Grammatical Comprehension in Language and Communication Disorders

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Autism Spectrum Disorder (ASD) and Developmental Language Disorder (DLD) have traditionally been considered separate disorders, although some similarities and overlaps in certain aspects of language have been detected. In this paper, we compare the deficits in receptive grammar in these two disorders. We analyze the proportion of grammatical errors in relation to semantic complexity in 84 children divided into four groups: children with autism language impairment (ALI), with autism language normal (ALN), with DLD, and with typical development (TD), all groups with the same age of receptive vocabulary. The results show significant differences in the comprehension of grammatical structures, both simple (canonical and non-reversible) and complex (non-canonical and reversible). Children with ASD and DLD show different language profiles depending on the syntactic complexity. In the simplest structures, no differences are found between the groups, starting at an equivalent vocabulary age of 7:8 years. However, there are differences between the ALI and DLD groups with respect to the TD group in the more complex structures, starting at an equivalent vocabulary age of 3 years. Therefore, both groups ALI and DLD present the greatest difficulties compared to ALN and TD. The paper discusses the importance of attending to these differences, since the repercussion of comprehension difficulties increases as children grow.

Keywords: Autism Spectrum Disorder; Developmental Language Disorder; Simple and complex language structures; Grammatical comprehension

Introduction

Two of the neurodevelopmental disorders that are most complex and have the most relevant language implications associated with them are the Autism Spectrum Disorder (ASD) and the Developmental Language Disorder (DLD). Although much of the literature argues that ASD and DLD are disorders with independent etiologies (see Creemers and Shaeffer, 2015, for a synthesis), other studies seem to indicate that the two conditions have considerable overlap (Friedmann & Novogrodsky, 2011; Tager-

Flusberg, 2006). In fact, they have a number of similarities: high heritability and great heterogeneity in terms of severity, prognosis and principal symptoms (Tager-Flusberg, 2015). Also, both disorders are characterized by communication and language deficits and some groups of children show similar characteristics in receptive aspects of language.

Grammatical deficits in ASD and DLD

Children with ASD show great heterogeneity in their language skills. This means that it is possible to find from children who are non-verbal or minimally verbal (who do not acquire language) to those who speak fluidly and have a very well-developed vocabulary (Lord et al., 2006). It is generally agreed that the pragmatic difficulties is one of the core deficits in ASD (Eigsti et al., 2011), while grammar impairments (structural aspects of language or syntax) are not necessary for its diagnosis (APA, 2013). However, these individuals may also show significant impairment in these areas.

While some children with ASD acquire language in a way similar to that of typically developing children (TD) (Boucher, 2012; Naigles & Chin, 2015; Tager-Flusberg & Caronna, 2007; Tek et al., 2014), others often exhibit delayed speech onset, along with poor expressive language (i.e., production of language less frequently and lexical and grammatical items of lower complexity) (Naigles & Tovar, 2012). In previous research, difficulties have also been found in these children's language comprehension (Garrido et al., 2015; Kjellmer et al., 2018; Kover et al., 2013; Norrelgen et al., 2015), including at the grammatical level (Perovic et al. 2013; Terzi et al., 2014).

Children with DLD, although they present a normal range of non-verbal intelligence, show significant language difficulties not attributable to neurological,

sensorial, intellectual or emotional deficiencies or to a known biomedical condition (Montgomery et al., 2017). DLD is typically defined as a developmental language disorder that includes severe difficulties in structural language (phonology, morphology, syntax and semantics) (Brignell et al., 2018; Durrleman et al., 2017; Ellis Weismer, 2013). DLD, like ASD, is a heterogeneous disorder, whose symptoms can manifest at both receptive and expressive levels.

In contrast with ASD, children with DLD present severe grammatical difficulties and more preserved pragmatics (Friedmann & Novogrodsky, 2011; Leclercq et al., 2014). Lexical difficulties in children with DLD appear from infancy, evidencing difficulties in word learning and vocabulary comprehension (Rice & Hoffman, 2015), as well as slow vocabulary acquisition. These difficulties are associated with worse reading and writing skills at school age (Law et al., 2009).

Comprehension of syntactic structures

Language comprehension depends on a series of skills that include vocabulary knowledge and syntactic and morphological skills, which develop at the same time and are closely related (Hagen et al., 2017). For Montgomery et al. (2017) the problem lies in the erroneous interpretation that children with DLD make of certain types of sentences, mainly complex ones.

Simple structures that follow canonical order (subject-verb-object –SVO–) and do not require syntactic movement or displacement do not usually present difficulty for children with TD, even in the early stages of life (Montgomery et al., 2008). Spanish is one of the languages that use the SVO sentence structure commonly (Thompson & Shapiro, 2007). In contrast, *complex structures* do not follow canonical order and they do require syntactic movement or displacement (that is, the syntactic constituent appears inserted in a position different from its natural canonical position) (Thompson

& Shapiro, 2007). Complex structures are acquired later than simple ones (Friedmann et al., 2009; van der Lely, 2005) and the comprehension of complex sentences imposes high linguistic processing demands on the interpretive system that must decode the sentence (Stavrakaki, 2001).

Another aspect that affects the comprehension of sentences is their semantic complexity. In this regard, sentences can be classified as reversible and non-reversible. Reversible sentences are those in which agent and object can be logically changed positions (e.g., "the boy is looking at the girl"). In contrast, non-reversible sentences involve inanimate objects and the position of agent and object cannot be switched (e.g., "the boy is eating bread") (Kover et al., 2014; Oakes et al., 2013). Thus, one might expect that more complex structures (those following a non-canonical word order and reversible ones) would be more difficult to comprehend by children with language difficulties, such as ASD or DLD (Norbury et al., 2002).

Complex structures in ASD and DLD

In relation to the comprehension of complex sentences in children with ASD, great variability has been found, with some papers reporting intact syntactic skills and others finding evidence of difficulties depending on the type of grammatical construction. For example, some studies seem to indicate deficits in the comprehension of reversible sentences in children with ASD compared to TD children matched in verbal mental age (Kover et al., 2014). In contrast, other studies show intact comprehension in passive sentences (Gavarró & Heshmati, 2014; Terzi et al., 2014), or in reflexive sentences (Gavarró & Heshmati, 2014; Janke & Perovic, 2015; Terzi et al., 2014). Some research has found that certain linguistic profiles in ASD are reminiscent of DLD; specifically, in the comprehension of structures with non-canonical word order, such as relative (Durrleman & Frank, 2012; Frizelle & Fletcher, 2015; Meir & Novogrodsky, 2019;

Sukenik & Friedmann, 2018) or passive (Durrleman et al., 2017; Perovic et al., 2013; Terzi et al., 2014) sentences.

Similarly, different studies indicate that children with DLD present significant difficulties in comprehending structures that do not follow canonical order, such as relative (Arosio et al, 2017; Frizelle & Fletcher, 2015), reflexive (Bishop et al., 2000) or passive sentences (Montgomery et al., 2017). A plausible explanation is at the basis of the impossibility of relying on word order cues for comprehension.

The heterogeneity existing in these disorders is so great that disparate results have also been found in relation to less complex grammatical structures. For example, the authors of some studies state that children with ASD are able to process these structures in order to determine "who did what" (Naigles & Chin, 2015). Other studies indicate that these children have subtle difficulties even in simple structures (Perovic et al., 2013). Likewise, it has been shown that children with DLD show difficulties in the comprehension of simple structures, especially when sentences are long (Stavrakaki, 2001).

So, syntactic deficits seem to be found in most children with DLD but only in some children with ASD (Sukenik & Friedman, 2018). The existence of a subgroup in ASD with certain language difficulties similar to those shown in DLD is gaining increasing strength (Durrleman & Delage, 2016; Huang et al., 2021; Perovic et al., 2013; Tager-Flusberg, 2006; Zebib et al., 2013). For example, Perovic et al. (2013) divided their sample of participants with ASD into two subgroups on whether or not a language impairment was present. In fact, the subgroup of children with ASD and language impairment has been referred to as ALI (Autism Language Impairment) in several studies (e.g., Hill et al., 2015; Loucas et al., 2008; Modyanova et al., 2017; Riches et al., 2010; Tager-Flusberg, 2006). Unfortunately, few studies have been

conducted comparing syntactic skills in both groups simultaneously, hence the need to clarify the differences and similarities in this area.

In sum, this heterogeneity in the results of studies that explore which formal aspects of language are intact and which present difficulties in ASD suggests that more research is needed. To this, it should be added that less attention has been paid to the formal aspects of language (e.g., in relation to pragmatic competence) in ASD in the published studies (Tuller et al., 2017), and to the paucity of publications in non-English speaking populations on this aspect (Prévost et al., 2017; Tuller et al., 2017). In fact, although a few studies have included Spanish-speaking children with ASD, they have not analyzed the grammatical profile across different levels of severity for this disorder along with other developmental disorders such as DLD (Garrido et al., 2015; Muñoz et al., 2014; Ramirez-Santana et al., 2019). To overcome these limitations in the literature, the present work investigates the comprehension of syntactic structures in ASD and DLD in Spanish-speaking children.

Specifically, we aim to clarify the existence, scope and nature of the error profile in the comprehension of different grammatical structures in Spanish in four groups of children: a) children with ALI, b) children with ASD normal language (ALN), c) children with DLD, and d) children with TD. As a secondary objective, based on the previous results, we will further analyze grammatical structures according to their complexity, analyzing some of the most common grammatical structures in Spanish: canonical vs. non-canonical and reversible vs. non-reversible structures.

Method

Participants

We recruited 84 Spanish-speaking children (mean age of 6.76, SD= 2.22; range= 4:4 – 13:00) from speech-language specialized schools, regular schools, and associations of parents of children with ASD, which we had contacted directly to present this study. Children were distributed into four groups: DLD (N=20), TD (N=21) and two ASD groups (N=43). Following the classification proposed in other studies (see Modyanova et al., 2017; Perovic et al., 2013) we divided the ASD sample into two groups: ALI with 22 participants and ALN with 21 participants. To ensure the participants had similar levels of verbal comprehension, the groups were matched (i.e., participants were paired across groups allowing a range up to 8 months of difference, with the exception of one child from the ALI group, whose vocabulary score was paired with another child from the same group) in terms of receptive vocabulary age, using the PPVT-III (Peabody Picture Vocabulary Test; Dunn & Dunn, 2006), meaning that each group had a different chronological age. The average age of the group members was 7:3 years for ALI (SD=0.67; range= 4:4 – 13:0), 7:0 years for ALN (SD=0.46; range= 4:7 – 10:4), 7:2 years for DLD (SD=0.39; range= 5:4 – 10:4) and 5:6 years for TD (SD=0.14; range= 4:5 – 6:6).

The inclusion criteria in the ALI and ALN groups were: having received the ASD diagnosis based on DSM-IV-TR (APA, 2000) and/or DSM-5 (APA, 2013) criteria, having no comorbid disorders and being enrolled in school. In addition, the diagnosis was verified by means of a social communication questionnaire (SCQ; Rutter et al., 2011) and the Gilliam Autism Rating Scale (GARS; Gilliam, 2006).

The inclusion criteria for the DLD group were: having been previously diagnosed by a speech therapist, not having any hearing problems, and being enrolled in school. More specifically, these children obtained language scores of 1.25 SDs below age specific norms in standardized tests used by speech therapist in Spain (i.e., Illinois Test of Psycholinguistic Abilities; Kirk et al., 2011, McCarthy Scale of Children's Abilities; McCarthy, 2009, and The Clinical Evaluation of Language Fundamentals–Fourth Edition; Semel et al., 2006). Also, nonverbal intelligence (evaluated with the WISC-IV; Wechsler, 2015) had to be within normal range (nonverbal IQ >85). For the participants of the TD group the inclusion criteria were: having no diagnosed disorder and being enrolled in school.

The participants in both ASD groups (ALI and ALN) were selected based on the scores they obtained in receptive vocabulary (PPVT-III; Dunn & Dunn, 2006) and grammatical comprehension, evaluated with the Grammatical Structure Comprehension Test (CEG; Mendoza et al., 2005). According to several authors, to place an ASD participant in the ALI group the child had to be below the tenth percentile (Pc) for both receptive vocabulary and grammatical comprehension, based on the expectations for a child of that chronological age (Hill et al., 2015; Modyanova et al., 2017; Tager-Flusberg, 2006). The participants in the ALN group had to perform above the tenth percentile in the aforementioned language comprehension tests.

Measures

The instruments used to evaluate the participants were:

Social Communication Questionnaire (SCQ; Rutter et al., 2011). This tool provides information about social interaction, communication difficulties and restricted, repetitive and stereotyped conducts. This measure offers a cutoff score of 15 points or more, which was used to confirm the ASD diagnosis.

Gilliam Autism Rating Scale (GARS; Gilliam, 2006). This scale evaluates nonverbal communication and gives a score of the autism's severity. A cut-off of 130 and higher indicates that the child is very likely to have autism. It was used here to confirm the ASD diagnosis.

LEITER-R International Performance Scale (Roid & Miller, 2011). This instrument measures intelligence, memory and attention through a nonverbal evaluation. It was used here as an IQ evaluation for the participants in the ALI group.

Wechsler Intelligence Scale for Children (WISC-IV; Wechsler, 2015). This test provides an overall IQ evaluation and two partial evaluations (verbal IQ and manipulative IQ). The scores from the overall scale were used to describe the samples of the ALN, DLD and TD groups.

Peabody Receptive Vocabulary Test (PPVT-III; Dunn & Dunn, 2006). This test gives a score of equivalent age in receptive vocabulary. It was used to compare the vocabulary level of the different participants.

Grammatical Structure Comprehension Test (CEG; Mendoza et al., 2005). This tool evaluates the comprehension of 20 grammatical constructions of varying complexity. It includes a total of 80 items which evaluate canonical structures (e.g., La niña es rubia [the girl is blonde]), non-canonical structures (e.g., El niño es abrazado por la mujer [the boy is hugged by the woman]), non-reversible (e.g., El gato come un plátano [the cat is eating a banana]) and reversible structures (e.g., Las niñas miran a los niños [the girls are looking at the boys]) (see Muñoz et al., 2014). To facilitate the

interpretation and analysis of these data, the proportion of errors for each type of grammatical structure was evaluated. This test shows good internal consistency, with a Cronbach's alpha score of 0.91 (Muñoz et al., 2008).

Procedure

The study was approved and conducted in accordance with the ethical standards of the Provincial Ethics in Biomedical Research Committee of Granada. All parents signed informed consent forms prior to their child's participation in the study. The evaluations were carried out in 1 or 2 sessions, depending on the needs of each child.

Data analysis

To analyze the data gathered, the statistics program SPSS, version 25, was used. First of all, descriptive analyses were performed of the variables of interest (i.e., chronological age, gender, vocabulary, intelligence), to describe the samples of participants. Additionally, analyses of variance (ANOVAs) were conducted to determine whether the participants of the different groups showed differences both in receptive vocabulary and cognitive ability and in the grammatical structures evaluated (canonical, non-reversible, non-canonical and reversible). In order to determine how much variance can be attributed to sentence structure, effect sizes were calculated through Eta squared, considering .01, .11 and >.14 to be small, medium and large, respectively (Castro & Martini, 2014). Prior to performing the second analysis, those variables that were asymmetrical (canonical structures for the ALI group and reversible structures for the ALN group) were transformed logarithmically. Secondly, linear regressions were performed to determine the influence of receptive vocabulary on the comprehension of different grammatical structures (i.e., canonical, non-reversible, non-canonical and reversible). Finally, analyses were also done of transversal development trajectories,

following the procedure developed by Thomas et al. (2009) and applied in similar studies (e.g., Thurman et al., 2015) for the different grammatical structures evaluated in relation to the level of receptive vocabulary. This procedure is similar to an ANOVA, but the differences between the intersection and the slope of the lines representing the trajectory's development in each group regarding comprehension of different grammatical structures are evaluated. We also analyzed the main effects of the groups (ALI, ALN, DLD and TD), of the continuous predictor variable of receptive vocabulary, and the potential interactions between group and slope. When significant differences were found, additional analyses were performed on pairs of groups, to determine the differences in the trajectories of the groups.

Results

First a descriptive analysis was performed (see Table 1) of the variables studied (i.e., age, gender, vocabulary and cognitive level) in the different groups. The results show that the groups are matched in vocabulary age and in cognitive ability (both with $ps>0.05$). Neither were significant differences in gender ($ps>0.05$).

INSERT TABLE 1 ABOUT HERE

Grammatical comprehension in children with ASD (ALI, ALN), DLD and TD
The analyses used to determine the proportion of errors in the comprehension of the grammatical structures studied are presented in Table 2. The results show significant differences between groups in the level of comprehension of the grammatical structures, in both the more accessible structures: canonical ($F(3,80)= 11.113$, $p<.001$) and non-reversible ($F(3,80)= 5.476$, $p<.005$) and the more complex ones: non-canonical ($F(3,80)= 23.174$, $p<.001$) and reversible ($F(3,80)= 29.976$, $p<.001$), showing large

effect sizes among the more accessible (η^2= .29, .17 respectively), and the more complex structures (η^2= .47, .53 respectively).

More specifically, comparisons between pairs of groups did not show differences in any grammatical structure between ALI and DLD, and ALN and TD (all with ps>.05). However statistical differences were found between ALI and TD in canonical (F(1,41)= 27.455, p<.001), non-reversible (F(1,41)= 11.132, p<.005), non-canonical (F(1,41)= 56.786, p<.001), and reversible (F(1,41)= 65.165, p<.001) structures, showing small and large effect sizes (η^2= .40, .21, .58, and .61 respectively). Moreover, statistical differences were found between ALN and DLD in canonical (F(1,39)= 8.089, p<.01), non-reversible (F(1,39)= 4.723, p<.05), non-canonical (F(1,39)= 18.034, p<.001), and reversible (F(1,39)= 30.006, p<.001) structures, showing medium and large effect sizes (η^2= .17, .11, .32, and .44 respectively). Indeed, statistical differences were found between DLD and TD in canonical (F(1,39)= 24.800, p<.001), non-reversible (F(1,39)= 14.014, p<.005), non-canonical (F(1,39)= 30.444, p<.001), and reversible (F(1,39)= 42.833, p<.001) structures, showing large effect sizes (η^2= .39, .26, .44, and .52 respectively). In a similar vein, statistical differences were found between ALI and ALN in canonical (F(1,41)= 9.668, p=.003), non-canonical (F(1,41)= 35.763, p<.001), and reversible (F(1,41)= 45.735, p<.001), showing medium and large effect sizes (η^2= .19, .47, and .53 respectively). However, differences were not found in non-reversible (p>.05) structures between ALI and ALN.

INSERT TABLE 2 ABOUT HERE

Influence of receptive vocabulary on the comprehension of grammatical structures in children with ASD (ALI, ALN), DLD and TD

Since the main objective of this study was to evaluate the comprehension profile of the different groups, tests were run to see if there were significant differences among the

participants in the various grammatical structures depending on receptive vocabulary age. The results of the linear regression analysis showed significant differences for each of the variables analyzed (see Table 3).

INSERT TABLE 3 ABOUT HERE

Comprehension of simple grammatical structures

Comprehension of canonical structures

The analyses of transversal development trajectories show that, generally speaking, as vocabulary age increases, the number of errors made in canonical structures decreases significantly in all groups evaluated (r = -0.75, $p<0.001$). The analysis of pairs of groups (see Figure 1) showed significant differences between the groups ALI and TD in all the receptive vocabulary ages evaluated, between ALN and DLD up to vocabulary age of 6:6, between ALN and TD between a vocabulary age range from 4:7 and 7:8 and between DLD and TD up to age 7:7 (all with $p<0.05$). However, there are no significant differences in the error trajectories in the comparisons between groups ALI and ALN or groups ALI and DLD (all with $p>0.05$). Therefore, it seems that the trajectories of errors made in the canonical structures show a similar tendency in all the groups evaluated starting at a receptive vocabulary age of 7:8 years.

INSERT FIGURE 1 ABOUT HERE

Comprehension of non-reversible structures

Likewise, the analyses of errors made in structures of the non-reversible type showed that, generally speaking, as vocabulary age increases, the errors made in this type of structure decrease significantly in all the groups evaluated (r = -0.74, $p<0.001$). The analysis on pairs of groups (see Figure 2) showed that there are significant differences between the groups ALI and TD, and between ALN and TD starting at a receptive

vocabulary age of 5:11 and between DLD and TD starting at a receptive vocabulary age of 5:4 (all with $p<0.05$). Yet there are no significant differences between the groups ALI and ALN, ALI and DLD, ALN and DLD (all with $p>0.05$). Therefore, it seems that the trajectories of errors made in non-reversible structures show a similar tendency in all the clinical groups compared to each other. However, differences do appear when comparing the clinical groups to the TD group starting at a receptive vocabulary age of 5:4.

INSERT FIGURE 2 ABOUT HERE

Comprehension of complex grammatical structures

Comprehension of non-canonical structures

The results show that, generally speaking, as the vocabulary age increases, the errors made in non-canonical structures decrease significantly in all the groups evaluated ($r = -0.67$, $p<0.001$). The analysis on pairs of groups (see Figure 3) showed significant differences between the groups ALI and ALN and between ALI and TD starting at a receptive vocabulary age of 3:11, between ALN and DLD in all the ages evaluated, between ALN and TD starting at 6:8 and between DLD and TD starting at 4:11 (all with $p<0.05$). It seems that, although the tendency of the errors made is similar in all the groups evaluated, the slope of the group ALI differs from the rest starting at a receptive vocabulary age of 3 years, showing that no drop occurs in the errors comparable to that observed in groups ALN and TD. However, no significant differences exist in the error trajectories in the comparisons between groups ALI and DLD (all with $p>0.05$).

INSERT FIGURE 3 ABOUT HERE

Comprehension of reversible structures

The results reveal that, in general, as vocabulary age increases, the errors made in reversible structures decrease significantly in all the groups evaluated (r = -0.71, $p<0.001$). The analysis on pairs of groups (see Figure 4) found significant differences between groups ALI and ALN, ALN and DLD and between groups DLD and TD in all the ages evaluated, between ALI and TD starting at receptive vocabulary age of 4:5 and between ALN and TD starting at 6:8 (all with $p<0.05$). Similarly, the results obtained in the non-canonical structures, although the tendency of the errors made is similar in all the groups evaluated, the slope of the ALI group differs from the rest starting at receptive vocabulary age of 4, showing that there is no drop in the errors comparable to that of the groups ALN and DT. However, there are no significant differences in the error trajectories in the comparisons between groups ALI and DLD (all with $p>0.05$).

INSERT FIGURE 4 ABOUT HERE

Discussion

It remains of great interest to find differences and elements in common between ASD and DLD groups despite the great heterogeneity of symptoms. Although both groups have greater language difficulties in some areas than in other (e.g., pragmatics deficits in ASD), some studies have found profiles with linguistic similarities when comparing the two groups (e.g., Tager-Flusberg, 2006), suggesting the presence of a subtype of individuals with ASD who have impairments similar to those in DLD. In this research, we analyzed the comprehension of Spanish grammatical structures of varying complexity in children with ASD and DLD, compared to children with TD.

The results show that there are significant differences between the groups in the comprehension of structures according to their complexity. Specifically, it seems that the simplest ones (canonical and non-reversible) are those that are best understood,

regardless of group evaluated. For instance, global analyses showed there was no difference between ALI and ALN groups in non-reversible structures. However, the analysis of the more complex structures (non-canonical and reversible) reveals more pronounced difficulties in the ALI and DLD groups with respect to TD and ALN groups. Therefore, the ALI and DLD groups are the ones that present the greatest difficulties compared to ALN and TD.

The differences in grammatical comprehension found in this study could be explained by the deficient lexical knowledge of some of the groups analyzed, thus affecting their syntactic comprehension, as indicated by Tager–Flusberg (1981) for children with ASD. However, the groups were matched in receptive vocabulary age and therefore vocabulary knowledge was similar in all of them. Specifically, children with ALI and DLD presented difficulties in the comprehension of certain types of phrases (especially non-canonical and reversible structures) with respect to children with ALN and TD. The data are consistent with those presented by Leclercq et al. (2014), and Montgomery et al. (2017), who state that children with DLD have greater difficulties processing words in a given sentence context, and in this study the same occurs in children with ALI.

Overall, our results are consistent with those of Tager-Flusberg (1981), who found that comprehension of non-reversible sentences was worse in children with ASD than in TD children who were equal in terms of receptive vocabulary. Children with ASD also had poorer comprehension of reversible sentences than would be expected based on their receptive language (Tager-Flusberg, 1981). Indeed, as discussed above, children with DLD present syntactic difficulties, in contrast, not all children with ASD present this type of difficulty (Durrleman et al., 2016; Janke & Perovic, 2015; Kover et al., 2014; Novogrodsky & Edelson, 2016). We found that, among the two groups of

children with ASD, the ALN group has a different realization than children with TD in terms of the proportion of errors in all structures analyzed.

Furthermore, although visual representations of grammatical error show greater differences between groups as vocabulary increases, this appears to be especially so for complex (i.e., non-canonical) grammatical structures. This might be explained by the fact that these grammatical structures are highly demanding to process because children must use syntactic knowledge of word order to distinguish between the correct and an incorrect interpretation in which the same lexical items are used but the word order is reversed (e.g., "The man chased the dog" versus "The dog was chased by the man"), in a similar vein that reversible structures work (Kover et al., 2014). Thus, our results seem to indicate that it takes more than just vocabulary expansion to achieve grammatical comprehension of more complex structures. In this sense, our results are not aligned with those from Swensen et al. (2007), who found that the underlying deficits may be lexical rather than syntactic in children with ASD.

In general, errors analysis has shown that, in all groups analyzed, as receptive vocabulary age increases, errors decrease, in both the simpler and the more complex structures. However, the results of pairwise analysis of groups seem to indicate differences between them, showing specific patterns when comparing the simpler structures with the more complex ones.

Comprehension of simple grammatical structures in children with ASD (ALI, ALN), DLD and TD

In relation to the simplest structures (canonical and non-reversible), the results show that there is a similar tendency in all groups. Specifically, in the case of canonical structures, the results show that there are no differences between the groups from a vocabulary age equivalent of 7:8 years, with the exception of ALI and DLD groups. It

seems that, albeit at different rate, comprehension of the simpler structures is similar from this age onwards. In the case of non-reversible structures, the results indicate that the ALI, ALN and DLD groups differ from the TD group, showing a larger pattern of errors. Therefore, although the structures are simple, these profiles show different executions.

These results partially support the findings of other authors who have described difficulties in the comprehension of canonical sentences in children with DLD (e.g., Montgomery et al., 2018). However, in the case of non-reversible structures, differences between the clinical groups and the TD group appear from a vocabulary age equivalent to 5:4 years, indicating that although error rates are high at the beginning and similar between groups, the TD group seems to present a higher learning rate than the rest.

Comprehension of complex grammatical structures in children with ASD (ALI, ALN), DLD and TD

Regarding the most complex structures (non-canonical and reversible), the results show a similar trend in all groups. However, participants in ALI and DLD groups do not reach the comprehension levels of other groups from a vocabulary equivalent to 3:11 years. It seems that the error profile is similar in the ALI and DLD children and distances itself from the TD and ALN groups from that age onwards.

Our results support the profiles identified by authors who suggest that children with ALI and DLD have difficulties in understanding complex structures (e.g., Delage et al., 2022). It also highlights that some language profiles of children with ASD are reminiscent of those children with DLD, a statement supported by different studies. It is observed specifically in the comprehension of constructions that do not follow canonical order, such as some relative ones (Frizelle & Fletcher, 2015; Meir &

Novogrodsky, 2019; Sukenik & Friedmann, 2018) or passive constructions (Durrleman et al., 2017; Perovic et al., 2013; Terzi et al., 2014).

Montgomery et al. (2018), coinciding with our results, find that children with DLD present difficulties in the comprehending certain structures, especially those that do not follow SVO order. Despite this, they claim that comprehending sentences represents, for children with DLD, a big effort regardless of the type of structure. However, our results do not agree with those described by Loucas et al. (2008), which show that syntactic difficulties mainly affect structures that do not follow canonical order and, although such difficulties were present in both groups, they were more severe in the DLD group than in the ALI group. In the present study, on the contrary to what was reported in the study conducted by Loucas et al. (2008), no significant differences were detected in the proportion of errors between these groups.

Although these difficulties are manifested in children with ASD and DLD, several studies (Durrleman & Delage, 2016; Sukenik & Friedmann, 2018) show, as our results do, that not all children with ASD have syntactic difficulties. Additionally, these results are consistent with those described by Levy and Friedmann (2009) and Leclercq et al. (2014), who indicate that children with DLD have difficulties interpreting reversible sentences in a particular way, i.e., when semantic or pragmatic knowledge cannot guide them.

Limitations and future studies

This study is not exempt from limitations. Frist, because the criteria used to determine membership in each group have been very strict, the number of participants in each group has been affected. Furthermore, although our study meets the ratio regarding the gender of people with ASD – usually reported in the literature regarding the lower proportion of women included in studies (Shaw et al., 2021) – it would be interesting

for future studies to replicate these analyses in larger samples and with a higher percentage of women, in order to generalize this study's findings. Third, the classification of the complexity of grammatical structures is subordinated to the grammatical constructions included in the test used. Fourth, it would also be interesting to be able to draw connections between these difficulties and other language and communicative skills, such as expressive language or social interaction. Finally, this study highlights the need for detailed studies on syntax in children with ASD and DLD not only in English, but also in different languages, and specifically in Spanish, which would help professionals in their clinical practice.

From this paper, clinical implications can be inferred that help understand these comprehension differences at school is vital in the school environment, since the impact of comprehension difficulties becomes evident as children grow up. As Montgomery et al. (2017) state, comprehension problems can interfere with oral and written communication as school demands increase, potentially affecting their performance. These findings have important clinical implications that can help in the interpretation of the results found in the evaluation of children with ASD and with DLD, as well as when establishing intervention programs favoring the development of receptive vocabulary during the intervention of these children's grammatical comprehension difficulties. First, it is important to evaluate different language domains, especially the one related to grammatical comprehension. The results of this work highlight the need for children with ASD and DLD to receive specific support related to grammatical comprehension of certain structures that are more difficult. In addition, the assessment of non-reversible and reversible sentences in children with ASD can provide information not only about lexical difficulties, but also syntactic difficulties (potentially causing problems in sentence comprehension), which emphasizes the importance not only of the error but

also of analyzing the nature of the error. In this sense, we could find children with difficulties in certain grammatical structures, which could guide the intervention in order to improve their social communication and functioning in general (i.e., by including instructions with a grammatical structure that makes it easy to understand what to do).

Finally, this study could add some implications for diagnosis. For example, it seems that there are certain difficulties in the comprehension of grammatical structures that could help in making a differential diagnosis between ALN and DLD at an early age. In this sense, it seems that before the age of 4 years, there are no differences between groups in the easy non-reversible structures. However, in non-canonical and reversible complex structures, differences do appear before that age, which could help to differentiate between these two clinical groups. Thus, from this work it is clear that, although there are individual differences, we could pay attention to certain particularities that seem consistent according to some disorders (ALI vs DLD) and that would guide the clinician when planning an evaluation or an intervention on receptive language.

Conclusions

The results of the present study indicate that children with ASD and DLD show different language profiles depending on syntactic complexity. In relation to the simplest structures the results show that there are no differences between the groups when they reach an equivalent vocabulary age of 7:8 years. Although the trend is similar in all groups the differences remain significant between the clinical groups and the TD group for some of the simpler (non-reversible) structures and for all the more complex structures from a vocabulary age equivalent to 3 of years. In fact, greater difficulties appear for the ALI and DLD groups in a systematic way, showing a different

profile when compared to the ALN and TD groups. Therefore, given that diverse language profiles have been found in the analyzed groups, different underlying causes could be suggested, which is supported by the work of other authors (Creemers & Schaeffer, 2015; Prévost et al., 2017; Schaeffer, 2018).

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Table 1. Descriptive analysis of the groups

	ALI (N=22)	ALN (N=21)	DLD (N=20)	TD (N=20)	Analysis		
					Statistic	*p*	η^2
Age (SD)	7:3 (0.67)	7:0 (0.46)	7:2 (0.39)	5:6 (0.14)	3.298	0.025	0.110
Gender (M:F)	15:7	17:4	10:10	10:11	3.295	0.362	0.195
Vocabulary age (SD)	5:6 (1.52)	6:5 (1.98)	5:7 (1.23)	6:2 (1.04)	1.694	0.177	0.059
Vocabulary (SD)	15.03 (13.64)	35.48 (18.06)	15.39 (16.83)	74.19 (13.57)	66.660	<.001	0.714
IQ (SD)	96.41 (13.69)	97.14 (14.85)	95.15 (5.41)	104.38 (9.90)	2.656	0.054	0.091

Note: Vocabulary age= Vocabulary age equivalent (years; months) according to PPVT-III (Dunn & Dunn, 2006), Vocabulary=Percentile score according to PPVT-III (Dunn & Dunn, 2006)

Table 2. Analysis of the proportion of errors in the different grammatical structures

	ALI	ALN	DLD	TD	Analysis		
					Statistic	p	η^2
Grammatical structures (SD)							
Canonical	0.68 (0.18)	0.51 (0.19)	0.67 (0.17)	0.43 (0.13)	11.113	<0.001	0.294
Non-reversible	0.58 (0.14)	0.49 (.19)	0.61 (0.15)	0.43 (0.16)	5.476	0.002	0.170
Non-canonical	0.83 (0.12)	0.54 (.19)	0.76 (0.14)	0.49 (0.16)	23.174	<0.001	0.465
Reversible	0.85 (0.10)	0.60 (.15)	0.82 (0.12)	0.57 (0.13)	29.976	<0.001	0.529

Table 3. Results of the linear regression analysis of receptive vocabulary on the grammatical structures.

	Predictor variable: Receptive vocabulary				
	B	SE	β	*p*	R^2
Canonical structures	-0.01	0.001	-0.753	<0.001	0.57
Non-reversible structures	-0.01	0.001	-0.738	<0.001	0.55
Non-canonical structures	-0.01	0.002	-0.666	<0.001	0.44
Reversible structures	-0.01	0.001	-0.713	<0.001	0.51

Figure 1. Trajectories of errors in canonical structures depending on receptive vocabulary age.
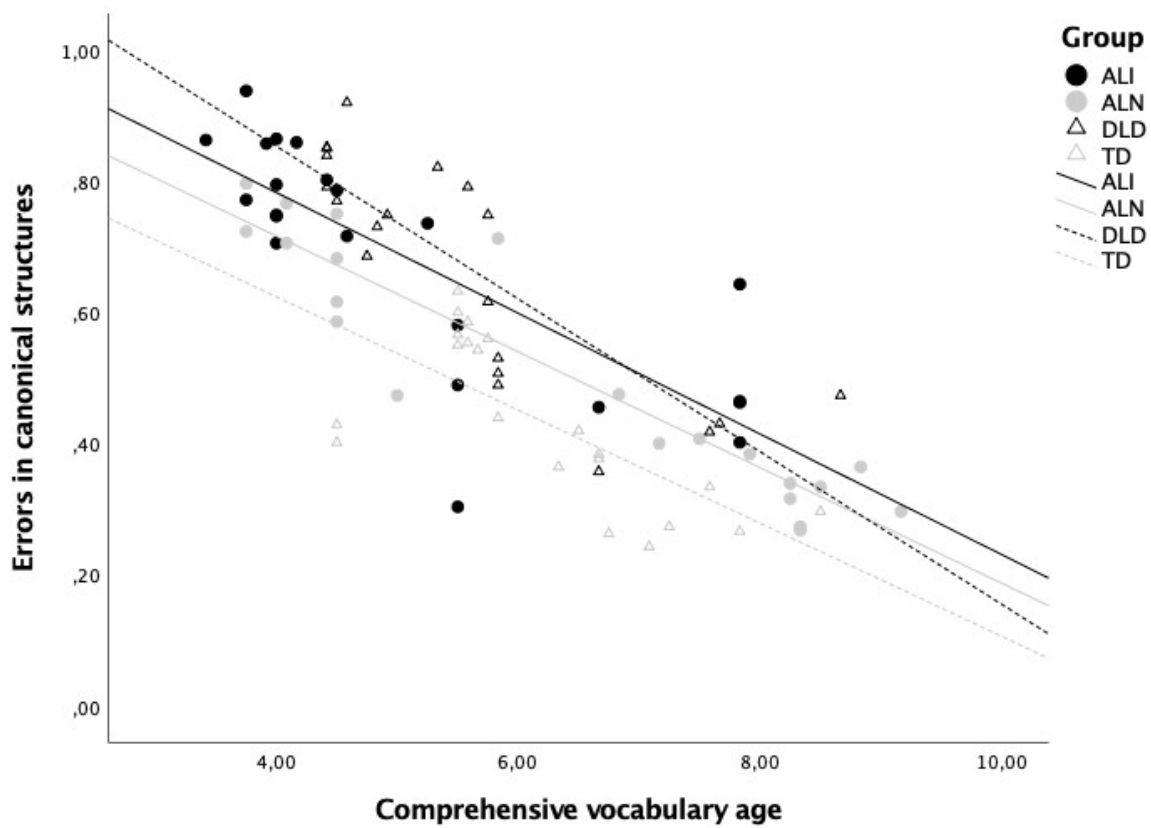
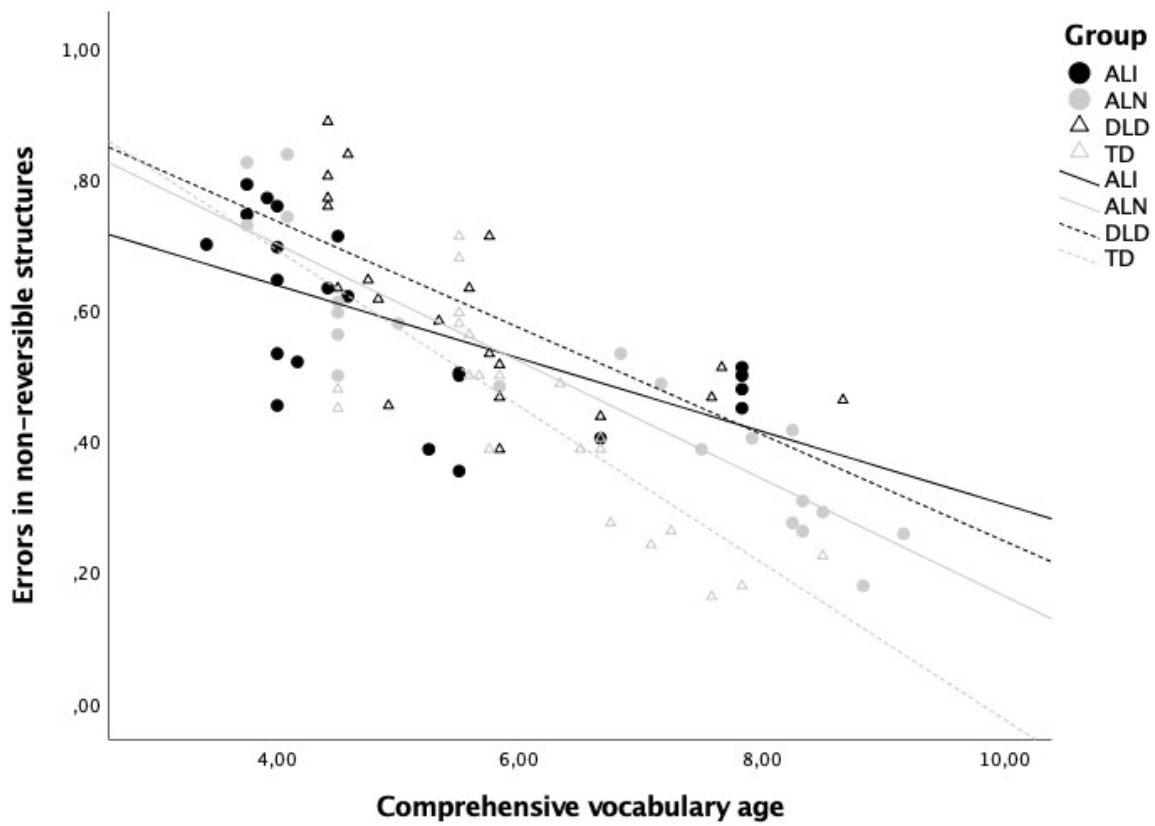Figure 2. Trajectories of errors in non-reversible structures depending on receptive vocabulary age.

Figure 3. Trajectories of errors in non-canonical structures depending on receptive vocabulary age.
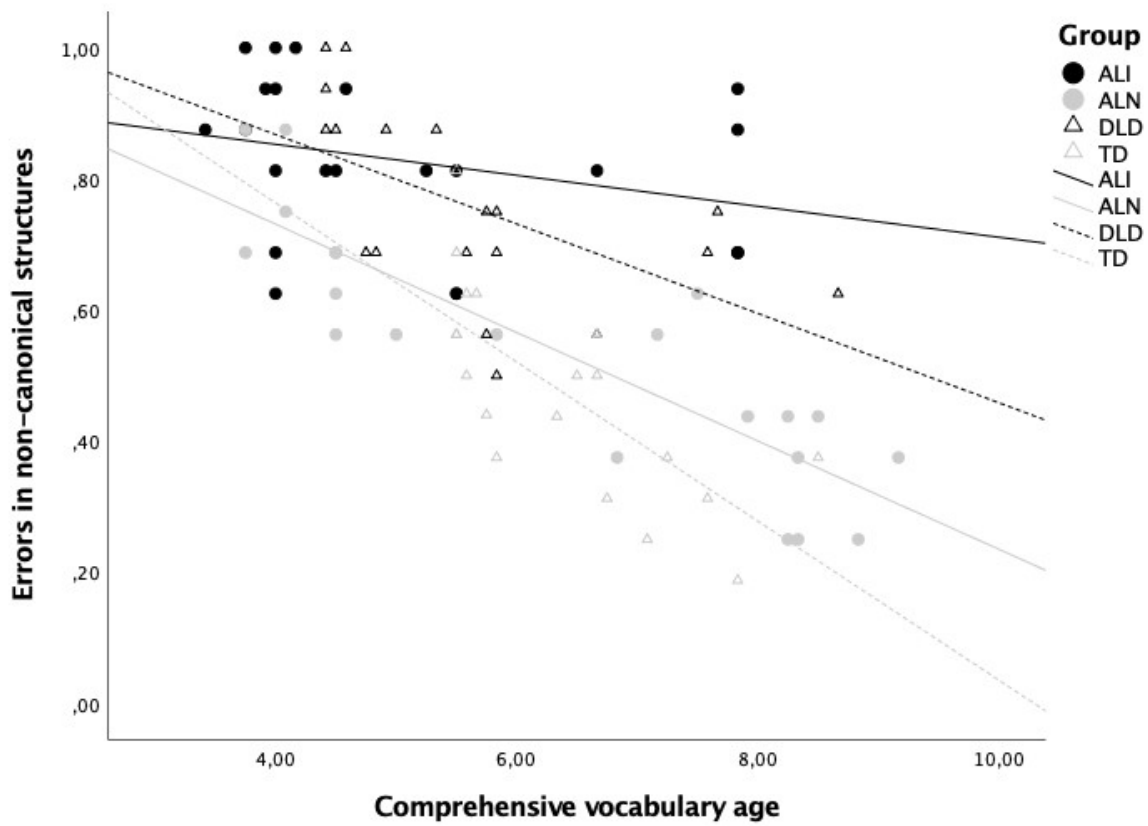
Figure 4. Trajectories of errors in reversible structures depending on receptive vocabulary age.