Valdés Kroff, J. R., Rooijakkers, F., & Parafita, M. C. (2019). Spanish Grammatical Gender Interference in Papiamentu. *Languages, 4*, 78. doi: 10.3390/languages4040078

Valdés, G. (2000). The teaching of heritage languages: an introduction for Slavic-teaching professionals. In O. Kagan & B. Rifkin (Eds.), *The Learning and Teaching of Slavic Languages and Cultures* (pp. 375-403). Slavica.

Valdés, G. (2005). Bilingualism, heritage language learners, and SLA research: Opportunities lost or seized?. *The modern language journal, 89*, 410-426. doi: 10.1111/j.1540-4781.2005.00314.x

Valdois, S., Peyrin, C., Lassus-Sangosse, D., Lallier, M., Demonet, J. F., & Kandel, S. (2014). Dyslexia in a French–Spanish bilingual girl: behavioural and neural modulations following a visual attention span intervention. *Cortex, 53*, 120-145. doi: 10.1016/j.cortex.2013.11.006

Van Assche, E., Duyck, W., & Gollan, T. H. (2013). Whole-language and item-specific control in bilingual language production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 39*, 1781-1792 doi: 10.1037/a0032859

Van Assche, E., Duyck, W., & Hartsuiker, R. J. (2011). Bilingual word recognition in a sentence context. *Frontiers in psychology, 3*, 174. doi: 10.3389/fpsyg.2012.00174

Van Assche, E., Duyck, W., Hartsuiker, R. J., & Diependaele, K. (2009). Does bilingualism change native-language reading? Cognate effects in a sentence context. *Psychological science, 20*, 923-927. doi: 10.1111/j.1467-9280.2009.02389.x

Van den Noort, M., Vermeire, K., Bosch, P., Staudte, H., Krajenbrink, T., Jaswetz, L., ... & Lim, S. (2019). A systematic review on the possible relationship between bilingualism, cognitive decline, and the onset of dementia. *Behavioral Sciences, 9*, 81. doi: 10.3390/bs9070081

Van Galen, G. P. (1991). Handwriting: Issues for a psychomotor theory. *Human Movement Science, 10,* 165–191. doi: 10.1016/0167-9457(91)90003-G

Van Hell, J. G., & Dijkstra, T. (2002). Foreign language knowledge can influence native language performance in exclusively native contexts. *Psychonomic bulletin & review, 9*, 780-789. doi: 10.3758/BF03196335

Van Hell, J. G., & Tanner, D. (2012). Second language proficiency and cross-language lexical activation. *Language Learning, 62*, 148-171. doi: 10.1111/j.1467-9922.2012.00710.x

van Heuven, W. J. B., Dijkstra, T., & Grainger, J. (1998). Orthographic neighborhood effects in bilingual word recognition. *Journal of Memory and Language, 39*, 458–483. doi: 10.1006/jmla.1998.2584

Van Kesteren, R., Dijkstra, T., & De Smedt, K. (2012). Markedness effects in Norwegian–English bilinguals: Task-dependent use of language-specific letters and bigrams. *Quarterly Journal of Experimental Psychology, 65*, 2129-2154. doi: 10.1080/17470218.2012.679946

Van Orden, G., & Goldinger, S. (1994). Interdependence of form and function in cognitive systems explains perception of printed words. *Journal of Experimental Psychology: Human Perception and Performance*, *20*, 1269-1291. doi: 10.1037//0096-1523.20.6.1269

Van Orden, G.C. (1987). A rows is a rose: spelling, sound and reading. *Memory and Cognition, 15,* 181-198. doi: 10.3758/BF03197716

Van Orden, G.C., Johnston, J.C., & Hale, B. L. (1988). Word identification in reading proceeds from spelling to sound to meaning. *Journal of Experimental Psychology: Learning, Memory and Cognition, 14*, 371-386. doi: 10.1037//0278-7393.14.3.371

Vanderauwera, J., De Vos, A., Forkel, S. J., Catani, M., Wouters, J., Vandermosten, M., & Ghesquière, P. (2018). Neural organization of ventral white matter tracts parallels the initial steps of reading development: a DTI tractography study. *Brain and language, 183*, 32-40. doi: 10.1016/j.bandl.2018.05.007

Vandermosten, M., Vanderauwera, J., Theys, C., De Vos, A., Vanvooren, S., Sunaert, S., ... & Ghesquière, P. (2015). A DTI tractography study in pre-readers at risk for dyslexia. *Developmental cognitive neuroscience, 14*, 8-15. doi: 10.1016/j.dcn.2015.05.006

Ventura, P., Morais, J., Pattamadilok, C., & Kolinsky, R. (2004). The locus of the orthographic consistency effect in auditory word recognition. *Language and Cognitive Processes*, *19*, 57-95. doi: 10.1080/01690960344000134

Vigliocco, G., & Hartsuiker, R. J. (2002). The interplay of meaning, sound, and syntax in sentence production. *Psychological Bulletin, 128*, 442–472. doi: 10.1037/0033-2909.128.3.442

Viviani, P., & Laissard, G. (1996). Motor templates in typing. *Journal of Experimental Psychology: Human Perception and Performance, 22,* 417–445. doi: 10.1037/0096-1523.22.2.417

Voga, M., & Grainger, J. (2007). Cognate status and cross-script translation priming. *Memory & Cognition, 35*, 938–952. doi: 10.3758/BF03193467

Von Studnitz, R. E., & Green, D. W. (2002). The cost of switching language in a semantic categorization task. *Bilingualism: Language and Cognition, 5*, 241–251. doi: 10.1017/S1366728902003036

Weekes, B. S., & Raman, I. (2008). Bilingual deep dysphasia. *Cognitive Neuropsychology, 25*, 411-436. doi: 10.1080/02643290802057311

Weinreich, U. (1953). *Languages in Contact*. The Hague: Mouton.

Werker, J. F., & Byers-Heinlein, K. (2008). Bilingualism in infancy: First steps in perception and comprehension. *Trends in cognitive sciences, 12*, 144-151. doi: 10.1016/j.tics.2008.01.008

Wilcox, K. C., Jeffery, J. V., & Gardner-Bixler, A. (2016). Writing to the Common Core: Teachers' responses to changes in standards and assessments for writing in elementary schools. *Reading and Writing, 29*, 903-928. doi:10.1007/S11145-015-9588-6

Witzel, N. O., & Forster, K. I. (2012). How L2 words are stored: The episodic L2 hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 1608-1621. doi: 10.1037/a0028072

Woumans, E. A., Clauws, R., Duyck, W., & Woumans, E. (2021). Hands Down: Cognate effects persist during written word production. *Frontiers in Psychology, 12,* 2629. doi: 10.3389/fpsyg.2021.647362

Woutersen, M., de Bot, K., & Weltens, B. (1995). The bilingual lexicon: Modality effects in processing. *Journal of psycholinguistic research, 24*, 289-298.

Wu, C., & Liu, Y. (2008). Queuing network modeling of transcription typing. *ACM Transactions on Computer-Human Interaction (TOCHI), 15*, 1-45. doi: 10.1145/1352782.1352788

Yamaguchi, M., & Logan, G. D. (2014). Pushing typists back on the learning curve: Revealing chunking in skilled typewriting. *Journal of Experimental Psychology: Human Perception and Performance, 40*, 592-612. doi: 10.1037/a0033809

Yang, J., Ye, J., Wang, R., Zhou, K., & Wu, Y. J. (2018). Bilingual contexts modulate the inhibitory control network. *Frontiers in psychology, 9*, 395. doi: 10.3389/fpsyg.2018.00395

Yates, M., Locker, L., & Simpson, G. B. (2003). Semantic and phonological influences on the processing of words and pseudohomophones. *Memory & Cognition, 31*, 856-866. doi: 10.3758/bf03196440

Yule, G. (2006). *The Study of Language*. 3rd edition. Cambridge University Press.

Zhang, Q., & Damian, M. F. (2010). Impact of phonology on the generation of handwritten responses: Evidence from picture-word interference tasks. *Memory and Cognition, 38,* 1162-1162. doi: 10.3758/MC.38.8.1162

Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: a psycholinguistic grain size theory. *Psychological bulletin, 131,* 3- 29. doi: 10.1037/0033-2909.131.1.3

Ziegler, J. C., Bertrand, D., Tóth, D., Csépe, V., Reis, A., Faísca, L., Saine, N., Lyytinen, H., Vaessen, A., & Blomert, L. (2010). Orthographic depth and its impact on universal predictors of reading: a cross-language investigation. *Psychological science*, *21*, 551–559. doi: 10.1177/0956797610363406

Ziegler, J., Ferrand, L., & Montant, M. (2004). Visual phonology: The effects of orthographic consistency on different auditory word recognition tasks. *Memory & Cognition*, *32*, 732-741. doi: 10.3758/bf03195863

Ziegler, J. C., Montant, M., & Jacobs, A. M. (1997). The feedback consistency effect in lexical decision and naming. *Journal of Memory and Language, 37,* 533–554. doi: 10.1006/jmla.1997.2525

Ziegler, J., Petrova, A., & Ferrand, L. (2008). Feedback consistency effects in visual and auditory word recognition: Where do we stand after more than a decade?. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*, 643-661. doi:10.1037/0278-7393.34.3.643

Zirnstein, M., Bice, K., & Kroll, J. F. (2019). Chapter 3. Variation in language experience shapes the consequences of bilingualism. In I. A. Sekerina, L. Spradlin, & V. Valian (Eds.), *Bilingualism, Executive Function, and Beyond: Questions and insights* (pp. 35–47).

Zmigrod, S., Zmigrod, L., & Hommel, B. (2015). Zooming into creativity: Individual differences in attentional global-local biases are linked to creative thinking. *Frontiers in psychology*, *6*, 1647. doi: 10.3389/fpsyg.2015.01647

Zoubrinetzky, R., Bielle, F., & Valdois, S. (2014). New insights on developmental dyslexia subtypes: heterogeneity of mixed reading profiles. *PloS one, 9*, e99337. doi: 10.1371/journal.pone.0099337