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Expressive language variation, growth and predictors in Mandarin-exposed young children with autism spectrum disorder

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ABSTRACT

Utilizing the Putonghua Communicative Development Inventory-Toddler Form, this longitudinal study assessed expressive language development (including lexicon, grammar, and decontextualized language) twice over a year's span in two subgroups (high verbal, low verbal) of 77 2–6-year-old Mandarin-exposed children with autism spectrum disorder (ASD). Both subgroups showed the steeper increase of structural language (lexicon and grammar) vs. the flatter growth of decontextualized language. Moreover, children's initial language skills (but not autism severity or language environment) predicted language outcomes one year later in both groups. The use of decontextualized language also predicted structural language development in the low verbal group. These findings confirmed the uneven expressive language growth across multiple language domains in subgroups of children with ASD and underscored the contribution of early language skills to their expressive language development. Moreover, the slow growth and significant predictivity of decontextualized language warrant targeted intervention in promoting children with ASD's talk beyond the 'here-and-now' situation in communication.

1. Introduction

Autism spectrum disorder (ASD) represents a heterogeneous group of neurodevelopmental disorders that are defined by impairments in social interaction and communication, and the presence of repetitive and stereotyped behaviours or interests (American Psychiatric Association, 2013). These impairments are presented early in childhood and may last throughout the lifespan, which lead to substantial burdens on affected individuals and their families. For the past decade, the global median prevalence of ASD has increased dramatically from 62/10,000 children in 2012 (Elsabbagh et al., 2012) to 100/10,000 children in 2022 (Zeidan et al., 2022). The recent autism prevalence in mainland China is approximately 1% of school age children (Sun et al., 2013; 2019), comparable to the global prevalence.

Although language deficits are no longer designated as core components of the diagnostic criteria for ASD, delay in language onset is one of the primary triggers for parents seeking hospital referrals for their toddlers eventually diagnosed with ASD (Robins et al., 2014). Comorbidity of speech and language disorders is often identified among preschool children with ASD; moreover, language is a dominant target for early intervention among preschool children with ASD (Boucher, 2012; Tager-Flusberg & Kasari, 2013). Of note are the previous findings in English-learning children with ASD that expressive language status of children at five years of age is probably the strongest predictor of outcomes (e.g., social interaction, academic and adaptive functioning, educational and employment history) in later childhood and adulthood (Howlin et al., 2013), which warrants research-based practices and effective services to target on early expressive language improvement in ASD.

Variation is a hallmark feature of expressive language development of preschool children with ASD, which occurs at the onset of language development and persists until the child enters school (Eigsti et al., 2007; Kjelgaard & Tager-Flusberg, 2001; Pickles et al., 2014; Smith et al., 2007; Tek et al., 2014). While some preschoolers with ASD reach language milestones (i.e., babbling, age of first words/phrases) on time and show intact structural language knowledge, 20%−30 % of children

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with ASD remain nonverbal despite years of interventions (Naigles & Chin, 2015). Moreover, trajectories of language development differ considerably, with some demonstrating typical but delayed development while others showing possible deviance and flatter growth (Anderson et al., 2007; Tek et al., 2014; Weismer & Kover, 2015). Anderson et al. (2007) reported that children with ASD exhibited diverse patterns of language development, including acceleration, improvement, stagnation, and regression. Smith et al. (2007) investigated vocabulary growth and its predictors in 35 English-exposed 20–71-month-olds with ASD over 2-year's span, using the MacArthur-Bates Communicative Developmental Inventory (MCDI; Fenson et al., 1993). Four distinct trajectories of vocabulary growth were identified, including those with flat growth, slow incline, high and steady increase, or steep rate of vocabulary growth (see similar results of Italian-exposed preschoolers with ASD in Riva et al., 2021). Tek et al. (2014) identified two distinct expressive language profiles among 17 toddlers with ASD via analyses of their spontaneous speech collected over a 2 years span. The participants were divided into two language subgroups based on a median split on their expressive language scores: the High-Verbal subgroup of children with ASD was comparable to typically developing (TD) children on the growth trajectory of vocabulary size, morpho-syntactic production and wh-question complexity; by contrast, the Low-Verbal subgroup exhibited flatter trajectories in most language measures.

In addition, the language domain in which strengths or deficits are reported can vary in children with ASD - while the structural language domains (e.g., phonology, lexicon, syntax) exhibit comparative strengths, impairment in pragmatics or socially based language is most characteristic of ASD (Naigles & Chin, 2015). In Tager-Flusbergs et al. (1990)'s longitudinal study, six 3–6-year-old boys with ASD produced negation and question in correct grammatical forms, yet in pragmatically restricted contexts. Ellawadi and Weismer (2015) found phonology an area of strength while pragmatics an area of impairment in preschoolers with ASD. Even high functioning children with ASD, who were matched with TD peers on vocabulary and grammar levels, performed more poorly in comprehending figurative language (e.g., metaphor; Rundblad & Annaz, 2010), as well as inferential language (i.e., indirect requests; Loukusa et al., 2007). They also displayed problems in referring to characters, and maintaining and elaborating on themes within narratives and dyadic interactions, which are disproportionate to their verbal capability (Norbury et al., 2014). Using the Children's Communicative Checklist-2 (Geurts, 2007), Geurts and Embrechts (2008) compared the expressive language profiles of preschool and school-age Dutch-speaking children with ASD and those with other developmental disorders. Both groups of children with ASD displayed more severe difficulties with pragmatic language than structural language. It's worth noting that the pragmatic impairments of children with ASD have been attributed to their core deficits in social communication and interaction (Baron-Cohen, 2000; Tager-Flusberg, 2001); by contrast, the grammatical strengths in children with ASD have been ascribed to the operation of separate computational mechanisms that are specific to "the domain of language" (Tager-Flusberg, 2001), or "the language faculty" in recent literature (Su & Naigles, 2022).

Importantly, various child characteristics (e.g., initial language skills, IQ, autism severity) and environmental factors (e.g., intervention, parental input, Social Economic Status) may lead to such heterogeneity and impact children with ASD's language growth (Anderson et al., 2007; Smith et al., 2007; Thurm et al., 2015; Weismer & Kover, 2015). For instance, a handful of studies using the CDIs among children with ASD learning Indo-European languages indicated that their earlier language ability, e.g., pre-speech gesture, receptive/expressive vocabulary predicted the subsequent language growth (Charman et al., 2005; Luyster et al., 2007; Riva et al., 2021). Moreover, Smith et al. (2007) reported that the two clusters of children with the least vocabulary growth (i.e., those with flat growth or slow incline) had the most significant developmental delay and autism severity. However, the language outcome in the above-noted CDI studies only includes expressive vocabulary growth, without a consideration of multiple language domains.

To date, most of the studies exploring expressive language development have been conducted in children with ASD exposed to Indo-European languages (e.g., English), leaving questions about whether universal patterns of expressive language development can be observed in children with ASD learning typologically different languages. Only a couple of studies have explored expressive language development of Chinese preschool children with ASD. Song and So (2022) collected data of 42 4–8-year-old Cantonese-speaking children with ASD over four times across nine months in parent-child spontaneous interactions. Children with ASD as a group showed rapid growth of word types, word tokens, and mean length of utterance (MLU), but their development trajectories varied, as what has been reported among English-exposed children with ASD. Additionally, initial expressive language abilities (but not autism traits, nonverbal IQ, or parental input) predicted children's language outcomes and development trajectories. However, this longitudinal study only focused on children's development of word types/tokens and MLU, without a detailed description of their linguistic profiles across various language domains. Beyond the normal parent-child interactions, Li et al. (2023) is the first study that focused on clinician– child interactions, which has unveiled profiles of lexical and grammatical (but not pragmatic) development of 81 2- to 7-year-old Mandarin-speaking children with ASD, who were divided into five age groups according to their chronological age. The findings support that noun bias is a universal inherent mechanism and that lexical and grammatical domains are synchronically developed in different subgroups of Mandarin-speaking preschoolers with ASD. Finally, using the standardized assessment of the toddler version of the Putonghua Communicative Development Inventory (PCDI, Tardif et al., 2008), Su & Naigles (2018) investigated expressive language profiles of 160 17–83-month-old Mandarin-exposed children with ASD, to examine whether Mandarin-exposed children with ASD demonstrated similar patterns of expressive language development as children with ASD learning Indo-European languages. The children were divided into three subgroups (high verbal, middle verbal, and low verbal), and all three subgroups demonstrated relative strengths in lexical and grammatical uses over the decontextualized use of language. Thus, the study testifies similar levels of variability between children with ASD exposed to Mandarin Chinese and those exposed to Indo-European languages. However, the last two studies are cross-sectional, which didn't explore children's developmental trajectory or the influential factors impacting their language growth.

In this longitudinal study, we attempt to further examine the development of expressive vocabulary, grammar, and decontextualized language over one year's span in 77 Mandarin-exposed 2–6-year-old children with ASD (further divided into the high verbal and low verbal subgroups), again using the PCDI-toddler form. As mentioned, several longitudinal studies using CDI in children with ASD learning Indo-European languages have focused on their vocabulary skills and have reported the variations in vocabulary development (e.g., Luyster et al., 2007; Smith et al., 2007; Riva et al., 2021). Less is known about preschoolers with ASD's language growth across multiple language domains (e.g., lexicon, grammar, and decontextualized use of language). In addition, we examine whether child characteristics such as age, initial language skills, autism severity, and environment factors such as language environment may impact children with ASD's language growth across language domains. Specifically, we wish to address two research questions: (1) Do the high verbal and low verbal children with ASD exposed to Mandarin Chinese show similar or distinct profiles of expressive language development across the multiple language domains of lexicon, grammar and decontextualized use of language? (2) Do influential factors such as age, initial language skills, autism severity, and language environment impact language outcomes in children with ASD? To our knowledge, this is the first longitudinal study tracking expressive language development and its influential factors in

Mandarin-exposed young children with ASD.

2. Materials and methods

2.1. Participants

We recruited 126 child participants suspected of having ASD to participate in this longitudinal study. The children were recruited from three autism training centres (Aimier, Xinyuan, and Aimeng) in Changsha, China. The training centres informed parents about the study when their children were receiving daily interventions during the one year's span of the study. Parents of the 126 children with ASD all gave informed consent for participation, approved by the Medical Ethics Committee of the Second Xiangya Hospital, Central South University.

In the present study, the 5th version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) served as the primary diagnostic criteria of ASD, and the parent rating scale of Autism Behaviour Checklist (ABC; Davenport, 2011; Yang et al., 1993) was a supplementary assessment. Of the original 126 children, 31 failed to meet the ASD diagnosis based on the DSM-5 criteria. In addition, 18 children scored below the cut-off score of 31 on the ABC at visit 1 or 2 and were also removed from the final participant pool. Thus, the final dataset consists of 77 Mandarin-exposed 2–6-year-old children with ASD (78% males) aged 25–71 months at first visit, all scoring above the cut-off score of 31 on the ABC. All children in the training centres were exposed to Mandarin Chinese, which is the standard language for education in China. Moreover, 52 out of the 77 children were exposed merely to Mandarin Chinese at home, while 25 children were also exposed to the regional Xiang-dialect in addition to Mandarin Chinese.

To examine the potential variability of expressive language development for those with higher or lower language abilities, two ASD subgroups were created using a median split of children's overall vocabulary production scores on the PCDI at visit 1 (see also Abdelaziz et al., 2018; Tek et al., 2014). Children who scored below the median were classified as the Low Verbal group (LV, n = 39, mean age= 43.28 months, 0–82 words), and those who scored above the median were classified as the High Verbal group (HV, n = 38, mean age=51.03 months, 85–712 words). These subgroups were created considering the evidence that this is a meaningful distinction among children with ASD with respect to their language development which may lead to different linguistic phenotypes (Abdelaziz et al., 2018; Tek et al., 2014). Table 1 shows descriptive data of the two ASD subgroups, including their mean age, ABC scores, and vocabulary production scores on the PCDI. Compared to the HV group, the LV group was significantly younger and had significantly lower vocabulary production scores (*ps* < .05).

Table 1
Participant information of the two ASD subgroups at two visits.

	LV (N = 39)		HV (N = 38)	
	Mean ± SD	Range	Mean ± SD	Range
Age in months				
Visit 1	43.28 ± 9.46	25-66	51.03 ± 10.64	28–71
Visit 2	55.26 ± 9.39	37-78	63.16 ± 10.52	40–82
ABC scores				
Visit 1	68.00 ± 25.17	32-124	73.03 ± 24.89	33–134
Visit 2	69.27 ± 22.69	33-126	66.86 ± 22.42	32-102
Vocabulary production scores				
Visit 1	16.51 ± 23.65	0-82	308.66 ± 157.89	85–712
Visit 2	143.97 ± 199.82	0-799	470.05 ± 197.80	50–784

2.2. Instruments

2.2.1. Putonghua communicative development inventory (PCDI)

The PCDI is a caregiver report of early language and communicative development for Mandarin-learning children (Tardif et al., 2008), adapted from the MacArthur-Bates CDI (Fenson et al., 1993). The toddler version of the CDIs was originally designed to measure language and communication development of TD 16–30-month-olds. Due to the substantial language delay in ASD, the toddler version of CDIs has been used to assess expressive language profiles of 1–7-year-old children with ASD across languages (English: Smith et al., 2007; Weismer et al., 2011; Mandarin Chinese: Su et al., 2018; Swedish: Miniscalco et al., 2014).

The PCDI-toddler form contains two components. Part I is the Vocabulary Production Checklist with 799 words organized into 24 semantic categories. Part II has 4 sections: Section (A) *'how children use words'* contains 4 production items, which ask questions about children's decontextualized language use, i.e., the frequencies of the child's references to the past, future, and absent objects and owners. Specifically, this section includes *absent owner* (ask whether children ever pick up or point to an object and name an absent person to whom it belongs), *absent toys/animals* (ask whether children ever mention objects that are not present), *past events/people* (ask if children ever talk about past events or people not present), and *future events* (ask if children ever talk about something that will happen in the future). The decontextualized use of language is defined as language use that extends beyond the immediate context. It generally involves topic introduction, temporal or conceptual displacement, audience awareness, as well as the ability to relate a series of events or descriptions in a referentially cohesive manner, and thus indicates some important aspects of social communication. Sections (B-C) assess grammatical language use. Section (B) *'sentence and grammar'* contains 4 grammatical items: serial verb construction, possessive, quantifier, and aspect marker. Section (C) includes *'word combination'* and '*Mean Length of Three Longest Utterances'* (MLU3). Section (D) *'sentence complexity'* requires the parents to choose among 2–5 alternative options contrasting in complexity for each of the 37 items that best reflects the child's current speech level.

2.2.2. Autism Behaviour Checklist (ABC)

The standardized Chinese version of the modified ABC (Yang et al., 1993) is a caregiver rating scale screening for autistic behaviours of individuals aged 18 months to 35 years. It includes 57 items categorized into 5 subscales: Sensory, Relating, Body and Object Use, Language, Social and Self-help. The ABC has yielded good reliability and validity among Chinese children with ASD and is one of the most frequently used screening measures in epidemiological studies of ASD in mainland China (Sun et al., 2013).

2.2.3. Procedures

Parents completed the PCDI-toddler form and the ABC at two time points over one year's span. The PCDI forms are designed to be self-explanatory (see also Fenson et al., 1993); moreover, the PCDI-toddler form mainly assessed whether the child can 'speak' (rather than 'understand') the target words or sentences. So, no additional training or instruction was provided to the parents who completed the forms.

3. Results

3.1. Expressive vocabulary development

Descriptive statistics of the total and 24 semantic subcategories scores for the LV and HV groups are presented in Table 2. Independent-sample T tests indicated that both the LV and HV groups increased significantly in the total score and in most of the 24 semantic categories on the vocabulary production checklist (LV: t(74) = .93–4.65, *ps* < .05 for 20/25 comparisons; HV: t(72) = 1.4–4.5, *ps* < .05 for 23/25 comparisons). However, the LV group's vocabulary growth didn't reach

Table 2
Mean (SD) scores of the total vocabulary and each semantic subcategory in the two ASD subgroups.

PCDI	LV(n=39)					HV(n=38)				
Semantic category	Visit 1 Mean (SD)	Visit 2 Mean (SD)	*t*	*p*	*d*	Visit 1 Mean (SD)	Visit 2 Mean (SD)	*t*	*p*	*d*
Total Score (n=799)	16.51 (23.65)	143.97 (199.82)	3.96	<0.001***	0.89	308.66 (157.89)	470.05 (197.80)	3.93	<0.001***	0.84
Sound effects(n=12)	0.97 (1.60)	3.44 (4.13)	3.47	0.001**	0.79	6.66 (3.22)	9.32 (2.96)	3.74	<0.001***	0.84
People(n=32)	3.82(4.71)	9.85(10.46)	3.28	0.002**	0.74	20.76(6.91)	23.97(7.41)	1.95	0.054	0.39
Games (n=28)	1.47(2.28)	7.69(9.09)	4.14	<0.001***	0.93	16.24(7.00)	21.13(7.33)	2.98	0.004**	0.63
Action Verbs (n=194)	2.29 (4.50)	27.38 (45.30)	3.44	0.001**	0.77	67.08 (43.28)	106.08 (58.66)	3.27	0.002**	0.70
Food & drinks (n=69)	1.59 (3.07)	18.33 (23.16)	4.47	<0.001***	1.01	40.53 (16.28)	54.08 (15.30)	3.74	<0.001***	0.79
Body parts (n=27)	0.41 (1.16)	7.59 (9.67)	4.65	0.001**	1.05	14.18 (7.22)	19.74 (7.33)	3.33	0.002**	0.74
Animals (n=49)	2.13 (5.28)	13.15 (18.25)	3.62	0.002**	0.82	26.21 (12.90)	35.47 (12.59)	3.17	0.001**	0.74
Adjectives & adverbs (n=66)	0.44 (1.27)	8.79 (15.18)	3.43	0.001**	0.78	19.76 (15.11)	34.63 (20.67)	3.58	0.001**	0.78
Household items (n=56)	0.69 (2.23)	12.44 (17.34)	4.19	<0.001***	0.95	25.32 (15.06)	37.76 (15.70)	3.53	0.001**	0.79
Toys (n=18)	0.28 (0.61)	3.72 (5.41)	3.94	<0.001***	0.89	7.76 (4.60)	11.8 4(5.63)	3.46	0.001**	0.73
Clothing (n=28)	0.23 (0.77)	4.44 (7.13)	3.66	<0.001***	0.83	8.74 (6.20)	16.32 (8.92)	4.30	<0.001***	1.12
Furniture & rooms (n=29)	0.18 (0.72)	5.44 (8.27)	3.96	<0.001***	0.90	10.53 (7.23)	18.18 (8.97)	4.10	<0.001***	0.88
Outside things (n=32)	0.23 (0.67)	6.41 (9.43)	4.08	<0.001***	0.93	12.03(8.04)	21.45(10.10)	4.50	<0.001***	0.99
Vehicles (n=14)	0.28(0.72)	3.77(5.23)	4.12	<0.001***	0.93	6.47(4.61)	9.97(4.53)	3.34	0.001**	0.71
Place to go (n=17)	0.03(0.16)	2.82(4.59)	3.80	<0.001**	0.86	4.63(4.35)	9.37(5.68)	4.13	<0.001***	0.89
Directional words (n=21)	0.13(0.66)	2.21(4.34)	2.95	0.004**	0.67	4.05(5.39)	10.00(7.25)	4.06	<0.001***	0.88
Quantifiers (n=9)	0.64(1.18)	1.79(2.31)	2.78	0.009**	0.63	3.63(1.92)	4.68(2.09)	2.28	0.025*	0.46
Pronouns (n=24)	0.21(0.47)	1.85(4.23)	2.41	0.017*	0.54	3.92(5.20)	8.16(7.64)	2.85	0.006**	0.58
Classifiers (n=20)	0.05(0.32)	1.15(3.64)	1.89	0.067	0.43	3.89(5.10)	7.16(6.46)	2.45	0.017*	0.49
Question words (n=12)	0.03(0.16)	0.74(2.16)	2.07	0.039*	0.46	1.24(2.12)	4.39(4.84)	3.68	0.001**	0.79
Modal particles (n=6)	0.49 (1.45)	0.79 (1.49)	0.93	0.332	0.20	1.29 (1.68)	1.92 (2.22)	1.40	0.166	0.25
Time (n=15)	0(0)	0.64(2.48)	1.62	0.105	0.37	2.05(3.10)	4.53(5.07)	2.57	0.012*	0.72
Helping words (n=12)	0.03 (0.16)	0.59 (2.06)	1.70	0.096	0.38	1.34 (2.03)	3.53 (4.17)	2.90	0.005**	0.63
Connecting words (n=9)	0(0)	0.49(1.67)	1.83	0.076	0.42	0.34(1.05)	1.82(2.71)	3.13	0.003**	0.67

Note. T-test
* $p<.05$
** $p<.01$
*** $p<.001$

significance for 'classifier', V1:M(SD)= 0.05(0.32), V2: M(SD)= 1.15 (3.64), 'modal particle', V1:M(SD)= .49(1.45), V2: M(SD)= .79(1.49), 'time', V1:M(SD)= 0, V2: M(SD)= .64(2.48), 'helping words', V1:M (SD)= .03(.16), V2: M(SD)= .59(2.06), and 'connecting words', V1:M (SD)= 0, V2: M(SD)= .49(1.67), ts(74)= .93–1.89, *ps*> .05, *d*= .20–.47 as shown in Fig. 1); for the HV group, the increases in 'people', V1:M (SD)= 20.76(6.91), V2: M(SD)= 23.97(7.41), t(72) = 1.68, $p = .10$, *d*= .39, and 'modal particle', V1:M(SD)= 1.29(1.68), V2: M(SD)= 1.92 (2.22), t(72) = 1.09, $p = .49$, *d*= .25, did not reach significance (as shown in Fig. 2). In addition, for the LV group, eleven out of the thirty-nine children are non-verbal children with zero score for vocabulary production at visit 1, among which six remained non-verbal at visit 2, three were minimally verbal producing no more than 14 words, and only two of the initially low verbal children produced 374 and 510 words at visit 2.

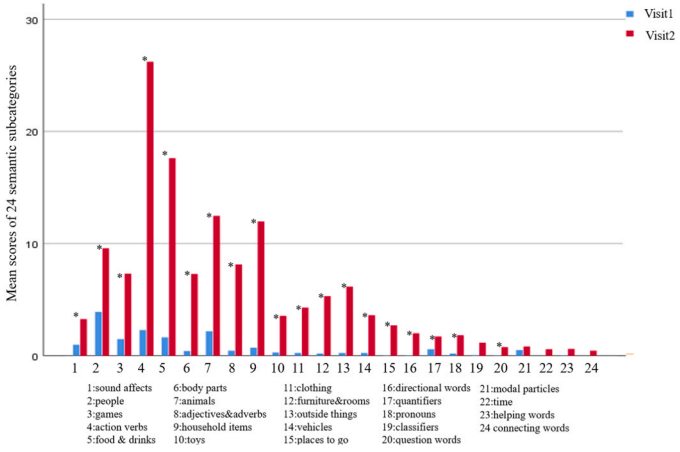

Fig. 1. The development of 24 semantic subcategories in the LV group

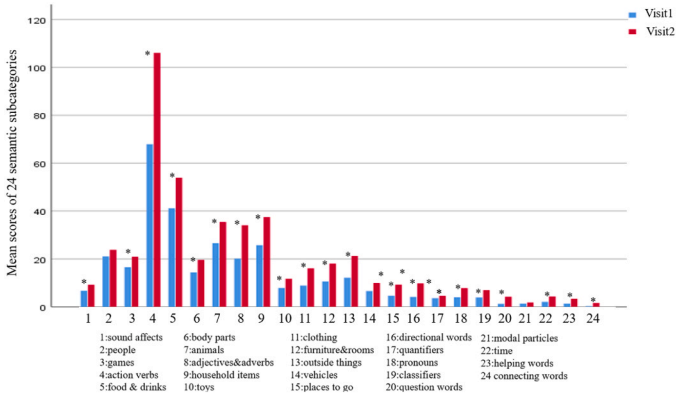

Fig. 2. The development of 24 semantic subcategories in the HV group

3.2. Grammatical use of language

Grammatical items. Table 3 displays the percentages of children who 'often' or 'sometimes' produced words with each grammatical construction. Pearson's Chi square tests of contingencies revealed that the uses of most grammatical items increased significantly in the LV group, such as serial verb construction (V1: 2.6%, V2: 28.2%, $x^2 = 9.57$, $p < .05$, $V = .35$), possessive (V1: 2.6%, V2: 20.5%, $x^2 = 6.96$, $p < .05$, $V = .28$), aspect marker (V1: 0, V2: 12.8%, $x^2 = 5.21$, $p < .05$, $V = .26$), and the HV group, such as possessive (V1: 34.2%, V2: 68.4%, $x^2 = 8.9$, $p < .05$, $V = .34$) and quantifier(V1: 36.8%, V2: 63.2%, $x^2 = 5.26$, $p < .05$, $V = .26$).

Word combinations. The percentages of participants who 'often' or 'sometimes' combined words into sentences were as follows: 5.4% at visit 1% and 47.4% at visit 2 for the LV group, 70.3% at visit 1% and 89.2% at visit 2 for the HV group. Chi square tests revealed that the increased percentage in the two groups reached statistical significance

Table 3
Percentage (%) of children using grammatical items in the two ASD subgroups.

Grammatical Items	LV (N=39)				HV (N=38)			
	Visit 1	Visit 2	x^2	*V*	Visit 1	Visit 2	x^2	*V*
Serial verb construction	2.6	28.2	9.57**	0.35	63.2	71.1	0.54	0.08
Possessive	2.6	20.5	5.96*	0.28	34.2	68.4	8.90**	0.34
Quantifier	2.6	10.3	1.84	0.16	36.8	63.2	5.26*	0.26
Aspect marker	0	12.8	5.21*	0.26	34.2	55.3	3.41+	0.21

Note. LV: Low Verbal; HV: High Verbal; Chi-square tests
***$p<.001$
* $p<.05$
** $p<.01$

(LV: x^2=16.88, p < .001, *V*=.47; HV:x^2=4.10, $p = .04$, *V*=.24).

MLU3 and sentence complexity. Table 4 presents the scores on MLU3 and sentence complexity. Both groups showed significant gains in MLU3, LV:V1:M(SD)= .12(.72), V2:M(SD)= 1.19(1.93), t(70) = 3.09, $p < .001$, *d*= .73, HV:V1:M(SD)= 2.50(2.16), V2:M(SD)= 3.86(2.29), t (62) = 2.40, $p = .02$, *d*= .61, and sentence complexity, LV: V1:M (SD)= .41(1.28), V2:M(SD)= 10.92(19.25), t(72) = 3.22, $p < .001$, *d*= .75, HV: V1:M(SD)= 21.73(19.97), V2:M(SD)= 34.54(25.80), t (72) = 2.39, $p = .02$, *d*= .56.

3.3. Decontextualized use of language

Table 5 presents the percentages of children who used words in a decontextualized context. Chi square tests showed that both groups only showed significant increases in the reference to absent toys or animals (LV: x^2=5.36, $p = .02$, *V*=.27; HV: x^2=4.89, $p = .03$, *V*=.20), but not in referring to absent owner, past events/people or future events (LV: x^2*s* = .40–3.38, *ps*>.05, *Vs*=.07–.21; HV: x^2*s* = 1.58–3.80, *ps*>.05, *Vs*=.17–.23).

3.4. Predictors of expressive language growth

Six hierarchical regression analyses were conducted with the scores of vocabulary, grammar or decontextualized language at visit 2 as the dependent variables separately. In the first step, we included three control variables as independent variables: chronological age, language environment (Mandarin alone vs. Mandarin + Xiang-dialect), and the initial language score of each dependent variable at visit 1 to control for the autoregressive effect. In the second step, the other two language variables (except for the dependent language variable) and the ABC scores at visit 1 were entered.

As depicted in Table 6, for both groups, children's initial scores for vocabulary, grammar and decontextualized language at Visit 1 associated with their later performances at Visit 2, when they were alone in model 1 with chronological age and language environment (*ps* < .05). These associations persisted in grammar and decontextualized language for both groups after adjusting for other variables (model 2), but not in vocabulary. Furthermore, model 2 showed that in the LV group, the decontextualized language was predictive for vocabulary, F (6, 30) = 3.16, $p < .05$, and grammar, F (6, 30) = 7.40, $p < .001$. However, for both groups, in the model predicting decontextualized language, neither vocabulary nor grammar score at visit 1 was significant, LV: F (6,30) = 6.02, $p < .001$, HV: F (6,30) = 5.47, $p < .05$. Moreover, age (*ps* > .16), language environment (*ps* > .43), and the ABC scores (*ps* > .07) didn't account for a significant amount of variance in any model.

4. Discussion

This longitudinal study examines expressive language growth and its influencing factors in two subgroups of Mandarin-exposed 2–6-year-old children with ASD. Both the LV and HV groups displayed significant increases in (a) the total vocabulary and the majority of the 24 semantic categories on the vocabulary checklist, (b) most of the grammatical production measurements including the four grammatical items (i.e., serial verb construction, possessive, quantifier, and perfective /experiential aspect maker), MLU3, word combination and sentence complexity. Nevertheless, neither group showed significant gains in most items of the decontextualized language including the references to possession, past and future events.

Our results suggested that both the LV and HV subgroups demonstrated uneven patterns of expressive language growth. Specifically, both subgroups exhibited a noticeable heterogeneity *across* language domains. As noted, the LV and HV groups consistently showed significant gains in most structural language measures (e.g., vocabulary and grammar), but not in decontextualized language (except for the absent toys/animals). Together with previous cross-sectional studies among English, Swedish, or Mandarin-learning children with ASD (Eigsti et al., 2007; Miniscalco et al., 2014; Su et al., 2018; Weismer et al., 2011), our longitudinal results further testify that despite the relative strengths in structural language development, the growth of decontextualized language might posit special challenges for young children with ASD across languages. On one hand, the intactness of basic vocabulary and grammar development could be ascribed to the resilience of the computational aspects of the language faculty in both typical and atypical language development, including the ASD population (Su & Naigles, 2022; Smith & Tsimpli, 2021; Leivada et al., 2017). Previous research has revealed that the universal underlying mechanisms, governed by the faculty of language, can assist young children with ASD in understanding word order (Swensen et al., 2007; Su & Naigles, 2019),

Table 4
Mean score (SD) of MLU3 and sentence complexity for the LV and HV groups at two visits.

	LV (N=39)				HV (N=38)			
	Visit 1	Visit 2	*t*	*d*	Visit 1	Visit 2	*t*	*d*
MLU3	0.12(0.72)	1.19(1.93)	3.09**	0.73	2.50(2.16)	3.86(2.29)	2.40*	0.61
Sentence complexity	0.41(1.28)	10.62(19.25)	3.22**	0.75	21.73(19.97)	34.54(25.80)	2.39*	0.56

Note. LV: Low Verbal; HV: High Verbal; T-test
***$p<.001$
* $p<.05$
** $p<.01$

Table 5
Percentage (%) of children using decontextualized language in the two ASD subgroups.

Decontextualized Language	LV (N=39)				HV (N=38)			
	Visit 1	Visit 2	x^2	*V*	Visit 1	Visit 2	x^2	*V*
Absent owner	7.9	23.1	3.37	0.21	60.5	76.3	2.19	0.17
Absent toys/animals	7.9	28.2	5.34*	0.27	55.3	78.9	4.83*	0.25
Past events/people	13.2	15.4	0.08	0.03	23.7	42.1	2.92	0.20
Future events	2.6	7.7	1.00	0.12	24.3	45.9	3.80	0.23

Note. LV: Low Verbal; HV: High Verbal; Chi-square tests, $^{**}p<.01$, $^{***}p<.001$
* $p<.05$.

Table 6
Summary of hierarchical regression analysis for variables predicting expressive vocabulary, grammar and decontextualized language in the two ASD subgroups.

Model	Variable	LV(N=39)				HV(N=38)			
		B	SE	β	ΔR^2	*B*	SE	β	ΔR^2
Analysis1: Predicting vocabulary growth									
1	V1age	-0.44	3.45	-0.02	0.18	-1.31	3.10	-0.07	0.14
	V1language environment	-14.55	74.47	-0.03		45.52	53.63	0.14	
	V1vocabulary	3.52	1.36	0.42*		0.41	0.21	0.33*	
2	V1age	2.29	3.23	0.11	0.21*	-2.30	3.16	-0.07	0.20
	V1language environment	7.79	68.01	0.02		45.52	53.63	0.14	
	V1vocabulary	-1.43	1.99	-0.17		0.04	0.28	0.03	
	V1grammar	175.10	122.93	0.24		14.51	26.10	0.13	
	V1decontextualized language	119.18	42.06	0.63*		34.44	21.47	0.34	
	V1ABC	0.71	1.20	0.09		2.52	1.39	0.31	
Analysis2: Predicting grammar growth									
1	V1age	0.01	0.03	0.04	0.22*	-0.05	0.03	-0.19	0.41***
	V1language environment	-0.54	0.64	-0.13		0.10	0.59	-0.02	
	V1grammar	2.80	1.01	0.43**		0.91	0.20	0.62***	
2	V1age	0.03	0.02	0.15	0.37***	-0.02	0.04	-0.09	0.07
	V1language environment	-0.35	0.49	-0.09		0.40	0.66	0.09	
	V1grammar	2.66	0.88	0.41**		0.63	0.31	0.43	
	V1vocabulary	-0.04	0.01	-0.55*		3.78	0.01	0.01	
	V1decontextualized language	1.49	0.30	0.90***		0.44	0.26	0.32	
	V1ABC	-0.01	0.01	-0.06		-0.02	0.02	-0.18	
Analysis 3: Predicting decontextualized language growth									
1	V1age	0.03	0.03	0.11	0.46***	-0.04	0.03	-0.17	0.51***
	V1language environment	-0.09	0.67	-0.02		-0.10	0.53	-0.02	
	V1decontextualized language	1.42	0.27	0.68***		0.92	0.17	0.68***	
2	V1age	0.03	0.03	0.14	0.09	-0.04	0.04	-0.17	0.02
	V1language environment	0.03	0.65	0.01		-0.15	0.61	-0.04	
	V1decontextualized language	1.48	0.40	0.71**		0.79	0.24	0.58**	
	V1vocabulary	-0.02	0.02	-0.19		-0.001	0.003	-0.04	
	V1grammar	2.06	1.18	0.25		0.28	0.29	0.19	
	V1ABC	-0.02	0.01	-0.24		-0.002	0.02	-0.02	

Note. LV: Low Verbal; HV: High Verbal; V1: Visit 1; V2: Visit 2; ABC: Autism Behavior Checklist
* $p<.05$
** $p<.01$
*** $p<.001$

aspect marker (Tovar et al., 2015; Su & Naigles, 2021), and object and subject wh-questions (Goodwin et al., 2012; Jyotishi et al., 2017; Su et al., 2021). This longitudinal study thus added incremental evidence for the pivotal role of language faculty in acquiring fundamental structural language of Mandarin-exposed children with ASD. One the other hand, the more impaired decontextualized language may reside in children with ASD's core deficits in social communication. That is to say, children with ASD may experience greater problems in navigating the cognitive and social worlds, and might over-rely on words that are learned of specific lexical content, thus rendering the decontextualized use of language more challenging for children with ASD in our sample (Su et al., 2018).

Our findings about the similar developmental trajectories of the HV and LV groups of children with ASD are partially different from those reported in Tek et al. (2014), which found distinct lexical and morpho-syntactic trajectories between the HV (steep increase) and LV (flatter growth) groups. However, in Tek et al. (2014) these HV-LV distinctions could be attributed to the significantly older age of the LV group (mean age = 34.55 ± 2.62 months) than the HV group (mean age = 30.95 ± 3.39 months). Given that language development is steeper at a younger age, it is more likely for them to find the flatter development in the older LV group. Similar to our results, Anderson et al. (2007) and Weismer and Kover (2015) also addressed that some young children with severely delayed language at baseline could make rapid progress over time, and even "catch up" to peers. However, it is also important to notice that in our LV group, 9 out of the 11 initially non-verbal children (i.e., 12% of the total ASD group) remained non-verbal or minimally verbal (producing no more than 14 words) over the one year's span. Children with ASD's expressive language development is thus complicated by the existence of these minimally verbal children whose expressive language may remain at floor level entering elementary school (Targer-Flusberg & Kasari, 2013; Su et al., 2018). However, despite their apparent disadvantaged expressive language levels, recent eye-movement experiments revealed that some proportions of the minimally verbal children had hidden language abilities to understand grammatical structures such as the basic word order and grammatical aspect structures which they were not able to utter in spontaneous speech (Su & Naigles, 2019; 2022). In this respect, standardized tests are

only the first step in assessing language development of children with ASD - more comprehensive tasks are warranted to delineate a clearer picture of children with ASD's linguistic strengths and weaknesses.

With respect to the predictors, for both groups, when scores of vocabulary, grammar and decontextualized language were placed in model 1 (controlling for age and language environment), their initial level positively associated with the outcomes of each domain one year later, suggesting that more advanced early language facility was linked with greater language gains over development (Luyster et al., 2007; Song & So, 2022). Furthermore, structural language had limited effect on predicting the usage of decontextualized language for both groups. Similar to our results, Miniscalco et al. (2014) found that the expressive vocabulary and grammar levels in preschool Swedish-exposed children with ASD did not predict their pragmatic growth over time. Therefore, it seems that structural language abilities may not guarantee subsequent social communication skills owing to the social deficits in the ASD group. Nevertheless, in the LV group, the usage of decontextualized language may reversely play a pivotal role in their subsequent structural language development. Additionally, autism severity (as measured by ABC) did not predict language outcomes in either ASD subgroup, which was consistent with previous results in English-exposed children that autism severity (measured by ADI-R) might not significantly impact language development in children with ASD (Anderson et al., 2007; Thurm et al., 2015). Moreover, our study revealed that age and language environment were not predictive of expressive language development for either group.

In contrast to the contextualized talk that is anchored in the present context, the decontextualized use of language involves the temporally abstract utterances of past or future events or semantically abstract conversations surrounding explanations of concepts or phenomena, and thus it not only requires more complex vocabulary and syntax knowledge but also greater demands on representational capacities (Rowe, 2013). In typical development, although the decontextualized language constitutes a relatively small proportion of total parent-child conversations with estimates ranging from 7% to 30% of parent talk, intervention studies found that embedding decontextualized language in early parent-child interactions could help facilitate children's theory of mind abilities, improve their overall language skills, and prepare them for later school success (Leech & Rowe, 2021; Rowe, 2013). However, relative less is known about the use of decontextualized language in parental input for children with ASD. Thus, the less facility in decontextualized language development in both groups of children with ASD warrants relevant intervention (e.g., including parent training) to promote their later language or cognition development. Finally, since deficits in social interaction and communication maintain the core deficits of individuals with ASD life long, it is important to assess and monitor pragmatic or socially based language in children with ASD entering adolescence or adulthood, even when their other aspects of language receive significant gains in language intervention.

Overall, these findings have implications for understanding heterogeneity in early expressive language development of children with ASD across languages: it appears to be a universal pattern that the development of structural aspect of language (vocabulary and grammar) surpassed the decontextualized language development across language subgroups. Because of its greater demands on children's representational capacities and the potential infrequent input, the decontextualized language might pose special difficulties for children with ASD, regardless of their age and initial language levels. The present findings thus shed lights on the importance of considering language production in various language domains (e.g., lexicon, grammar, and pragmatics/socially based language) during clinical assessment and intervention for young children with ASD (see also Li et al., 2023). More importantly, the results highlight the need to implement tailored interventions to improve the decontextualized talk in young children with ASD, which may potentially enhance their overall language abilities and bring positive long-term developmental outcomes.

5. Limitations

The current findings are limited in that they are based on a relatively small sample of children with ASD. Thus, the overall sample pool was solely divided into high vs. low verbal subgroups. Larger data may enable us to conduct a more detailed categorization of the participants (e.g., low verbal, middle verbal, high verbal), and then may help to paint a clearer picture of children in different levels of language proficiency. Further, our sample size may also be small for regression analyses as well. Moreover, for the pragmatic/socially based language domain, we have only assessed the use of decontextualized language, while future studies will need to use appropriate measures to investigate other important aspects of pragmatics or social communication in children with ASD. Lastly, beyond this initial assessment via parent-child report, multiple assessments using a wider range of standardized tests or experimental measures, which collect more information about interventions and other potential factors (e.g., the amount of parental input) will be needed in future research to inform more precisely the expressive language development of young children with ASD.

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Declaration of interest

The authors report there are no competing interests to declare.

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