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Abstract

Background: It has been established that people with autism spectrum disorder (ASD) often have difficulties understanding spoken language. Understanding reflexive and clitic pronouns is vital to establishing reference-based inference, but it is as yet unclear whether such constructions pose specific difficulties for those with ASD. Pronoun interpretation seems be connected to the development of pragmatic abilities, and can therefore be considered a plausible marker in the differential diagnosis between ASD and developmental language disorder (DLD).

Aims: The aim of this study is to establish whether or not there are differences between ASD and DLD in relation to their understanding of pronoun constructions (both reflexive and clitic). The working hypothesis was that although no differences were expected between groups in relation to automatic (online) pronoun processing, the comprehension of reflexive pronouns would constitute a diagnostic marker between the group with ASD and language disorder and the DLD group

Methods & Procedures: This study carried out two experiments with three clinical groups (two with ASD and different levels of language proficiency and one with developmental language disorder) and two control groups with typically-developing people (with equivalent language levels), analysing their on-line and off-line processing in pronoun resolution tasks. The first experiment uses an on-line method (eye-tracking) to record pronoun processing in real time. The second uses an off-line method to analyse comprehension accuracy.

Outcomes & Results: The results of the two experiments indicated no differences in the way in which the clinical and control groups resolved the tasks, but a shorter reaction time was observed only in the age-matched control group in comparison with the ASD group without language disorder in the first

experiment, maybe due to the fact that processing pronouns involves a greater cognitive load among the latter group.

Conclusions & Implications: The comprehension of reflexive pronouns cannot be considered a diagnostic marker for distinguishing ASD from DLD

What this paper adds.

What is already known on this subject.

Previous studies have found that the performance of children with ASD in the comprehension of personal pronouns is equivalent to youngest control groups but poorer regarding the interpretation of reflective pronouns. However, children with DLD do not usually have problems with the use of pronouns, which suggests that their pronoun processing is not affected. As pronoun interpretation seems be connected to the development of pragmatic abilities, it could be considered a plausible marker in the differential diagnosis between ASD and DLD

What this study adds.

Previous studies have focused on assessing pronoun use among the ASD population, and only a very few have sought to measure their comprehension. This paper presents the results of two experiments involving pronoun processing by people with ASD (both with and without language disorder) and people with DLD, in comparison with two control groups, one matched for age and language proficiency with the ASD group and the other matched for language proficiency with the ASD-LD and DLD groups. This design enables us to analyse how reflexive and clitic pronoun processing is related in people with ASD and DLD, regardless of their language proficiency. This paper also uses an off-line and online procedure. This last involving eye-tracking. This procedure allows to obtain data about how the pronouns are processed in real time. The study focuses on how people with ASD and DLD cope with pronoun processing. It represents an attempt to identification of language markers that may help distinguish between the two groups and adapt the interventions to the specific problems experienced by each one. Nonetheless, the results have shown that there are no differences between the groups with respect to clitic and reflexive pronouns comprehension.

Clinical implications of this study.

The results indicate that it is not possible to identify any specific impairment in pronoun processing among the clinical groups (ASD and DLD)

Introduction

The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5, American Psychiatric Association, 2013) defines *autism spectrum disorder* (ASD) as a neurodevelopmental disorder characterised by persistent deficits in social communication and social interaction, coupled with the presence of restricted, repetitive patterns of behaviour, interests, or activities. People with ASD often present intellectual disability (Dykens & Lense, 2011) and structural language impairment (Tager-Flusberg & Joseph, 2003) (for example, difficulty understanding and constructing grammatically correct sentences). Language deficits can range from total absence of speech to a poor understanding of spoken discourse, but in all cases, even when the formal aspects of language appear unaltered, its use in reciprocal social communication is affected (DSM-5, American Psychiatric Association, 2013). It is therefore possible to distinguish between people with ASD and impairments in structural language (ASD-LD) and those with only ASD, even though those in the latter group may also have difficulty understanding spoken language in everyday situations (Tager-Flusberg, Paul, & Lord, 2005).

The DSM-5 also considers *language disorder* (LD) as a communication disorder, characterised by deficits in the acquisition, development and use of language in any of its formats (spoken, written, signed or other) which affect the individual's understanding or production of vocabulary, sentence structure and discourse (DSM-5, American Psychiatric Association, 2013). More recently Bishop, Snowling, Thompson, Greenhalgh, and the CATALISE-2 consortium (2017) have proposed the term *developmental language disorder* (DLD) to refer to children whose language problems (productive or receptive) have a significant impact on everyday functioning, have poor prognosis and are not associated to biomedical conditions. For those language problems with an association with biomedical

conditions the authors recommend referring to ‘language disorder associated with the specific condition’. With respect to DLD, the term ‘developmental’ emphasises the fact that language problems emerge in the course of development, rather than being associated with a known biomedical cause.

For a number of decades now, ASD and DLD have been believed to be related in some way (Brignell et al., 2018; De Fosse et al., 2004; Eigsti & Bennetto, 2009; Kjelgaard & Tager-Flusberg, 2001; Ramirez-Santana, Acosta-Rodriguez, & Hernández-Exposito, 2019; TagerFlusberg, 2006; Terzi, Marinis, Kotsopoulou, & Francis, 2014; Tomblin, 2011; Weismer, 2013), given that the limitations in social development and problems of behavioural inflexibility identified in some children with ASD may stem from their serious problems in the field of language development. Furthermore, the language problems experienced by children with DLD often seem to be associated with difficulties in their social development (Bishop, Chan, Adams, Hartley, & Weir, 2000).

In some cases, the overlap found between ASD and DLD goes further than social communication, posing linguistic problems also that affect the grammatical, semantic and lexical planes (Roberts, Rice, & Tager-Flusberg, 2004). The similarities observed in some studies (i.e. Roberts et al., 2004) between the language impairments presented by those with ASD-LD and those with DLD have led some authors to explore a possible comorbidity between ASD and DLD. However, some authors sustain that the language difficulties present in ASD and DLD are qualitatively different (Tager-Flusberg et al., 1990) and that the overlap occurs in some dimensions and in some developmental stages, but not in all. If this were the case, it would be difficult to argue that the language difficulties observed in the ASD-LD group stem from the disorder's comorbidity with DLD (Williams et al., 2008) or that the similarities detected reflect a common aetiology (Whitehouse, Barry, & Bishop, 2007). Studies which find different language errors between the two groups in relation to nonword, sentence repetition tasks, statistical word learning and syntax (Haebig, Saffran, & Weismer, 2017; Sukenik & Friedmann, 2018) also subscribe to this line of reasoning.

While the study of a possible comorbidity between the two disorders is of great interest, another equally important question is the identification of language markers that may help distinguish between the two groups. This in turn will not only contribute to a better differential diagnosis, but will also help adapt

the interventions carried out to the specific problems experienced by each group. Furthermore, at a theoretical level, these language markers may help provide greater insight into the underlying aetiology. In this sense, the present study focuses on how people with ASD and DLD cope with pronoun processing.

To date, the studies carried out with children with ASD have found that they have difficulties in the use of personal pronouns. Children in this group reverse the use of the pronoun *you* and *I* when talking to both themselves and others more frequently (Naigles et al., 2016) and over longer periods than typically-developing children (Evans & Demuth, 2012). Another documented error in the use of pronouns by children with ASD is that they tend to use proper nouns in contexts where the personal pronoun would be sufficient to ensure understanding (Arnold, Bennetto, & Diehl, 2009). The ability to replace someone's name with an appropriate pronoun requires the speaker to establish a shared context with their listener and to clearly distinguish between new characters in the story and those that are already known (Arnold et al., 2009), and this skill may be impaired in people with autism.

The experiments carried out by Hobson, Lee and Hobson (2010) are also related to the difficulties in the use of personal pronouns. Here, the authors compared children with and without autism in relation to their understanding and use of first person plural pronouns (*we* and its equivalents *us* and *ours*) and the third person singular pronouns. In a group of 15 children and adolescents with autism (mean age: 14.8) and 15 children and adolescents with learning difficulties (mean age: 14.8), matched for non-verbal IQ, the authors failed to find any significant differences in the use of *we*, but did find a less frequent use of third person pronouns among those with autism. They also found a positive correlation between the frequency of use of *we/us/ours* and the interpersonal connectedness rate in both groups, although the group of children with autism was found to have a lower interpersonal connectedness rate in relation to the evaluator participating in the task. When they used the pronoun *he* they tended to look less at the reference subject and return the evaluator's gaze less frequently than their counterparts without autism. This poorer performance in the case of the pronoun *he* in relation to the first person plural prompted the authors to consider the possibility that this was not due to a deficit in personal pronoun production, but rather to a lack of engagement in the communicative act. Nevertheless, since

the sample group included children with autism and intellectual disability, the data cannot be directly extrapolated to children with a higher level of intellectual functioning. Furthermore, the comparison group comprised children and adolescents with learning difficulties. Therefore, the differences cannot be extrapolated to the comparison between children with autism and children with typical development.

Another series of studies observed that children and adults with ASD produce more ambiguous subject pronouns than their typically-developing peers when narrating a story (Norbury & Bishop, 2003; Novogrodsky & Edelson, 2016). These errors in the use of pronouns are linked to pragmatic deficits characteristic of people with ASD that manifest themselves when the speaker attempts to create a shared mental context with his or her listener (Norbury, Gemmell, & Paul, 2014). It is therefore logical to assume that these errors occur in both those with ASD and those with ASD accompanied by language disorder (ASD-LD). The aspect that has attracted most attention to date is pronoun production, and within that field the use of subject pronouns, since these are the most frequent ones used in spoken discourse. However, other types of pronouns (object pronouns, possessive pronouns and reflexive pronouns) may also be affected by pragmatic deficits, although only a few studies have focused on their analysis. One exception is the study by Novogrodsky and Edelson (2016), which analyzes subject, object and possessive pronouns in a sample of children with high functioning ASD aged between 6 and 14, and a group of typically-developing children matched with the first group for chronological age and verbal cognitive proficiency based on the Woodcok-Jonhnson III (Woodcock et al., 2001). The results revealed that children with ASD produced more ambiguous pronouns when telling a story than their typically-developing counterparts, despite the fact that the group of children with ASD did not contain any with language impairment (the ASD and control groups were matched for verbal cognitive proficiency) and had age-appropriate syntactical performance. The differences in the use of pronouns was qualitative (i.e. more ambiguous pronouns) rather than quantitative (i.e. no difference in the number of pronouns used) and affected both subject and possessive pronouns.

Previous studies have mainly focused on assessing pronoun use among the ASD population, and only a very few have sought to measure their comprehension. One of those that has is the aforementioned study by Hobson et al. (2010) on first person plural and third person singular pronouns. Here, the authors

found no differences between children and adolescents with autism and those without autism but with learning difficulties, which were matched for chronological age and verbal mental age. A similar result was reported by a study conducted by Perovic, Modyanova and Wexler (2013) with a sample group of 14 children with ASD aged between 6.6 and 17 years. The study compared participants' comprehension of personal and reflexive pronouns in relation to that of typically-developing children (aged between 3 and 9 years). The performance of children with ASD in the comprehension of personal pronouns was found to be equivalent to the two youngest control groups, one matched for non-verbal IQ and the other matched for receptive grammar, but poorer than both these control groups regarding the interpretation of reflective pronouns. In light of these results, the authors concluded that children with ASD had the same difficulty understanding personal pronouns as younger children, but the difficulties observed in the comprehension of reflexive pronouns could not to attributed (in the authors' opinion) to a general language delay, but was rather due to an impaired grammatical knowledge specific to children with ASD. According to Perovic et al. (2013) the interpretation of reflexive pronouns depends on one's mastery of syntax; however, if that were really the case, then surely we should expect the same type of errors in children with DLD, but unlike children with ASD, children with DLD do not usually have such frequent problems with pronoun reversal (Lindgren et al., 2009) nor with pronouns in narrative discourse (Van Der Lely, 1997), which suggests that their pronoun processing is not affected. According to Hamann (2001), pronoun interpretation seems be connected to the development of pragmatic abilities, and can therefore be considered a plausible marker in the differential diagnosis between ASD and DLD. The aim of this study is to establish whether or not there are differences between the two groups in relation to their understanding of pronoun constructions (both reflexive and clitic). These constructions require speakers to make a connection between the pronoun and its antecedent:

(1) *Juan pidió a Pedro que **le** limpiara los zapatos* - Juan asked Pedro to clean his (i.e. Juan's) shoes.

(2) *Juan pidió a Pedro que **se** limpiara los zapatos* - Juan asked Pedro to clean his (own) shoes.

The main different lies in the fact that in the first sentence, the antecedent of the pronoun 'le' is the name that appears at the beginning (Juan), whereas in the second sentence the antecedent of the pronoun

'se' is the name located nearest (Pedro). If the connection between the pronoun and its antecedent is not made correctly, the resulting sentence loses its original meaning and cannot be fully understood. To avoid this happening, it is necessary to fully understand the semantic and pragmatic aspects involved in the selection of the correct antecedent. Previous studies (Love, Walenski, & Swinney, 2009) have observed that children as young as 4 correctly resolve the pronoun reference in the second type of sentence (2) during an online task, but tend to make mistakes in the first type of sentence (1) because they associate the pronoun with the name located closest to it. The second type of sentence (type 2) is resolved by interpreting the reflexive pronoun in accordance with its syntactical role, while in the first type (type 1), the interpretation of clitic pronouns requires syntactical and pragmatic knowledge (Perovic et al., 2013).

Many different methods have been used to study impairment patterns in pronoun processing, including both off-line techniques (such as drawing-statement pairing) and online procedures (such as those involving eye-tracking). The first type of procedure provides information about errors in the comprehension of pronoun phrases, while the second complements this information by offering data about how those phrases are processed in real time.

This paper presents the results of two experiments involving pronoun processing by people with ASD (both with and without language disorder) and people with DLD, in comparison with two control groups, one matched for age and language proficiency with the ASD group and the other matched for language proficiency with the ASD-LD and DLD groups. This design enables us to analyse how reflexive and clitic pronoun processing is related in people with ASD and DLD, regardless of their language proficiency.

The first experiment uses an on-line method (eye-tracking) based on the paradigm described by Thompson and Choy (2009) to record pronoun processing in real time. The second uses an off-line methodology based on the paradigm employed by Love et al. (2009) to analyse comprehension accuracy. The aim of these experiments is to answer the following two questions: a) is off-line comprehension of pronoun phrases affected in the same way or differently among people with ASD (with or without language disorder) and those with DLD?; and b) are the eye movement patterns of the

two groups during the processing of pronoun references different from those of their typically-developing control groups?

In relation to the first question, and consistently with the results reported by Perovic et al., 2012), there is a link between pronoun resolution and pragmatic deficits. Thus, off-line comprehension of clitic pronouns among young people with ASD, with and without language disorder, was expected to be similar to that of their typically-developing peers, matched for language and non-verbal IQ. Similarly, participants with DLD were expected to perform similarly to their language proficiency-matched peers. In relation to the off-line comprehension of reflexive pronouns, since this process is more closely linked to a mastery of pragmatics and syntax, young people with ASD-LD (although not the other experimental groups) were expected to perform more poorly than their control group.

In relation to the second question, as with typically-developing children analysed in other studies (Love et al., 2009), all the groups were expected to show typical behavior in the on-line real-time processing tasks because all the groups have a language proficiency as least equivalent to the children control group.

EXPERIMENT 1: Automatic (on-line) processing of personal pronouns.

Materials and method

Participants

The sample group comprised 73 Spanish monolingual subjects divided into five different groups: two control groups and three clinical ones. The data pertaining to the different groups is presented in table 1. One of the clinical groups comprised children with ASD but within-normal-range language performance, defined as 'high language proficiency' subjects (ASDHL group) (n = 15; 13 boys and two girls; mean age = 12.22 years; SD = 3.38; 7.20 – 18.10). Another comprised children with ASD and low language proficiency (ASDLL) (n = 13; 13 boys; mean age = 12.18 years; SD = 3.22; 6.61 – 17.61), and the third was made up of children with DLD (n = 15; nine boys and six girls; mean age = 10.44

years; SD = 1.92; 7.90 – 14.70). All those with ASD had received a clinical diagnosis of this development disorder, and the condition was further operationalised and confirmed (Calibrated Severity Score > 7) by expert evaluators, using the AQ (Autism-Spectrum Quotient, Baron-Cohen, Wheelwright, Skinner, Martin & Clubley, 2001) and ADOS-2 (Autism Diagnostic Observation Schedule, Second Edition, Lord et al., 2015) instruments. Furthermore, the low language proficiency of those in the DLD and ASDLL groups was confirmed using the CEG test (Mendoza, Carballo, Muñoz, & Fresneda, 2005) (see the description below). In all cases, subjects scored lower than the 20th percentile. For the clinical groups, all participants had a nonverbal IQ over 80 and those in DLD had ADOS scores above threshold for ASD.

For the control groups, all participants did not meet criteria for ASD or for learning disabilities, language delays, or other behavioral or psychiatric disorders and also had a nonverbal IQ over 80.

The first control group had an equivalent age to all three clinical groups (AGE-matched group) (F (3, 54) = 1.184, p =.325) (n = 15; five boys and 10 girls; mean age = 11.83 years; SD = 3.12; 7.17 – 18.06), while the second one had an equivalent language proficiency to those in the ASDLL and DLD groups (LL-matched group), measured using the CEG test (F (2, 40) = .135, p =.875) (n = 15; 13 boys and 2 girls; mean age = 6.86 years; SD = 2.77; 3.10 – 13.00).

The three low language proficiency groups (ASDLL-DLD-LL-matched groups) had equivalent levels of non-verbal IQ, measured using Wechsler's Intelligence Scales for children (WISC- IV) and adults (WAIS-III) (Wechler, 2001, 2005) (X^2 (2) = 5.249; p = .072), as well as equivalent language levels, measured using the CEG test (X^2 (2) = .137; p = .934). Furthermore, the two normal-range language proficiency groups (ASDHL-AGE groups) were also matched in related to both variables (Z= -1.226; p = .220; Z= -.417; p = .677, respectively). The homogeneity of the distribution of the data in the matching variables, across the different contrast groups, was guaranteed by applying the Kolmogorov-Smirnov test.

Children with ASD were recruited from local autism associations, control group and children with DLD were recruited from local schools of middle-class neighborhoods in Andalusia, Spain. In the case of participants with DLD, schools and speech and language therapy centres were contacted to locate

individuals aged 6 to 14 years old with a diagnosis of DLD.

INSERT TABLE 1 AROUND HERE

Instruments and procedure

The Grammar Structure Comprehension Test (CEG, Mendoza, Carballo, Muñoz, & Fresneda, 2005) was used to determine language proficiency. This test was inspired by the Test for the Reception of Grammar (TROG) and is similar in format to the PPVT-III. This test assesses grammar comprehension of increasing difficulty in school children aged between 4 and 11 with typical language development, and in children and adults with various linguistic problems. According to the test manual, the age range can be extended with people who have specific language disorders and other problems that may affect language comprehension. The test has shown a very high relative criterion validity, with CEG-Peabody correlation values (r = .809, p < 0) and CEG-ITPA (r = .644, p < 0) (Muñoz-López, Fresneda, Mendoza-Lara & Carballo, 2008).

It uses a multiple-choice paradigm in which respondents must choose which of the four drawings provided best corresponds to the statement read out by the examiner. Thus, the test is made up of 80 elements, distributed in 20 blocks of four elements each, which encompasses the most representative grammatical structures in the Spanish language. Since it does not measure verbal response, it is an ideal instrument for the purposes of this study, given the characteristics of our participants. For the participants over age 11, the maximum norms available for this instrument were applied. The maximum direct score that can be obtained is 80, and the reliability index of the instrument, measured using Cronbach's α coefficient, is over .9.

The experimental material used was designed in accordance with the Thompson and Choy paradigm (2009), in which participants listen to a short three-sentence story in Spanish. The first sentence introduces the two characters, the second (the critical sentence) describes a transitive event and the third affirms the event without providing any additional information. At the end of each story, participants are asked a question to check their comprehension. One example of the stories used is given in table 2.

INSERT TABLE 2 AROUND HERE

A total of 90 stories were created, divided into three different lists each containing 30 stories with a homogeneous mix of the two experimental conditions and a filler condition. In one of the experimental conditions the critical sentence contained the clitic pronoun '*le*', in the second one it contained the reflexive pronoun '*se*' and in the third condition, the critical sentence had a similar structure but no anaphora (filler items). All the items were counterbalanced between the lists and randomly assigned to participants.

At the same time, four different figures were shown on a screen. Two of them corresponded to the characters included in the story (in the example, an old man and a farmer), with one being the target and the other the competitor. The role of target or competitor stimulus is relative to the experimental condition in question, so in reference to the example, which belongs to the clitic pronoun condition, the target would be the picture of the old man and the competitor the picture of the farmer, but in the reflexive condition it would be the other way round. In addition to the pictures of the characters in the story, participants were also shown another two featuring a human distracter (in the example, the picture of a butcher) and one of the objects mentioned in the story (in the example, a hat). Each picture occupied one of the quadrants of the screen and all were shown in black and white to avoid any bias stemming from some chromatic elements standing out over others (see figure 1).

INSERT FIGURE 1 AROUND HERE

Participants were instructed to listen carefully to the story while looking at the screen and to answer the question asked at the end. Questions were posed in yes/no format and participants answered by pressing the corresponding key on the keypad in front of them. The audio recordings were loud enough to enable comfortable listening and the stories were read out by a monolingual Spanish woman. The procedure included two practice items before the presentation of the experimental items. Data was collected in individual working sessions lasting appropriately 40 minutes, under controlled laboratory conditions, the testing was conducted in a quiet and uncluttered room. Eye movement data was recorded using the SR Research Eyelink 1000 system at a sampling speed of 500 Hz and monitoring of the dominant eye (determined by the participant's manual dominance), with no chin rest. The task was carried out on a

laptop computer with a 15inch screen that complied with all the recommendations specified by the material manufacturer and had a resolution of 1280 x 720 pixels.

By tracking participants' eye movements, the system records their fixations on different stimuli (pictures) and their synchronization with different periods of interest, which were previously defined in relation to the different syntactical elements of the stories (see table 2): SN1, SN2, object, pronoun, verb (to which the pronoun is linked) and circumstantial complement. The result was a series of measures indicating the response precision to the questions asked (off-line comprehension), reaction time (measured from the end of the question to the issuing of the response) and proportion of fixations on the different areas of interest, defined by the quadrants around the corresponding pictures (see figure 2) (online processing).

The experimental tasks were piloted before their application in a sample of a typical developing subject to ensure the intelligibility of the stimuli, the correct operation of the computer programming and the experimental apparatus.

Depending on the participant characteristics, the tests were individually applied in two or three sessions: one or two for CEG and Wechsler's scales and another for the experimental tasks. Each session was approximately 60 minutes in length.

This research project was conducted in accordance with all ethical requirements and with the 1964 Helsinki declaration. The Andalusian Regional Biomedical Research Ethics board approved recruitment and data collection procedures and the signed and informed consent of all participants (or their legal guardians) was obtained before the start of the tests. All participants and their guardians were informed that they were free to withdraw consent to participation at any time and that their refusal to participate would not lead to adverse consequences. All participants were highly motivated to collaborate performing the tasks.

Results

Due to the non-normality of the data, the decision was made to use non-parametric comparison tests using the SPSS (v-22) statistical package. The significance level was set at .05, and the Bonferroni correction was applied when necessary to correct the problem of multiple testing. The effect size measure used was Cliff's Delta, since it is an appropriate statistic in non-parametric comparison.

The different groups were compared in accordance with the planned comparison method, with comparisons being drawn between the AGE and ASDHL groups, as well as between the ASDLL, DLD and LL groups, as the best strategy for achieving the established research aims. On the other hand, the variable gender in each group has been analyzed and is not related to any of the variables included in the design.

Behavioural results

This section analyses the behavioural results obtained in the experimental tasks, specifically reaction time (RT) and percentage of correct answers in the comprehension test (CA). The mean RTs were calculated on the basis of the correct answers given for each item in the comprehension test, with observations that involved ±2 SD in relation to the mean RT for each subject in each experimental condition being eliminated as outliers. A total of 9.7% of the observations were eliminated as a result of this criterion. The descriptive statistics pertaining to the different groups are given in table 3.

INSERT TABLE 3 AROUND HERE

In relation to the first planned comparison (ASDHL vs. AGE), the results of the Mann-Whitney U test revealed significant differences between RTs in both experimental conditions, with participants in the AGE group responding more quickly in both the reflexive condition (Z=-2.800, p=.005, Δ=.6) and the clitic pronoun condition (Z=-2.136, p=.033, Δ=.457). Nevertheless, no differences were observed in the percentage of correct answers, for which variable both groups scored equally (Z=-1.191, p=.233 and Z=-1.272, p=.203 for the reflexive and clitic conditions, respectively). Nor were any significant

differences observed in the second planned comparison, in which the ASDLL, DLD and LL groups were compared using the Kruskal Wallis test, for either RT (reflexive: X^2 (2)=2.873, p=.238; clitic: X^2 (2)=2.331, p=.312) or percentage of correct answers (reflexive: X^2 (2)=.210, p=.900; clitic: X^2 (2)=1.076, p=.584).

If we analyse the comparisons made between the two experimental conditions in each of the groups, the results of the Wilcoxon signed ranks test indicate no statistically significant differences for either RT or percentage of correct answers except in the RTs of the AGE group, in which participants were found to respond more quickly to questions involving reflexive pronouns than to those featuring clitic ones (see table 4).

INSERT TABLE 4 AROUND HERE

Eye Movements

The mean proportion of fixations on the target and competitor for each of the conditions and in each of the groups is shown in figure 2. The sentence regions corresponding to the pronoun (Pro), verb (Ver) and Complement (Com) are represented because together they correspond to the predicate of the sentence and it is in these regions that the pronoun construction process takes place (Thompson & Choy, 2009). In Spanish, unlike in English, both reflexive and clitic pronouns come before the verb, which is why as early on as in the Pro region it is possible to distinguish between target and competitor processing.

INSERT FIGURE 2 AROUND HERE

As shown in figure 2, if we compare the eye movements of the ASDHL and AGE groups, we detect a similar pattern in both experimental conditions for each of the target and competitor stimuli, with the profile of the ASDHL group being somewhat less marked than that recorded for the control group. In the reflexive condition, in both groups the proportion of fixations on the target in comparison with the competitor is greater in the Pro region, which is exactly the opposite of what happens in the clitic pronoun condition.

In order to determine the existence of any inter-group differences, for each participant, a summary variable was calculated consisting of the differences between the proportion of fixations on the target and on the competitor for each of the regions of the sentence predicate. Thus, it is possible to compare the way in which participants in each group processed the task in each of the sentence regions and in each experimental condition. The results of the comparison between the ASDHL and AGE groups using the Mann-Whitney U test revealed no significant differences in any of the regions (Pro: Z=-.603, p=.546; Ver: Z=-.808, p=.419 and Com: Z=-.705, p=.481) in either the reflexive condition or the clitic one (Pro: Z=-.479, p=.632; Ver; Z=-1.199, p=.231 and Com: Z=-.975, p=.330), indicating that both groups seem to behave in the same way regarding on-line pronoun processing.

The visual inspection of the results for the 'low language proficiency' groups and their respective control group reveals an inverted profile in the latter between the two conditions. Thus, in the reflexive condition, the number of fixations on the target is greater in the Pro region and then decreases gradually until the Com region, just the opposite of what happens with the number of fixations on the competitor. In the clitic pronoun condition the reverse relationship was observed between the number of fixations on the target and the number of fixations on the competitor in the Pro and Com regions. The two clinical groups (ASDLL and DLD) were found to have a similar but 'flatter' pattern, with less accentuated differences.

The comparison carried out between the ASDLL, DLD and LL groups using the Kruskal Wallis test, revealed no statistically significant differences between the three groups in any of the sentence regions involved in pronoun resolution, in either the reflexive condition (Pro: X^2 (2)=2.209, p=.331; Ver: X^2 (2)=1.489, p=.475; Com: X^2 (2)=.665, p=.717) or the clitic one (Pro: X^2 (2)=3.494, p=.174; Ver: X^2 (2)=.161, p=.923; Com: X^2 (2)=3.494, p=.174), indicating a similar execution of the task by all three.

Discussion

The results of the first experiment indicate no differences in the way in which the clinical and control groups resolved the task, at least as far as success rate is concerned. In this sense, the results are consistent with those reported by Hobson et al. (2010) on first person plural and third person singular pronouns, with no differences being found in their study between children and adolescents with ASD and those without ASD but with learning difficulties. The results regarding participants' comprehension of the pronoun condition are also consistent with those reported by Perovic et al. (2013) in relation to the comprehension of personal pronouns. However, a difference was observed between the two sets of results in relation to participants' comprehension of reflexive pronouns, with Perovic et al. finding (unlike in the present study) significant differences between children and adolescents with ASD and younger typically-developing children matched for non-verbal IQ and receptive grammar. The reason for this disparity between the two studies may be the fact that Perovic et al. (2013) used possessive subjects (‘Bart’s dad’) in their sentences rather than noun phrases (‘the judge’), as we did in our case, and this may have generated a greater degree of confusion among participants when associating the reflexive pronoun with its local antecedent.

In our study, a shorter reaction time was observed only in the AGE group in comparison with the ASDHL group. This difference may be a reflection of the fact that processing pronouns involves a greater cognitive load among the latter group, in comparison with the former, since even in the absence of language impairments, people with ASD may have difficulty understanding discourse in everyday situations (Tager-Flusberg, Paul, & Lord, 2005). In the comparison between the ASDLL, DLD and LL groups, no differences were observed in reaction time since all three groups were matched for language proficiency and the performance of the ASDLL and DLD groups was being compared with that of a group of younger typically-developing children.

Nevertheless, the most interesting result obtained in this experiment stemmed from the eye movement analysis. We had expected to find similar eye movement patterns in all groups during the processing of pronoun references, and this is indeed what we observed. The eye movement data gathered reveal that

pronoun resolution is carried out in the same way by the different clinical groups and their corresponding control groups.

The graphic analysis shows similar profiles and the statistical contrasts carried out indicate no significant differences in the profile of fixations on the different sentence regions that are most relevant for pronoun resolution. The results therefore seem to support our working hypothesis in relation to this question.

Given that observed with typically-developing children in other studies (Love et al., 2009), we expected to find that, even though the groups with language impairment (ASDLL and DLD) performed no worse in real-time processing tasks, they would have difficulty in off-line tasks. This was particularly true for the ASDLL group, since the use and comprehension of pronouns is a particularly difficult aspect for these children (Arnold et al., 2009; Evans & Demuth, 2012; Naigles et al., 2016; Norbury & Bishop, 2003; Novogrodsky & Edelson, 2016), However, the results of the first experiment do not support this hypothesis. Nevertheless, the data obtained in experiment 1 regarding off-line pronoun processing cannot be considered definitive since although the paradigm included off-line processing measures, it was not specifically designed to gather detailed information about the explicit processes involved in this activity. This was the aim of experiment 2, which also included a visual support in picture form to accompany the comprehension of sentences featuring pronouns. Here, the type of task used is more similar in format to that employed by Perovic et al.(2013).

EXPERIMENT 2: Conscious (off-line) pronoun processing.

Method

Participants

The participants in this second experiment were the same as those described for the first experiment, both regarding the global sample and the configuration of the different clinical and control groups, whose composition was identical to that described above.

Instruments and procedure

For this second experiment and, in accordance with the paradigm proposed by Love et al. (2009), an acceptability judgment task was used regarding the use of reflexive and clitic pronouns. The task consisted of 30 sentences divided into two series of 15 which were identical except for the type of pronoun they contained. Thus, 15 sentences were created with reflexive pronouns and another 15 with clitic pronouns, which together made up the two experimental conditions used in the experimental design. For example:

- *El canguro **se** está poniendo los guantes en el gimnasio* (the kangaroo is putting the gloves on himself in the gym).

- *El canguro **le** está poniendo los guantes en el gimnasio* (the kangaroo is putting the gloves on him (the other kangaroo) in the gym).

In each test, a sentence is read out while at the same time two pictures appear on the screen. Participants must listen to the sentence and choose the picture that they believe best reflects the scene described. For the reasons outlined in the previous experiment, the images were presented in black and white (see figure 3).

A list was created in which the order in which the items were presented was counterbalanced, and steps were taken to ensure that the two versions of the same sentence (i.e. the two experimental conditions) were presented as far apart as possible. The percentage of correct answers was recorded, along with reaction time measured from the start of the sentence.

INSERT FIGURE 3 AROUND HERE

Participants were asked to listen carefully to the sentence while looking at the screen, and to select the picture which best represented the oral description they were listening to using the keyboard in front of them (two clearly differentiated keys). Participants took part in this experiment under the same

conditions described in the corresponding section of Experiment 1. The only difference was the duration of the working sessions, which in this case was approximately 20 minutes.

Results

As in the previous experiment, non-parametric comparison tests were selected for the data analysis, using the same statistical package. The significance criteria and statistics for estimating the effect size were also the same as in the first experiment. Similarly, the comparison of the different groups followed the same planned comparison logic, with the ASDHL-AGE groups being compared first, followed by the low language proficiency groups (ASDLL, DLD and LL).

The variables analyzed were reaction time (RT) and percentage of correct answers in the acceptability judgment test (CA). Mean RT values were calculated on the basis of the correct answers given, and any considered to be outliers (13%) were excluded from the analysis (any response time outside the ±2 *SD* margin in relation to the mean RT for each subject in each experimental condition was considered an outlier). Table 5 contains the descriptive data for each group.

INSERT TABLE 5 AROUND HERE

In the first planned comparison (ASDHL vs. AGE), no statistically significant differences were observed between either the two conditions in each group or between the groups themselves. The results of the Wilcoxon signed ranks test reveal that the RTs and CAs were similar for the two experimental conditions in both the AGE (RT: Z=-.227, p=.820; CA: Z=-.463, p=.643) and the ASDHL groups (RT: Z=-1.477, p=.140; CA: Z=-.085, p=.932). No differences were observed between the groups in either of the two experimental conditions for RT (reflexive: Z=-.898, p=.369; clitic: Z=-1.497, p=.134) or percentage of correct answers (reflexive: Z=-1.842, p=.065; clitic: Z=-1.146, p=.252).

The second planned comparison revealed similar results to the first, with no significant differences being observed when the ASDLL, DLD and LL groups were compared using the Kruskal Wallis test for either RT (reflexive: X^2 (2)=.253, p=.881; clitic: X^2 (2)=1.003, p=.606) or percentage of correct

answers (reflexive: X^2 (2)=.002, p=.999; clitic: X^2 (2)=456, p=.796). No differences were found either between the two conditions within each group, for either of the two variables analysed using the Wilcoxon test. Similar results were recorded for all three groups, both regarding RT (ASDLL group: Z=-.734, p=.463; DLD group: Z=-.682, p=.496; LL group: Z=-1.704, p=.088) and in relation to CA (ASDLL group: Z=-1.192, p=.233; DLD group: Z=-.630, p=.529; LL group: Z=-1.416, p=.157).

Discussion

The second experiment analysed the explicit anaphoric processing carried out by the different clinical groups and compared it with that carried out by their respective control groups. The results indicate that all groups behave similarly regarding their interpretation of both reflexive and clitic pronouns. The first planned comparison, which focused on the groups with a higher language proficiency, both with and without ASD, supports the hypothesis that, consistently with that found in other studies (Perovic et al., 2013), both groups are equivalent with regard to pronoun comprehension. The second planned comparison revealed similar results, with no statistically significant differences being observed between the clinical ASDLL and DLD groups and their respective control group in relation to pronoun comprehension. In contrast to what was expected, children and adolescents with ASD and language disorder did not perform any worse than their respective controls in relation to their understanding of clitic pronouns, and nor did those in the DLD group.

General discussion

This study analyses pronoun comprehension (reflexive and clitic) in a group of children and adolescents with ASD, with and without language disorder, a group of children and adolescents with DLD and two groups of typically-developing children and adolescents.

The working hypothesis was that although no differences were expected between groups in relation to automatic (online) pronoun processing, the comprehension of reflexive pronouns would constitute a

diagnostic marker between the group with ASD and language disorder and the DLD group. Nevertheless, the results reveal that all three clinical groups performed similarly to their respective age-matched (in the case of the ASDHL group) and language proficiency-matched (in the ASDLL and DLD groups) control groups regarding the processing of reflexive and clitic pronouns.

The explanatory hypothesis regarding the existence of a possible difference between the ASDLL group and its language-matched control group in relation to the comprehension of reflexive pronouns was based on the idea that this poorer performance would be associated with pragmatic and syntactical deficits. However, given that the expected differences were not in fact observed, the comprehension of reflexive pronouns cannot be considered a diagnostic marker for distinguishing ASD from DLD. This finding is inconsistent with that reported by Perovic et al. (2013). One possible explanation is that mentioned earlier in this paper: the different type of sentences used in the two studies (possessive subjects in Perovic et al.'s case and noun phrases here). Also the task involved only the comprehension of sentences, not discourse, with which children with ASD may have more difficulty (Åsberg, 2010).

Another consideration to bear in mind is that it may not be possible to directly extrapolate results obtained in English to a Spanish-speaking context, since the syntactical structures are different in the two languages (Pérez-Leroux, Cuza, & Thomas, 2011). As explained earlier, in Spanish (unlike in English), both reflexive and clitic pronouns come before the verb, and it may be that this alters the way in which such constructions are processed, so in English it would be interesting to explore possible differences among similar groups using the same tasks.

The only parameter in which the ASDHL group was observed to perform differently from its typically-developing age-matched control group was that of response time in pronoun processing, with the clinical group taking longer to respond. This has been attributed to the high cognitive load involved in linking pronouns to their antecedents for those with ASD, due to their pragmatic deficits.

Nevertheless, it should be remembered that participants in this study included children and adolescents with ASD and language disorder but within-normal-range IQ, whose language difficulties may differ from those experienced by others with a lower cognitive level (Boucher, Bigham, Mayes, & Muskett,

2007). Hence, the results obtained are limited solely to the former group (i.e. ASD with language disorder and within-normal-range IQ).

The results of this study show that the differences found in previous research regarding pronoun production are not evident in relation to comprehension, perhaps because in this study the task was less cognitive demanding (comprehension of sentences vs production of narratives). Indeed, the aforementioned differences were not observed either when the task involved retelling a story, but were evident only when participants were asked to produce a narrative story (Novogrodsky & Edelson, 2016). In the two experiments carried out here, participants merely listened to sentences while looking at pictures depicting some of their elements (in the first experiment) or representing the scenario described (in the second experiment). This type of picture-based task is a typical one used in the speech therapy sessions attended by these children, and may therefore be overly familiar to them, thus facilitating resolution.

Another limitation, which may be responsible for the absence of differences between groups, is linked to the characterisation of the participants. Subsequent studies should strive to ensure a more diverse group of participants regarding the language dimensions affected by their disorder, establishing sub-groups in accordance with this criterion. This will perhaps enable differences to be identified in the processing of clitic and reflexive pronouns which, on the basis of the data collected here, cannot be considered evidence for establishing useful linguistic markers for diagnosing people with ASD and DLD.

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Table 1

Sample characteristics

	ASDHL group n = 15	ASDLL group n = 13	DLD group n= 15	LL-matched group n = 15	AGE-matched group n = 15	*p* value of the comparison
Age	12.22 (3.38)	12.18 (3.22)	10.44 (1.92)	6.86 (2.77)	11.83 (3.12)	ASDHL = ASDLL=DLD=AGE > LL**
Non-verbal IQ	110.93 (15.19)	100.15 (14.77)	96.86 (8.89)	108.33 (13.23)	104.33 (13.44)	ASDLL=DLD=LL/ASDHL=AGE
Language proficiency	74.40 (3.83)	57.00 (11.78)	57.66 (5.77)	58.93 (11.75)	73.80 (4.19)	*ASDLL=DLD=LL<AGE=ASDHL***

Note. Age and Non-verbal IQ: Mean and standard deviation (in parentheses).

Language proficiency: CEG (raw scores).

Labels for groups: ASDHL (Autism Spectrum Disorder with 'High Language proficiency' group), ASDLL (Autism Spectrum Disorder with 'Low Language proficiency' group), DLD (Developmental Language Disorder group), AGE (Age-matched group) and LL (Language proficiency-matched group).

**$p < .01$; *$p < .05$ (Bonferroni correction applied).

Table 2

Example of the story used in experiment 1 and interest periods defined for the eye movement analysis.

Sentence 1	*Un abuelo y algunos agricultores estaban en una granja (An old man and some farmers were on a farm)*					
Sentence 2 (critical)	SN1	SN2	OBJECT	CLITIC / REFLEXIVE	VERB	COMPLEMENT
	El abuelo	*pidió al agricultor*	*con sombrero*	*que* ***le/se***	*despertara*	*al amanecer,*[1]
Sentence 3	*y él lo hizo (and he did)*					
Comprehension question	*¿**le/se** despertó el agricultor al amanecer? (did the farmer wake him up/wake up at dawn?)*					

[1] The old man asked the farmer to wake **him/himself** up at dawn.

Figure 1

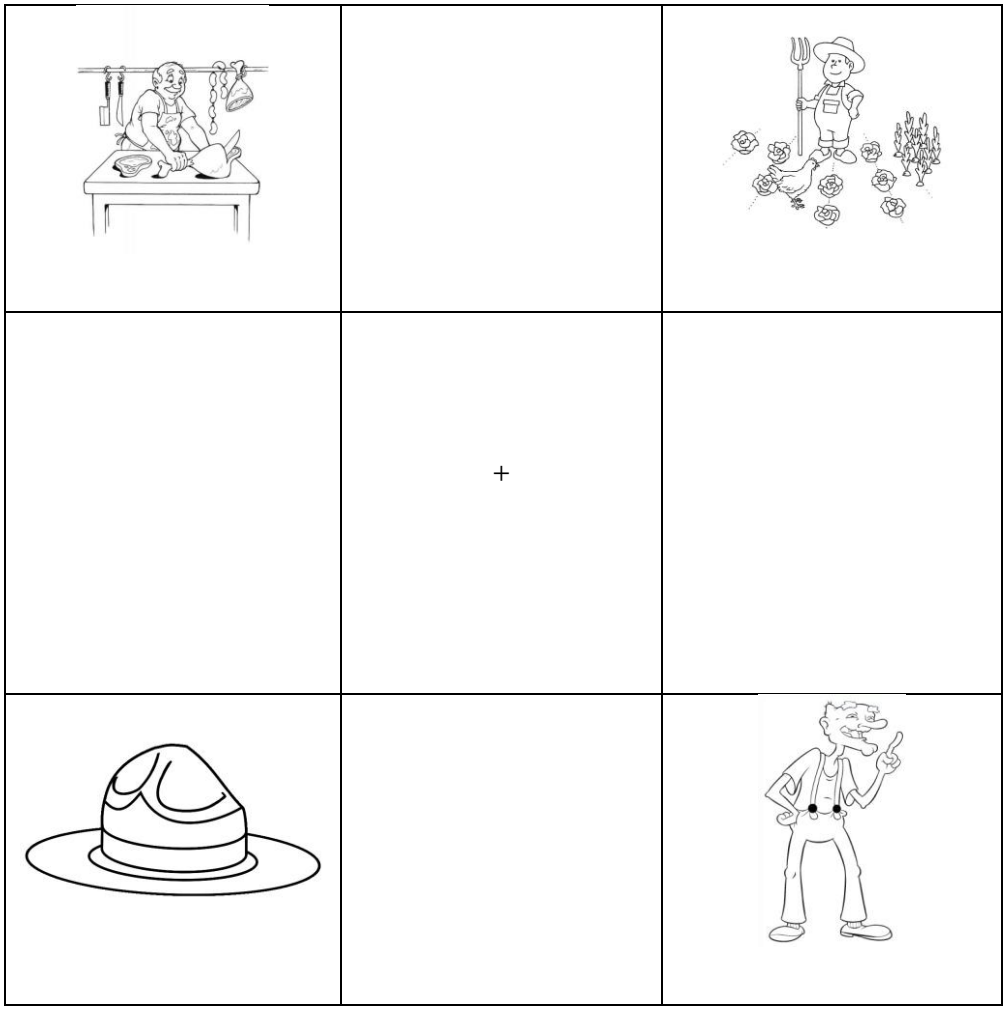

Fig. 1 Example of a screen used in experiment 1.

Table 3

Experiment 1. Mean RTs (in milliseconds) and percentage of correct answers.

	ASDHL group *n* = 15	ASDLL group *n* = 13	DLD group *n* = 15	LL group *n* = 15	AGE group *n* = 15
Reflexive condition					
Mean RT	3344	3339	3192	4306	1890
	(1676)	(2062)	(1.035)	(2.141)	(463)
Percentage of correct answers (CA)	79.18	62.48	59.81	59.28	72.81
	(23.36)	(19.61)	(15.88)	(17.96)	(21.23)
Clitic condition					
Mean RT	3039	3134	3429	4280	2151
	(1538)	(1527)	(1.595)	(2.091)	(577)
Percentage of correct answers (CA)	69.64	56.81	50.05	53	74.51
	(15.54)	(18.5)	(19.09)	(12.26)	(16.63)

Note. Mean and standard deviation (in parentheses).

Labels for groups: ASDHL (Autism Spectrum Disorder with 'High Language proficiency' group), ASDLL (Autism Spectrum Disorder with 'Low Language proficiency' group), DLD (Developmental Language Disorder group), AGE (Age-matched group) and LL (Language proficiency-matched group).

Table 4

Experiment 1. Results of the comparison between the experimental conditions (reflexive and clitic) in mean RT (in milliseconds) and percentage of correct answers, in each of the groups.

	ASDHL group *n* = 15	ASDLL group *n* = 13	DLD group *n* = 15	LL group *n* = 15	AGE group *n* = 15
Mean RT	*Z*=-1.363, *p*=.173	*Z*=-0.314, *p*=.753	*Z*=-0.625, *p*=.532	*Z*=-0.398, *p*=.691	*Z*=-1.988, *p*=.047, Δ=.26
Percentage of correct answers (CA)	*Z*=-1.948, *p*=.051	*Z*=-0.578, *p*=.563	*Z*=-1.221, *p*=.222	*Z*=-1.352, *p*=.176	*Z*=-0.220, *p*=.826

Note. Labels for groups: ASDHL (Autism Spectrum Disorder with 'High Language proficiency' group), ASDLL (Autism Spectrum Disorder with 'Low Language proficiency' group), DLD (Developmental Language Disorder group), AGE (Age-matched group) and LL (Language proficiency-matched group).

Figure 2

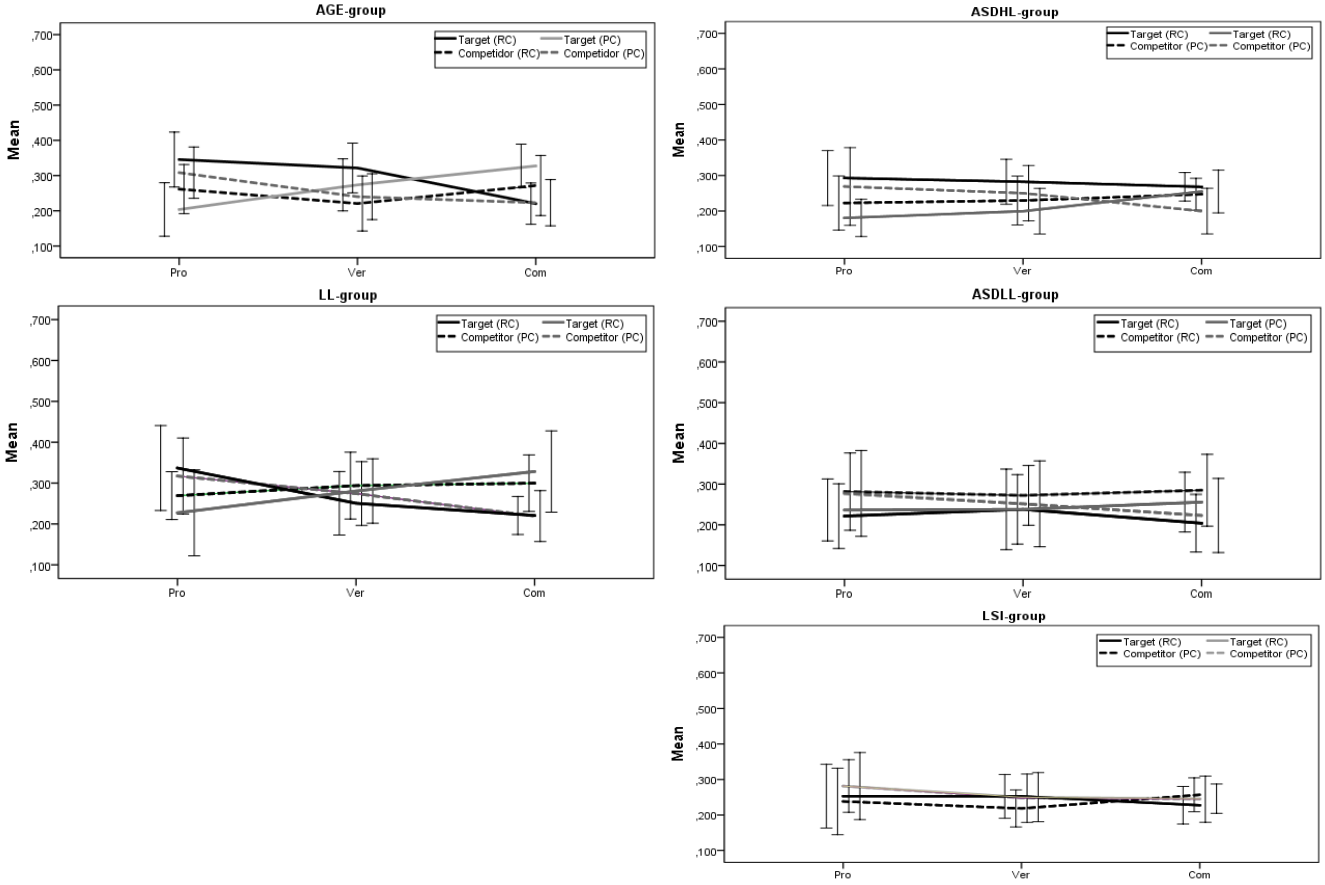

Fig. 2 Mean value of the proportion of fixations during the periods of interest on the verb (Ver), pronoun (Pro) and complement (Com) in each group. Black type indicates data for the reflexive condition (RC) and grey type indicates data for the clitic condition (CC). The unbroken line represents records for the target and the dotted line represents records for the competitor. Error bars: 95% CI.

Figure 3

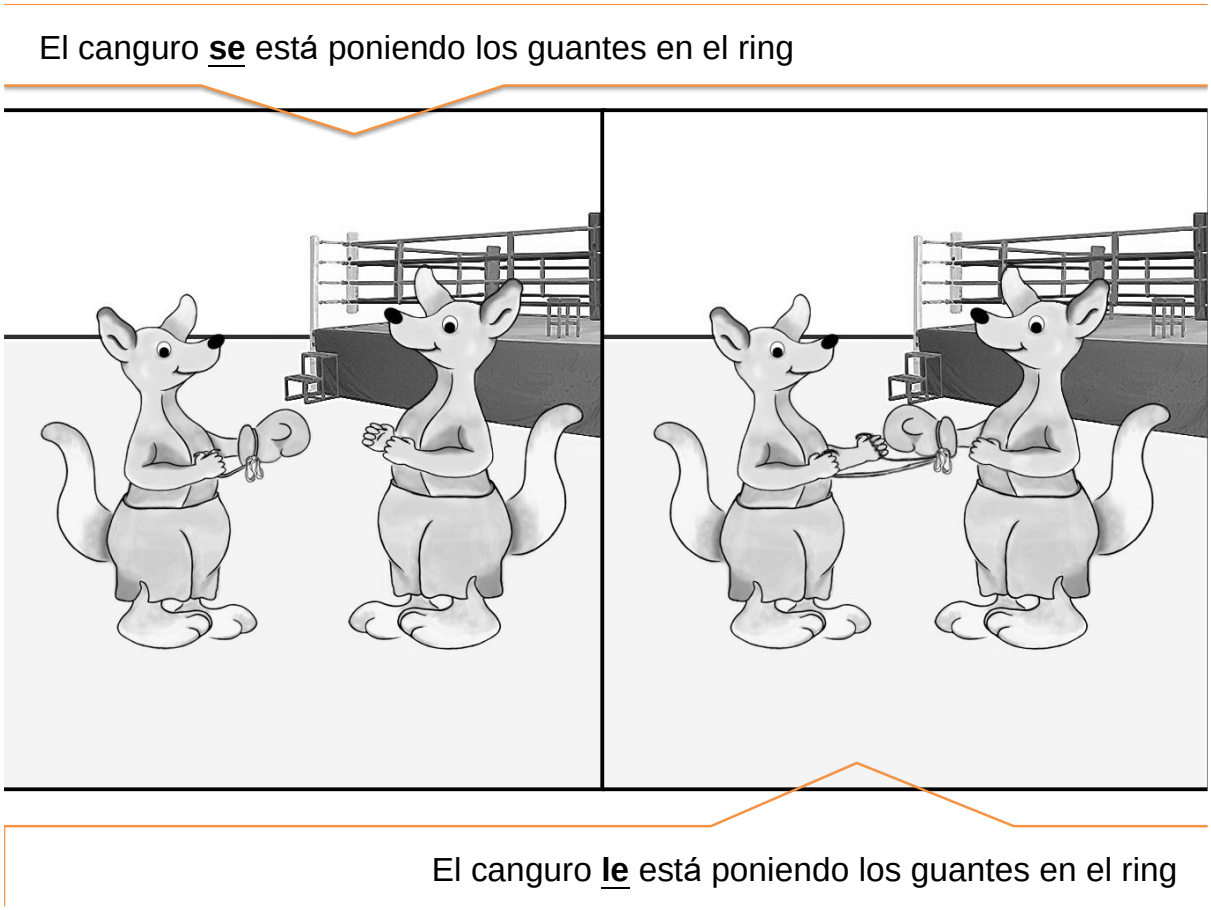

Fig. 3 Example of a screen used in experiment 2. Two situations are presented visually and one sentence read out (the transcriptions are shown in the illustration for information purposes only), and participants must select the drawing that best fits what they have just heard.

Note. Sentence 1: -*El canguro **se** está poniendo los guantes en el gimnasio* (the kangaroo is putting himself gloves on in the gym). Sentence 2: -*El canguro **le** está poniendo los guantes en el gimnasio* (the kangaroo is putting him (the other kangaroo's) gloves on in the gym).

Table 5

Experiment 2. Mean RTs (in milliseconds) and percentage of correct answers.

	ASDHL group *n* = 15	ASDLL group *n* = 13	DLD group *n* = 15	LL group *n* = 15	AGE group *n* = 15
Reflexive condition					
Mean RT	2927	3355	3014	3499	2534
	(1.539)	(2070)	(1449)	(2670)	(1099)
Percentage of correct answers (CA)	93.77	76.41	78.22	78.22	91.55
	(18.59)	(25.32)	(20.54)	(18.42)	(9.58)
Clitic condition					
Mean RT	2227	3012	3237	2614	2385
	(1437)	(1261)	(1827)	(1383)	(1056)
Percentage of correct answers (CA)	93.33	83.07	82.66	85.33	90.22
	(16.52)	(23.5)	(16.48)	(17.12)	(7.5)

Note. Mean and standard deviation (in parentheses).

Labels for groups: ASDHL (Autism Spectrum Disorder with 'High Language proficiency' group), ASDLL (Autism Spectrum Disorder with 'Low Language proficiency' group), DLD (Developmental Language Disorder group), AGE (Age-matched group) and LL (Language proficiency-matched group).