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in ADHD and DLD : evidence from thematic priming

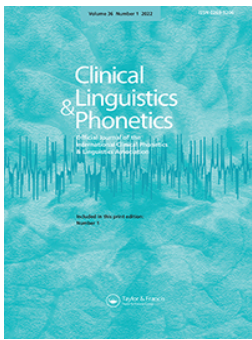
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ORIGINAL ARTICLE



The contribution of visual and linguistic cues to the production of passives in ADHD and DLD: evidence from thematic priming

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ABSTRACT

This study investigated how thematic priming via visual and linguistic cues influences the choice of syntactic voice in healthy French-speaking adults and in French-speaking children with typical and atypical development. In particular, we focused on children with attention deficit hyperactivity disorder (ADHD) and developmental language disorder (DLD), two clinical groups with documented syntactic difficulties. Twenty adults ($M=24;7$) and 60 children aged 6–11 (20 typically developing, 20 with DLD and 20 with ADHD) were presented with agent or patient cues that progressively increased in strength over three conditions: a no cue condition, a visual cue condition with two cue types (perceptual vs. referential) and a linguistic cue condition with two cue types (topicalization of the agent/patient with and without subsequent sentence initiation). Results showed that all participants produced more passives after having been presented with a patient cue, regardless of cue type (cue > no cue), but linguistic cues facilitated the production of passives significantly more than visual cues (linguistic cue > visual cue). We also found that children with DLD were more sensitive than children with ADHD to visual cues (DLD > ADHD), which were more implicit than the linguistic cues and may have required more attentional resources. The opposite pattern (ADHD > DLD) was true for the linguistic cues, which required syntactic processing. These findings highlight how the development of dynamic tools using cue modality and cue sensitivity might be useful for discriminating children with and without syntactic impairment.

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Introduction

One of the hallmarks of developmental language disorder (DLD)¹ is impaired acquisition of syntax, with non-target-like utterances often persisting into adulthood (Leonard, 2014). However, it is now widely accepted that the deficit in DLD is not strictly limited to language, with a number of studies (e.g., Kapa & Plante, 2015) highlighting the frequently reported difficulties in other domains, in particular in attention and verbal working memory (henceforth working memory, WM). Children with attention deficit hyperactivity disorder (ADHD) represent another population known to have deficits in attention and reduced WM capacity (Martinussen et al., 2005; R.A. Barkley, 1997), as well as atypically high levels

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¹Previously referred to as specific language impairment.

of distractibility, hyperactivity and impulsivity according to the fifth edition of the Diagnostic Statistical Manual (DSM-5) (American Psychiatric Association, 2013). While language impairment is not a diagnostic marker of the disorder, children with ADHD are frequently diagnosed with co-occurring language difficulties, with an estimated 30% to 50% of children with ADHD also being diagnosed with comorbid language deficits (Baker & Cantwell, ; Beitchman et al., 1989; Cohen, 2001; Cross, 2004; Gallagher, 1999). Of these language deficits, difficulties with syntax have been reported, especially when syntax is evaluated using global standardized assessments (Cohen et al., 1993, 1989, 1998, 2000; Kim & Kaiser, 2000; Love & Thompson, 1988; Purvis & Tannock, 1997; R.A. Barkley, 1997; Zesiger et al., 2010). However, results from studies investigating syntax deficits in children with ADHD are highly variable, with both high and low co-occurrence estimates being provided by researchers (see Redmond, 2005 for an overview). Thus, DLD is a disorder with a primary deficit in syntax but frequently co-occurring attention and WM limitations, and ADHD is a disorder with a primary deficit in attention but possible co-occurring weakness in syntax, leading to a situation in which distinguishing the two disorders can become a challenge.

Syntax in DLD and ADHD

One characteristic of syntax in DLD is specific difficulties with noncanonical structures that do not follow the subject-verb-object (SVO) word order in languages like English, French, and Hebrew, such as object relatives, object questions and object clitic pronouns. For example, Friedmann and Novogrodsky (2004) showed that school-aged Hebrew-speaking children with DLD perform at chance level on tasks that assess the comprehension of object relatives (scores comparable to those of four-year-old TD children), whereas comprehension of subject relatives was significantly better, although still lower than age-appropriate norms (scores comparable to those of six-year-old TD children). Similar findings have been reported for production (e.g., Delage et al., 2007; Novogrodsky & Friedmann, 2006).

In what concerns object questions, Friedmann and Novogrodsky (2011) showed that in 14 Hebrew-speaking children with DLD aged 9;3 to 12;0, the comprehension of subject questions was significantly better than the comprehension of object questions, with the participants in this study demonstrating a severe deficit in the comprehension of *which* object questions in particular. As for the production of questions, it has been shown that in languages such as French, children with DLD preferentially produce *in situ* questions, in which the object remains in its base position,² rather than *ex situ* questions, in which the object is fronted (Cronel-Ohayon, 2004; Hamann, 2006; Jakubowicz, 2011).

Finally, the impaired acquisition of object clitic pronouns is considered a clinical marker of DLD in French, with low production rates of such clitics reliably distinguishing individuals with DLD from those without the disorder in this language (Paradis et al., 2003; Tuller et al., 2011). Nominative and reflexive clitics, in contrast to accusative clitics, develop relatively unimpaired (Chillier-Zesiger et al.).

Concerning the grammatical abilities of children with ADHD, reports of poor performance on standardized tests suggest that at least some children with ADHD display previously undetected syntactic difficulties (Cohen et al., 1993, 1989, 1998, 2000; Kim &

²This is a licensed and frequent structure in French, in particular in colloquial speech (Prévost, 2009).

Kaiser, 2000; Love & Thompson, 1988; Purvis & Tannock, 1997; R.A. Barkley, 1997; Tirosh & Cohen, 1998). The disadvantage to using standardized tests, however, is that due to the heterogeneous nature of the structures tested, such tests can be quite uninformative when it comes to pinpointing strengths and weaknesses on specific structures. Using more fine-grained measures to assess seven- to-eight-year-old children with ADHD on (i) the repetition of active and passive sentences containing ten to 14 syllables and (ii) the production of past tense morphology, which are both clinical markers of DLD in English, Redmond et al. (2011) showed that children with ADHD performed comparably to typically developing (TD) children on the two syntax tasks and that both ADHD and TD performance was significantly better than that of children with DLD. Similar results were found in school-aged French-speaking children: children with ADHD could be distinguished from children with DLD when tested on the production of third person object pronouns, a reliable clinical marker of DLD in French (Stanford & Delage, 2020). In the same study, children with ADHD showed performance approaching that of children with DLD when tested on a variety of structures using a standardized evaluation that is commonly employed to identify DLD in French-speaking children, pointing to a clear asymmetry between ADHD performance on omnibus syntactic evaluations and those that are more targeted.

The acquisition of passives

The previous results seem to demonstrate that children with ADHD stand out from children with DLD when these two groups are tested (i) in a targeted manner and (ii) on complex syntactic structures. Another complex syntactic construction in which object movement is found and which can be elicited in a targeted fashion is passives. A number of studies have investigated the acquisition of passives in various languages, such as Armon-Lotem et al. (2016), in which the authors compared 11 typologically distinct languages and highlighted potential acquisition differences among them. In languages such as English, French and German, passives are constructed periphrastically with a dedicated auxiliary BE + past participle + *by*-phrase introducing the external argument, which is optionally expressed (Belletti & Guasti, 2015). Research on the acquisition of passives in TD children reports a delay for passives when compared to active structures, in line with the asymmetries observed for subject and object relatives, object questions and object clitic pronouns. At 18 months, TD children reliably show unhindered comprehension of active structures containing an eventive verb (e.g., *chase*, *build*, *eat*) as in (1), but difficulties understanding its passive counterpart (2) are still observed at the age of four, and these difficulties persist until five or six years of age for passive structures containing a stative verb (e.g., *see*, *hear*, *love*) (Maratsos et al., 1985).

- (1) The mother is chasing the girl
- (2) The girl is being chased by the mother

In a similar vein, in some languages, short passives, i.e., passives without a *by*-phrase, are systematically reported as emerging earlier in development than long passives, i.e., passives in which the *by*-phrase is present (Horgan, 1978). It has been hypothesized that this asymmetry is due to children's difficulty assigning the agent thematic role within the *by*-phrase (Fox & Grodzinsky, 1998) or to short passives being interpreted as adjectival

passives, which are empirically shown to appear earlier in the productions of young children than verbal passives (Terzi & Wexler, 2002). However, it should be noted that evidence for a short-long passive asymmetry is mixed, with Messenger et al. (2011) reporting that using a syntactic priming paradigm, English-speaking children aged 3;4 to 4;10 ($M= 4;1$) were more likely to produce a long passive when a short passive prime (e.g., *The girl is being chased*) was used than when an active prime (e.g., example 1) was used. Messenger and colleagues interpret these findings as evidence that early abstract representations of passives are similar for both short and long passives.

The early acquisition of *get*-causative passives³ (3) compared to *be*-passives is also well documented in English-speaking TD children (Crain et al., 1993, 2009; Harris & Flora, 1982; Slobin, ; Snyder & Hyams, 2015; Turner & Rommetveit, 1967). A similar comparison between causative and *be*-passives has been observed in French- and Italian speaking TD children for reflexive causative passives (RCPs) (see 4 for an example in French and in Italian), a Romance-type causative structure that is used in combination with a reflexive clitic (Borga & Snyder, 2018 for French; Manetti & Belletti, 2014 for Italian). As with the *get*-causative passive in English, RCPs in French and Italian are already understood and produced by the age of two years in TD children. Interestingly, research on Italian speakers has shown that Italian-speaking children overwhelmingly produce RCPs in elicitation tasks whereas Italian-speaking adults produce virtually no RCPs when they perform the same tasks (Belletti & Manetti, 2019; Manetti & Belletti, 2014). Such findings provide support for theories of early RCP access in language development and indicate that this structure takes a privileged position in the speech of young children even when it is quite rare in the input.

(3)	The girl is getting chased by the mother				
(4)	La fille	se	fait	poursuivre	par la mère
	La bambina	si	fa	inseguire	dalla mamma
	The girl	REFL.3SG	do.3SG	chase-INF	by the mother
	"The girl is getting chased by the mother"				

Persistent comprehension difficulties with passives are reported for children with DLD. Montgomery and Evans (2009) showed that 6- to 12-year-old English-speaking children with DLD performed significantly worse than age-matched TD controls on a task that required them to comprehend semantically reversible long passives,⁴ as in (2), replicating results from previous studies (Norbury et al., 2002; Bishop et al., 2000; Van der Lely, 1996, 1998; Van der Lely & Harris, 1990; Van der Lely & Stollwerck, 1997). Due to the nature of passive derivation, Montgomery and Evans (2009) hypothesized that the comprehension of passives would require an increased need related to the ability to store information in WM and to allocate attentional resources to the processing task, which they also measured in

³Although there are parallels between causative and *be*-passives, there are also some important differences. For example, stative verbs are rejected in causative passives, e.g., **John got loved/ John was loved* (Hirsch & Wexler, 2004). Additionally, causative passives require the logical object to be [+affected], e.g., **The answer got found/ The answer was found* (Guasti, 2016). For our work, which focuses exclusively on eventive verbs and [+affected] logical objects, these distinctions are not pertinent.

⁴Similarly to TD children, empirical evidence suggests that not all passives are equally difficult for children with DLD, as they demonstrate little trouble comprehending non-reversible passives or short passives (D. v. Bishop et al., 2000; Van der Lely, 1996).

their participants. These predictions were confirmed, and Marinis and Saddy (2013) provided further evidence of a WM-passive link in their study investigating comprehension of passives in English-speaking children with DLD ($N=25$, $M=7;0$), showing a correlation between the processing of passives and WM capacity as measured by a listening recall task.

Concerning production, Leonard and colleagues (Leonard et al., 2006) elicited passives by asking English-speaking children with DLD ($N=18$, $M=5;1$) to complete descriptions initiated by an experimenter of events performed by a number of puppets. The use of passive sentences was promoted by having one of the puppets ask participants questions about the patient/theme (i.e., thematic role priming) and then by the experimenter using a passive frame for the initiated description (i.e., structural priming), which the child was expected to use as a model (see example 5). Leonard and colleagues' results showed that children with DLD were less likely to use passive structures than their language-matched and age-matched TD peers, more likely to produce errors with the participle *-ed*, and more likely to produce passives without a *by*-phrase. This was the case despite Leonard et al. eliciting *get*-causative passives in their study, which, recall, have been shown to be acquired more easily than their *be*-passive counterparts.

(5)	Puppet:	I wasn't paying attention. What just happened?
	Experimenter:	The baseball got thrown by the bird and ...
	Expected response:	Snow White got hugged by the bear

Passives and thematic priming studies

For this work, we are particularly interested in thematic priming for eliciting passives, a type of priming that primes a thematic role (agent vs. patient) rather than the passive structure itself. Previous work done by Belletti and Manetti (2019) on thematic priming showed that by making the patient of an event more salient by introducing it into the discourse via a question (e.g., "What is happening to $X_{\text{patient}}?$ "), TD Italian-speaking children ($N=39$; $M=5;0$) are more likely to use a passive structure to describe the event. It should be noted, however, that while there was an increase in the number of produced passives following a question that topicalized the patient, children in Belletti and Manetti's study showed a preference for clitic left dislocation structures (CLLD), a structure that contains a left-dislocated object in a left peripheral topic position, followed by an active sentence with a resumptive accusative clitic pronoun, as in (6). Again, because thematic priming does not prime the passive structure *per se*, any licensed structure adopted by the participant that emphasizes the patient demonstrates sensitivity to the thematic prime.

(6)	Question:	Che cosa succede al bambino? "What is happening to the child?"
	Response:	(Il bambino) la mamma lo lava (The child) the mother him washes "The child, the mother is washing him"

Thematic priming using visual cues, such as perceptual and referential cues, has also been shown to be effective in enhancing the production of passives (for adult studies see Clark & Chase, 1972; Gleitman et al., 2007; Myachykov et al., 2011, 2012; Prentice, 1967;

Tomlin, 1995). Perceptual cues direct a speaker's attention toward one of the two referents (agent or patient) in an event to be described via a non-referential visual cue (e.g., a dot or an arrow), whereas referential cues allow the speaker to preview either the agent or patient of an event in a neutral position before being asked to describe the event. When Myachykov et al. (2018) compared perceptual and referential cues in English-speaking adults ($N = 24$; $M = 19.8$), they found that both cue types were equally effective in eliciting passives. To our knowledge, thematic priming using perceptual and referential cues has not been used to elicit passives in production studies with children.

While the use of thematic priming has been shown to increase the number of passive structures produced by TD children and healthy adults, the only study that we are unaware of that has explored the effect of thematic priming on the production of passives in children with DLD is that of Leonard et al. (2006). However, missing entirely from the literature on thematic priming effects in DLD is a comparison between thematic priming cues using different modalities: linguistic (such as those used by Belletti & Manetti, 2019; Leonard et al., 2006) vs. visual (such as those used by Myachykov et al., 2018). It could be argued that due to the nature of the syntactic impairment in children with DLD, providing them with nonlinguistic cues that do not necessitate syntactic computation, or the recruitment of verbal WM resources might generate a more favourable outcome.

Finally, we do not know of any studies that have examined the effect of priming on syntax in children with ADHD, although there is some evidence that children with ADHD demonstrate syntactic weakness like that found in DLD. Furthermore, if the processing of passives is indeed related to attention and WM capacity as suggested by Montgomery and Evans (2009) and Marinis and Saddy (2013), children with ADHD, like children with DLD, would be expected to have difficulty producing this structure. For this reason, we propose a thematic priming study that will address these unexplored topics in both populations.

Study aims

Studies examining the acquisition of passives in French are rare. To our knowledge, the only studies having systematically investigated this subject come from Durreleman et al. (2017) and Snyder and Hyams (2015). While Durreleman and colleagues focused on the receptive acquisition of passives in TD children and children with autism spectrum disorder, Snyder and Hyams used spontaneous speech samples of young children to analyse the emergence of different types of passives in TD children. No work has studied the production of passives in French in atypical development. Thus, we wanted to enrich the literature on the production of passives in French-speaking TD children and to conduct the first study on the subject in French-speaking children with ADHD and with DLD. We chose to focus on children with DLD because they have known difficulties with noncanonical structures, and on children with ADHD because there is some debate as to whether they present subtle syntactic difficulties similar to those found in DLD. Specifically, we asked the three following questions

- (i) Does making the patient of an event to be described more attentionally salient via thematic priming affect the number of passives produced by French-speaking children (DLD, ADHD and TD) and healthy adults?
- (ii) Is one cue modality (visual vs. linguistic) more beneficial than the other?

- (iii) Within the different modalities, is one type of cue (referential vs. perceptual in the visual modality and topicalized vs. topicalized + sentence stem⁵ in the linguistic modality) more beneficial than the other?

In each case, we also questioned if the potential effect interacts with cognitive development. To respond to these questions, we adopted a thematic priming paradigm containing three conditions: a no cue condition, a condition with two visual cues and a condition with two linguistic cues (see [section 2.2](#) for a detailed description of the different cues).

For question 1, we hypothesized that a main effect of cue would be present, with all groups of participants producing more passives when exposed to a patient cue than when exposed to no cue (cue > no cue), although this should be less pronounced for children with DLD. Due to the syntactic complexity of the passive structure, we would expect to find that children with DLD resist producing passives and produce a greater number of ungrammatical responses (or licensed but less complex structures) than their TD peers. Thus, even when the patient of an event is attentionally salient, children with DLD should produce fewer passives than TD children (TD > DLD), precisely because, in a thematic priming paradigm, the child is free to choose the type of syntactic structure he/she uses to describe the event. As for children with ADHD, attention deficits may make it difficult to exploit cues, resulting in fewer passives in this population as well (TD > ADHD).⁶

For question 2, we anticipated a main effect of cue modality, with linguistic cues, which are stronger in nature and more constraining, generating more passives than visual cues in all groups of participants (linguistic > visual). We also speculated that despite a main effect of cue modality, children with DLD and ADHD may respond differently to visual and linguistic cues. Children with DLD may be slightly more receptive to visual cues than children with ADHD, as such cues do not require language processing, but the focus of attention is targeted in a rather subtle way (which may penalize children with a primary deficit in attention).⁷ In the linguistic conditions, we would expect to observe the opposite pattern: children with a primary deficit in syntax may be at a disadvantage despite the very targeted way in which attention is probed.⁸ However, if syntactic impairment is indeed present in children with ADHD, this group may also demonstrate difficulty utilizing linguistic cues. Thus, similar DLD and ADHD performance would offer support for overlapping ADHD and DLD profiles. Conversely, different levels of receptiveness to different

⁵A sentence stem is the beginning of a sentence that is provided to a speaker to help him/her get his/her sentence started (see Example 9).

⁶It was pointed out by an anonymous reviewer that there was no prediction regarding how the two clinical groups would perform compared to one another. However, the authors purposefully chose not to make such a prediction as it was hypothesized that both groups would demonstrate some difficulties with the task, although perhaps for different reasons.

⁷This hypothesis is based on the finding that children with ADHD benefit more from clear, direct instruction and respond best to specific goals (R. A. Barkley, 2000; Daley & Birchwood, 2010). In contrast with the linguistic cues in which discourse constraints clearly facilitate the selection of a particular referent as the subject of the participant's productions, the task expectations of the visual cue conditions are less obvious and may therefore be less effective for children with ADHD. Additionally, children with ADHD tend not to perform well when working independently, whereas on-task behavior improves significantly when working one-to-one with a teacher or in a small group (Hart et al., 2011). In a sense, the visual cue conditions mirror an independent work scenario, whereas the linguistic cue conditions, in which the child engages directly with the experimenter, are more reflective of a one-to-one learning environment.

⁸We make this prediction as the linguistic cues use questions containing a topicalized patient, which require the concurrent integration of both syntactic and discourse related knowledge (Avrutin, 2000).

types of cues would indicate clear boundaries between the two disorders, opening the door to further investigation of how different cue types could be considered for the purposes of differential diagnosis.

For question 3, we expected the adult participants in our study to behave like those in Myachykov et al. (2018) and that performance would thus be similar for both types of **visual** cues. As the current study is the first to examine this exploratory question in children, we put forward the speculative hypothesis that the child groups may demonstrate a preference for referential visual cues (referential > perceptual) as they not only make the patient of an event more attentionally salient, but also activate the patient referent in WM. In what concerns the two types of linguistic cues, we predicted that the condition in which the patient was topicalized, and the participant was provided with a sentence stem would generate the most passives (topicalization + sentence stem > topicalization) in all groups as this cue maximally limits other possible grammatical responses in French (with the exception of CLDs).

Current study

Participants

Eighty native French-speaking individuals participated in this study: 20 children with DLD ($M = 9;0$, $SD = 1;7$), 20 children with ADHD ($M = 8;10$, $SD = 1;5$), 20 TD children ($M = 8;1$, $SD = 1;5$) and 20 healthy adults ($M = 24;7$, $SD = 4;4$). The child groups did not statistically differ for age. Participants in the DLD group had been officially diagnosed by a qualified clinician, and only children with documented deficits in syntax were included in this study. We verified these deficits via a morphosyntax subtest of the French standardized evaluation, the *Bilan Informatisés de Langage Oral* (BILO-3 C, Khomsi et al., 2007), on which all of our DLD participants scored at least 1.25 SDs below age-specific norms. Five children in the DLD group had been diagnosed with comorbid attention difficulties, but in three of these children impairment in attention was deemed very mild. In the other two participants, while clear attention deficits were present, impairment in syntax was considered the primary deficit by the clinicians involved in their intervention services, and they were thus permitted to participate in the study as part of the DLD group. As a group, DLD children did not reach the threshold (≥ 1.25 SDs below age norms) for attention deficits or hyperactivity disorder based on the French adaptation of the Conners Comprehensive Behavior Rating Scales for parents (CBRS, Conners, 2010), a tool designed to assist clinicians in evaluating children for difficulties in these domains. All children in this group were receiving speech-language therapy on a regular basis (one to two sessions per week).

Children in the ADHD group had also been formally assessed and diagnosed by a qualified professional, and parents of these participants were asked to complete the CBRS, which revealed significant weakness for both the inattention and hyperactivity measures. Using the information obtained with this questionnaire, we classified our participants with ADHD into one of two groups: (i) predominately hyperactive/impulsive ($n = 2$) and (ii) mixed hyperactive and inattentive ($n = 18$). None of the participants demonstrated a predominately inattentive profile. Three of the participants in the ADHD group had suspected but undiagnosed DLD, for which they were not receiving speech

therapy. As a group, children with ADHD did not reach the threshold (≥ 1.25 SDs below age norms) for syntactic impairment based on their BILO scores.⁹ The majority of the testing sessions took place over weekends or during school holidays, thus only four of the 20 children with ADHD had taken prescribed medication at the time of testing. As the scores of these four children on our EF measures (described below) did not significantly affect the ADHD group average (i.e., the average on the EF measures did not differ when these children were removed), we did not exclude these participants from the study. Individual CBRS and BILO results for the two clinical groups can be found in [Table A1](#).

Participants in the TD group were all attending conventional schools and had no reported history of language or attention difficulties. Repeated measures ANOVAs confirmed that participants in all three child groups were within the normal range ($\geq 10^{\text{th}}$ percentile) for nonverbal reasoning (Raven, Raven, & Court, 1998), although post hoc Tukey HSD analysis revealed that both TD and ADHD performance was significantly better than that of the DLD group on this measure. We considered this unproblematic as the definition of DLD as described by D. Bishop et al. (2017) specifies that nonverbal delays are no longer exclusionary for a DLD diagnosis, provided the delays are not related to intellectual disability. Repeated measures ANOVAs also confirmed that only the DLD group demonstrated syntactic impairment and only the ADHD group demonstrated deficits in attention. Furthermore, the three groups could not be distinguished for the following EF measures: (i) visual selective attention (Sky Search, TEA-ch, Manly et al., 2006), (ii) processing speed (Same World, TEA-ch, Manly et al., 2006), (iii) attentional flexibility (Opposite World, TEA-ch, Manly et al., 2006), and (iv) WM capacity, both phonological loop and central executive (Digit Memory, WISC, Wechsler, 2003). [Table 1](#) displays descriptive summary data for each group of participants and [Table 2](#) summarizes the results of the various syntax and cognitive tests.

Children with DLD and ADHD were recruited by contacting speech-language pathologists and educational psychologists in French-speaking Switzerland, and TD children were recruited through parent associations in the same area. The adult participants were BA and MA students at the University of Geneva. Because of the multilingual nature of Switzerland, bilingual participants were included provided acquisition of French had occurred before the age of three. In total, 15 simultaneous bilingual children (DLD_{n=9}, ADHD_{n=1}, TD_{n=5}) and

Table 1. Summary of participant information.

Group	<i>N</i>	Bilingual <i>N</i>	Sex	Age range (year; month)	Age: <i>M</i> (SD) (year; month)
DLD	20	9	8F, 12M	6;10–11;8	9;0 (1;7)
ADHD	20	1	7F, 13M	6;3–10;7	8;10 (1;5)
TD	20	5	12F, 8M	6;4–11;7	8;1 (1;5)
Adults	20	2	10F, 10M	18;9–33;0	24;7 (4;4)

⁹An anonymous reviewer pointed out that while the BILO performance of the ADHD group was significantly better than that of the DLD group, it was also significantly worse than that of the TD group (see [Table 2](#)). This is an interesting observation as it could potentially provide evidence of syntactic weakness in children with ADHD, and indeed, individual BILO results for the ADHD group revealed scores of at least -1.25 for nine of the 20 participants with ADHD. However, recall that Stanford and Delage (2020) reported that children with ADHD are more likely to perform below TD norms when tested using standardized omnibus syntax tests, such as the BILO, while performing comparably to TD peers on probe syntax tests that target clinical markers of DLD (findings that corroborate work done by Redmond et al., 2011).

Table 2. Summary of syntax and cognitive test scores for the child groups.

	TD	ADHD	DLD	Group effect	Pairwise
NVR z-score (SD)	0.33 (0.62)	0.21 (0.97)	-0.63 (1.04)	$p = .003, \eta^2 = 0.19, \alpha = 0.91$	DLD < (TD = ADHD)
BILO z-score (SD)	0.53 (1.00)	-0.94 (2.35)	-3.51 (1.86)	$p < .001, \eta^2 = 0.47, \alpha = 1.00$	TD > ADHD > DLD
CBRS inattention z-score (SD)	-0.69 (0.62)	-2.22 (0.62)	-1.09 (0.77)	$p < .001, \eta^2 = 0.51, \alpha = 1.00$	ADHD < (TD = DLD)
CBRS hyperactivity z-score (SD)	-0.93 (0.68)	-2.01 (0.41)	-0.82 (0.55)	$p < .001, \eta^2 = 0.52, \alpha = 1.00$	ADHD < (TD = DLD)
SA accuracy/20 (SD)	18.10 (1.83)	17.95 (2.74)	17.35 (2.62)	$p = .59, \eta^2 = 0.02, \alpha = 0.13$	na
PL total span (SD)	11.75 (2.94)	11.70 (3.53)	9.90 (2.59)	$p = .10, \eta^2 = 0.08, \alpha = 0.47$	na
CE total span (SD)	8.80 (2.07)	8.25 (2.69)	8.65 (2.06)	$p = .74, \eta^2 = 0.01, \alpha = 0.10$	na
PS seconds (SD)	30.49 (7.32)	32.84 (7.60)	34.91 (12.94)	$p = .36, \eta^2 = 0.04, \alpha = 0.23$	na
AF seconds (SD)	36.77 (9.18)	44.01 (12.16)	43.31 (14.25)	$p = .12, \eta^2 = 0.07, \alpha = 0.43$	na

Note. NVR = nonverbal reasoning, BILO = *Bilan Informatisé du Langage Oral*, CBRS = Conners Comprehensive Behavior Rating Scales, SA = selective attention, PL = phonological loop, CE = central executive, PS = processing speed, AF = attentional flexibility

two simultaneous bilingual adults took part in this study. Due to the elevated number of bilingual participants in the DLD group, we used an independent *t*-test to verify that the monolingual and bilingual participants in that group did not differ for expressive syntax on the BILO ($p = .19$), and in particular for their ability to produce the passive¹⁰ ($p = .79$). See Table A2 for a table of languages spoken by the bilingual participants in this group.

Approval for this study was obtained from both the Ethics Committee of the Faculty of Psychology at the University of Geneva and the Cantonal Ethics Committee for Research in the canton of Geneva, Switzerland. Parents of all children gave informed, written consent for their child's participation. Adult participants also gave informed, written consent prior to participation in this study.

Procedure and material

In a one-to-one setting, the participants completed an elicited production task containing three conditions: a no cue condition, a visual cue condition with two cue types and a linguistic cue condition with two cue types. The conditions were presented in that fixed order to all participants. The task began with a familiarization phase in which the child was asked to identify the eight characters (depicted in a neutral position on a separate sheet) that would appear in the test items. During the familiarization phase, the child was also shown pictures of the 12 actions that would occur in the task and asked to name them. Eight of the actions corresponded to high-frequency agentive transitive verbs (e.g., *push*) and four of the actions corresponded to high-frequency agentive intransitive verbs (e.g., *run*). Incorrect responses or misinterpretations were corrected at this stage. The task was administered by graduate students in a speech-language pathology postgraduate program in Geneva and took place either at the home of the child or in a consulting room at a private speech therapy practice. The protocol took approximately 20 minutes for the child participants to complete and 10 minutes for the adults.

No cue condition

In the first condition following the familiarization phase, the participants were presented with images containing two characters of the same gender in which one of the characters was performing an action on the other. In the images, the agent appeared equally on the left and on the right. The participants were asked to describe in one sentence what was happening in the image (e.g., *The grandmother is drawing the woman*). Two training items were provided at the beginning of the task to ensure that the children understood what was expected in terms of their productions (i.e., a single sentence focusing on the action and the two characters), but no feedback was given to the participants concerning their choice of voice (active or passive). This condition was included so that we could determine how frequently passives are used in the speech of French-speaking children and adults when attention is not oriented towards one of the two referents in an image to be described. Given the attention difficulties of the children we were testing, we wanted to keep

¹⁰To test the production of the passive, we used the productions from the second linguistic condition of the priming study (see example 12 below).



Figure 1. Example of an experimental item to which children could respond using an active structure, (i.e., *The lady is pushing the girl*) or a passive structure (i.e., *The girl is being pushed by the lady*).

our protocol optimally short. Thus, our test items in this condition included six images depicting a transitive action (Figure 1) and two filler images depicting an intransitive event (Figure 2).

Visual cue condition

The second condition adapted the visual priming paradigm used with adults by Myachykov et al. (2012), (2018) to test whether orienting visual attention to one of the two referents in an event influences the type of syntactic frame used by children. Two factors were manipulated at two levels each: (1) cue referent (agent/patient) and (2) cue type (referential/perceptual). Six different transitive actions were repeated twice in this condition so that the participants were presented with a total of twelve randomized test items: six containing a referential cue, i.e., an image of one of the two referents that appeared in a neutral position before the event to be described, that lasted 1000 ms (Figure 3), and six containing a perceptual cue, i.e., one of the two referents appeared in black and white while the other appeared in colour (Figure 4).¹¹ Four filler items depicting an intransitive action

¹¹An anonymous reviewer asked if the participants were given specific instructions to justify the fact that they saw two pictures for referential cues and one picture for perceptual cues. During the practice session at the beginning of the visual cue condition, it was clearly explained to the participants that sometimes they would see pictures in which one of the two characters was in colour while the other was in black and white, and sometimes they would see a picture of one of the two characters alone before seeing the picture of the event. It was made clear to all participants (and understanding was checked during the practice phase) that they should only provide descriptions of images in which two characters appeared together.



Figure 2. Example of a filler item to which participants would be expected to respond using an intransitive verb (i.e., *The man is sleeping*).

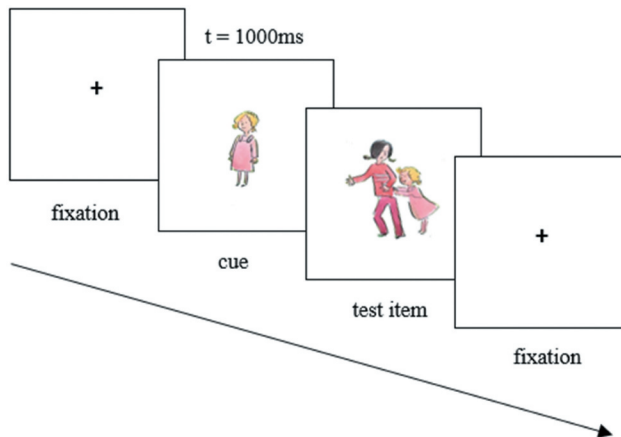


Figure 3. Example of a referential cue trial in which the agent of the event (the little girl who is pushing the big girl) is cued via an image of the agent in a neutral position that is previewed for 1000 ms before the event to be described appears.

were also included. Of the six test items containing a referential cue, three of the cues corresponded to the agent of the event and three corresponded to the patient. Furthermore, half of the cues depicted female characters and the other half depicted male characters, and the characters rotated across the events in such a way that they were equally likely to be either the agent or the patient of the event. Again, only characters of the same gender

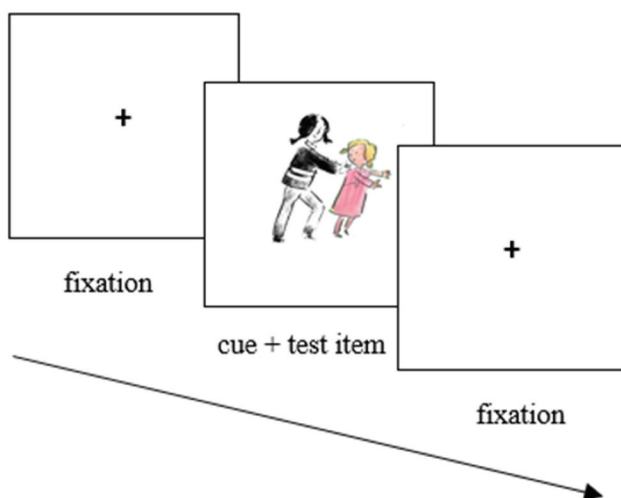


Figure 4. Example of a perceptual cue trial in which the patient of the event (the little girl who is being pushed by the big girl) appears in colour and the agent (the big girl) appears in black and white.

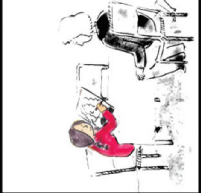
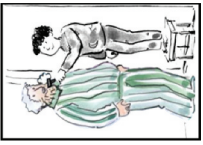
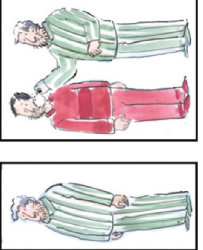
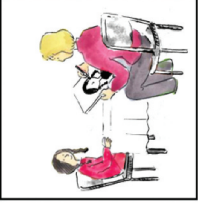
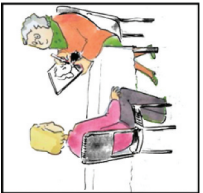

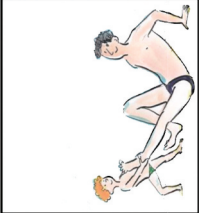

appeared in an event together. The six test items with a perceptual cue were controlled in the same way. Before starting the task, the participants engaged in a practice session in which they were presented with two training items with a referential cue and two training items with a perceptual cue in order to familiarize them with the different types of cues they would encounter during this condition.

Linguistic cue condition

The third condition explored whether orienting attention via discourse-related properties – topicalizing one of the two referents in the event to be described in this case – plays a role in syntactic choice in children. Using the same type of visual stimuli as in the no cue condition, the participants were shown an image such as the one in [Figure 2](#). Following the first linguistic cue type, the participant heard a question about one of the two referents to which he/she was instructed to respond (7). This part of the task contained six experimental items (three followed by a question that topicalized the agent of the event and three followed by a question that topicalized the patient) and two filler items, and it was preceded by a practice session containing two training items. Items containing female characters and items containing male characters were evenly distributed. Finally, six experimental items and two filler items using the second linguistic cue type followed the same procedure, but this time the questions were followed by a sentence stem and the participants were simply asked to complete the sentence (8), which constituted the most constrained cue type. The different conditions and cue types are summarized in [Table 3](#).¹²

¹²We would like to thank Kristine Jensen de López for granting us permission to use and adapt these pictures, which were created in the context of the NASUD project she led, which was funded by the Danish Agency for Science, Technology, and Innovation (grant 273–07-0495).

Table 3. Summary of the different experimental conditions.

	Example of an Agent item	Example of a Patient item
Visual cue 1: Perceptual cue		
Target response	<i>The girl is drawing the lady</i>	<i>The old man is being shaved by the boy</i>
Visual cue 2: Referential cue		
Target response	<i>The old man is shaving the man</i> "What is the old lady doing?"	<i>The girl is being drawn by the lady</i> "What is happening to the old man?"
Linguistic cue 1: +TOP feature		
Target response	<i>The old lady is drawing the lady</i> "What is the boy doing?" The boy ... "	<i>The old man is being shaved by the man</i> "What is happening to the girl?" The girl ... "
Linguistic cue 2: +TOP feature & sentence initiation		
Target response	<i>(The boy) is pulling the man</i>	<i>(The girl) is being pushed by the lady</i>

(7)	Topic Agent Experimenter: Topic Patient Experimenter:	Que fait la dame ? what does the lady “What is the lady doing?” Qu’est-ce qui arrive à la fille ? what is it that happens to the girl “What is happening to the girl?”
(8)	Topic Agent + stem Experimenter: Topic Patient + stem Experimenter:	Que fait la dame ? La dame ... what does the lady? the lady ... “What is the lady doing?” The lady ... Qu’est-ce qui arrive à la fille ? La fille ... what is it that happens to the girl? the girl ... “What is happening to the girl?” The girl ...

Coding criteria

The answers were coded under five main categories: Passives (*be* or RCP) (9), Actives with a DP (10) Actives with a clitic pronoun (11), Actives with clitic left dislocation (12), and Other. “Other” consisted of ungrammatical responses containing a reflexive pronoun (13), responses in which the thematic roles had been reversed and responses that could not be easily interpreted.

- (9) a. *be* passive
La fille est poussée par la dame¹³
the girl is pushed by the lady
“The girl is being pushed by the lady”
- b. RCP passive
La fille se fait pousser par la dame
the girl *se*-makes push by the lady
“The girl is getting herself pushed by the lady”
- (10) La dame pousse la fille
the lady pushes the girl
“The lady is pushing the girl”
- (11) La dame la pousse
the lady her-Cl pushes
“The lady is pushing her”
- (12) La fille, la dame la pousse
the girl, the lady her-Cl pushes
“The girl, the lady is pushing her”
- (13) La fille se pousse
The girl herself pushes
“The girl pushes herself”

¹³While the majority (93%) of the participants’ passive productions contained a *by*-phrase, we accepted both long and short passives as target responses.

Results

Preliminary analyses

We coded 1,740 utterances produced by children and 580 produced by adults, excluding utterances following distractors. Unsurprisingly, performance following agent cues (for all conditions) was at ceiling for all groups, i.e., all groups of participants correctly produced an active sentence in more than 90% of the cases when the agent was cued (92% for children with DLD, 96% for children with ADHD, 94% for TD children and 99% for adults), so these data will not be analysed further.

To demonstrate that thematic priming occurred when a patient cue was provided, we first looked at the percentage of all productions (regardless of cue modality) that could be considered as demonstrating sensitivity to patient thematic priming: (i) passives, (ii) active structures with an object pronoun and (iii) structures with a CLLD. When visual and linguistic cues were considered together, children with DLD demonstrated such sensitivity 44% of the time, children with ADHD 48% of the time, TD children 51% of the time, and adults 57% of the time. A repeated measures ANOVA revealed that the four groups could not be statistically distinguished on this measure, $F(3,76) = 1.92$, $p < .13$, $\eta^2 = 0.07$. Further analyses of the different types of responses to patient cues showed that all groups of participants overwhelmingly produced target passives (see Table 4) when presented with a patient cue, so our remaining analyses will focus exclusively on the production of target passives in the four groups following patient thematic priming.

Main analyses

To establish a baseline for passive production, we first examined how many passives were produced in the no cue control condition. Our results showed that in this condition, no child group productions were passives (0%) and only one passive (1% of all productions) was produced by the adult group.

Next, to respond to our three research questions, we investigated whether an effect of patient cue was present. After that, we zoomed in on cue modality to determine if one modality (visual or verbal) was more effective than the other in eliciting the passive before zooming in on each modality separately and comparing the efficacy of the different types of cues therein.

Independent *t*-tests used to analyse the performance of the baseline adult group revealed a significant effect of cue (cue > no cue), $t(38) = 11.85$, $p < .00$, and a significant effect of cue modality (verbal > visual), $t(38) = 9.74$, $p < .001$. There was no significant effect of visual cue type (referential = perceptual), $t(38) = 0.15$, $p = .88$, or of linguistic cue type (topicalization = topicalization + sentence stem), $t(38) = 1.29$, $p = .21$.

Effect of cue

Our first main research question asked if making the patient of an event to be described more attentionally salient via a visual cue or a linguistic prime affected the number of passives produced by French-speaking children (TD, DLD, and ADHD combined). Our results confirmed an effect of cue as children produced passives 51% of the time when a patient cue was provided, an increase from the no cue condition that independent *t*-tests revealed to be significant $t(118) = 16.05$, $p < .001$.

Table 4. Table summarizing the types of target and non-target responses produced by our participants when a patient cue was provided. Visual cue 1 = perceptual cue; Visual cue 2 = referential cue; Linguistic cue 1 = topicalization; Linguistic cue 2 = topicalization + sentence stem.

Visual cue 1	Target passive	Active with DP	Clitic pronoun	CILD	Other
DLD	12/60 (20%)	44/60 (73%)	0/60 (0%)	0/60 (0%)	4/60 (7%)
ADHD	4/60 (8%)	53/60 (88%)	3/60(5%)	0/60(0%)	0/60(0%)
TD	8/60 (13%)	52/60 (87%)	0/60 (0%)	0/60 (0%)	0/60 (0%)
Adult	12/60 (20%)	48/60 (80%)	0/60 (0%)	0/60 (0%)	0/60 (0%)
Visual cue 2					
DLD	15/60 (25%)	42/60 (70%)	0/60 (0%)	0/60 (0%)	3/60 (5%)
ADHD	8/60 (13%)	46/60 (77%)	4/60 (8%)	0/60 (0%)	2/60 (3%)
TD	16/60 (27%)	44/60 (73%)	0/60 (0%)	0/60 (0%)	0/60 (0%)
Adult	13/60 (22%)	45/60 (75%)	2/60 (3%)	0/60 (0%)	0/60 (0%)
Linguistic cue 1					
DLD	33/60 (55%)	20/60 (33%)	7/60 (12%)	0/60 (0%)	0/60 (0%)
ADHD	43/60 (72%)	11/60 (18%)	5/60 (8%)	0/60 (0%)	1/60 (2%)
TD	48/60 (80%)	5/60 (8%)	4/60 (7%)	0/60 (0%)	3/60 (5%)
Adult	56/60 (93%)	0/60 (0%)	4/60 (7%)	0/60 (0%)	0/60 (0%)
Linguistic cue 2					
DLD	30/40 (75%)	5/40 (13%)	0/40 (0%)	0/40 (0%)	5/40 (13%)
ADHD	38/40 (95%)	1/40 (3%)	0/40 (0%)	0/40 (0%)	1/40 (3%)
TD	37/40 (93%)	1/40 (3%)	1/40 (3%)	0/40 (0%)	1/40 (3%)
Adult	40/40 (100%)	0/40 (0%)	0/40 (0%)	0/40 (0%)	0/40 (0%)

Effect of cue modality

Our second research question examined whether one cue modality (visual vs. linguistics) played a role in the number of passives produced following patient cues and if this interacted with child group. Descriptive statistics showed that all groups of participants produced more passives following patient cues that were linguistic in nature than patient cues that were visual: 65% vs. 23% in children with DLD, 83% vs. 10% in children with ADHD and 86% vs. 20% in TD children (see Figure 5). Repeated measures ANOVAs with cue type (visual, linguistic) as the within subjects variable and child group (TD, DLD, ADHD) as the between subjects variable were run and revealed a reliable main effect of cue

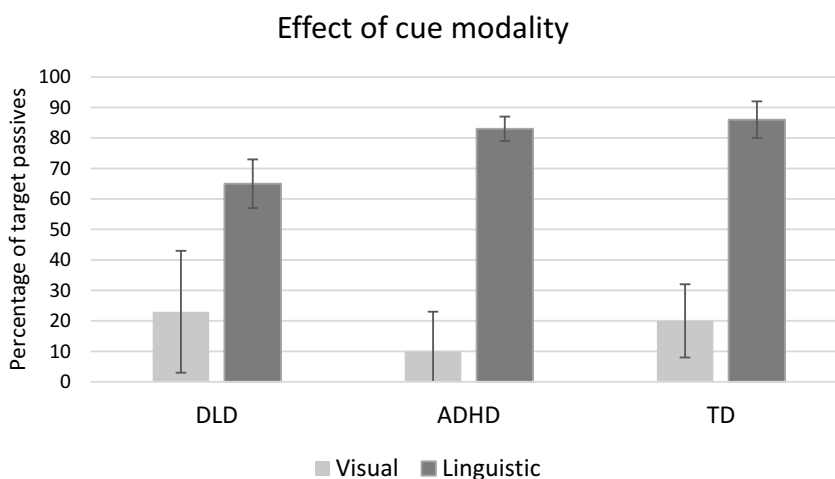


Figure 5. Graph showing the percentage of passives produced by the three child groups when visual and linguistic patient cues were provided.

modality in the child participants, with children, when grouped together, producing significantly more passive voice responses after linguistic patient cues than after visual patient cues, $F(1,57) = 205.70$, $p < .001$, $\eta^2 = 0.78$. There was no main effect of child group as it was not possible to statistically distinguish where the differences between TD, DLD and ADHD performance lie ($p = .95$). However, a significant crossover interaction effect of cue type by child group was observed, $F(2,57) = 4.85$, $p = .01$, $\eta^2 = 0.15$. Although patient cues that were linguistic in nature were more effective than visual patient cues for all child groups (hence the main effect of cue modality but no effect of child group), how sensitive the participants were to a particular cue modality depended on child group (specifically DLD vs. ADHD). In particular, children with DLD showed greater sensitivity to visual cues than children with ADHD whereas the opposite pattern was true for linguistic cues (see Figure 6).

Effect of visual and linguistic cue type

Our third research question asked if within the different modalities, one type of cue (e.g., referential vs. perceptual within the visual modality and topicalization vs. topicalization + sentence stem within the verbal modality) would be more beneficial than the other for the elicitation of passives.

Visual cues. Within the visual cue category, referential patient cues generated more passives in all child groups than perceptual patient cues: 25% vs. 20% in children with DLD, 13% vs. 7% in children with ADHD and 27% vs. 13% in TD children (Figure 7). We thus wanted to examine the possibility that our participants were more sensitive to one type of visual cue than the other. For children, repeated measures ANOVAs showed a statistically significant main effect of visual cue type, $F(1,57) = 7.00$, $p = .01$, $\eta^2 = 0.11$, but no significant effect of child group ($p = .25$). There was also no significant interaction with child group, $F(2,57) = 0.65$, $p = .52$, $\eta^2 = 0.02$. In other words, all child groups produced more passives following a patient cue when the cue was referential (involving both attention and WM) than when it was perceptual (involving attention only).

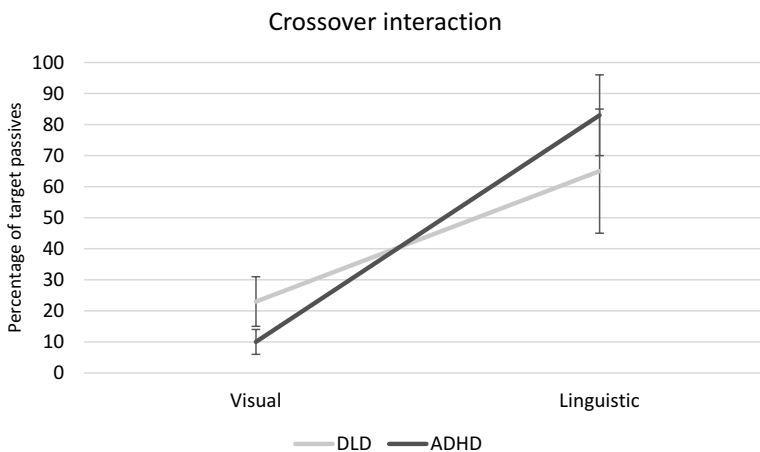


Figure 6. Graph showing the crossover cue-by-cognitive-group interaction effect.

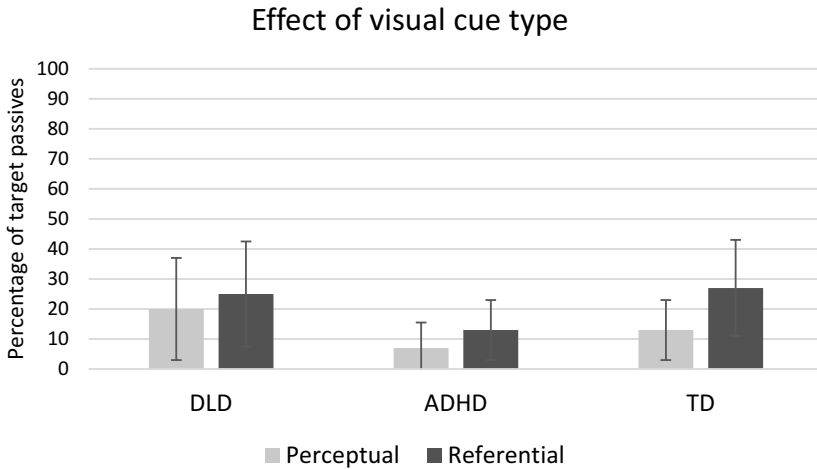


Figure 7. Graph showing the percentage of passives produced by the three child groups when perceptual and referential patient cues were provided.

Linguistic cues. Linguistic cues generated the most passives in our study and all child groups produced more passives when the patient was topicalized and a sentence stem was provided than when the patient was simply topicalized: 75% vs. 55% in children with DLD, 95% vs. 72% in children with ADHD and 92% vs. 80% in TD children (Figure 8). Repeated measures ANOVAs showed a statistically significant main effect of linguistic cue type, $F(1,57) = 16.94, p < .001, \eta^2 = 0.23$ and a tendency for there to be an effect of child group (see Figures 8 and 9), $F(1,57) = 2.98, p = .06, \eta^2 = 0.09$. No significant interaction with child group was observed, $F(2,57) = 0.50, p = .61, \eta^2 = 0.02$.

Our main results are summarized in Figure 9, which demonstrates (i) the significant main effect of cue (cue > no cue) (ii) the significant main effect of cue modality (linguistic > visual), (iii) the significant crossover interaction of cue type by child

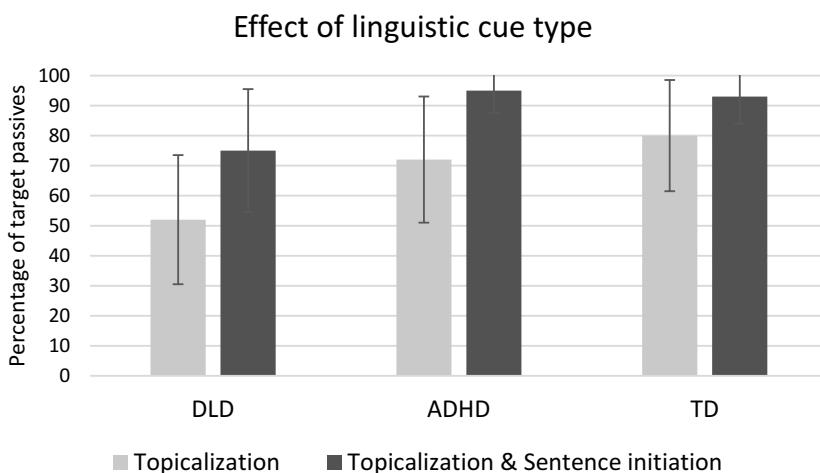


Figure 8. Graph showing the percentage of passives produced by the three child groups when linguistic patient cues were provided.

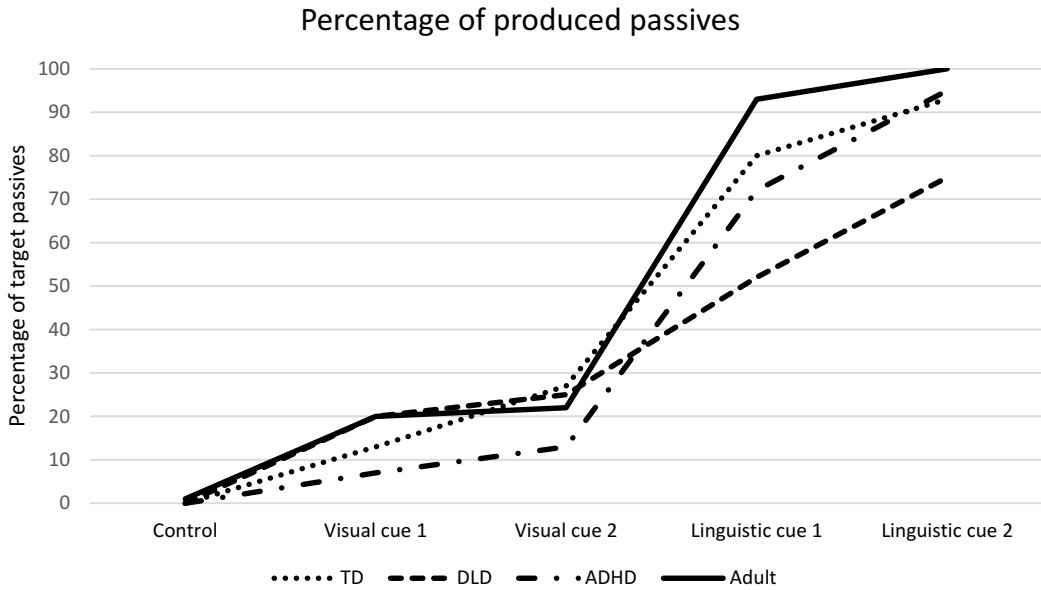


Figure 9. Graph summarizing the main results. *Note:* Visual cue 1 = perceptual cue; Visual cue 2 = referential cue; Linguistic cue 1 = topicalization; Linguistic cue 2 = Topicalization + sentence initiation

group (i.e. children with ADHD benefitted less than children with DLD from the visual cues whereas the opposite pattern was true for the linguistic cues), (iv) the significant main effect of visual cue type in children (referential > perceptual), and (v) the significant main effect of linguistic cue type in children (topicalization + sentence stem > topicalization).

Additional analyses

As the syntactic performance of children with atypical development, in particular those with ADHD, can demonstrate a high degree of variability, we also looked at the individual performance of the participants in our two clinical groups on our cue measures (Table A1). This was done by considering the individual scores for the percentage of target passives following patient thematic priming in the visual and linguistic cue conditions. We then examined how these individual scores deviated from the TD mean. However, because percentages were low for all three groups for the visual cues, only the results for the linguistic cues will be reported here.

Six participants with ADHD and ten with DLD scored at least 1.25 *SDs* below the TD mean (i.e., obtained a score of 34% or less) for the first linguistic cue type (i.e., a question about the patient without being followed by a sentence stem). Of these 16 children whose performance was at the low end of the spectrum for the first linguistic cue type, five had been red flagged as having difficulties in both syntax and attention. Three other children identified as having dual attention-syntax difficulties performed comparably to their TD peers. As for performance following the second linguistic cue type (i.e., a question about the patient followed by a sentence stem), two children with ADHD and six with DLD reached the -1.25 cut off, indicated by a score of 70% or less. Of these eight children, three had both syntactic and attention weakness. Two of these children had also demonstrated impaired

performance following the first linguistic cue type and exclusively produced active structures with a DP throughout the duration of the experiment. Five children with dual difficulties performed like their TD peers following the second linguistic cue type.

Finally, the individual results also showed that poor performance on the standardized syntactic test was not associated with limited ability to produce passives in the linguistic cue condition, with several children in both groups demonstrating impaired BIL0 scores but 100% or near ceiling accuracy producing passives following linguistic cues. For example, participants 28 and 29, who obtained a z-score of -7.25 and -8.08 respectively, both had passive production accuracy rates of 100% for both linguistic cue types (Table A1).

Discussion

The current study investigated the production of passives in French-speaking TD children, children with DLD and with ADHD, and adults via a priming paradigm that used visual and linguistic cues to draw attention to the patient of an event to be described. Children with DLD and ADHD were chosen for this study as there is some evidence that they may have overlapping attention and syntactic deficits (Redmond, 2005, 2016; Redmond et al., 2011). We thus designed a priming paradigm that would manipulate the contents of the attentional focus in order to elicit a particular complex syntactic structure, the passive voice, which is known to be difficult for children with syntactic deficits. Our reasoning was that if DLD and ADHD are indeed disorders with common symptoms, children in these two groups should perform similarly in all conditions. Conversely, if the two disorders are in fact different and syntax is intact in children with ADHD, it should be possible to distinguish the two groups of children based on sensitivity to different types of cues: children with DLD should make more use of visual cues than linguistic cues, as the former does not require language processing, and children with ADHD should demonstrate a preference for linguistic cues if syntax is unimpaired in this population, as the processing of the less explicit visual cues may require greater attentional capacity.

Main results

Effect of cue

Our first main finding showed that cueing a patient referent, either via a visual or a linguistic cue, significantly increases the chance of a passive structure being produced in healthy French-speaking adults and in French-speaking children, TD and those with atypical development. Our results for visual cues are in line with findings reported by Myachykov et al. (2018) on healthy adults, and our results for linguistic cues corroborate Belletti and Manetti's (2019) findings on healthy Italian-speaking adults and TD Italian-speaking children. Collectively, these results demonstrate that the choice of sentential subject and the resulting syntactic structure can be facilitated by directing the attentional focus, be it via visual or linguistic cues, to one of the two referents in an event to be described.

Effect of cue modality

Our second main finding was that although the percentage of produced passives always increased whenever a patient cue was provided, all participants in our study benefitted more from linguistic than visual cues. The proportion of passive voice responses following

a visual patient cue when the perceptual and referential conditions were averaged was 18% for children and 21% for adults, whereas the proportion of passives following a linguistic patient cue when the linguistic conditions were averaged was 78% for children and 97% for adults. While the proportions related to visual cues may seem low, it is important to note that our results are comparable to those reported in (Myachykov et al., 2018) in which the proportion of passive voice responses produced by their adult participants following a visual patient cue was roughly 24%. There are, nonetheless, some possible explanations as to why visual cues only moderately facilitated the production of the passive voice in our study. For starters, in the perceptual cue condition in which one of the two referents was presented in black and white while the other was presented in colour, we reasoned that the visual salience of the referent in colour would be more likely to attract the participants' attention than the less salient referent in black and white. This rationale was based on research showing that colourless images are processed less efficiently than those in colour, and that attention is sustained for a shorter period of time for black and white representations (e.g., Wichmann et al., 2002). However, since this visual cue condition followed our control condition in which both referents in each image appeared in natural colours, it is possible that what actually captured the attention of the participants was in fact the referent in black and white, as this was what differed from what the participants had previously seen in the prior condition. To avoid this potential problem, future studies may consider the use of unnatural colours for the target reference, e.g., colouring the patient entirely in blue when trying to elicit the passive voice, instead of contrasting natural colours with black and white to capture attention. It is thus possible that low levels of receptiveness to the perceptual visual cue were due to weaknesses in the design of the items in that condition. It is also possible that the control condition, in which all participants overwhelmingly used the active voice, and which preceded the visual cue conditions, structurally primed the active voice, making it more difficult to inhibit in the following condition. Future priming studies should either avoid placing a control condition before an experimental condition or should use a separate group of control participants for the control condition, as suggested by Ibbotson et al. (2013). Nonetheless, the fact that our results are similar to those found by Myachykov et al. (2017), a study that had neither the potential item flaws previously described nor a control condition that may have primed the active voice, suggests that visual cues are simply less explicit than linguistic cues and thus generate a more modest priming effect.

When we compared performance following visual cues to performance following linguistic cues, we also observed a significant crossover interaction effect of cue type by child group. Indeed, children with DLD displayed a pattern of performance in which they were more receptive than children with ADHD to visual cues, and children with ADHD demonstrated the opposite pattern (see Figure 6). These trends are in line with our predictions that children with a primary deficit in attention would be at a disadvantage in the subtler visual cue condition whereas children with a primary deficit in syntax would benefit less from the linguistic cues that required syntactic processing. Previous work has shown that the salience of visual cues influences how semantic information is stored and retrieved by children and adolescents with ADHD, and that compared to their TD peers, individuals with ADHD demonstrate weaker abilities to encode implicit information (Krauel et al., 2009). This would suggest that in our visual cue condition, referential activation remained low for the ADHD group, which may explain why passive production was also low. Alternatively, it could be the case that children with ADHD in our study did

take stock of the visual cues but benefitted from them less than the other two child groups because the active voice was potentially primed by the preceding control condition, as previously suggested. As children with ADHD are known for their inhibition difficulties and deficits in cognitive flexibility, inhibiting the primed active voice and switching to the passive would likely be more cognitively demanding for this group than for the other two groups. It should be noted that the relation between inhibition and susceptibility to priming is an area that remains unexplored (Kidd, 2012), but our reasoning is in line with findings from previous studies that indicate that the speech of children with ADHD, similar to that of children with autism spectrum disorder, is more likely to contain perseverations, i.e., word and structural repetitions (Fortea et al., 2018; Norbury et al., 2014), which, in the case of ADHD, have been linked to deficits in planning/organization, WM and impulsivity.

These results are interesting because it seems possible to clearly distinguish children with DLD and ADHD based on how they respond to different types of attentional cues: children with DLD are more responsive than children with ADHD to visual cues that avoid linguistic processing, whereas children with ADHD are more responsive than children with DLD to linguistic cues that explicitly direct attention to one of the two referents through topicalization. In other words, the low production rates of the passive voice by children with ADHD in the visual cue conditions do not seem to be caused by a deficit in syntax, but rather by inattention, impulsivity, or difficulties with inhibition. When their attention is directed to a well-defined target, children with ADHD behave similarly to their TD peers. Similarly, the low production rates¹⁴ of passives by children with DLD in the linguistic conditions (when compared to children with ADHD and TD children) do not seem attributable to attention difficulties as children with DLD were sensitive to the subtle attentional cues provided in the visual conditions. Rather, DLD performance in the linguistic conditions seems to indicate specific difficulty with the linguistic cues. At the linguistic level, this specific difficulty could involve some breakdown when interpreting questions containing a topicalized patient, perhaps linked to reduced sensitivity in children with DLD to the discourse properties of topicalization or to the increased computational complexity of these structures. This would be in line with previous analyses of young children's difficulties with D-linked questions as opposed to non-D-linked questions, as the more "expensive" D-linked questions necessitate integrating both syntactic and discourse related knowledge simultaneously (Avrutin, 2000). At a more general level, it could also be the case that reduced processing capacity affects performance on high-cognitive-load syntax tasks in children with DLD. While more data are necessary to draw any firm conclusion, these results nonetheless highlight the inherent nature of the syntactic difficulties of children with DLD, which resist even explicit attentional cues.

Effect of visual cue type and effect of linguistic cue type

Effect of visual cue type. While the results confirmed that all participants benefited more from linguistic than visual cues, we nevertheless performed analyses to compare performance of the two visual conditions in order to determine if one type of cue (perceptual vs. referential) facilitated the production of passives more than the other. The findings showed that children,

¹⁴It is important to highlight that we used "low production rates" here to mean low compared to the other two child groups and adults. It is clear that children with DLD produced a significantly greater number of passives when linguistic rather than visual cues were used. However, if we normalize performance to that of TD children and healthy adults, we see that the proportion of passives produced by children with DLD in the visual conditions is relatively high, whereas it is rather low in the linguistic conditions.

when considered together and not as individual groups, were more sensitive to referential visual cues in which one of the event's referents had been previously previewed by the participant than to perceptual cues in which attention was simply directed towards one of the two referents at the same moment the event was to be described. Conversely, adults responded similarly to both types of cues, as was the case in Myachykov et al. (2018) study. The crucial difference between referential and perceptual visual cues is that when a referential cue is provided, not only is attention directed to that particular referent, the referent's conceptual accessibility is also increased via activation in WM. While Myachykov et al. argue that attention plays a special role in the syntactic choice of adults and that adults do not need the additional activation of a referent in WM to benefit from a visual cue, it seems to be the case that conceptual accessibility, and thus WM, does play a role in determining subject assignment in children displaying different types of cognitive development. This might be the case because attention and WM are still developing in school-aged children and may be less separable, in line with a developmental integrative framework model of the sort put forward by (Garon et al., 2008). Therefore, being presented with a cue that engages both cognitive mechanisms should facilitate the task for the child groups. As for adults, whose attentional and WM systems have reached maturation, the engagement of one system is sufficient for optimal performance, as shown by Myachykov et al. (2018).

Finally, as previously mentioned, one cannot rule out the possibility of a task-related effect for the difference between the two visual cues in children. As the character in black and white in the perceptual cue condition is what represented a change in the images from the previous block, it is possible that the child participants were more sensitive to this change than the adult participants and that this is what captured their attention.

Effect of linguistic cue type. As with visual cues, we performed analyses to investigate the possibility that one type of linguistic cue (topicalization vs. topicalization + sentence stem) had a greater facilitatory effect than the other. Confirming our prediction, the results showed a significant main effect of cue type in the child participants: significantly more passives were produced by children when they were provided with a cue that contained both topicalization and sentence initiation than when they were provided with a cue that only contained topicalization. As this effect was observed in all three child groups with roughly the same magnitude, the linguistic cues did not show a significant interaction with child group. It is unsurprising that the most passives were produced by our child participants when a patient was topicalized and provided as the response stem, as forcing the children to begin their response with the patient greatly restricted the type of structure that could be used. In fact, when asking a question about the patient and making the patient the response stem, only two continuations are felicitous: a passive and a CILD. While CILDs are licensed in French and would have thus been a viable option for our participants in the second linguistic condition, this structure was overwhelmingly absent from the productions of our participants. No effect of linguistic cue type was found for the adult participants who performed at ceiling in both linguistic conditions.

Additional analyses

Finally, examining the individual results of the two clinical groups in the linguistic cue condition revealed that a number of children from both groups performed at least 1.25 SDs below the TD mean for target passive production following both types of linguistic

patient cues, although this number was higher for children with DLD for both cue types. While some children who had been signalled as having weakness in both syntax and attention were present in this subgroup, other children who had been identified as having dual difficulties performed similarly to their TD peers. Thus, it does not seem to be the case that there is an additive effect of co-occurring attention and syntactic limitations, which is consistent with previous findings (Hutchinson et al., 2012; Redmond, 2016).

Analysis of individual results also highlighted that poor performance on the standardized syntax assessment that was part of our pre-test evaluation was not always associated with difficulty producing the passive in the priming task. For children with ADHD, this is in line with recent work done by Stanford and Delage (2020) showing that this population is more likely to perform poorly on omnibus syntax tests that contain a variety of syntactic structures than on probe syntax tests that focus on one specific construction. In the case of children with DLD, the fact that more than half of these participants were able to reach ceiling or near ceiling levels of accuracy for passive production following the final linguistic cue offers strong support for the added value of including Dynamic Assessment paradigms (Hasson et al., 2013; Hasson & Joffe, 2007), which focus on the extent to which an individual's language performance is modifiable, when evaluating children's syntactic abilities, a method that has become increasingly popular among speech-language practitioners.

Conclusion/ Clinical Implications

The aim of this study was to enrich the literature on the production of passives in French-speaking adults and TD children and to conduct the first study on the subject in French-speaking children with ADHD and with DLD. We focused on children with DLD and ADHD as there is some debate as to whether these two populations present overlapping syntactic difficulties, thus we wanted to investigate if their syntactic profiles could be distinguished. To do this, we conducted an elicited production study using a thematic priming paradigm with visual and linguistic cues to facilitate the production of the passive by directing the focus of attention toward the patient of an event to be described. Our main research questions asked whether our participants would be sensitive to the cues we provided them, if this sensitivity would be similar for various visual and linguistic cues, and if receptiveness to the different cues would be influenced by different types of deficits, i.e., deficits in syntax and/or attention.

Collectively, the results indicate that the allocation of attentional resources, either via visual or linguistic cues, to one of the two referents in an event to be described influences the choice of sentential subject and the ensuing syntactic frame (active or passive), in both typical and atypical development and in healthy adults. Participants were, however, more sensitive to linguistic than to visual cues (linguistic > visual) and in the child groups, there was an interaction effect (DLD > than ADHD for visual cues and ADHD > than DLD for linguistic cues). In what concerns visual cues specifically, children, as opposed to adults, benefit more from cues that not only direct attention to one of the two referents, but that also activate that referent in WM (referential > perceptual). This may be due to an immature cognitive system in school-aged children in which the different components (e.g., selective attention and WM) function more efficiently in coordination than separately when choosing a syntactic frame. However, as work on the relationship between executive functions

and sentence planning in children remains virtually absent from the literature, this is a hypothesis for future work to investigate. As for linguistic cues, pairing topicalization with sentence initiation seems to create a more felicitous context for eliciting a sentence about the patient than providing only topicalization (topicalization + sentence initiation > topicalization) as the former maximally restricts which element can appear in the subject position, although this may not be true for all languages, such as Italian, in which clitic left dislocation structures are productive.

As for clinical implications, that children with DLD were more receptive than children with ADHD to visual cues and that the reverse pattern was true for linguistic cues seems to provide some evidence that children with ADHD have no real syntactic deficit and that their apparent weakness in syntax is in fact related to task-dependent demands. However, as this study is the first of its kind, more work is needed to verify the reported effects. Nonetheless, this work is an important first step in investigating how various types of cues can be used to elicit complex syntactic structures in clinical populations, and we suggest that cue sensitivity might offer a fruitful avenue for further exploration, in particular for researchers interested in developing dynamic tools for distinguishing children with and without syntactic impairment.

Limitations

This study had some limitations. To begin with, although the choice of using a fixed-order design was purposeful as we wanted to employ a dynamic type of assessment in which the assistance given to the participants via the cues increasingly shifted from implicit to explicit, it is possible that the low rates of passive productions in the visual cue condition may have been influenced by this choice. Had we used a randomized-order design, the rates of produced passives may have increased following the visual cues. Also, our study did not include a sentence stem only condition, i.e., a condition in which children saw an image and were then given a sentence stem for describing the event in the image without being asked a question that topicalized one of the two referents. As such, we cannot conclusively determine whether the high rates of passive productions in the second linguistic condition are due to the simultaneous topicalization and presence of a sentence stem, or to the presence of a sentence stem alone. However, it should also be noted that the inclusion of an additional condition would have increased the duration of the testing for children who were already in difficulty, due to deficits in either syntax or attention or both. Finally, in this same vein, another limitation of the current study is its lack of power due to the small number of items in the various conditions and small number of participants. Again, it was intentional to keep the protocol optimally short due to the nature of the deficits found in our clinical groups but replicating this study in a way that improves reliability should be the aim of future work. As for the number of participants, factors such as comorbidity and heterogeneity in clinical populations remain a real challenge for researchers attempting to include larger sample sizes.

Disclosure statement

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert

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Table A1. Individual results for the two clinical groups for the standardized syntax test (BILO), the two scores obtained via the CBRS questionnaire (note that for four participants with DLD, the parents either did not want to complete the CBRS or simply did not return it), and the two production scores obtained via the linguistic cues in our experimental protocol. Participants in bold indicate individuals who had either been formally diagnosed as having dual deficits in attention and syntax or who had been red flagged as having suspected co-occurring deficits. Cells highlighted in grey show participants who performed at least 1.25 SDs below TD norms following linguistic cues.

Participant	Age (y;m)	Main diagnosis	Double diagnosis	BILO z-score	CBRS Inattention z-score	CBRS Hyperactivity z-score	Linguistic cue 1 score (%)	Linguistic cue 2 score (%)
TD mean				0.53 (1.0)	-0.6 (0.6)	-0.8 (0.7)	80 (36.5)	93 (18.3)
1	6;3	ADHD	na	-0.69	-2.9	-2.0	0	100
2	6;6	ADHD	na	0.74	-2.3	-1.4	0	100
3	7;1	ADHD	na	-1.90	-2.3	-2.6	100	100
4	7;3	ADHD	na	1.1	-1.1	-1.7	100	100
5	7;8	ADHD	na	-2.40	-1.4	-1.7	0	50
6	7;10	ADHD	na	2.10	-2.4	-1.8	100	100
7	8;0	ADHD	Suspected DLD	-3.92	-2.4	-2.4	0	100
8	8;1	ADHD	na	-3.5	-1.2	-1.6	100	100
9	8;9	ADHD	na	3.58	-1.3	-2.2	100	100
10	9;2	ADHD	Suspected DLD	-6	-2.6	-1.3	67	50
11	9;4	ADHD	Suspected DLD	-3.13	-1.4	-1.7	33	100
12	9;6	ADHD	na	0.74	-3	-2.4	100	100
13	9;6	ADHD	na	-1.83	-3.0	-2.4	100	100
14	10;0	ADHD	na	-1.86	-2.4	-2.3	100	100
15	10;0	ADHD	na	-1.05	-2.0	-1.7	100	100
16	10;2	ADHD	na	-2.81	-2.4	-2.1	100	100
17	10;4	ADHD	na	-0.55	-2.1	-2.4	100	100
18	10;6	ADHD	na	0.10	-3.0	-2.6	33	100
19	10;7	ADHD	na	1.65	-2.7	-1.6	100	100
20	10;7	ADHD	na	0.84	-2.4	-2.3	100	100
ADHD mean				-0.94 (2.35)	-2.22 (0.62)	-2.01 (0.41)	72 (42.3)	95 (15.4)
21	6;10	DLD	na	-2.10	-0.2	-0.4	0	0
22	6;10	DLD	na	-1.4			0	0
23	7;2	DLD	ADHD	-2.11	-0.6	-1.3	33	100
24	7;3	DLD	ADHD	-1.90	-1.3	-0.8	0	0

(Continued)



Table A1. (Continued).

Participant	Age (y;m)	Main diagnosis	Double diagnosis	BILO z-score	CBRS Inattention z-score	CBRS Hyperactivity z-score	Linguistic cue 1 score (%)	Linguistic cue 2 score (%)
25	7;7	DLD	na	-2.40	-0.6	-0.8	33	100
26	7;8	DLD	ADHD	-1.90			0	0
27	7;10	DLD	na	-1.65	-2.0	-1.9	0	50
28	8;3	DLD	na	-7.25	-1.0	-0.1	100	100
29	8;6	DLD	na	-8.08	-0.1	-0.2	100	100
30	8;11	DLD	na	-3.77			100	100
31	9;0	DLD	na	-4.75	-1.2	-0.9	67	100
32	9;1	DLD	ADHD	-4.33	-1.3	-1.4	100	100
33	9;4	DLD	na	-4.33	-1.4	-1.4	33	100
34	9;4	DLD	na	-4.33	0.1	0.0	33	100
35	10;5	DLD	na	-1.86	-1.3	-0.2	67	50
36	10;5	DLD	ADHD	-2.68	-1.1	-1.1	100	100
37	10;7	DLD	na	-4.74	-0.4	-0.6	33	100
38	11;3	DLD	na	-4.05	-2.3	-1.3	100	100
39	11;6	DLD	na	-2.00	-2.6	-0.7	100	100
40	11;8	DLD	na	-4.64			100	100
DLD mean				-3.51 (1.86)	-1.09 (0.77)	-0.82 (0.55)	55 (42.27)	75 (41.4)

Note: BILO = *Bilan Informatisé du Langage Oral*; CBRS = Conners Comprehensive Behavior Rating Scales; Linguistic cue 1 = topicalization of the patient; Linguistic cue 2 = topicalization of the patient + subsequent sentence initiation.

Table A2. Summary of languages spoken by the bilingual participants.

Group	Participant	Languages
DLD	1	French, Spanish
	2	French, Japanese
	3	French, Portuguese
	4	French, Arabic
	5	French, Turkish
	6	French, Albanian
	7	French, Arabic
	8	French, Arabic
	9	French, Portuguese
TD	10	French, Italian
	11	French, Italian, German
	12	French, Portuguese
	13	French, English
ADHD	14	French, English
	15	French, English