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DLD and ALI Language Profiles Are Not the Same: Evidence from Mandarin *Wh*-Words

Rui Huang, Jeannette Schaeffer, and Xiaowei He

1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that is characterized by deficits in communicative, social interaction and repetitive behaviors (American Psychiatric Association, 2013). Individuals with Autism and Language Impairments (ALI) represent a subgroup within ASD (Tager-Flusberg & Joseph, 2003). Recent studies suggest that the impaired language profiles of children with ALI are similar to those of children with Developmental Language Disorder (DLD, previously known as Specific Language Impairment, SLI) (e.g., Bishop, 2010; Perovic et al., 2013; Roberts et al., 2004; Tager-Flusberg, 2006). DLD in children is a deficit in language without disability in hearing, intelligence and other conditions (Bishop et al., 2017; Leonard, 2014:3). Given the seemingly similar language profiles of ALI and DLD, some children with ALI have been misdiagnosed with DLD (Bishop et al., 2008). This raises the question as to whether the language profiles in ALI and DLD are really similar, and if so, whether their errors stem from the same underlying causes.

The current study addresses this question by investigating the interpretations of Mandarin Chinese *wh*-words (e.g., *shei* ‘who’, *shenme* ‘what’) in children with ALI and children with DLD. Mandarin *wh*-words can have both interrogative (question) and non-interrogative (statement) readings. The licensing conditions that sanction the non-interrogative interpretations of *wh*-words concern grammar and prosody. As such, the ability to distinguish the question and statement readings of *wh*-words is a reflection of language abilities. If the ALI and the DLD groups show different performance in accessing non-interrogative readings of *wh*-words, the two pathological groups cannot be easily assumed to share the same etiology.

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2. Background

2.1. Non-interrogative use of Mandarin-Chinese *wh*-words and its acquisition

Besides interrogative/question readings, Mandarin-Chinese *wh*-words can also have non-interrogative/statement interpretations (Cheng, 1991; Huang, 1982; Li 1992; Lin, 1998a). Non-interrogative/statement interpretations of Mandarin-Chinese *wh*-words must be subject to certain grammatical (syntactic-semantic) and prosodic contexts.

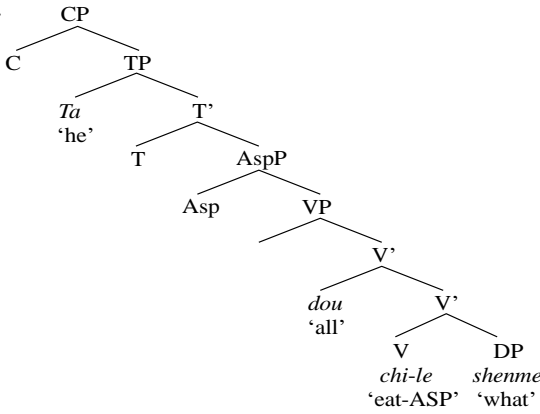
According to previous theoretical literature on Mandarin-Chinese, non-interrogative *wh*-words are treated as ‘Polarity Sensitive Items (or PSIs)’. There is a range of licit licensing contexts that sanction non-interrogative *wh*-words, including negation (and other downward entailing operators), modals, and also adverbial quantifiers such as *ye* ‘also’, or *dou* ‘all’ (Cheng, 1991, 1994, 1995; Lin 1996; 1998b; Liao 2011; Liu, 2016, 2019, a.o.). The contrast between (1a) and (1b) indicates that the interaction between the *wh*-word *shenme* ‘what’ and the adverbial quantifier *dou* ‘all’ affects the interpretations of *wh*-words. The in-situ *shenme* in (1a) maintains its typical question reading. In contrast, non-interrogative *shenme* occurs only when it precedes *dou*, as in structures such as (1b). Following Cheng (1995), licensing of the polarity *wh*-words takes place by m-command by the adverbial quantifier *dou*¹. In this case, in order to satisfy its PSI licensing requirements and to be quantified by *dou*, the *wh*-word *shenme* in (1b) has moved to a pre-*dou* position. As is shown in (2b), after movement of *shenme*, *dou* is able to m-command *shenme*, because a) *dou* does not dominate *shenme*, b) *shenme* does not dominate *dou*, and c) the maximal projection of *dou* (VP) dominates *shenme*. As such, *dou* can license non-interrogative *shenme*, and assign universal quantification to *shenme*. The tree in (2a) shows that *dou* dominates *shenme*, and thus does not m-command *shenme*. Therefore, it cannot license the non-interrogative *shenme*, making (1a/2a) a question.

(1) a. Ta dou chi le shenme? (question reading)
 he all eat ASP what
 ‘What were all the things that he ate?’

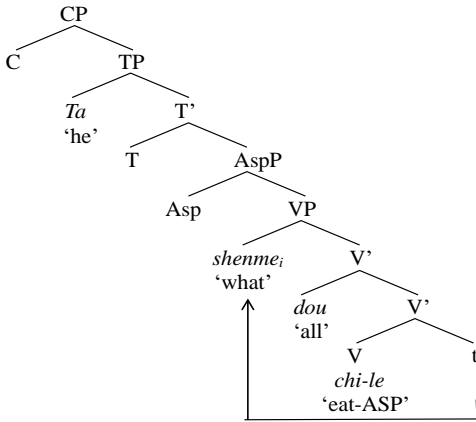
b. Ta shenme dou chi le. (statement reading)
 he what all eat ASP
 ‘He ate everything.’

¹ M-command is defined as follows (Chomsky 1986): If *X* and *Y* are two nodes in a syntactic tree, *X* m-commands *Y* if and only if: a) *X* does not dominate *Y*, b) *Y* does not dominate *X*, and c) the maximal projection of *X* dominates *Y*.

(2) a.



b.



(Xue & Han, 2009)

The non-interrogative interpretation of *shei* ('who') is obtained by the same derivation, as is shown in (3).

(3) a. $[_{AspP} Dou [_{AspP} shei_i [_{Asp} zai [_{VP} t_i [V' kan \ shu]]]]]?$ (question reading)
 all who ASP read book
 'Who are all the people that are reading books?'

b. $[_{AspP} Shei_i [_{Asp} dou [_{Asp} zai [_{VP} t_i [V' kan \ shu]]]]]$. (statement reading)
 who all ASP read book
 'Everyone is reading books.'

Although the range of grammatical licensing conditions of non-interrogative *wh*-words is wide, the (non-)interrogative interpretations of *wh*-words sometimes cannot be determined by grammatical cues only. In the negative structure (4), for instance, the *wh*-word *shenme* is licensed by the negative marker *mei* ‘not’. With the absence of other cues, *shenme* can receive either a question reading or a statement reading. Nonetheless, the interpretations of *shenme* can be discriminated by additional prosodic markers (Liu et al., 2016; Yang et al., 2020). More specifically, the ambiguity of (4) can be resolved by adding different intonation components. When the *wh*-word *shenme* is assigned a rising intonation, it gets a question reading (4a), whereas it obtains a statement reading (4b) when a level intonation is added.

- (4) Ta mei chi shenme
 he NEG eat what
 a. ‘What did he not eat?’ (rising intonation - question reading)
 b. ‘He did not eat anything.’² (level intonation - statement reading)

Previous studies have shown that typically-developing (TD) children are able to make a distinction between question and statement interpretations of Mandarin-Chinese *wh*-words as young as 4 years old (Fan, 2012; Fan et al., 2017; Huang & Crain, 2014; Huang et al., 2018; Lin, 2017; Su et al., 2012; Zhou, 2013; Zhou et al., 2012). A couple of studies have reported distinction difficulties for preschool children with ASD (Su et al., 2014; Zhou et al., 2019). However, it remains unknown whether or not children with ALI and children with DLD have difficulties accessing non-interrogative readings of *wh*-words.

2.2. Language Deficits in DLD and ALI

Individuals with DLD are characterized by deficits in structural language, or grammar, specifically in morphosyntax and phonology (Bishop et al., 2017; Leonard, 2014). The impaired language phenotypes of individuals with DLD are attributed to deficits in the computational system, but not in the pragmatic domain (see Schaeffer, 2012).

In contrast, one of the prominent hallmarks of autistic individuals is a deficit in pragmatics. They show impaired social communication and interaction (Baron-Cohen, 1988; Tager-Flusberg, 2011). As a subgroup of ASD, individuals with ALI have an additional deficit in structural language resembling DLD (Durrleman et al., 2017; Kjelgaard & Tager-Flusberg 2010; Perovic et al., 2013). Furthermore, atypical patterns of prosody have been observed in individuals with ASD (e.g. Diehl et al., 2015; Peppé et al., 2006; Terzi et al., 2016; Zhou et al., 2019). As such, individuals with ALI have problems with pragmatics, communication, grammar and prosody.

² Huang (2013) argues that *shenme* in the negative construction with level intonation (4b) can also convey an ‘insignificance’ reading: ‘He hardly ate anything’.

2.3. Predictions

Based on the analysis of the non-interrogative use of Mandarin-Chinese *wh*-words presented in section 2.1 and on our knowledge of language deficits in individuals with ALI and individuals with DLD as described in section 2.2, we formulate two predictions:

Prediction 1

Children with DLD and children with ALI show problems with statement readings of Mandarin *wh*-words in contexts with grammatical cues.

Prediction 2

Children with ALI, but not children with DLD, show problems with statement readings of Mandarin *wh*-words in contexts with prosodic cues.

An open research question we seek to answer concerns the underlying mechanism of the potential deficits in the two pathological groups.

To test our predictions, two experiments were designed to investigate the interpretations of non-interrogative *wh*-words in Mandarin-speaking children with ALI and children with DLD in various grammatical and prosodic contexts. The nonverbal cognitive abilities in the two groups are also tested to obtain insight in the mechanisms that underlie the language difficulties in the two pathological groups.

3. Methods

3.1. Participants

Three groups of 4-6-year-old Mandarin-speaking children: 32 children with ALI ($M=5;3$, $SD=0.65$), 21 children with DLD ($M=5;2$, $SD=0.51$), 28 TD (typically developing) children ($M=5;2$, $SD=0.43$) and a control group of 28 adults ($M=18;9$, $SD=0.56$) participated in the current study.

The children with ALI were recruited from rehabilitation centers and hospitals. They were diagnosed with ASD by psychiatrists with the *Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition)* (DSM-V; American Psychiatric Association 2013). The children with DLD were selected from rehabilitation centers. All TD children were recruited from regular kindergartens. Children in the DLD group and the TD group were confirmed by teachers and parents to have no mental impairments, no hearing loss as well as no behavioral disorders.

All three groups of children underwent a series of standardized tests to assess their language and cognitive abilities: the *Peabody Picture Vocabulary Test–Revised Chinese Version* (PPVT-R; Sang & Miao, 1990), the *Rating Scale for Preschool Children with Language Disorder–Revised Chinese Version 2008*

(RSPCLD-R)/the *Rating Scale for School Children with Language Disorder--Revised Chinese Version 2009* (RSSCLD-R)³ (B. Lin & M. Lin, 2008) and the *Wechsler Preschool and Primary Scale of Intelligence-Fourth Chinese Edition* (WPPSI-IV CN)⁴ (Wechsler, 2012).

The three child groups were age-matched ($p = 0.89$). All children had a full-scale IQ of 75 or higher, and a non-verbal IQ above 70. Moreover, the DLD and the ALI group were matched on scores of Verbal Comprehension Index (VCI) in the WPPSI-IV CN ($p = 0.363$). There was a 1.25 standard deviation below the mean scores of the TD group in at least two out of the four language measures for all children with ALI and all children with DLD.

3.2. Materials and Procedure

The experiments employed a Question-Statement Task (Zhou & Crain, 2011), in which participants are asked to listen to a story with animations displayed in a slideshow using Microsoft PowerPoint. At the end of the story, a puppet on the computer screen says something related to the story by using the actual test sentence: either a question about the outcome, or a statement about the content. The participant's task is to give reactions to what the puppet says: an answer if the puppet asks a question, and to say whether the puppet is right or wrong (yes/no) if the puppet makes a statement (and to further explain why they judge the puppet's statement wrong).

All test sentences were pre-recorded and were expressed by puppets. All participants were tested individually by one experimenter in a quiet room. There are two practice trials before the test trials. The practice session was set to help participants get familiar with the task on the one hand, and to ensure that they understood the task on the other hand. Only those participants who responded correctly in the practice trials continued to the test session.

The next section reports the designs of the two experiments including four test conditions: the grammar-question and the grammar-statement condition in Experiment 1, and the prosody-question and the prosody-statement condition in Experiment 2.

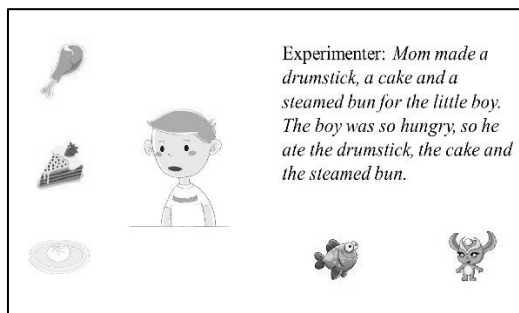
3.2.1. Experiment 1: *Wh*-words in Grammar Conditions

Experiment 1 investigates participants' ability to access the (non-)interrogative interpretations of *wh*-words by using grammatical cues (as

³ Four language measures were administered: receptive vocabulary (from PPVT-R); oral language comprehension, oral language expression and language development (all from RSPCLD-R or RSSCLD-R).

⁴ The nonverbal cognitive abilities were tested in WPPSI-IV CN: *Visual Spatial Index (VSI)*, *Fluid Reasoning Index (FRI)*, *Working Memory Index (WMI)* and *Processing Speed Index (PSI)*. The scores of the *Full Scale Intelligence Quotient (FSIQ)* and *Non-Verbal Index (NVI)* were also obtained from WPPSI-IV CN.

discussed in section 2.1) in two grammar conditions. The two grammar conditions are different in terms of the position of the *wh*-word with respect to the universal quantifier *dou* (preceding or following *dou*). On a typical trial illustrated in Figure 1, the participants hear a question in the grammar-question condition, where the *wh*-word follows *dou*, and a statement in the grammar-statement condition, where the *wh*-word precedes *dou*. The question and the statement on each trial are uttered by one of the puppets randomly. The order of the question and the statement on each trial is also randomized. Given that the experiment used a within-subject design, in order to avoid a sense of repetition, the question and the statement on each trial are identical in sentence structure (except of course the relative positions of the *wh*-word and *dou*), but not in actual words. There are 10 trials, yielding a total of 20 test sentences (10 questions and 10 statements). Test sentences in 5 trials contain the *wh*-word *shei* ‘who’ in the subject position, and test sentences in the other 5 trials test the object *wh*-word *shenme* ‘what’. The target yes and no responses in the grammar-statement conditions are counterbalanced. Moreover, all test sentences were recorded with level intonation to control for the influence of prosodic features on the participants’ interpretations.



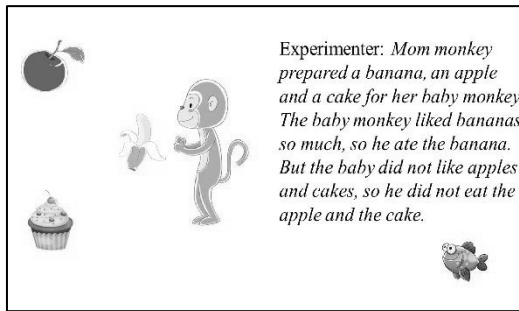
Conditions	Sample Sentences
grammar-question	Puppet 1: Mama dou zuo le shenme? mom all cook-PERF what 'What was all the food that mom cooked?'
grammar-statement	Puppet 2: Didi shenme dou chi le. boy what all eat-PERF 'The boy ate everything.'

Figure 1. Sample items in grammar conditions in Experiment 1

3.2.2. Experiment 2: *Wh*-words in Prosody Conditions

Experiment 2 examines whether participants are able to differentiate the question readings and the statement readings of *wh*-words via various prosodic cues (level intonation or rising intonation). Figure 2 illustrates a typical trial. After the story, the participants are presented with only one type of test sentence uttered

by the puppet: either a question with rising intonation in the prosody-question condition, or a statement with level intonation in the prosody-statement condition. There are 10 trials with 5 lead-in stories. Each story is presented to the participants twice: one combined with a question and one with a statement. The same syntactic structure is employed in all test sentences: Subject (noun phrase) + Negation marker (*mei*) + Verb + *Wh*-word (*shei/shenme*). Thus, the question and the statement constitute a minimal pair, differing in prosody only. To minimize the effect of a potential question-bias⁵, the test sentences were presented in a fixed order: all five sentences with level intonation (statements) first, followed by the five sentences with rising intonation (questions).



Conditions	Sample Sentences
prosody-statement	Puppet: Xiaohouzi mei chi shenme. (level intonation) little monkey NEG eat what 'The baby monkey did not eat anything.'
prosody-question	Puppet: Xiaohouzi mei chi shenme? (rising intonation) little monkey NEG eat what 'What did the baby monkey not eat?'

Figure 2. Sample items in prosody conditions in Experiment 2

4. Results and Discussion

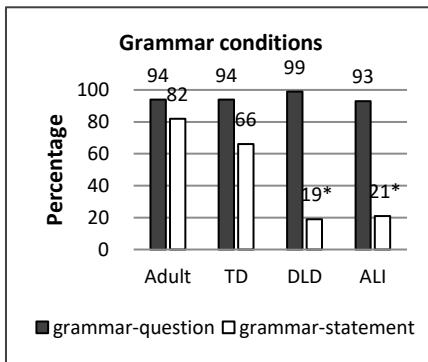
All participants responded 100% correctly to the practice trials, so their responses to the experimental trials were all included in the data analysis. This section presents the participants' mean percentages of correct responses in the grammar conditions (Experiment 1) and the prosody conditions (Experiment 2), and reports the correlation between the performance in the two experiments with the scores on the nonverbal cognitive tests in the DLD group and the ALI group.

⁵ Su et al. (2014) found that Mandarin-speaking adults and children demonstrate a question-bias towards the interpretation of all *wh*-words (incl. non-interrogative *wh*-words) when the sentences with rising intonation (questions) were presented first.

4.1. Performance on Grammar Conditions (Experiment 1) and Prosody Conditions (Experiment 2)

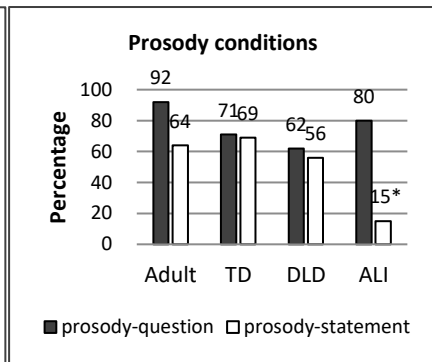
The mean proportions of correct responses in the grammar conditions (Experiment 1) for all groups are presented in Figure 3. All child groups and the adult group perform at ceiling in the grammar-question condition (black bars). A Kruskal-Wallis test reveals no significant differences between the four groups ($\text{Chi}^2(3)=5.332, p=.149$). In contrast, pairwise comparisons show that both the ALI and the DLD group score significantly lower than the TD children (ALI-TD: $p=.000$, DLD-TD: $p=.000$) (see white bars). The DLD and the ALI group do not differ from each other ($p=1.000$). No significant difference is observed between the TD group and the adults either ($p=.937$).

Figure 4 presents a comparison of the mean proportions of correct responses in the prosody conditions by the four groups.⁶ A Kruskal-Wallis test reveals that there is no significant difference between the four groups on the prosody-question condition (black bars) ($\text{Chi}^2(3)=5.559, p=.135$). However, pairwise comparisons show that the ALI group performs significantly more poorly than the TD children ($p=.000$) and than the children with DLD ($p=.016$) on the prosody-statement condition (white bars). There is no significant difference between the DLD group and the TD group ($p=1.000$), and between the TD group and the adults ($p=1.000$).



* significantly different from TD

Figure 3. Proportions of correct responses on grammar conditions



* significantly different from TD

Figure 4. Proportions of correct responses on prosody conditions

⁶ One TD child assigned an insignificance reading to the *wh*-word *shenme* in the prosody-statement condition (see footnote 2). As the statement (e.g. *Xiaohouzi mei chi shenme*. 'The baby monkey hardly ate anything.') can also be considered a true description of the story, this was coded as correct.

The results on the Grammar Conditions (Experiment 1) show that both the ALI and the DLD group have unimpaired knowledge of the question readings of *wh*-words. The results on the grammar-statement condition suggest that both pathological groups show difficulties using syntactic-semantic cues to access the non-interrogative readings of *wh*-words. Thus, our first prediction is borne out: children with DLD and children with ALI show problems with statement readings of Mandarin *wh*-words in contexts with grammatical cues.

As is shown in Figure 4, neither the children with DLD, nor the children with ALI had any problems with the question reading of the *wh*-word in the prosody experiment either (Experiment 2). However, the children of the DLD group and of the ALI group performed significantly differently on the prosody-statement condition: the children with DLD performed TD-like, while the children with ALI scored significantly lower than the TD children. The results from the prosody experiment support our prediction 2 that children with ALI, but not children with DLD, show problems with statement readings of Mandarin *wh*-words in contexts with prosodic cues. Our findings are also consistent with many previous studies reporting that children with ASD have difficulties perceiving and producing prosody (e.g., Diehl et al., 2008; Peppé et al., 2006; Zhou et al., 2019).

4.2. Nonverbal Cognitive Abilities

The scores in the two experiments and the scores of the four nonverbal cognitive indexes for the three child groups are summarized in Table 1.

Table 1. Statement scores and Nonverbal Cognitive Performance

	Grammar-statement condition	Prosody-statement condition	VSI	FRI	WMI	PSI
TD (n=28)	66%	69%	112.6	107.1	100.5	106.4
ALI (n=32)	21%*	15%*	98.9*	102.0	92.4*	91.9*
DLD (n=21)	19%*	56%	92.7*	92.4*	92.5*	95.5*

VSI=Visual Spatial Index; FRI=Fluid Reasoning Index; WMI=Working Memory Index; PSI=Processing Speed Index.

* significantly lower than TD ($p < .05$).

Regarding the grammar conditions (Experiment 1), Pearson's correlations show a significant correlation only between the Visual-Spatial Index (VSI) scores and the grammar-statement scores ($r=.384$, $p=.030$) in the ALI group. No correlations are detected between the other three cognitive abilities and the grammar-statement performance in the ALI group (FRI: $p=.496$; WMI: $p=.334$; PSI: $p=.172$). Furthermore, in the DLD group, there are no correlations between any of the four nonverbal cognitive abilities and the grammar-statement scores (VSI: $p=.169$; FRI: $p=.701$; WMI: $p=.960$; PSI: $p=.100$).

As for the prosody conditions (Experiment 2), the ALI group's low accuracy in the prosody-statement condition is not correlated to any of the tested nonverbal cognitive abilities (VSI: $p=.552$; FRI: $p=.948$; WMI: $p=.462$; PSI: $p=.899$).

Now, recall the open question regarding the underlying mechanisms of the deficits in the two pathological groups. Given the correlation between VSI and grammar-statement scores in the ALI group, the ALI group's problems with the non-interrogative/statement readings of *wh*-words cued by grammar may be caused by weak visual-spatial capacities, although the theoretical connection between visual-spatial ability and grammar ability is not immediately clear. Given the absence of correlations between non-verbal cognitive scores and scores on Experiment 1 in the DLD group, we find no evidence that the DLD group's problems with the statement readings in experiment 1 are caused by general cognitive disabilities. We therefore suggest that they stem from their primary morpho-syntactic impairment. In other words: DLD and ALI superficially show similar grammatical deficits (Experiment 1), but these may have different underlying causes. Regarding the prosodic weakness found in the ALI group only, we suggest that this is a deficit in and of itself in autistic individuals, and not caused by an extra-linguistic cognitive deficit.

4.3. Conclusion

The first aim of the current study was to test whether children with DLD display a similar language profile to children with ALI through an investigation of their abilities to access non-interrogative interpretations of Mandarin-Chinese *wh*-words via grammatical cues (Experiment 1) and via prosodic cues (Experiment 2). The results show that neither the DLD nor the ALI group has problems with the question interpretations of *wh*-words in Experiments 1 and 2. Furthermore, both the ALI and the DLD group perform significantly worse than the TD group on the grammar-statement condition on Experiment 1. However, only the ALI group, but not the DLD group shows difficulties accessing the non-interrogative interpretations of *wh*-words in the prosodic contexts in Experiment 2. These results confirm our prediction that both children with ALI and children with DLD have problems with non-interrogative readings of *wh*-words cued by grammar, and our prediction that children with ALI, but not children with DLD make errors with non-interrogative readings of *wh*-words if these are driven by prosody.

Our second aim was to determine underlying causes of potential difficulties and differences in the DLD group and the ALI group. Regarding the grammar scores (Experiment 1), statistical analyses showed a correlation between Visual-Spatial Index (VSI) scores and the scores on the grammar-statement condition in the ALI group. In the DLD group, no correlations were found between the scores on the grammar-statement condition and any of the four nonverbal cognitive indices. This suggests that although the children with ALI and the children with DLD displayed similar errors in the grammar experiment, their problems seem to be caused by different underlying mechanisms: a primary linguistic deficit in DLD, but potentially a weak visual-spatial capacity in ALI. Moreover, there is no

correlation between the ALI group's scores in the prosodic experiment and their nonverbal cognitive abilities, implying that for the children with ALI, their poor performance on the prosody-statement condition can probably not be explained by weak nonverbal cognitive abilities. We therefore hypothesize that the prosodic deficits found in the ALI group constitute a deficit in and of itself. This result in Experiment 2 provides further evidence for the distinction in language profiles between DLD and ALI.

Our findings suggest that despite the superficial similarities of the language impairments in children with DLD and children with ALI, the two pathological groups have different underlying etiologies. As such, our results add experimental evidence to the growing body of research uncovering the differences between language impairments in DLD and in ALI. The differences found in our study have clinical implications as well. For instance, they indicate that diagnoses and interventions should be extended to the domain of prosody as well as to nonverbal cognitive capacities.

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