Title

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Novel Word Learning in Multilingual Children with and without Autism Spectrum Disorder: Roles of Social Cognition, Multilingualism and Vocabulary Proficiency

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Abstract

While the impact of social cognition on novel word learning has been extensively studied in monolingual populations, limited research has investigated its role in multilingual children with and without autism spectrum disorder. This study examined the role of multilingualism on the acquisition of novel English words under directly addressed and overhearing conditions. Participants included four groups of children with different language status (multilingual and monolingual and diagnostic status (typically developing and autistic). The results revealed that the learning preferences vary across participant groups depending on their language and diagnostic statuses. Additionally, dynamic patterns of novel word learning were unveiled, demonstrating the influence of English vocabulary proficiency on multilingual children's learning process. The findings highlighted the complex role of multilingualism on driving the formation of learning preference for typical developing and autistic children.

Keywords: social cognition, multilingualism, English word learning, autism spectrum disorder

Introduction

Word learning is a fundamental aspect of language acquisition for both first (Duff et al., 2015) and second language development (Schmitt, 2002). Novel words can be acquired from various learning modes, among which the learning modes associated with direct (e.g., eye-gaze) and indirect (e.g., overheard) social interaction have been extensively discussed in recent years (Akhtar et al., 2002; Kuhl et al., 2005; Paulus & Fikkert, 2014).

Previous studies on monolingual typically developing (TD) children indicate comparable word learning performance in direct and overhearing modes from an early age (before 5 years old: Boderé & Jaspaert, 2017; before 20 months old: Shneidman et al., 2009). For monolingual children with autism spectrum disorder (ASD), the overhearing learning mode is equally (Luyster & Arunachalam, 2020) or more (Hu & Qi, 2023; McMahon & Henderson 2014; Swanson & Siller, 2013) conducive to learning success. Unlike the direct learning mode which requires cognitive and social efforts, the overhearing learning mode offers an environment free of social pressure (McMahon & Henderson 2014; Racine1 et al., 2007), which could be beneficial for children with deficits in social cognitive abilities.

Given the prevalence of bi/multilingualism in the world, the current study investigates the effect of multilingualism on word learning and asks the question: do multilingual children, both TD and ASD, demonstrate similar patterns of word learning in direct and overhearing modes as their monolingual counterparts? The following sections focus on research related to bi/multilingual populations, the main focus of this study.

Direct and Indirect Word Learning by Bi/Multilingual Children

Some previous findings have indicated that TD multilingual children, aged 4 to 5 years, tend to learn novel words in a direct learning condition, particularly when the learning content aligns with social-pragmatic cues (Gangopadhyay & Kaushanskaya, 2020, 2021; Yow et al., 2017). Learning through overhearing is typically achieved through extensive language training and exposure, which poses challenges for L2 learners with limited exposure and lower language proficiency (Akhtar, 2001; Boderé et al., 2022). In other words, L2 proficiency has a central role in boosting multilinguals' performances in the overhearing mode (Frijns et al., 2021). In comparison to monolingual peers, TD multilingual individuals sometimes showed better learning performance in the direct learning mode and other times

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showed poorer learning performance (Gangopadhyay & Kaushanskaya, 2021; Yow et al., 2017). In other words, the effect of multilingualism on word learning under the direct condition is still inconsistent.

There is a scarcity of research investigating the effect of social interaction modes on multilingual autistic children. With regard to general vocabulary proficiency, some research has claimed that exposing autistic children to two or more languages may have certain negative effects on word retention, as the amount of language input for each language may be reduced (Gonzalez-Barrero & Nadig, 2018). However, others have shown that multilingualism is not detrimental (Barrero & Nadig， 2019; Fort et al., 2018; McComas, 2015) or even beneficial (Petersen, 2010) for vocabulary development in autistic children. Sen et al. (2011) also found neither positive nor negative effects of multilingualism on ASD in language learning for multilinguals aged 4-10 years.

L1-dominant Multilingual Society and ASD in Hong Kong

Hong Kong stands as a diverse and multilingual society, with the majority of its residents (88.2%) utilizing Cantonese as their dominant language, while 5.5% of respondents reported using it as an additional language, including English, Mandarin, and regional Chinese dialects (2021 Population Census). However, English, as an L2, holds a significant position in Hong Kong society from a sociolinguistic perspective (Lai, 2013). The reported prevalence of ASD in Hong Kong is 1 in 68 children, and this rate is anticipated to rise further (Centre for Disease Control and Prevention, HKSAR 2012).

The English language usage and vocabulary proficiency among multilingual children with and without ASD in Hong Kong display notable individual variability (Li, 2022). In L1-dominant multilingual regions, such as France and Hong Kong, both L2 exposure and proficiency have been found to play a central role in the acquisition of new L2 content for both preschool-aged (McBride-Chang et al., 2008) and school-aged children (Liu et al., 2017; Gonzalez-Barrero & Nadig, 2018). In Hong Kong, children from economically advantaged families, with additional resources supporting their English language learning, tend to excel in English compared to their counterparts from socioeconomically modest backgrounds. The latter group primarily encounters English within the limited context of classroom instruction and homework assignments (Li, 2022).

Current Study

There is limited research regarding the impact of direct and indirect learning modes on vocabulary acquisition in multilinguals. Moreover, the existing studies have yielded mixed findings. The primary objective of this study was to examine the combined effects of multilingualism and direct/indirect learning modes on novel word learning for both ASD and TD children, aged 5 to 11, an age period that has received relatively less attention. Given the substantial variability in English proficiency among multilingual children in Hong Kong, the current study also took into consideration the potential role of individual's vocabulary proficiency in predicting the success of novel word learning in different learning modes. Two research questions were posed:

Q1: What are the effects of language status (multilingual or monolingual) and diagnostic status (TD or ASD) on novel word learning in direct and overhearing conditions?

Q2: How does L2 vocabulary proficiency affect word learning patterns in the TD and ASD groups?

In Hong Kong, the 5 to 11 year old age period are within key stages of English learning as outlined in the "Key Learning Area Curriculum Guide" issued by the Education Bureau. As such, this research holds significant pedagogical and practical value in both English education and ASD intervention.

Experiment Design

Participants

Four groups of participants were involved: 28 Cantonese-English multilingual TD children (hereafter, MultiTD; 8 girls, 20 boys), 27 multilingual children with ASD (MultiASD; 9 girls, 18 boys), 25 monolingual TD children (MonoTD; 16 girls, 9 boys), as well as 26 monolingual children with ASD (MonoASD; 8 girls, 18 boys). The mean age was comparable among the four groups: MultiTD (mean =7.45 yrs, SD=1.48), MultiASD (mean=7.15 yrs, SD=1.36), MonoTD (mean=7.94 yrs, SD=1.46) and MonoASD (mean age=7.49 yrs, SD=1.49). Cantonese-English multilingual children were recruited from local kindergartens and primary schools in Hong Kong. They were native Cantonese speakers who started learning English via formal classroom instruction at 2 to 5 years old. Multilingual participants also have varying degrees of exposure to Mandarin, other Chinese dialects, or French. Monolingual participants were native English speakers from the United States and had no intensive L2 learning experience. According to parental reports, all children were free of any hearing and visual disabilities.

Participants completed the nonverbal intelligence subtest of the Kaufman Brief Intelligence Test 2 (KBIT-2). To rule out intellectual disability, all children must score >=70 on the KBIT-2. The four groups achieved similar mean standard scores: 118.53 (SD = 15.83) for the MonoTD group, 117.48 (SD= 15.52) for the MonoASD group, 112.76 (SD=17.82) for the MultiTD group and 108.84 (SD= 22.09) for the MultiASD group. According to one-way ANOVA and the Bonferroni-corrected post-hoc tests, the four groups were balanced in pair in terms of age (t=0.457~1.33, p=.187~.968, Cohen ' s d=0.122~0.331) and KBIT scores (t=0.663~1.03, p=.145~.911, Cohen's d=0.221~0.257).

English vocabulary proficiency was assessed with the Peabody Picture Vocabulary Test (PVT). Parents of the multilingual children filled out a language background survey (Birdsong et al., 2012) and the "Language History Questionnaire" (Li, 2020). The TD and autistic children were matched in the standard scores of PVT both for multilingual (MultiTD: mean=73.96, SD=23.73; MultiASD: mean=68.19, SD=26.81; t=1.407, *p*=.498, Cohen's d=0.376) and monolinguals (MonoTD: mean=112.29, SD=14.16; MonoASD: mean=107.29, SD=17.56; t=0.747, *p*=.878, Cohen's d=.216).

Materials and Training Procedures

The experimental materials were revised based on Hu & Qi (2023). The training took place in a quiet laboratory using the online *Gorilla* platform. Children were informed about the experimental process without receiving specific hints about the to-be-learned words. In the formal experiment, children listened to stories, with two adult female figures appearing as the "storyteller" and the "reference listener", positioned on the left or right sides of the computer screen. Two learning conditions were presented: "direct" and "overhearing." In the direct condition, the storyteller gazed at the participant and the children could see the full facial expressions and mouth movements of the storyteller. In the overhearing condition, the storyteller faced the reference listener, and participants could only see half of the storyteller's face.

Each story contained a target pseudo-word embedded in a sentence-final or middle position with three occurrences. The pseudo-words included 10 nouns and 10 verbs and were matched in the number of syllables and phonological neighborhood size (Marian et al., 2012). A total of 20 stories were used. Half of the target words were taught in the direct condition and the remaining half in the overhearing condition.

The training involved 4 test time points using a four-choice word identification task (see Figure 1). Time 1 (T1) occurred immediately after hearing the story. Time 2 (T2) occurred after completing a block of 5 stories. Time 3 (T3) took place after all four blocks. Time 4 (T4) was a one-week retention test of the 20 words. Children were asked to select the correct picture that went with the auditorily presented word by clicking the mouse. No feedback was provided throughout the training or the testing phase. Stimuli and the location of the correct picture were randomized for each test. For T4, entirely new images, different from the training set, were used. The total duration for training and testing was approximately 50 minutes (not including T4).

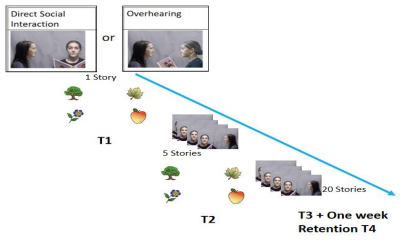


Figure 1 Scheme for experiment design (Hu & Qi, 2023)

Results

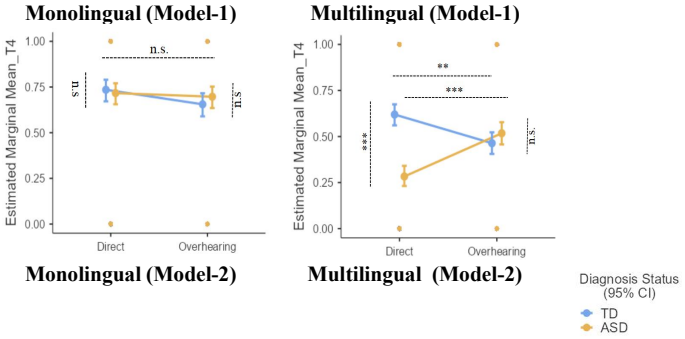
The binary responses (correct=1, incorrect=0) collected at T4 (one-week retention) were used as the dependent variable for subsequent statistical analysis because this test point reflects the final detectable learning outcomes and long-term consolidation of the current training. Additionally, data from T1 were considered as a covariate, representing the learners' initial memory state for the vocabulary.

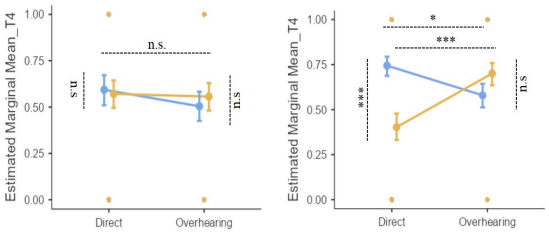
The Generalized Logistic Model (GLM) was used to analyze individual responses. PVT standard scores were used as a measure of English vocabulary proficiency. Deviation coding was used for categorical data, and continuous data were centered and scaled to minimize multicollinearity. When presenting results, estimated marginal means (EMM) were presented based on specific GLM analysis, rather than raw accuracy rates. The chance level for the four-alternative forced-choice task was set at 25%. The p-values were corrected with Bonferroni adjustment for post-hoc comparisons.

General Group Differences in Word Learning Patterns

For the first research questions, GLM was programmed with fixed effects of multilingualism (monolingual, multilingual), diagnosis status (TD, ASD), learning mode (direct, overhearing), and their interactions. Two-step modeling was utilized to include covariates: for Model-1, the intercepts of T1 scores and age were treated as covariates to investigate group differences. For Model-2, the PVT scores were additionally controlled to further examine the multilingualism effect beyond the differences in English proficiency and in age. Figure 2 depicts the general differences across the four participant groups for both Model-1 and Model-2.

Figure 2 General group differences between multilingual and monolingual children with or without ASD. ***p < 0.001, **p < 0.01, *p < 0.05, n.s.= not significant.





In the results, Model-1 explained 41% (R^2) of the variance accounting for children's performance. The main results uncovered pairwise and three-way interactions among the three variables of multilingualism, diagnosis status, and learning mode (see details in Table 1).

Table 1. Results for GLM models.

GLM Models	χ^2(df=1)	*p*
Model-1		
Language	74.626	<.001
Diagnosis	0.575	.448
Mode	0.370	.543
Age	2.098	.147
T1	793.673	<.001
Diagnosis *Mode	11.568	<.001
Language*Diagnosis	9.241	.002
Language*Mode	3.736	.053
Language*Diagnosis*Mode	6.102	.014
Model-2		
Language	1.880	.170
Diagnosis	0.0266	.870
Mode	0.0464	.829
Age	5.609	.018
T1	567.179	<.001
Proficiency	81.113	<.001
Diagnosis *Mode	28.765	<.001
Language*Diagnosis	3.415	.065
Language*Mode	4.872	.027
Language*Diagnosis*Mode	9.669	.002

Monolingual Learning Pattern (Model-1) There were no significant differences (z=-0.334, *p*=.99) between MonoTD (EMM_overall=0.679, 95%CI[0.651, 0.738]) and MonoASD (EMM_overall=0.707, 95%CI[0.664, 0.746]) groups across learning modes. Besides, no learning mode difference was found for either MonoTD (z=-0.334, *p*=.99) or MonoASD (z=-0.334, *p*=.99) groups.

Multilingual Learning Pattern (Model-1) There were no differences in terms of overhearing mode between the MultiTD (EMM_overhearing=0.464, 95%CI[0.246, 0.623]) and MultiASD (EMM_overhearing=0.518, 95%CI[0.457, 0.578]) groups (z=-1.25, *p*=.99). For direct mode, the MultiASD (EMM_direct=0.283, 95%CI[0.232, 0.341]) group failed to achieve above-chance performance, while the MultiTD (EMM_direct=0.62, 95%CI[0.561, 0.675]) group got far better performance (z=7.646, *p*<.001). The MultiTD group demonstrated better performance in the direct mode than the overhearing mode (z=3.659, *p*=.007). MultiASD performed much worse in direct mode than in overhearing mode (z=-5.396, *p*<.001). In other words, the MultiTD and MultiASD groups exhibited contrasting learning patterns.

Multilingual and Monolingual Differences (Model-1) The MultiTD group performed comparably to the MonoTD group in the direct mode (z=2.44, *p*=.411), but exhibited a significant lag in the overhearing mode (z=3.207, *p*=.038). The performance of the MultiASD group is consistently lower than that of the MonoASD group in both the direct (z=7.618, *p*<.001) and overhearing (=3.551, *p*=.011) learning modes.

Effects of Multilingualism with Control of Proficiency (Model-2) After controlling for vocabulary proficiency, the main effect of language status (model-1: $\chi^2(1)$= 74.626, *p*<.001; model-2: $\chi^2(1)$= 1.88, *p*=.17) and its interaction with diagnosis status disappeared (model-1: $\chi^2(1)$=9.241, *p*=.002; model-2: $\chi^2(1)$= 3.415, *p*=.065), indicating that the differences between monolingual and multilingual groups vanished both for TD and ASD children. However, the three-way interaction remained significant (model-1: $\chi^2(1)$= 6.102, *p*=.014; model-2: $\chi^2(1)$= 9.669, *p*=.002), suggesting that even after accounting for vocabulary proficiency, learning mode difference in multilingual TD (model-2: post-hoc for direct & overhearing: z=3.514, *p*=.012) and multilingual ASD (z=-5.445, *p*<.001) individuals persisted. This three-way interaction suggests that multilingualism somehow increased the interaction between groups (ASD vs. TD) and modes.

Proficiency-Driven Word Learning Patterns for Multilinguals

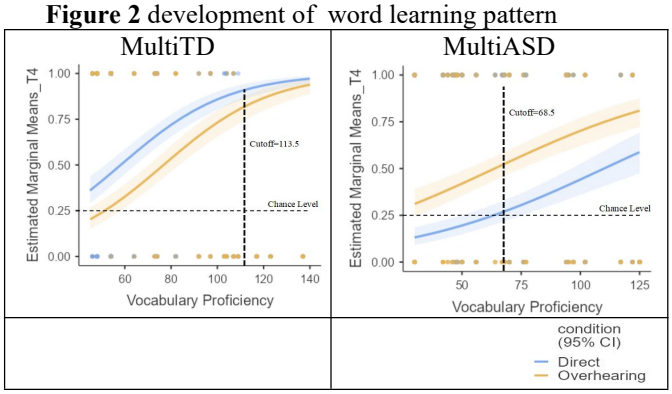
To answer research question two, four separate GLM models were conducted within each multilingual group (MultiTD, MultiASD) and each learning mode (direct, overhearing), by treating proficiency as a continuous independent variable. Due to the age-corrected nature of the PVT scores, age was not included as a covariable.

For the MultiTD group, proficiency played a robust predictive role across learning modes (direct: β= 0.0299, 95%CI[0.0192, 0.0416], z=5.23, *p*<.001; overhearing: β= 0.0569, 95%CI[0.0442, 0.071], z=8.352, *p*<.001). Figure 2-left panel depicts the association between proficiency and children's retention performance in both the direct and overhearing modes. The developmental path of novel word learning in the overhearing mode (orange line) exhibits a noticeable lag compared to that in the direct mode (blue line), particularly during the initial low proficiency stage. Besides, the learning curves exhibit progressively increases for both modes with the accumulation of vocabulary proficiency. A threshold of 113.5 was detected based on the maximum of the Youden index in an ROC curve analysis (Bantis et al., 2014), indicating that when a child's PVT standard score surpasses 113.5, their performance in the overhearing mode will catch up with that in the direct mode.

For the MultiASD group, proficiency also served as a strong positive predictor of children's performance in different learning modes (direct: β= 0.0326, 95%CI[0.0225, 0.0434], z=6.15, *p*<.001; overhearing: β= 0.0158,

95%CI[0.0069, 0.0251], z=3.438, p<.001). Generally, the MultiASD group exhibited a developmental path contrary to that of the MultiTD group. Figure 2-right panel depicts that the development of word learning in the direct mode (blue line) far lags behind that in the overhearing mode (orange line) throughout the observed proficiency continuum for the MultiASD group. Notably, children with a PVT score below 68.5 performed around chance level under the direct mode. Moreover, the preference for the overhearing condition seemed to persist throughout the observed vocabulary proficiency range.

Figure 2 development of word learning pattern



Discussions and Conclusions

Learning Patterns of Monolingual Children with and without ASD We found that monolingual TD children aged 5-11 years did not show a preference for either direct or overhearing mode. This aligns with previous research indicating that TD children can benefit from both direct and indirect conditions during early development (Boderé & Jaspaert, 2017; Shneidman et al., 2009). We also found that monolingual children with ASD showed comparable performance to TD children in learning novel words, regardless of the learning mode. These findings align with Luyster and Arunachalam (2020), which also found no preference for direct or overhearing learning scenarios in monolingual autistic children aged 4-6 years. However, our results differ from previous research suggesting that children with ASD tend to favor the use of overhearing conditions for vocabulary learning. Thus, it is still premature to draw definitive conclusions regarding which learning condition is more conducive to learning.

Learning Patterns of Multilingual Children with and without ASD Multilingual TD children demonstrated an advantage in the direct mode compared to the overhearing mode. This aligns with previous research, indicating that multilingual individuals benefit more from learning environments involving direct social interactions than those without direct interactions (Buac et al., 2019; Fan et al., 2015). In the overhearing mode, multilinguals whose L2 is the non-dominant language may face challenges in effectively identifying crucial information to infer the meaning of novel words (Akhtar, 2001). Conversely, in the direct mode, multilinguals can effectively concentrate their attention by attending to the talker's gaze, optimizing their limited cognitive resources to process information relevant to the novel words (Reddy, 2001, 2003; Kirschner et al., 2018). Furthermore, they can benefit from additional pragmatic cues, such as the talker's facial expressions and exaggerated mouth movements, which help them pinpoint essential information and enhance their learning outcomes.

Multilingual children with ASD demonstrated the opposite learning pattern. The direct mode may be unfavorable or even detrimental for autistic children's word learning, especially those children with smaller vocabulary. It is possible that the direct mode may induce anxiety or even aversion (Wang et al., 2018). Also, autistic children's impaired joint attention may hinder their ability to benefit from decoding information from eyes, facial expressions, and mouth movements (Charman, 2003; Nadig et al., 2007).

Nevertheless, it is important to note that multilingual autistic children were still able to learn new word in the overhearing mode. This low-pressure learning environment may enhance language acquisition for children with ASD through a mechanism called "eye avoidance," which serves as a protective mechanism (e.g., Kleimann et al., 2008). Additionally, children's language usage habits may also contribute to their early development in overhearing mode. Based on language background questionnaires collected from parents in this study, it was found that low-proficiency autistic children spend more time using English in non-interactive ways such as through iPads, phones, games, or English videos, while low-proficiency TD children spend more time using English interactively, such as communicating with nannies, family members, friends, and classmates.

Effects of Multilingualism The current results showed an intricate picture of multilingualism's effect on novel word learning. Broadly speaking, multilingualism, when decoupled from the confound of small L2 vocabulary, did not negatively or positively impact the overall performance of multilingual ASD. It thus supports the previous findings claiming that multilingualism is not detrimental for ASD (Barrero & Nadig, 2019; Fort et al., 2018; McComas, 2015). However, the current results also uncovered a potential link between multilingualism and the development of learning mode preference in multilingual children. Only the multilingual groups, but not the monolingual groups, showed learning mode differences. It can be argued that multilingualism makes an additional contribution to the formation of learning mode bias. This bias enables learners who are at an early stage of L2 development (i.e., with very small L2 vocabulary) to effectively acquire new vocabulary.

Proficiency-Driven Development for Multilingual Children with or without ASD The current study suggests that English proficiency is a significant predictor of novel word learning in both direct and overhearing modes by multilingual children. As children's vocabulary proficiency improved, TD children quickly caught up in the overhearing

mode, reaching native-like levels. However, multilingual autistic children continued to prefer the overhearing mode, even at higher vocabulary levels. It is possible that as experience accumulates, multilingual TD children gradually gain the ability to allocate cognitive resources more effectively to acquire new L2 vocabulary. This enables them to rely less on extralinguistic cues and still achieve effective learning outcomes (Akhtar, 2001; Boderé et al., 2022; Frijns et al., 2021). In addition, we found that high-proficiency multilingual TD children had more diverse uses of English than low-proficiency children. In contrast, the language usage habits of multilingual autistic children did not significantly change with increased English proficiency, which may contribute to the persistence of the overhearing preference.

Theoretical Implication Multilingual TD and ASD children both showed a stronger bias toward their preferred learning mode, compared to monolingual children, who appeared to be more balanced. Multilingual TD children took more advantage of the extralinguistic cues from socially interactive contexts. However, the multilingual ASD group took a different route. Instead of the social cues in the direct mode, they may have relied more on fine-grained auditory perceptual cues in the overheard speech. This may be attributed to the fact that multilingual children have more opportunities to encounter linguistic ambiguity or communication breakdown in daily language use across scenarios (Dörnyei & Kormos, 1998).

The learning mode bias can also be interpreted as an implicit learning strategy unconsciously developed by active learners, facilitating their optimal utilization of favorable learning resources (Amerstorfer, 2020). As TD multilingual learners' English proficiency develops, we observed a dynamic transition from mode-biased learners to balanced learners who learned equally well across conditions. However, we also noted that multilingual children with ASD consistently exhibited a stronger inclination to the directly-addressed mode. It can be inferred that the formation, transformation, or maintenance of the mode-bias strategies may be associated with the overt habits of language use that multilingual children engage in daily. In this study, multilingual autistic children were raised in Hong Kong where the L1 is the dominant language. Unlike monolingual ASD children living in their native language communities, these multilingual ASD children had limited opportunities for direct English language interaction. Moreover, unlike TD children in Hong Kong who tended to diversify their English language usage across various contexts, multilingual ASD children demonstrated a preference for increasing English input through non-social means like electronic devices or the internet. In other words, their consistent avoidance of English use in the direct mode may hinder the development of sensitivity to social cognitive cues, thus maintaining their bias to the overhearing mode.

In summary, by examining the patterns of novel word acquisition in English across direct and overhearing modes, notable group differences among 5- to 11-year-old children with different language and diagnosis statuses were unveiled along a vocabulary proficiency continuum. Multilingualism plays a complex role in driving the formation of learning mode preference among diverse learners. Distinct dynamic learning systems were observed between TD and ASD multilingual cohorts, contingent upon their L2 vocabulary proficiency. In addition, children's daily language usage habits may explain the learning mode preference. These findings thus stressed the heterogeneous role social cognition may play in different stages of development and different neurodevelopmental populations.

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