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RESEARCH

The comprehension of passives in Autism Spectrum Disorder

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This study investigates the comprehension of passives in children with Autism Spectrum Disorder (ASD). Subsets of children with ASD have been previously found to present linguistic profiles reminiscent of Specific Language Impairment (SLI), a condition including difficulties with certain constructions displaying noncanonical word orders. However, research on one such construction, passives, is sparse and remains inconclusive. Furthermore, studies on typical development of passives in French are lacking. Twenty French-speaking children with ASD (mean age 9;3), including children with both normal and delayed nonverbal levels, were compared to 20 age-matched typically-developing (TD) children and to 65 younger TD children split into groups of children aged 4–5, 6–7 and 8–9 years. Various passive types were assessed via a sentence-picture matching task: eventive versus psychological, and short versus long. Most children with ASD showed difficulties on passive constructions as compared to age controls, although with the same basic pattern of performance. More subtle delay on passives was evident in a subgroup who was otherwise unimpaired on standardized assessments of vocabulary and morphosyntax, while a pronounced delay on passives was detectable in another subgroup also displaying more general lexical and morphosyntactic impairment. Difficulties with passives were dissociated from nonverbal abilities and working memory. The findings reveal that the syntax of passives is delayed in ASD, not deviant. This delay was attested even in the subgroup with seemingly intact general language skills as revealed by standardized assessments, suggesting that subtle difficulties with this construction may be present and go undetected by global language tests. Performance on passives was unrelated to nonverbal abilities, in line with work suggesting that the linguistic phenotype of some children with ASD resembles SLI. This underscores the importance of careful assessment of the language abilities of children with ASD, including those within normal IQ range.

Keywords: Autism Spectrum Disorder; passives; syntax

1 Introduction

One of the hallmarks of Autism Spectrum Disorder (ASD) is impaired communicative skills (DSM-V, APA 2013), with delays and deficits in language often being amongst the first symptoms noticed (Kurita 1985; Short & Schopler 1988; Lord & Paul 1997). Language abilities are highly heterogeneous, ranging from an absence of functional language to fluent speech (Lord et al. 2006), although throughout the spectrum pragmatic impairments are attested (Tager-Flusberg 1996). Consequently, pragmatic impairments have attracted considerable attention from researchers (Baltaxe 1977; Happé 1995; Ozonoff & Miller 1996; Baron-Cohen 1997; Chin & Bernard-Opitz 2000; Reddy et al. 2002) while the development of formal aspects of language have been comparatively less investigated. Some early reports suggested intact morphosyntactic abilities (Tager-Flusberg 1990;

Lord & Paul 1997), though other studies recognized impairment in this domain and noted similarities with specific language impairment (SLI), a condition defined by language deficits in the presence of intact cognitive abilities (Rapin & Allen 1988; Allen 1989). More recently, scholars have devoted more attention to grammar, identifying syntactic deficits, though exploration of the relation between these and nonverbal cognitive levels has given rise to mixed results (see, for example, Roberts et al. 2001, who concluded that the two are causally linked, and Prévost et al., 2017; Tuller et al. 2017, who concluded that they are not). That language impairment and nonverbal abilities can be dissociated in ASD is reminiscent of SLI, and some researchers have indeed argued that subgroups on the autistic spectrum may present language profiles reminiscent of SLI, displaying impairments in phonology and syntax (Kjelgaard & Tager-Flusberg 2001; Roberts et al. 2004; Tager-Flusberg 2006), possibly because there is a shared etiology (Bishop 2010). In support of this view, one of the hallmarks of SLI, namely difficulty in verbal working memory (Gathercole & Baddeley 1990; Montgomery 2002; Hick et al. 2005; Montgomery & Evans 2009; Marinis & Saddy 2013), has indeed been reported in subgroups with ASD as well, and found to relate to syntax (Roberts et al. 2004; Eigsti 2009; Kjelgaard & Tager-Flusberg 2010; Riches et al. 2010; Durrleman & Delage 2016). In the current work, we asked if the comprehension of passive constructions, a vulnerable domain in SLI (van der Lely 1996; Rice et al. 2001; Leonard et al. 2006), is impaired in a similar fashion in ASD. Focusing on French-speaking children with ASD, we furthermore sought to determine whether any observed impairment represented a qualitative difference, or merely a delay with respect to typical development of passives. Finally, we investigated whether such impairment for passives would be dissociated from nonverbal intellectual abilities and related to deficits in working memory, as appears to be the case for grammatical deficits in SLI.

1.1 Grammatical abilities in children with ASD: An overview

Early work exploring morphosyntax in ASD by means of measures of spontaneous language production (such as Mean Length of Utterance or The Index of Productive Syntax) have led to claims that children with ASD show similar grammatical competence to that of typically-developing (TD) peers of comparable mental age (Bartak et al. 1975; Pierce & Bartolucci 1977; Tager-Flusberg et al. 1990). More recent work applying targeted experimental tasks has uncovered specific grammatical deficits that do not clearly stem from general cognitive level (Roberts et al. 2004; Terzi et al. 2012; Perovic et al. 2013; Prévost et al., 2017). This strikes a parallelism with SLI, a condition where language fails to develop normally in the absence of other cognitive deficits. Various scholars have thus attempted to elucidate the nature and extent of overlap between ASD and SLI (Tager-Flusberg 2004; Bishop 2010; Tomblin 2011), with some claiming that subgroups of children with ASD present language profiles similar to that of SLI (e.g. Kjelgaard & Tager-Flusberg 2001; Roberts et al. 2004; Tager-Flusberg 2006; Riches et al. 2010; Prévost et al., 2017; Durrleman & Delage 2016).

Various structures involving noncanonical word orders, such as accusative clitics (1), object relative clauses (2) and object wh-questions (3), have all been found to be affected even in higher-functioning individuals on the spectrum (Riches et al. 2010; Terzi et al. 2012; Prévost et al., 2017; Durrleman et al. 2015; Durrleman & Delage 2016).

(1) Jean **la** voit.
John her/it sees
'John sees **her/it**'

(2) **The girl** that John sees.

(3) **Which girl** does John see?

The noncanonical order of these constructions is due to the internal (accusative) argument undergoing syntactic fronting. Another construction where this is found is passives. Passive structures, the focus of the current investigation, have scarcely been studied in the population with ASD and the existing studies have yielded conflicting findings, as we will explain in the following section.

1.2 Passive structures and their acquisition

The properties listed in (4) are characteristic of a passive structure (Siewierska 2011):

(4) a. The passive has an active counterpart.
b. The internal (accusative) argument of the active is promoted to be the subject of the passive construction (receiving nominative case in many languages).
c. The external (nominative) argument of the active is demoted to be the oblique phrase, and is expressed overtly only optionally.
d. The passive uses a special (verbal) morphology

While TD children of age 18 months already understand an actional/eventive sentence such as (5) (Hirsh-Pasek & Golinkoff 1991), their comprehension of the corresponding passive structure in (6) only emerges around the age of 5 (e.g. de Villiers & de Villiers 1973; Strohner & Nelson 1974; Harris 1976; Deen 2011; Hirsch 2011):

(5) The girl kicked the boy.

(6) The boy was kicked (by the girl)

Various grammatical accounts have been put forth to explain the transformation involved in passives and why it would be delayed in acquisition. It has been proposed that these structures involve argument movement (A-movement) giving rise to a chain between the gap in post-verbal position (where the internal argument was initially merged and its thematic role assigned) and the pre-verbal subject position, and children's difficulties have thus been attributed to a delayed acquisition of A-chains (Borer & Wexler 1987, 1992). Other authors have rather focussed on the intervention of the logical subject (*John/PRO* in (7)) on the chain created by passive movement, and explained selective delays with these structures rather than with A-movement across the board (in line with Hyams & Snyder 2005, 2006; Snyder & Hyams 2015).[1,2]

(7) The book was written by [$_{vP}$ **John/PRO** write <the book>]

According to this view, difficulties with passives would be amenable to the locality principle of Relativized Minimality (RM) (Rizzi 1990, 2004; Starke 2001), which states that

[1] See Snyder & Hyams (2015) who recapitulate literature attesting to the fact that young children are successful with other A-movement constructions, such as reflexive clitics in Romance and certain raising constructions, where intervention does not arise.

[2] It is important to note that a syntactically represented external argument would intervene on the chain formed by the internal argument in passives, whether explicitly realized or implicit, and thus this applies also in instances of short passives (see e.g. Collins 2005; Ortifelli 2012a, b; Snyder & Hyams 2015).

a local relation between X and Y cannot hold if there is an intervener, Z, which has the same structural features as X.

(8) X … **Z** … Y

Passives have also been analysed as involving "smuggling", an operation where a chunk moves past an intervener (see W in example 9a), with the consequence that a section of this chunk can move higher without locality violations. Indeed according to RM, the external argument in Spec,vP should block A-movement of the object to Spec,IP. Instead, the smuggling analysis involves the chunk, PartP (corresponding to YP below), moving to Spec,VoiceP (XP below), a position c-commanding the intervening logical subject (W in 9a, John/PRO in 9b). As such, Spec,IP becomes attainable for the internal argument thanks to smuggling via Spec,VoiceP (the escape hatch).

(9) a. Z $[_{YP}$ XP] W <$[_{YP}$ XP]> Collins (2005)
b. <**the book**> was $[_{PartP}$ <**the book**> written <DP>] $[_{VoiceP}$ by $[_{vP}$ **John /PRO** <write **the book**>

For the purpose of the acquisition of passivization, the complexity of chunk-movement would imply it being difficult for children under 4 years old, either because the operation itself is maturationally unavailable before that age (Snyder & Hyams 2015), or because of the limited computational capacity of younger children (Belletti & Guasti 2015). The various analyses thus all converge to suggest that passives are challenging to acquire.

Within the realm of passive types, some are more difficult for children than others. Those including the *by*-phrase, referred to as long passives, have been reported to emerge later in the development of some languages than passives without the *by*-phrase, where the agent is omitted (Horgan 1978). This has been hypothesized to be due to children's difficulties transmitting the agent theta role within the *by*-phrase (Fox & Grozdinsky 1998). Another view is that short passives may be parsed as adjectival passives (Borer & Wexler 1987), which are produced earlier than verbal passives (Israel et al. 2001). Empirical support for the view that adjectival passives are easier than verbal passives comes from languages where the adjectival participle is realized differently to the verbal participle. In these cases, children clearly acquire adjectival passives early while verbal passives continue to show a delay (see Berman & Sagi 1981 for Hebrew; Terzi & Wexler 2002 for Greek). That an adjectival interpretation is more easily accessible to children would follow from these structures being derivable without movement, while movement operations are necessary for verbal passives (whether of the logical object or of the entire VP chunk containing it).

The idea that children apply an adjectival analysis when faced with (short) actional passives has also been appealed to in order to account for earlier mastery of these structures (6) than psychological passives (10), which disallow an adjectival analysis and still remain problematic at least until age 5–6 (Maratsos et al. 1985; Borer & Wexler 1987; Hirsch & Wexler 2006). The corresponding actives of (6) and (10) do not show this difference (Gordon & Chafetz 1990; Fox & Grodzinsky 1998; Hirsch & Wexler 2006; Perovic et al. 2014).

(10) Bart was loved by Lisa.

Indeed, while children can interpret passives of eventive verbs as adjectival passives (e.g. *The teddy was/looks torn; The torn teddy*), psychological verbs are generally ill-formed as adjectival passives (e.g. *This teddy was/?/*looks loved; ?/*The loved teddy*).[3] A non-movement analysis of psychological passives is thus impossible, and in light of the view that smuggling is only consolidated after the age of 4 (Snyder & Hyams 2015), younger children are expected to struggle with psychological passives.

Still, the necessary consolidation of smuggling cannot alone explain the delay associated with psychological/stative passives, which are clearly delayed past age 4 (Hirsch & Wexler 2006; Hirsch et al. 2006). What more would be required for success with psychological passives? According to Grillo (2008) and Gehrke & Grillo (2008), the passivization of stative verbs implies "semantic coercion", i.e. type-shifting to a change of state predicate (i.e. accomplishments or achievements). This is because for these authors, passives necessarily involve the zooming in on a consequent state subevent which entails both a revision of the semantics of the predicate (checking if it can have a inchoative reading) and a revision of the syntactic structure of the predicate (involving VP-movement to Spec,VoiceP). This operation of type-shifting would thus add additional processing complexity, as reported already for coercion in other domains (see Pinango et al. 2006; Brennan & Pylkkänen 2008), and explain why only older children are successful at psychological passives. As an illustration of how the type-shifting operation works: the sentence *Lisa loves/fears Bart* would need to be coerced into *Lisa has come to love/fear Bart* before being passivized into *Bart is loved/feared by Lisa*. Evidence in favour of the view that coercion of this sort is required for passivization comes from the fact that those stative verbs which resist coercion cannot be transformed into passives. For example, *Bart appeals to Lisa/The solution escapes Lisa* cannot be coerced into **Bart has come to appeal to Lisa*, nor **The solution has come to escape Lisa*, and in turn cannot be passivized: **Lisa is appealed to by Bart; *Lisa is escaped by the solution*. The later development of psychological passives would arguably be related to a delay in the ability to handle semantic coercion, according to Grillo (2008) and Snyder & Hyams (2015). Psychological passives are acquired once the child has received sufficient input from the linguistic environment to know which verbs are passivized (Snyder & Hyams 2015).

Being structures which emerge later in TD, passives are also susceptible to being affected in instances of atypical development. Difficulties with passives are reported to persist into adolescence in William's Syndrome (Perovic & Wexler 2010), Down's Syndrome (Perovic 2006) and grammatical SLI, where reversible, full verbal passive constructions are problematic (van der Lely 1996; Bishop et al. 2000; Norbury et al. 2002; Montgomery & Evans 2009, a.o.). Interestingly, these populations also show deficits in verbal working memory (e.g. Rhodes et al. 2011 for William's Syndrome; Baddelely & Jarrold 2007 for Down's Syndrome; Gathercole & Baddeley 1990; Hick et al. 2005 for SLI), and working memory resources have been hypothesized to be involved in the processing of passives (Montgomery 2002; Montgomery & Evans 2009). Due to the movement operation involved, these structures require storing of the NPs of the sentence in memory before syntactically and semantically integrating with the verb phrase thanks to the cue provided by the passive morphology (e.g. Gibson 1998; Gordon et al. 2004; Gordon et al. 2006). According to the view that the complexity of passive structures significantly relates to working memory resources, it is expected that populations with difficulties in the mastery of passives will also display deficits in working memory. This perspective has gained empirical support from a recent study by Marinis & Saddy (2013) involving children with

[3] Still, as pointed out by Hirsch & Wexler (2006), the dichotomy between actional and psychological passives is imperfect in that some psychological verbs give rise to well-formed adjectival passives (*a remembered poem*) while some actional verbs do not (?? *a held letter*). The relevant criterion, they suggest, is rather whether or not a given verb can yield a resultative passive thanks to their involving a target state (see also Embick 2004), which is indeed more generally (if not always) the case for actional verbs than psychological verbs.

SLI (N = 25, MA = 7 years old), showing a correlation between the processing of passives and working memory abilities measured by a listening recall task (Pickering & Gathercole 2001). Working memory has not been extensively studied in children with ASD, and there is currently a debate about whether working memory is impaired in individuals with ASD (see, for example, Bennetto et al. 1996 versus Russell et al. 1996), and what the underlying cause might be, with some suggesting that performance may be qualitatively atypical (Belleville et al. 2006).

Work on passives in ASD is limited. One unpublished study (Perovic et al. 2007) reports difficulties with these structures in English. These authors used a sentence-picture matching task to explore both verbal passives with an obligatory eventive interpretation, as in (1b), as well as psychological passives, as in (10). Perovic et al. (2007) speculated that if grammar was not impaired in ASD, their participants (N = 11, 6; 6–16 years old, mean age = 11) would show either intact knowledge of both types of passives, or at least knowledge comparable to that of younger TD controls functioning at similar mental-age (MA) levels, i.e. difficulties with psychological, but not actional passives. Their results indicate that children with autism performed poorer than verbal and non-verbal MA-matched controls on all types of passives, i.e. both short and long, and with actional/eventive and non-actional/psychological verbs. Difficulties in the TD groups were only apparent with psychological passives. The authors concluded that children with autism lack A-chains and moreover, due to their underdeveloped grammar, they cannot even resort to a linguistic strategy of interpreting eventive passives as adjectival passives (Borer & Wexler 1987).

Work by Terzi et al. (2014) assessed the comprehension of Greek passives in a cohort of 20 Greek-speaking children with autism (age 5–8 years, mean age 6;08). The nonverbal abilities of all of these children, as measured by RPM, was 80 and above. Their performance was compared to that of a control group of twenty TD children of similar chronological age. Groups in this study showed similar levels of performance; the authors concluded that this similarity was due to the fact that the children with ASD tested were all high functioning, implying that there is a relationship between the general cognitive level and grammatical skills with passives.

A more recent study (Gavarró & Heshmati 2014) assessed the comprehension of actional passives in 10 Persian-speaking children with ASD (5–13 years old, mean age 8;9 years) in an attempt to reconcile the findings of Perovic et al. (2007) and Terzi et al. (2014). The authors split their participants into two groups of five considered either as "high" or "low" functioning according to their scores on Raven's Coloured Progressive Matrices (RPM) (Raven et al. 1986). They reported that the high-functioning subgroup performed like TD controls, while the lower-functioning group experienced difficulties. More precisely, the lower-functioning group performed significantly worse on both short and long passives, and moreover showed impairment for actives. Given the sample size, however, and the apparent lack of Iranian RPM norms, these findings have to be interpreted with caution.

To sum up, subsets of children on the autistic spectrum have been found to present linguistic profiles reminiscent of SLI, including difficulties with verbal working memory (Kjelgaard & Tager-Flusberg 2001) and complex noncanonical constructions (Prévost et al., 2017; Durrleman et al. 2015; Durrleman & Delage 2016; Tuller et al. 2017). However, the studies on one such construction in ASD, namely passives, are sparse and remain inconclusive due to small sample sizes and conflicting reports. Indeed, some studies found that comprehension of this structure is spared, while others found difficulties which are reported to be either related, or not, to nonverbal abilities. No work has specifically explored the relationship between mastery of passives and working memory resources in the population with autism. With this work, we aimed to improve our understanding of the acquisition of passives by children with ASD, as well as by TD French-speaking children. Our research questions can be summarized as follows: Do children with ASD show difficulties in the realm of passive development when compared to their TD peers? In particular, are difficulties similar to those previously reported for SLI and do they display any patterns of passives not observed in TD? Finally, does performance on passive relate to other aspects of cognition?

Our work investigates the comprehension of passives in a sample of 20 native French-speaking participants with ASD, from whom we also collected measures of nonverbal abilities and verbal working memory, as well as 85 native French-speaking neuro-typical children. If a subgroup of children with ASD presents language profiles of children with SLI (Kjelgaard & Tager-Flusberg 2001; Roberts et al. 2004; Tager-Flusberg 2006; Riches et al. 2010; Prévost et al., 2017; Durrleman & Delage 2016), we expect this group to be delayed on the comprehension of passives, and, as in SLI, their performance on passives will be unrelated to intellectual abilities. While gaps have been reported between the comprehension of short and long passives in some languages, this pattern is not attested cross-linguistically (Armon-Lotem 2015). The current study being the first systematic exploration of the acquisition of passives in French, we test a large sample of French-speaking children ($N = 85$) or varying ages (4–10 years old) so as to determine to what extent TD French-speaking children display increased difficulty with long passives as compared to short passives. If this turns out to be the case, we also expect a subgroup of our ASD participants to show this same pattern, providing their language acquisition is delayed rather than deviant. In turn, given the complexity involved in the derivation of psychological passives (Hirsch et al. 2006; Hirsch & Wexler 2006; Gehrke & Grillo 2008; Grillo 2008; Snyder & Hyams 2015), we expect psychological passives to lag behind actional passives in TD French, and our sample will allow us to ascertain until which age difficulty with these structures persists. More specifically, psychological passives are expected to remain difficult longer still in ASD, as has been found for SLI (van der Lely 1996; Babyonyshev et al. 2005). Given that children with SLI are reported to present difficulties with verbal working memory, we predict that children with ASD presenting difficulties with passives should also present difficulties with verbal working memory (Gathercole & Baddeley 1990; Montgomery 2002; Hick et al. 2005; Montgomery & Evans 2009; Marinis & Saddy 2013). More precisely, mastery of passives in ASD should show a relation with increased working memory resources, as has been highlighted for SLI (Marinis & Saddy 2013).

2 Methodology

2.1 Participants

Participants with ASD included 20 individuals aged 7;8 to 10;11 ($M = 9;4$, SD = 1;0). They were recruited through parent associations in French-speaking Switzerland (*Autisme Genève* and *Autisme Suisse Romande*) and through the Autism Center at the Regional University Hospital Center in Tours (France). All of these participants were diagnosed with ASD by a qualified clinician according to DSM-IV-TR criteria (APA 2000), and their autism severity was further explored via the French adaptation of the Childhood Autism Rating Scale (CARS), Second Edition (Schopler et al. 1980; translated by Rogé 1989),[4] and ADOS (Lord et al. 1989) scores were also available for a number of children. Inclusion criteria for this group were an ASD diagnosis and the ability to comprehend and produce sentences of at least four words.

[4] This instrument is a behavior rating scale given to parents consisting of 15 items with a scale of 1 ("normal for child's age") to 4 ("severely abnormal"), so that total scores range from 15 to 60 (30 to 36 = mild autistic symptoms, 37 to 60 = severely autistic symptoms).

A large number of TD children were tested in order to provide both appropriate controls for the children with ASD and to allow for examination of typical patterns of passive development in French-speaking children. These TD children included a group of age controls, a group of much younger children (ages 4–5), which could serve as language controls, and two other groups (spanning ages 6–9) to complete the developmental panorama. The age-matched TD group included 20 children who were age-equivalent to the ASD group ($M = 9;3$, SD = 1;0). The group of 4- and 5-year-olds ($n = 24$) provided a snapshot of early mastery of passives in French. We also reasoned that this group could serve as approximate language matches for any of the children with ASD who might have impaired language. A study of spontaneous language samples in French-speaking children (Tuller et al. 2017) revealed that TD 4-year-olds had language levels (measured by MLU and measures of rate and frequency of subordinate clauses) which were similar to those observed in children with SLI with a mean age of 8;7 as well as children with ASD and language impairment, also with mean age of 8;7 (while TD 6-year-olds had more advanced language levels than children in both of these groups). In order to complete the developmental picture for passives in French, we also included a group of 6- to 8-year-olds ($n = 22$) and a group of 8- to 9-year-olds ($n = 19$). In sum, these different groups of TD children allowed us to establish the developmental trend for passives in TD French, and determine where along this curve children with ASD performed. Crucially, all TD children attended normal schools and had no reports of any behavioral or cognitive difficulties that could be indicative of an ASD diagnosis.

2.2 Materials

Standardized tasks included both language and verbal working memory measures. Receptive vocabulary was assessed via either the ELOLA (De Agostini et al. 1998), which is the (normed) French adaptation of the British Picture Vocabulary Scale (Dunn et al. 1982), or the receptive vocabulary subtest of the N-EEL battery (Chevrie-Muller & Plaza 2001). A morphosyntax subtest of this latter battery yielded an indication of receptive morphosyntactic abilities. Verbal working memory was assessed through standardized digit span tasks taken from the Wechsler Intelligence Scale for Children (WISC IV, Wechsler 2006). Forward digit span (FDS) is a measure of verbal short-term memory, requiring participants to maintain the correct order of an increasing sequence of digits and to repeat it. In contrast, backward digit span (BDS) is a measure of complex verbal working memory, central executive functioning (according to the WM model originally proposed in Baddeley & Hitch 1974), because it requires the retaining and recalling of a given number sequence coupled with the manipulating of this sequence to provide the reverse order of digits. This is then a complex-span task, as an additional processing demand is combined with the memory task of recalling a list of items. Standardized test measures used were z-scores.

When selecting the experiment assessing knowledge of passives, we took into consideration the fact that children with ASD frequently display significant deficits in discourse pragmatics and information structure, and the syntactic operations involved in passives have been argued to be simpler in instances where discourse contexts establish a featural distinction between the fronted patient and intervening agent (Snyder & Hyams 2015). In light of our aims to tap into the grammatical difficulties in ASD, we opted for a picture-selection task without elaborate discourse contextualizing which would render the patient salient for Topic, Focus or WH features. As such, we avoided creating a situation where the TD children might have an advantage to interpret and track discourse cues to a larger extent than their peers with ASD, meaning that any difficulties arising from this task should be syntactic rather than pragmatic. The task was divided into two parts, the first testing comprehension of action verbs, and the second comprehension of non-action verbs. Part 1 was essentially a shortened replicate of the COST Action 33 passive experiment designed for TD 5-year-old children (Armon-Lotem et al. 2015).[5] The structures in this part all tested action verbs in (i) long passives, (ii) short passives, and (iii) actives. Children were presented with four pictures appearing at the same time on a computer screen and had to choose the picture that matched a pre-recorded sentence. The characters depicted were a mother/father, a little girl/boy, a big girl/boy, and a grandmother/grandfather, who were introduced at the beginning of the experiment, as part of a warm-up phase. Three characters appeared in each picture, with two always being directly involved in the action and one being an observer. Among the three non-target pictures, one involved a thematic role reversal of the agent and patient, one involved the neutral "observer" character substituting the agent, and one depicted no action (see Appendix 1 for a list of all experimental items). Example (11) illustrates a short passive sentence with the accompanying slide in Figure 1 (top left corresponding to the target, top right to "no action", bottom left to "substitution of the observer for the agent" and bottom right to "theta role-reversal"). As an illustration of a long passive, consider (12) which was presented with the slide in Figure 2, containing the target image at the top right corner.

(11) La mamie est caressée.
the grandma is patted
'The grandma is patted.'

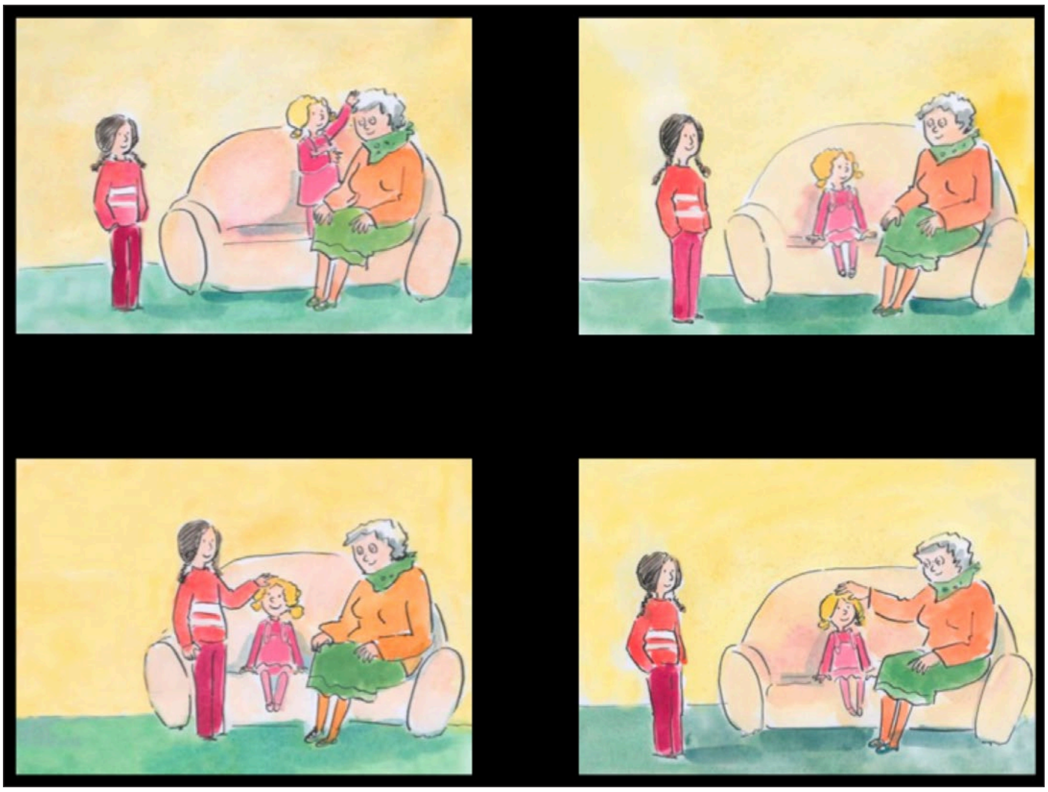

Figure 1: Picture from the short actional passive condition of the passives task.

[5] We would like to thank Sharon Armon-Lotem and her colleagues for permission to adapt this experiment, and, in particular, Kristine Jensen de López, for use of the pictures, which were created in the context of the NASUD project she led, funded by the Danish Agency for Science Technology and Innovation (grant 273-07-0495).

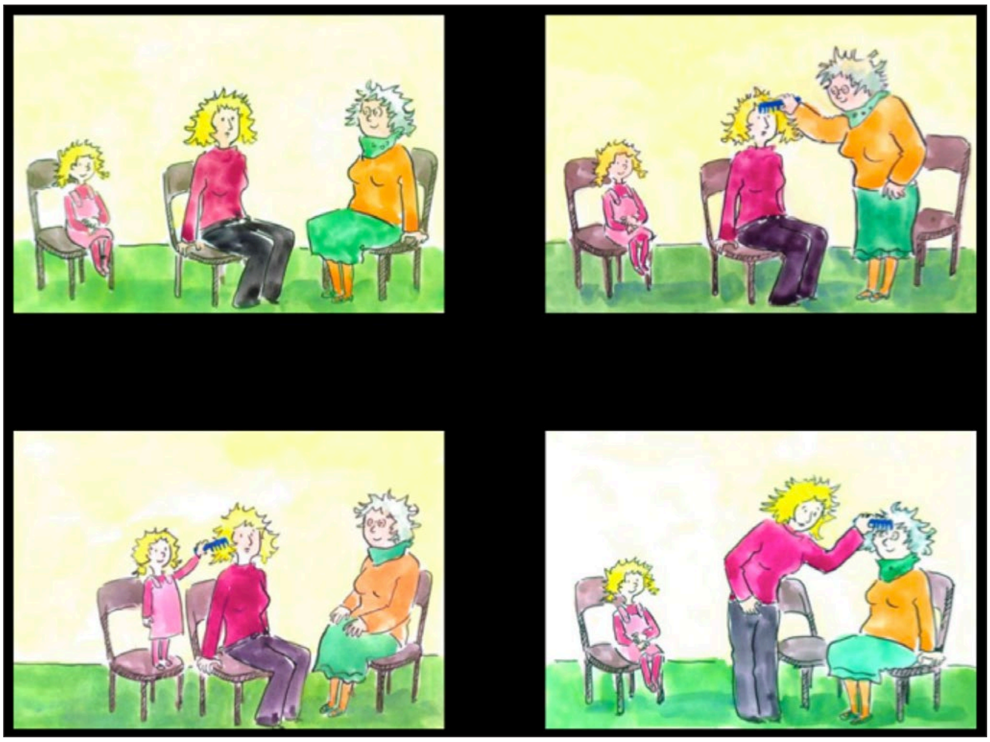

Figure 2: Picture from the long actional passive condition of the passives task.

(12) La maman est coiffée par la mamie.
the mom is combed by the grandma
'The mom is combed by the grandma.'

Given the attention difficulties of many children with ASD, the original COST A33 experiment, which included 88 items, was reduced here to a total of 44 items. Our items were divided into 11 short passives and 11 long passives, and interspersed with 22 actives. The second part of the passives experiment, which we created for the purpose of this study, used characters from the first part of the experiment to test non-actional psychological verbs via 16 items including the verbs *aimer* ('love'), *adorer* ('adore'), *détester* ('hate'), and *imaginer* ('imagine'). There were a total of 8 passives and 8 actives. The passive structures were all long passives (i.e. including the *by*-phrase) because short psychological passives are not acceptable to all French speakers. A training phase allowed children to become familiar with our visual representation of psychological verbs, which is illustrated in Figure 3 for the corresponding passive in (13).

(13) La mamie adore la petite fille.
the grandma adores the little girl
'The grandma adores the little girl.'

Table 1 provides a summary of the variables manipulated in the passive comprehension experiment. All measures from the passive experiment are expressed in either raw scores or in percentages (for inter-condition comparisons).

2.3 Procedure

Each participant was tested individually in a quiet room. In the case of the subjects with autism this was either a room in their homes or in the offices where they were accustomed to going for therapeutic interventions. For TD children, experiments were conducted in

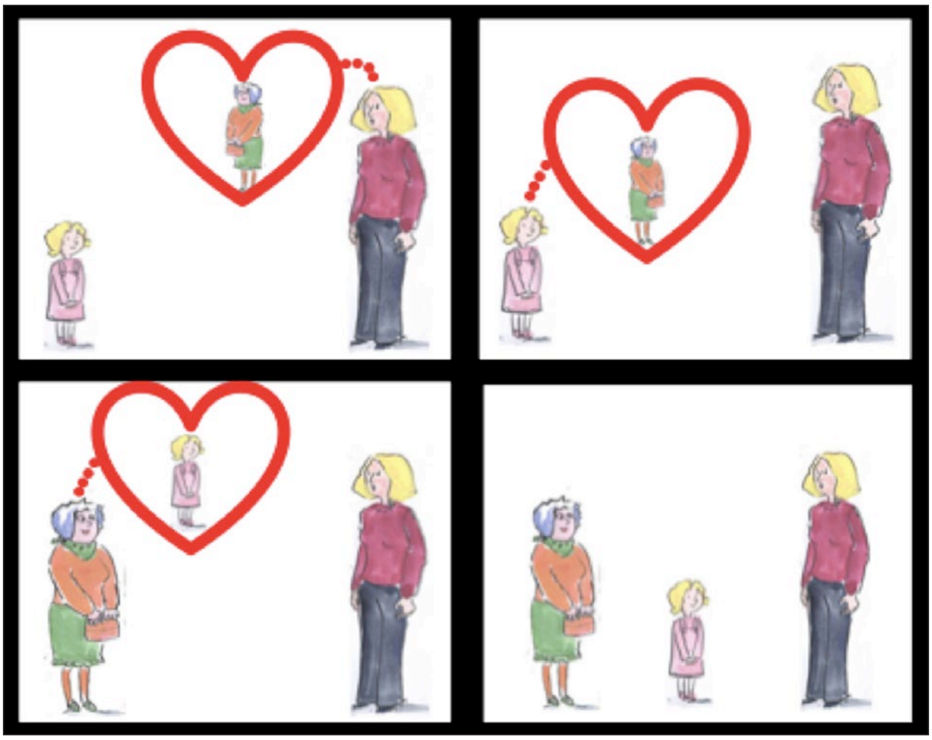

Figure 3: Picture from the (long) psychological passive condition.

Table 1: Conditions in Part 1 and Part 2 of the passive comprehension experiment.

	Actional Verbs (Part 1)	Psychological Verbs (Part 2)	Total
Short Passives	11 items		11
Long Passives	11 items	8 items	19
Actives	22 items	8 items	30

a classroom at their school. The experimental sessions were all administered on a laptop computer equipped with Microsoft PowerPoint. Slides were shown in full-screen mode and accompanied by a corresponding pre-recorded sentence. If children requested it, the experimenter repeated the sentence. All participants understood that they had to select one picture and were immediately praised for doing so, independently of whether or not the selected picture was correct.

3 Results

Since this study aimed to determine how French-speaking children with ASD perform on comprehension of passives compared with chronological-age and younger peers, and in particular whether the dissociations observed in young TD children (active/passive, short/long passive, actional/psychological passive) can be observed in these children, we first wanted to exclude any children whose performance was not above chance, as their results would not be informative for the questions under investigation. All children in each of the TD groups performed above chance for actives (actional and non-actional). One child in the ASD group displayed random performance, and his performance even on active sentences was at chance, as determined by a binomial analysis. Throughout the total 60 items in the task (across all conditions), he selected each of the four possible pictures about equally (16/60 correct pictures, 18/60 pictures representing theta-role reversal, 13/60 pictures with substitution of the observer for the agent, and 13/60 pictures with no action). This child was therefore excluded from further analysis, as was his TD age-match, resulting in an ASD group of 19 children, and an age-matched TD group of the same number.[6]

We used non-parametric tools given non-conformity to normality of distributions, as ascertained by a Shapiro-Wilk test, and homogeneity of variances, as ascertained by use of Levene's test, for most measures in most groups.[7] We used ANOVA by ranks (Kruskal–Wallis test) in order to reveal group effects, the Mann-Whitney test for inter-group comparisons (with correction for multiple comparisons) and the Wilcoxon test for intra-group comparisons, associated with Spearman's rank correlations.

Starting with the TD children (see Figure 4), group effects were found for the total of correctly understood actional passives ($H(4, 103) = 57.75$ $p < .001$). The TD 4–5 year olds performed significantly worse than the 6–7 year olds ($U(45) = 148$, $p = .01$, $r = -.380$) and the 6–7 year olds significantly worse than the 8–9 year olds ($U(40) = 91$, $p < .001$, $r = -.547$). Group effects were also found for comprehension of psychological passives ($H(4, 103) = 36.66$ $p < .001$). For these passives, there was no significant difference between the 4–5 and 6–7 year olds ($p = .9$), however the 6–7 year olds performed significantly less well than the 8–9 year old group ($U(40) = 63.5$, $p < .001$, $r = .617$). Better performance was also obtained on (eventive and psychological) active sentences as compared to (eventive and psychological) passives for all TD children aged 4–9 ($N = 65$): for actional verbs ($Z(23) = 4.88$, $p = < .001$) and for psychological verbs ($Z(23) = 5.36$, $p < .001$). Short and long passives yielded a significant difference in performance only in the youngest group aged 4–5 ($Z(23) = 2.29$, $p = .02$), but not in the TD 6–7 group ($Z(21) = .38$, $p = .7$), nor in the TD 8–9 group ($Z(18) = .45$, $p = .6$). Finally, comparing (long) actional and psychological passives, the former had significantly higher

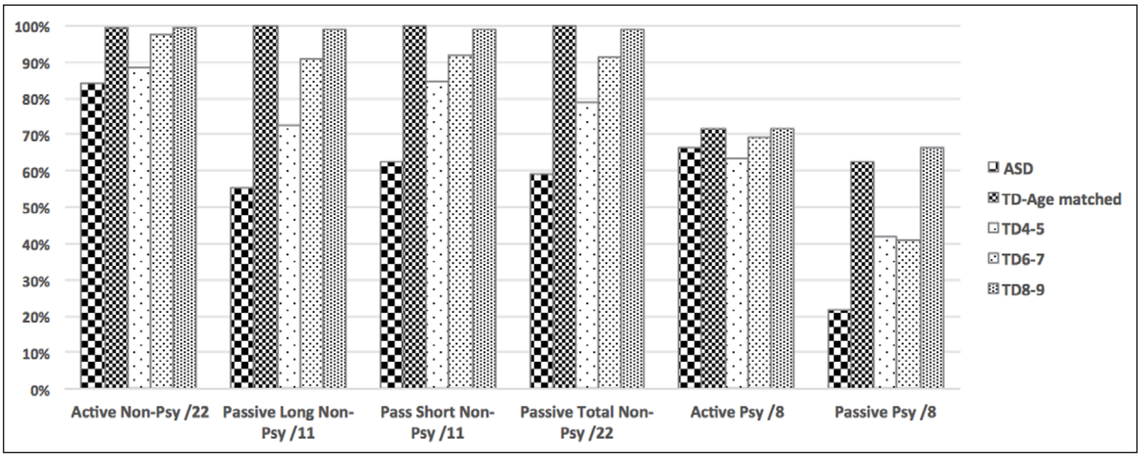

Figure 4: Comprehension rates (%) for actional and psychological actives and passives: ASD group vs. control groups.

[6] One additional child in the ASD group had chance performance on actives; however, he did not select each of the four alternative answers equally (17/30 correct pictures, 8/30 theta-role reversal pictures, 3/30 observer-substitutes-agent pictures, and 2/30 no-action pictures), and therefore was maintained in the study.

[7] We choose to limit statistical analyses to inter-/intra-group comparisons and correlational analyses, given the preliminary nature of our study, which included a limited sample size of 19. We acknowledge that the line of inquiry adopted here should be pursued both with a larger sample size (given the large number of variables) and the use of more sophisticated statistical tools.

comprehension rates than the latter in all of the TD groups (4–5 years: $Z(23) = 4.01$, $p < .001$; 6–7 years: $Z(21) = 4.07$, $p < .001$, and 8–9 years: $Z(18) = 3.82$, $p < .001$).

Turning to the ASD group, global results for Parts 1 and 2 of the passive experiment, with actional and psychological verbs, respectively, show that the children with ASD displayed significantly lower performance than that of the age-matched controls, on all measures, whether, for Part 1, on rate of actives ($U(37) = 32.5$, $p < .001$, $r = -.772$), short passives ($U(37) = 28.5$, $p < .001$, $r = -.800$) and long passives ($U(37) = 28.5$, $p < .001$, $r = -.800$), or, for Part 2, on rate of psychological actives ($U(37) = 85$, $p = .005$, $r = -.515$) and passives ($U(37) = 53.5$, $p < .001$, $r = -.648$). Despite these differences, the children with ASD followed similar trends as the TD children in that (1) better performance was obtained on active sentences compared to passive sentences ($Z(18) = -3.290$, $p = .001$ for actional verbs and $Z(18) = -3.532$, $p < .001$ for psychological verbs), (2) no significant differences were found between short and long passives ($Z(18) = -1.169$, $p = .243$), and (3) (long) actional yielded significantly higher comprehension rates than psychological passives ($Z(18) = -2.534$, $p = .011$).

The results for the ASD group presented above concern mean results but, in fact, they hide a large inter-subject variability. We chose to split the ASD group into two subgroups on the basis of independent measures of standardized language assessment, more precisely on lexical and grammatical comprehension. We calculated a composite score on standard deviations obtained by ASD participants for these measures. Nine children obtained a composite score inferior to two standard deviations[8] below the mean (*Mean standard deviation* = –4.05 *SD*); this subgroup of children with ASD will be referred to as the ASD-LI (Language Impaired) group (mean age = 9;3). The other 10 participants obtained composite scores between 0.6 and –1.5 *SD* ($M = -0.7$), thus within the normal range. We refer to these children as the ASD-LN (Language Normal) group (mean age = 9;4). Although the ASD-LI children were not younger than the ASD-LN children ($U(18) = 44.5$, $p = 1$), they had significantly lower standardized scores on both lexical comprehension ($U(18) = 10.5$, $p = .005$, $r = -.638$) and grammatical comprehension ($U(18) = 0$, $p < .001$, $r = -.844$). When individual results on the passive experiment of the 10 children of the ASD-LN group were considered, it was revealed that all children had above chance performance for active eventive sentences, which is also the case for 9 of them for passive eventive sentences.[9] As for the ASD-LI group, 7/9 children obtained above-chance performance for active eventive sentences and only 1/9 did so for passive eventive sentences. The ASD-LI group consequently performed significantly worse than the ASD-LN for both measures of actional passives (for short actional passives, $U(18) = 2.5$, $p < .001$, $r = -.798$; for long actional passives, $U(18) = 10.5$, $p = .005$, $r = -.642$), though not for psychological passives ($U(18) = 33$, $p = .326$) which were difficult for both groups (see Figure 5). Indeed for these particular structures, only three children in the ASD-LN group (and no child in the ASD-LI group) obtained above-chance performance.

While the ASD-LN children performed better than the ASD-LI children on actional passive measures, they performed clearly worse than the group of age-matched TD peers for long actional passives ($U(28) = 28.5$, $p < .001$, $r = -.749$), for short actional passives

[8] This cut-off is frequently used by speech and language therapists to identify impairment, and is also part of the International Classification of Diseases (ICD) specifications.

[9] Binomial analyses for chance was defined at 50%, and yielded the following thresholds for above-chance performance: 15/22 (actional actives and passives) and 7/8 (psychological actives and passives). Chance level was calculated for 2 pictures (50%) as this took into account the fact that children could have eliminated the picture depicting no action, and the picture where the observer was substituted for the agent, by merely processing the verb and the content of the lexical noun(s) naming the participant(s) in the sentence heard, and then could have guessed between the two remaining pictures (chance performance), or adopted an SV(O) strategy (below-chance performance).

($U(28) = 28.5$, $p < .001$, $r = -.750$) and for psychological passives ($U(28) = 38$, $p = .005$, $r = -.520$). ASD-LN also performed worse on passives as compared to TD children aged 8–9 (long actional passives, $U(28) = 32$, $p = < .001$, $r = -.676$; short actional passives, $U(28) = 31.5$, $p < .001$, $r = -.683$; psychological passives, $U(28) = 32.5$, $p = .002$, $r = -.582$). However no differences were observable between this ASD-LN group and younger TD children, aged 4–5 and 6–7. On the other hand, the ASD-LI children displayed significantly weaker performance on passives compared to TD children as young as 4–5 (long actional passives, $U(32) = 23.5$, $p = < .001$, $r = -.595$; short actional passives, $U(32) = 13.5$, $p < .001$, $r = -.672$; psychological passives, $U(32) = 36.5$, $p = .004$, $r = -.504$). These results are illustrated in Figure 6, though it should be recalled here and elsewhere that group sizes for ASD-LI ($n = 9$) and ASD-LN ($n = 10$) are small.

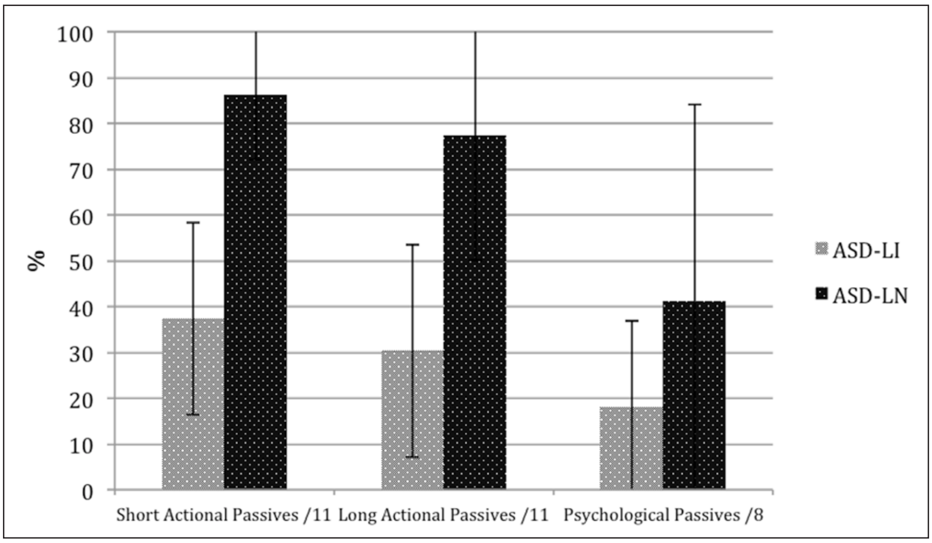

Figure 5: Comprehension rates for passives: ASD-LI and ASD-LN.

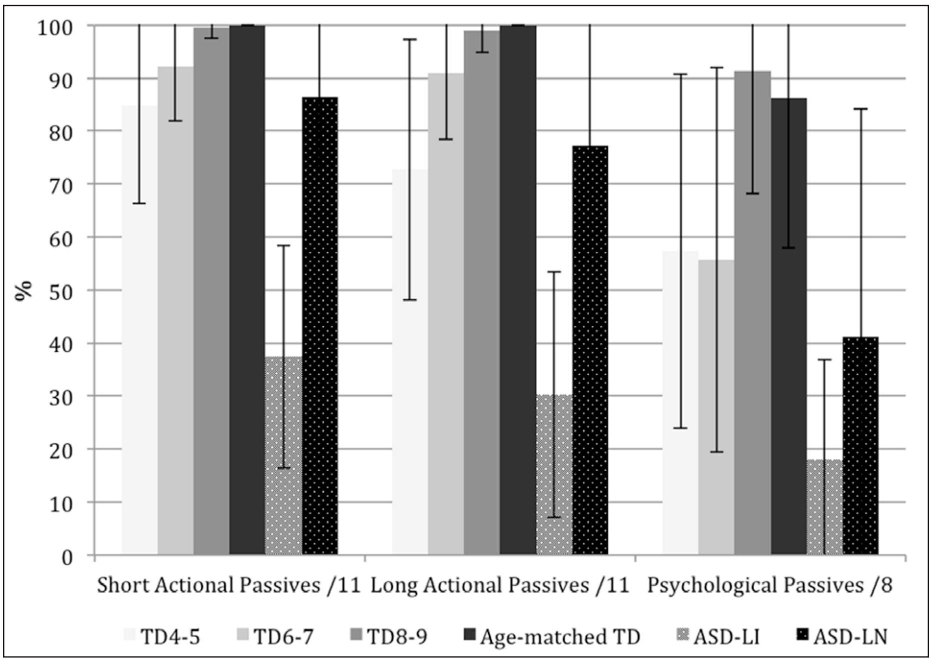

Figure 6: Comprehension rates for passives: TD groups, ASD-LI and ASD-LN.

Performance across groups and conditions was also examined by comparing the proportion of participants who had above-chance performance, as in Table 2, which underlines the ASD-LN/TD 6–7 similarities (percentage of participants with above-chance performance on actional and psychological actives and passives), and the differences between all the groups and the ASD-LI group (which had fewer participants performing above chance on actional active and passive conditions and none on psychological passives). Actional passives group together both short ($N = 11$) and long ($N = 11$) in Table 2.

Comprehension rates between short and long actional passives differ only in the TD 4–5 group ($Z(23) = 33$, $p = .02$). Even if the difference is not significant in the ASD-LI group, the number of participants with below-chance performance (fewer than 4/11 correct responses) was much greater for long passives than for short passives (2/9 = 22%, versus 6/9 = 67%); in contrast, only one child in the ASD-LN group performed below chance on long actional passives.

In light of the debate on the impact of nonverbal abilities on grammatical competence in ASD, we ran correlational analyses for the performance of the whole ASD group on the test of nonverbal reasoning (Raven's Coloured Progressive Matrices) and on the passive task. No significant correlations were found between performance on RPM and any of the measures of passives (for RPM x all passive items/30, $r_s = .293$, $p = .224$, $df = 17$; see Appendix 3 for other measures). One significant correlation emerged for RPM and comprehension of actives: RPM and psychological active sentences (but not actional actives) were significantly correlated ($r_s = .628$, $p = .004$, $df = 17$). However, examination of individual results revealed that the 19 children with ASD all had (relatively) high scores on psychological active sentences, with no child scoring below 6 out of the total of 8 items. Moreover, no significant inter-group difference was found for RPM between the ASD-LN group and the ASD-LI group ($U(18) = 24$, $p = .9$). When the 8 children with ASD with subnormal RPM scores (inferior to the 10th percentile) were compared to the 11 children with normal RPM scores, no differences were found in any of their scores on passive sentences, though differences were found for active sentences (significant, for psychological actives, $U(18) = 10$, $p = .004$, $r = -.630$ and nearly so for actional actives, $U(18) = 20$, $p = .051$).[10]

To explore the relationship between syntactic performance and working memory in children with ASD, we ran correlational analyses on the performance of this group on FDS and BDS and measures from the passive experiment. No significant correlations arose with the performance on the passive task, on measures of either active or passive sentences (see

Table 2: Percentage of participants with above-chance performance, by group and by condition.

Participants	Actional Actives (/22)	Actional Passives (/22)	Psychological Actives (/8)	Psychological Passives (/8)
ASD-LI (*n* = 9)	77.8 *(7/9)*	11.1 *(1/9)*	77.8 *(7/9)*	0 *(0/9)*
ASD-LN (*n* = 10)	100	90 *(9/10)*	90 *(9/10)*	30 *(3/10)*
TD 4–5 (*n* = 24)	100	75 *(18/24)*	70.8 *(17/24)*	29.2 *(7/24)*
TD 6–7 (*n* = 22)	100	100	90.9 *(20/22)*	27.3 *(6/22)*
TD 8–9 (*n* = 19)	100	100	100	89.5 *(17/19)*
Age-matched TD (*n* = 19)	100	100	100	78.9 *(15/19)*

[10] Again, these statistical results should be taken with caution, due to small group sizes.

Appendix 3), despite the fact that many children had low scores for FDS and BDS (groups means: FDS, M = –1.09; .94 SD and BDS, M = –1.4; 1.7 SD), and, as we have seen, many children had low performance on the passive task. Moreover, the ASD-LN children did not have significantly higher scores than the ASD-LI children for either FDS ($U(18) = 36$, $p = .48$) or BDS ($U(18) = 27$, $p = .15$). Likewise, autism symptomatology as indicated by scores on the CARS did not show correlations with any measures, for passives or actives (see Appendix 3), nor did the ASD-LN group differ from the ASD-LI group for the CARS ($U(18) = 14.5$, $p = .68$).

Finally, we note that although chronological age was correlated with measures from the passive experiment among the 84 TD children, all TD groups taken together as a group of 4- to 10-year-olds (for actional passives, $r_s = .71$, $p < .001$, $df = 82$; for psychological passives, $r_s = .52$, $p < .001$, $df = 82$), no such correlations were found in the ASD group (for psychological passives, $r_s = -.070$, $p = .775$, $df = 17$; for actional passives, $r_s = -.100$, $p = .682$, $df = 17$), though the age range was smaller (7 to 10).

In addition to correct responses on passives, error types were also analyzed in order to see if the error patterns in the two ASD subgroups were distinct from each other and from those observed in the TD groups. As Figure 7 shows, though frequencies were different, errors in active sentences displayed basically the same pattern in the two ASD subgroups, and in the TD 4–5 group. Figure 8 shows that this similarity in pattern also holds for errors in passive sentences: a marked predominance of theta-role reversal errors in both ASD

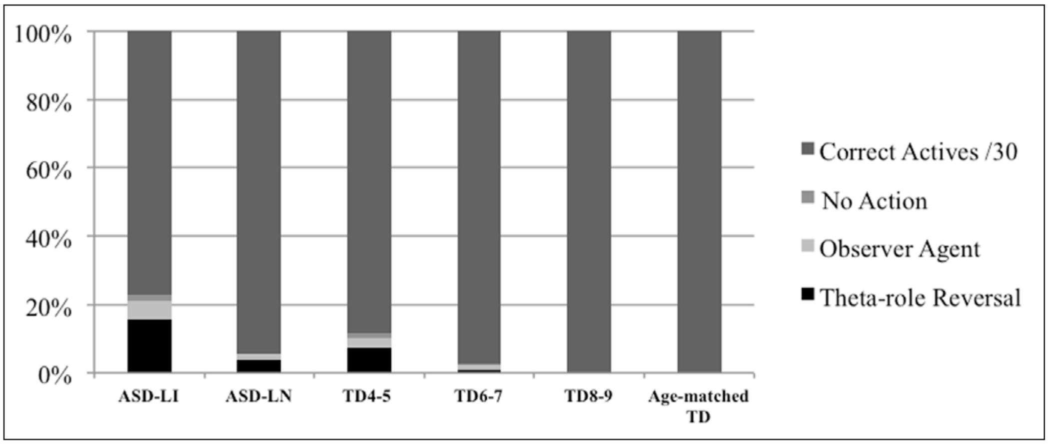

Figure 7: Error types for active sentences.

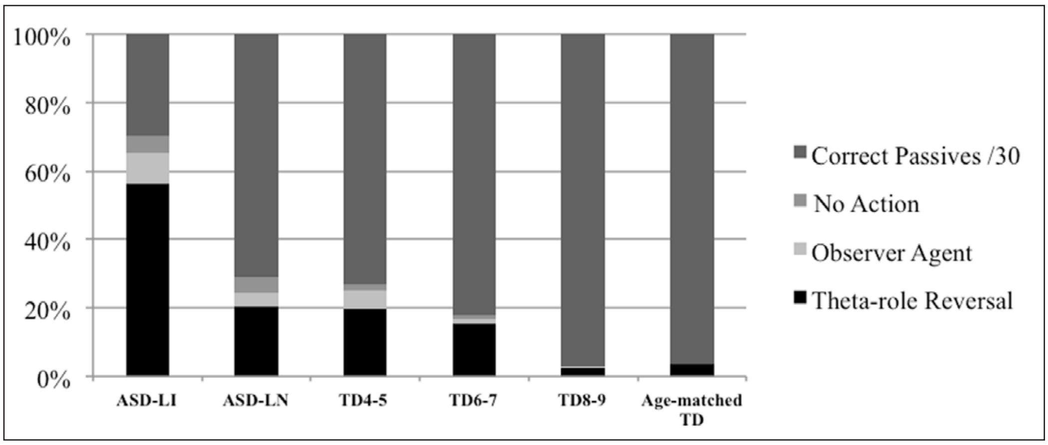

Figure 8: Error types for passive sentences.

subgroups and in TD children until the age of 7. Selection of the image substituting the observer for the agent was unobserved in the older TD children (from the age of 8) and less frequent than theta-role reversal in the other groups. Finally, selection of the picture not depicting any action was also found exclusively in the two ASD groups (6/9 ASD-LI children and 5/10 ASD-LN children had at least one error of this type) and in the youngest TD groups (7/24 TD4-5 children and 6/22 TD6-7 children had at least one error of this type).

"No Action" and "Observer substitutes Agent" errors are different from "Theta-role Reversal" errors, as these imply that either the verb or the participant(s) provided in the sentence was ignored or not understood. As Figures 7 and 8 suggest, these responses were extremely marginal in the TD children aged up to 6 (on average, 0.9% of all responses). They were more frequent in the ASD-LI group, where such responses amounted to 14.1% of all responses (8/9 children had at least one), and in the ASD-LN group (8.7% of responses), as well as in the TD4-5 group (7.1% of all responses). Although comprehension of short and long active passives did not differ significantly, error patterns differed in the ASD group: while theta-role reversal accounted for a significantly greater proportion of errors in long passives (72%) compared to short passives (40%, $Z(18) = -3.184$, $p = .001$), no-action pictures constituted a significantly bigger share of errors in short passives (24%) compared to long passives (2%, $Z(18) = -2.937$, $p = .003$).

4 Discussion

The main goal of this work was to investigate syntax in ASD with the aim of gaining insights into the heterogeneity of language abilities among children with this condition, and determining if a subset of children on the spectrum displays syntactic impairment previously established for SLI. We specifically assessed the comprehension of passive constructions in this population, because these noncanonical structures serve as excellent tools for detecting grammatical difficulties, while studies on this area of grammar in ASD are sparse and have yielded conflicting findings (Perovic et al. 2007; Gavarró & Heshmati 2014; Terzi et al. 2014). We thus aimed to understand if difficulties in this realm of syntax are attested in ASD, and if they relate to, or are dissociated from, nonverbal abilities and working memory. Aside from providing insights on the development of passives in French-speaking children with ASD, we also aimed to report these patterns in TD French-speaking children, as this has not been previously examined.

If language impairment in ASD resembles that of SLI, we predicted that a subgroup of children with ASD would display deficits in passives, thus striking a parallelism with that which has been reported for children with SLI (van der Lely 1996; Rice et al. 2001; Leonard et al. 2006), and that mastery of passives would be dissociated from nonverbal abilities but could be related to working memory resources (Montgomery & Evans 2009; Marinis & Saddy 2013; Frizelle & Fletcher 2015).

The results of this study revealed that the general pattern of performance for different passive types was largely similar in ASD and TD groups, i.e. better performance on actional/eventive passives than on psychological passives, and no difference between short and long passives. While actional/eventive passives reached ceiling levels by age 8 (100%), psychological passives were still slightly below (89.5%).[11] The well-known discrepancy between eventive and psychological passives has already been reported for both TD and SLI populations (Bever 1970; Maratsos et al. 1985; Marchman et al. 1991;

[11] It is worth noting that while some work has reported difficulties with actional passives persisting into adulthood, in particular in low-education adults and with implausible passives (Ferreira 2003; Dąbrowska & Street 2006), difficulty with the passives presented in our task does not seem problematic in our sample of French-speaking children after the age of 8.

Pinker et al. 1987; Babyonyshev et al. 2005). This pattern of performance fits with the predictions of all accounts of passives, whether they claim that children resort to an adjectival analysis for eventive passives, while such a strategy would not be available to psychological passives (Borer & Wexler 1987, 1992; Hirsch & Wexler 2006), or whether the claim is that semantic coercion is necessary for passivization of psychological verbs and is computationally costly, thus emerging later in development (Gehrke & Grillo 2008; Belletti & Guasti 2015; Snyder & Hyams 2015). In our study, French TD children show improved performance on this only as of age 8 years.

The dichotomy between passives with and without a *by*-phrase in children aged 4–5 would follow from the approach in Fox & Grozdinsky (1998), which states that children experience difficulties assigning theta roles within the prepositional phrase. However children appear to overcome these difficulties by age 5, as has been attested for actional passives (short and long) in other languages (Armon-Lotem et al. 2015). In the ASD-LI group, whose performance on passives was below that of even the youngest TD group aged 4–5, more children did in fact perform above chance on short passives. Moreover, the error analysis revealed that more static-image errors were attested for short passives than long passives, further suggesting that short passives, due to the absence of the external argument, appear to favour an adjectival analysis. This proposal has previously been put forth to account for SLI error patterns (van der Lely 1996), and to explain better performance with short passives as compared to long passives in young TD children (see, e.g. Armon-Lotem et al. 2015). However this adjectival analysis did not necessarily lead to improved scores for short passives in our study, plausibly precisely because our materials proposed a static image amongst the alternatives available, which could also correspond to the adjectival interpretation and nevertheless corresponded to an erroneous option.

The children with ASD, aged from 7;8 to 10;11 (mean age 9;4), performed significantly lower on actional and psychological passives than their age-matched peers. For the subset of children with ASD without language impairment, performance on psychological passives was also below that of TD children aged 8–9, and for the subset with language impairment, performance on these structures further lagged behind typically-developing peers aged 6–7 and TD 4–5. The maturational lag with psychological passives is also observed in the younger TD children, as mentioned above (in line with work by Maratsos et al. 1985), and cannot merely be due to misunderstanding the materials as confirmed by their higher scores for the corresponding actives. The specific difficulty with psychological passives attested even in the subgroup of children with ASD who master actional passives is potentially related to challenges with the semantic coercion argued to be involved specifically in this subset of passives (namely the shifting from a stative to an eventive interpretation, see Gehrke & Grillo 2008; Grillo 2008). The fact that children with ASD showed a globally similar developmental pattern to their TD peers (i.e. better with actional than psychological passives, equivalent for long and short passives), suggests that this clinical population displays a delay rather than a deviance for these structures, with a marked difficulty observed for the most complex operations involved in passivization of psychological verbs. Indeed not only grammatical smuggling (chunk-movement) but also semantic coercion (shifting from a stative to an eventive meaning) are both necessary to consolidate these passives. As a result, even when smuggling is successful, coercion appears to pose a persistent challenge to ASD, possibly because of difficulties in cognitive flexibility (Hill 2004; Ozonoff et al. 2005).

Did a particular subset of the children with ASD present *syntactic* profiles reminiscent of SLI? There were clearly children in the ASD group who had considerable difficulties with passives, both actional and psychological. These 9 children, dubbed the ASD-LI group in light of their scores on the standardized language tasks (both receptive vocabulary and comprehension of morphosyntax), performed much worse than the other 10 ASD children (the ASD-LN group), their performance not reaching above-chance levels for either type of passive. Even the ASD-LN group did not perform as well as the TD age peers on either type of passive; their performance was much more similar to that of the 6- to 7-year-old TD group. However, both of these groups displayed the developmental patterns discussed above: actives were understood better than passives, and actional passives better than psychological passives. In this way, the ASD subsets resembled typical development with a delay, and one most pronounced for the most complex structures (i.e. psychological passives), which corresponds to the common characterization of linguistic deficits observed in SLI children (see for example Tuller & Jakubowicz 2008).

Do the errors of the children with ASD on the passive experiment resemble those of TD children? More precisely, did their difficulty comprehending passives give rise to TD strategies in their responses? One clear similarity in performance was that the predominant error pattern was pointing to the picture illustrating characters in reversed thematic roles, as has been previously reported for TD 5-year-olds for a number of languages (Armon-Lotem et al. 2015) and for SLI (van der Lely & Harris 1990; Friedmann & Novogrodsky 2004). The other types of errors, choosing a picture with the observer substituting the Agent and choosing a static image, was much less frequent, in all groups. The first (predominant) error type, reversed roles, suggests that children simply analyzed the passive as an active sentence, apparently not capitalizing on the passive morphology to apply a movement analysis and assign the accurate interpretations to the arguments in the sentence, whereby the subject would be the theme. The second error type, that of a static, distractor image, could conceivably correspond to an adjectival analysis. Alternatively, both the “No Action” and the “Observer substitutes Agent” responses could be indicative of children not attending to the sentence and responding haphazardly, support for which is their occurrence only in the young TD children (who were about the same age as the children in the cross-linguistic study by Armon-Lotem et al., who also made errors of this type) and in the children with ASD. Interestingly, the error trends reported above were observed in both the ASD-LN and ASD-LI groups, with a larger number of “Theta-role reversal” and “Observer substitutes Agent” errors found for the children with language impairment. All these incorrect responses are plausibly the result of children’s difficulty with locality constraints on chain formation (Borer & Wexler 1992; Hyams & Snyder 2005, 2006; Snyder & Hyams 2015), part of a more general difficulty observed in children with ASD, which echoes what is found in young TD children, for the acquisition of structures involving noncanonical word orders (Riches et al. 2010; Terzi et al. 2012; Prévost et al., 2017; Durrleman et al. 2015; Durrleman & Delage 2016). While comprehension rates on more complex passive structures improves smoothly in relation to age in TD children, this was not the case for children with ASD, a situation already reported for other noncanonical structures in this population (Durrleman et al. 2015).

The participants in the ASD-LI group differed from their TD age-peers for actional actives, the simplest sentences in the experiment. Does this demonstrate some kind of deviance specific to ASD? No. Children with SLI have also been reported to show a difficulty in the parsing of actives, such that their comprehension difficulties are not restricted to passives either (van der Lely & Harris 1990; Marinis & Saddy 2013). Moreover, the younger TD children in our study also performed less well than the older TD children for actives (both actional and psychological), and thus this difference was not specific to the ASD group.

There was no relationship between autism symptomatology as yielded by the CARS and active sentences, as has also been found by Loucas et al. (2008) and Lindgren et al. (2009),[12] nor between memory scores and actives, as previously reported for SLI (Marinis & Saddy 2013). Gavarró & Heshmati (2014) suggested that cognitive deficits might explain why some children with ASD have difficulties even with active sentences. Some authors have proposed that this could be due to the language abilities of this subgroup with low-functioning autism being not only delayed but impaired, based on the reasoning that simpler linguistic structures are not problematic even in early stages of TD (Perovic et al. 2007, 2013). Our results do not provide clear support for these views, as the correlation between nonverbal level and performance on actional actives was not significant, and the difference between low functioning and high functioning children found for actives was obtained by comparing very small groups (8 and 11, respectively). The observed weaknesses could also be the consequence of difficulties in non-linguistic realms that influence the children's capacity to attend to the task at hand. Indeed if these difficulties lead to them getting easily distracted and pointing randomly, or simply pointing at a picture they like rather one that matches their comprehension of the sentence as requested, this would also lead to diminished scores for even simple linguistic items. Still, if children were pointing randomly, we would have expected more "no action" and "Observer substitutes Agent" responses than what we found, since this error pattern was rather limited.[13]

While children with intact nonverbal abilities performed well for actives, they crucially did not show significantly better performance on passives compared to children with impaired nonverbal abilities. This suggests that deficits in complex syntax persist in the presence of intact nonverbal skills. The results with passives for the subset of high-functioning children thus cannot be attributed to deficits in nonverbal abilities, highlighting the similarity with the SLI profile, and contrasting with the high-functioning children studied by Terzi et al. (2014), for whom passives appeared to be unimpaired as compared to TD peers. We note that the task used in that study contained only three pictures for the child to choose between: correct, theta-role reversal, and other patient (but no static image picture). This could have made the task easier, yet the results were in fact not so good (range of 33% to 100% in both ASD and TD children, and means of 67% and 70%, respectively). Recall that the children were aged 5 to 8 years, and they performed less well than the (younger) Greek TD 5-year-olds in the Armon-Lotem et al.'s (2015) study, who were at 85% accuracy (range of 61.5% to 100%) for short passives.

Deficits with movement operations such as those involved in passives are also reported to result in similar difficulties in passives for children with SLI (van der Lely 1996) and have been hypothesized to be related to deficits in working memory (Montgomery & Evans 2009; Marinis & Saddy 2013), as reported for other constructions involving long-distance dependencies such as relative clauses (Frizelle & Fletcher 2014). Indeed mastery of complex grammatical constructions such as passives requires storing and manipulating verbal sequences in a fashion reminiscent of the working memory system (Baddeley & Jarrold 2007), due to syntactic movement to a noncanonical position. This would

[12] Whitehouse et al. (2008) suggested that severity of autism symptomatology may impact performance on linguistic tasks such as non-word repetition, thus giving rise to similar results reported for SLI but due to different underlying reasons.

[13] Another aspect of the autistic condition which may have affected their performance is difficulty in theory of mind (Baron-Cohen et al., 1985; Happé 1993; Tager-Flusberg 1997), because psychological verbs arguably imply the ability to understand mental-states. However if this were the case, we would expect our participants with ASD to show more difficulty with actives of psychological verbs, where theory of mind would be implied, as compared to actional verbs. This was not the case, as the subgroup with difficulty on actives performed even slightly better with actives of psychological verbs (86.1%) as compared to actives of actional verbs (72.7%), a difference which reached significance ($Z(18) = -2.312$, $p = .021$). This difference might be related to attention difficulties, as there were 22 actional active items and only 8 psychological active items.

arguably involve maintaining and manipulating verbal information, as is the case for the (complex) backward digit span, such that a relationship between complex syntax and complex spans is expected, and indeed has already been demonstrated for TD children (Montgomery et al. 2008). However, this study has found no evidence that children with ASD show a relationship between better syntactic performance and increased working memory resources. While many of the children we tested clearly did display working memory difficulties (7/19 had z-scores of –2 SD or below on BDS) and many of them clearly had difficulties with passives, these difficulties were not linked to each other. This result is contrary, at least in part, to findings in Eigsti (2009), Durrleman & Delage (2016), and Riches et al. (2010), which were all studies of syntactic production, whereas ours is a comprehension study. Indeed production may entail a higher degree of computational complexity than comprehension: apart from the fact that the derivation needs to be constructed, production also entails lexical retrieval and articulatory planning. Finally, regarding the fact that working memory related to success on comprehension of passives in SLI in Marinis & Saddy's (2013) study, it is relevant to note that the working memory task they used, a listening recall task, had a strong language component, in contrast to our digit span tasks. Listening recall involves listening to lists of sentences and remembering the last words of each sentence in the list, as well as answering questions about the meaning of these sentences which keeps the participant parsing the phonology, syntax and semantics of the sentences heard. Digit span tasks involve stocking monosyllabic numbers up to 9. The difference in working memory involved in these evaluations may potentially explain the difference between the results reported by Marinis & Saddy (2013) and those of the current study. Still, Schaeffer (2016) explores grammatical abilities (sentence-repetition, subject-verb agreement and mass-count distinctions) in high-functioning children with ASD ($N = 27$; MA 10 years) and finds no link with working memory, while the link emerges in her sample of children with SLI ($N = 27$, MA 9;6), crucially not only between verbal working memory tasks (such as non-word repetition and the forward and backward digit-spans of WISC-R; Wechsler, 1974) and grammar (sentence-repetition and mass-count distinctions), but also between nonverbal working memory tasks (Odd-one-out, Henry 2001) and grammar (mass-count and subject-verb agreement). However given that the constructions investigated are different from passives, direct comparisons remain difficult. More work is clearly necessary to determine if there is a relationship between syntactic dependencies such as passives and working memory in ASD, and, if so, which precise component of working memory would be specifically involved (see also Gvion & Friedmann 2012).

Finally regarding similarities between ASD and SLI linguistic profiles, on a descriptive level we can conclude that there are indeed overlapping patterns in both populations. Indeed the difficulties on passives of a subset of children with ASD is reminiscent of that previously reported for children with SLI, and this performance is dissociated from non-verbal reasoning. However we cannot conclude that this implies the same subjacent causes and thus is the result of a shared etiology (Bishop 2010). The fact that we do not find a correlation between language skills and working memory in our ASD group, whereas this link is recurrently reported for SLI, could point to a difference worth exploring further in future research.

5 Conclusion

This study contributes new results on the syntactic profile of children with ASD, an understudied theme, as well as to the literature on the acquisition of the comprehension of passives in French, never previously examined. Comprehension of various passive types was investigated and compared to corresponding actives: eventive passives versus psychological passives, short passives versus long passives. The findings revealed that many children with ASD show difficulties for passive constructions as compared to both age-matched TD peers and younger TD children; however, they show the same basic pattern of performance, i.e. in both TD and ASD groups, actives were better mastered than passives, eventive passives were better mastered than psychological passives, and there were no differences in comprehension of short and long passives. Two different profiles emerged in this clinical population according to standardized assessments on both lexical and grammatical comprehension: one ASD subgroup displaying intact general language skills and the other displaying impairment. Crucially, the most complex passives, psychological passives, proved to be delayed in both groups, with this delay being more pronounced in the ASD group with general language impairment. This suggests that even in individuals showing intact language skills as revealed by standardized tests, subtle difficulties with specific grammatical constructions may nonetheless be present, in particular those involving syntactic and semantic operations that also emerge late in TD. That complex syntax is affected in many individuals with ASD, yet follows the same developmental path as that attested in TD, suggests a delay rather than a deviance in ASD grammatical growth. These difficulties with passives were seen to be unrelated to nonverbal abilities, as the subgroup of children within normal IQ range also displays worse performance on these structures. As such, our study is in line with work suggesting that the linguistic phenotype of ASD is superficially reminiscent of that in SLI (Kjelgaard & Tager-Flusberg 2001; Roberts et al. 2004; Tager-Flusberg 2006, Prévost et al., 2017). However, the fact that working memory did not relate to success on passives in ASD is in contrast to findings reported by one previous study for SLI (Marinis & Saddy 2013). As noted, our working memory task and that of Marinis and Saddy were very different, with theirs having a strong language component. Future work is necessary to understand if there is a relationship between syntactic dependencies such as passives and working memory in ASD, and if so, which underlying component of working memory would be involved. Finally, the development of passives did not seem to clearly improve with age in ASD as in TD, suggesting that this delay may persist into adolescence and even adulthood, as has been reported for other studies of complex syntax in ASD (Riches et al. 2010; Durrleman et al. 2015).

In sum, this study has informed us on the nature of syntactic impairment in ASD, more specifically for the complex syntax implied in passives, and shown specific deficits in this area of grammar, in particular for a subgroup of French-speaking children on the spectrum. This strikes a parallelism with SLI, in particular because of the highlighted dissociation between passive performance and non-verbal intelligence. The dissociation with IQ, as well as with age, underscores the importance of carefully assessing complex grammatical constructions in children with ASD, including in older children as well as those within normal IQ range, as difficulties may persist and thus require the relevant therapeutic interventions.

Abbreviations

ASD = Autism Spectrum Disorder, SLI = Specific Language Impairment, TD = Typically Developing, ASD-LI = Autism Spectrum Disorder – Language Impaired, ASD-LN = Autism Spectrum Disorder – Language Normal, RM = Relativized Minimality

Additional Files

The additional files for this article can be found as follows:

- **Appendix 1.** Experimental items of the passives task. DOI: https://doi.org/10.5334/gjgl.205.s1

- **Appendix 2.** Data for ASD group. DOI: https://doi.org/10.5334/gjgl.205.s2
- **Appendix 3.** Correlational Analyses in ASD Group. DOI: https://doi.org/10.5334/gjgl.205.s3

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Competing Interests

The authors have no competing interests to declare.

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