Bilingual exposure might enhance L1 development in Cantonese-English bilingual autistic children: evidence from the production of focus

Article

Accepted Version

Bilingual exposure might enhance L1 development in Cantonese-English bilingual autistic children: Evidence from the production of focus

Haoyan GE
Hong Kong Metropolitan University

Albert Kwing Lok LEE
The Education University of Hong Kong

Hoi Kwan YUEN
Hong Kong Metropolitan University

Fang LIU
The University of Reading

Virginia YIP
The Chinese University of Hong Kong

Correspondence
Haoyan Ge, School of Education and Languages, Hong Kong Metropolitan University, Ho Man Tin, Kowloon, Hong Kong SAR, China.
E-mail:hge@hkmu.edu.hk

Abstract

This study investigated bilingualism effects on the production of focus in 5- to 9-year-old Cantonese-English bilingual autistic children's L1 Cantonese, compared to their monolingual autistic peers as well as monolingual and bilingual typically developing (TD) children matched in nonverbal IQ, working memory, receptive vocabulary, and maternal education. The results from an elicitation task showed that monolingual autistic children had significantly lower accuracy than TD children in producing focus in subject and object positions. Bilingual autistic children in general performed similarly to monolingual autistic children but outperformed their monolingual autistic peers in the production of object focus with a significantly higher accuracy. The total amount of English exposure did not relate to the accuracy of focus production in autistic and TD children. Our results also revealed autistic children's tendency to make use of less prosodic means to produce focus. The overall findings indicate that bilingual exposure has no detrimental effect on the language skills of autistic children but might enhance the production of focus in bilingual autistic children's L1 Cantonese.

Bilingual exposure might enhance L1 development in Cantonese-English bilingual autistic children: Evidence from the production of focus

INTRODUCTION

It is well established that exposure to two languages during early development does not negatively impact typical language acquisition (e.g., de Houwer, 1995; Deuchar & Quay, 2000; Genesee et al., 1995; Müller & Hulk, 2001; Paradis & Genesee, 1996; Yip & Matthews, 2007). While the impact of bilingualism has been examined in typically developing (TD) children, it has not been systematically studied in children with autism spectrum disorder (ASD), who often exhibit language impairments and delays compared to TD children (Eigsti, De Marchena, Schuh, & Kelley, 2011; Howlin, 2004; Tager-Flusberg, Paul, & Lord, 2005). Considering the existing language difficulties in autistic children, professionals and parents often wonder whether exposure to more than one language exacerbates the impairments (Hampton et al., 2017; Kay-Raining Bird et al., 2012; Yu, 2013). Research in this area is urgently needed to guide professionals and parents in language decisions for autistic children.

Bilingualism in autistic children

As an emerging research area, bilingual language development in autistic children has gained increasing attention within the last ten years (Dai et al., 2018; Gonzalez-Barrero & Nadig, 2017, 2019; Hambly & Fombonne, 2012; Kay-Raining Bird et al., 2012; Ohashi et al., 2012; Petersen et al., 2012; Reetzke et al., 2015; Valicenti-McDermott et al., 2012; Zhou et al., 2019). Most previous research used standardized language assessment tools or parental reports to measure the general language ability of bilingual autistic children. The findings show that bilingual autistic children can develop similar

language abilities to those of monolingual autistic children matched by intellectual abilities. Bilingualism has no detrimental effects on a range of language skills in autistic children, including receptive and expressive vocabulary, syntactic skills, sentence repetition and functional communication (Beauchamp et al., 2020; Dai et al., 2018; Hambly & Fombonne, 2012; Meir & Novogrodsky, 2020; Ohashi et al., 2012; Petersen et al., 2012; Reetzke et al., 2015; Valicenti-McDermott et al., 2013; Zhou et al., 2019). Recent studies have even shown that bilingual autistic children outperformed their monolingual autistic peers in total vocabulary size (Petersen et al., 2012), verbal fluency (Gonzalez-Barrero & Nadig, 2017), and narrative production (Peristeri et al., 2020).

In addition, a few recent studies have investigated the effects of bilingualism on autistic children's cognitive abilities (Iarocci, Hutchison, & O'Toole, 2017; Ratto, Potvin, Pallathra, Saldana, & Kenworthy, 2020; Sharaan, Fletcher-Watson, & MacPherson, 2021; Peristeri, Baldimtsi, Andreou, & Tsimpli, 2020). Some found that bilingualism is unrelated to cognitive outcomes such as attention control and problem-solving (Iarocci et al., 2017; Sharaan et al., 2021), whereas others found that bilingual autistics outperform their monolingual autistic peers in inhibition, set-shifting and global processing information (Ratto et al., 2020; Peristeri et al., 2020).

The bilingualism effects on specific linguistic constructions of autistic children have not been systematically studied with well-designed experiments. To date, only two recent studies have investigated the performance of specific language structures in bilingual autistic children (Meir & Novogrodsky, 2021; Skrimpa et al., 2022). Using a picture verification task, Skrimpa et al. (2022) investigated the effects of bilingualism on pronoun comprehension in Greek-Albanian bilingual autistic children. In an elicitation task, Meir and Novogrodsky (2021) evaluated the bilingualism effects on

informativeness and definiteness marking of referential expressions in Russian-Hebrew bilingual autistic children. In general, the two studies are consistent with previous work focusing on language assessments in suggesting that bilingualism does not impede the language abilities of autistic children.

Taken together, previous research primarily used assessment tools to compare the general language skills in monolingual and bilingual autistic children. It is far from clear how bilingual autistic children interpret and use different levels of linguistic knowledge in real conversations. To address this question, the current study investigates the production of narrow focus by Cantonese-English bilingual autistic children. Focus is a key concept of informational structure (Krifka, 2008). Since focus relates discourse to the real world, deficits in focus production in autistic children may seriously compromise their access to real-world content, thus, further challenging their communication skills. The production of focus involves multiple levels of knowledge, including syntax, prosody, and pragmatics, providing an ideal test case of a phenomenon sensitive to multiple levels of linguistic knowledge. Investigating Cantonese-English bilingual autistic children allows us to explore whether bilingual exposure would impose additional language burdens on autistic children, from the perspective of two typologically different and genetically unrelated languages.

Focus marking in English and Cantonese

Focus commonly refers to new or contrastive information in a sentence. For instance, focus in answer (1) presents *cat* as new information about question (1). Focus becomes contrastive, as in (2), if it rejects a stated alternative (e.g., *dog*) in the context (Chafe, 1976; Gussenhoven, 2006).

(1) Question: Who is packing the schoolbag?

Answer: The [cat]$_F$ is packing the schoolbag.

(2) Question: Is the *dog* packing the schoolbag?

Answer: No, the [cat]$_F$ is packing the schoolbag.

Languages differ in the linguistic devices used to realize focus and the extent to which the same devices are used. In English, focus is typically realized by assigning prosodic prominence to the focal element(s), manifested primarily in an expanded pitch range, accompanied by increased intensity and longer duration (Gussenhoven, 1983). For instance, the answer to question (1) would typically be uttered as (3a), where *CAT* is accented (capitalization denotes accentuation). The answer (3b) with accentuation on the object *SCHOOLBAG* is not felicitous.

(3) a. The [CAT]$_F$ is packing the schoolbag.

b. # The [cat]$_F$ is packing the SCHOOLBAG.

Unlike English, the use of prosody to mark focus is highly constrained in Cantonese, a tonal language with six contrastive lexical tones (Chao, 1947). Specifically, there is no clear evidence for on-focus pitch expansion in Cantonese (Man, 2002; Wu & Xu, 2010). Instead, longer duration and higher intensity are manifested in focused elements in Cantonese (Gu & Lee, 2007; Leung & Peng, 2015; Wu & Xu, 2010). For example, the subject *MAAU1MAAU1* 'cat' in (4a) is accented with increased duration and intensity. Compared to English, Cantonese uses focus particles (FP) and word order to a larger extent to achieve the same purpose (Lee, 2019; Matthews & Yip, 2011). For example, the FP *hai6* could be imposed before the focused element to mark focus, as in (4b). Cantonese also allows both prosody and morphosyntax to mark focus, as in (4c).

(4) Question: Gau2gau2 zap1 syu1baau1?
dog pack schoolbag
"Does the dog pack the schoolbag?"
Answer: a. m4hai6 [MAAU1MAAU1]$_F$ zap1 syu1baau1

	No	cat	pack	schoolbag	
b.	m4hai6	hai6	[maau1maau1]$_F$	zap1	syu1baau1
	No	FP	cat	pack	schoolbag
c.	m4hai6	hai6	[MAAU1MAAU1]$_F$	zap1	syu1baau1
	No	FP	cat	pack	schoolbag

'No, the CAT packs the schoolbag.'

Previous theoretical studies on Cantonese suggest that the rich inventory of FPs in Cantonese makes prosody optional to realize focus (Lee, 2019; Matthews & Yip, 2011). Empirical evidence also shows that Cantonese-speaking adults and children rely more on syntax than prosody in focus comprehension (Ge et al., 2022). However, it is far from clear which linguistic cue is preferred by Cantonese-English bilingual autistic children in focus production.

Focus production in autistic children

Most investigations into focus production in autistic children examined the contrastive focus accents in sentences. A major study by Paul et al. (2005) examined the production of contrastive accents in an experimental protocol involving natural speech among English-speaking autistic individuals between 14 and 21 years of age. Participants first heard a sentence (e.g., 'He wore the red tie for you') and then were asked to read out another sentence (e.g., 'I prefer BLUE ties on gentlemen') as if they were answering. The findings show that autistic speakers had difficulty with placing contrastive accents to mark focus correctly in context. Another series of studies used a test of prosodic abilities, namely the Profiling Elements of Prosodic System – Children (PEPS-C; Peppé & McCann, 2003), to examine the use of prosody in focus production. Regarding the production of focus, children first saw a picture (black sheep with ball) and heard a sentence that did not match the picture (e.g., 'The black cow has the ball'). They were then asked to correct the sentence (e.g., 'No, the black SHEEP has the ball'). Peppé and his colleagues (2007) tested 6- to 13-year-old English-speaking children with high-

functioning autism (HFA) and Asperger syndrome (AS). They found that the HFA group made significantly more errors than the TD group, whereas the AS group performed similarly to the TD group. As a step forward, Diehl and Paul (2013) used acoustic measures of prosody to compare 8- to 16-year-old English-speaking autistic and TD individuals. Their findings showed that the autistic group had significantly higher pitch ranges and intensity than the TD group, even when the prosody of focus was judged correct by the raters.

Compared to the production of prosodically marked focus, there is limited work on the production of syntactically marked focus by autistic children. To the best of our knowledge, only one published study investigated the use of morphosyntax in focus production by autistic children (Terzi et al., 2016). Using an elicitation task, they tested how Greek-speaking children with HFA produced focus structures. The autistic group performed significantly worse than TD children in producing focus structures but showed TD-like patterns in producing non-focused structures. Terzi et al. (2016) interpreted the results by arguing that autistic children had greater difficulties than TD children at the interface of syntax with pragmatics and prosody.

In summary, there is a dearth of published research on how autistic children produce focus in real conversations. The existing results from monolingual autistic children are both insufficient and inconclusive.

The current study

Against this background, the current study investigates the impact of bilingual exposure on focus production in 5- to 9-year-old Cantonese-English bilingual autistic children and Cantonese-speaking monolingual autistic children, compared to their TD monolingual and bilingual peers. We focus on bilingual autistic children in Hong Kong,

not only because they are understudied but also because Cantonese and English are two typologically divergent and genetically unrelated languages. To the best of our knowledge, this is the first investigation of bilingualism effects on focus production in autistic children. We raise two research questions: (I) How do monolingual and bilingual autistic children use syntax and prosody to produce focus in Cantonese? (II) How does bilingual exposure impact the focus production of Cantonese-English bilingual autistic children's L1 Cantonese? In terms of the first research question, focus production in monolingual autistic children has been shown to be problematic, relative to TD children. Thus, we predict that autistic children would find focus production difficult and show non-TD-like performance. The second research question concerns bilingualism effects on focus production by autistic children. Based on the previous findings, we predict that bilingualism would not be detrimental to the production of focus in Cantonese-English bilingual autistic children, or at least it would not exacerbate the focus production difficulties potentially observed in monolingual autistic children.

METHOD

Participants

Forty-four autistic children and sixty TD children participated in this study. Two autistic children and four TD children failed to complete the testing for various reasons. Therefore, only 42 autistic children and 56 TD children were included in the analyses. All children were born in Hong Kong and acquired Cantonese as their first language and English as a second language before age 3. TD children had no family history of diagnosed developmental disorders or impairments. The parents' informed consent was obtained prior to the study. All procedures were approved in accordance with the ethical

research committee at the university where the testing took place. Since English teaching was officially included in the kindergarten curriculum in 2006 (The Curriculum Development Council, 2006), almost every Cantonese-speaking child is exposed to English in Hong Kong kindergartens. Therefore, monolingual children who participated in this study also had some exposure to English. Nonetheless, there is a wide range of variations regarding children's exposure to English in everyday life. Information on children's language exposure and use was collected through a parental report. We adopted Kidd et al.'s (2015) design in which parents were asked to fill out a report including (a) the language(s) the parents/caretaker(s) and teachers speak to the child; and (b) the average amount of time the child is exposed to Cantonese and English at home, school and community per week. According to Hambly and Fombonne (2012), the lifetime ratio of the dominant language in sequential bilinguals was approximately 88%. Since the children in this study were also sequential bilinguals, we followed Hambly and Fombonne (2021) and considered children bilingual with English exposure amounting to over 12% of the total language input (around 13.5 hours of English exposure per week).

The Cantonese Receptive Vocabulary Test (CRVT; Cheung et al., 1997) was used to assess the children's receptive Cantonese vocabulary knowledge. Children's non-verbal IQs were assessed with the Primary Test of Nonverbal Intelligence (PTONI; Ehrler & McGhee, 2008). The working memory (WM) of the children was evaluated by the Backward Digit Span task, based on the procedure included in the McCarthy Scales of Children's Abilities (1972). Maternal education was assessed as a proxy for socioeconomic status. ASD diagnoses were validated with the Autism Diagnostic Observation Schedule, Second Edition (ADOS™-2; Lord et al., 2012). Module 3 was selected based on children's language and developmental levels. Children were

classified as ASD when they received a total score of ≥ 7. The monolingual and bilingual autistic children did not differ in the ADOS-2 total scores ($p = 0.606$).

Demographic information of the four groups of children is provided in Table 1.

[Insert Table 1 here]

The four groups of children were matched regarding nonverbal IQ, Cantonese receptive vocabulary, working memory and maternal education. Monolingual TD children were marginally younger than monolingual autistic ($p = 0.08$) and bilingual autistic children ($p = 0.05$). No significant difference was observed among other groups in terms of age. For the age of acquiring English, monolingual autistic children and monolingual TD children were matched. Bilingual autistic children started to learn English at a marginally significantly later age than bilingual TD children ($p = 0.059$) but marginally earlier than monolingual autistic ($p = 0.059$) and TD children ($p = 0.059$). Bilingual TD children started to learn English at a significantly younger age than monolingual TD ($p < 0.001$) and monolingual autistic children ($p < 0.001$). In terms of Cantonese exposure, while monolingual TD children received significantly more amount of Cantonese exposure than bilingual TD children ($p = 0.009$), monolingual autistic children ($p = 0.036$) and bilingual autistic children ($p = 0.036$), the other three groups of children were matched in this aspect. Regarding English exposure, there was no significant difference between monolingual TD and monolingual autistic children. However, bilingual autistic children had significantly more English exposure than monolingual autistic children ($p = 0.025$) and monolingual TD children ($p = 0.048$) but significantly less than bilingual TD children ($p < 0.001$).

Task and materials

A picture elicitation task was used to generate children's production of focus. In this task, experimenter A first showed the participant one picture at a time, as in Figure 1, and described the picture in a paired SVO sentence in which the subject, verb and object had a consistent tone throughout the sentence (e.g., maau**1**maau**1** zap**1**gan2 syu**1**baau**1** 'The cat is packing the schoolbag').

[Insert Figure 1 here]

The participant was asked to remember the sentences. Then experimenter B pretended that she could not see the pictures and started guessing what was in them. Experimenter B first asked the participant to describe the picture, and then replaced the subject, verb, and object with something completely different from the picture separately in each sentence, giving rise to four questions that elicited broad, subject, verb, and object foci and their expected correct answers using different linguistic strategies for each picture, as illustrated in (5). Participants were asked to correct experimenter B whenever a wrong picture description was given, and they were expected to use either prosody or syntax or both to mark contrastive focus. Twenty-seven experimental pictures and paired sentences in three different tones were constructed. To avoid excessively long testing sessions, we compared only three lexical tones, namely T1, T3, and T4, respectively, the high, mid, and low tones. We avoided the rising tones T2 and T5, as well as mid-low T6, which is similar to and known to be undergoing a merger with T3 (Mok et al., 2013). The pictures were randomly allocated to 3 lists, and each participant completed one list which consisted of 9 experimental pictures in three different tones (3 pictures for each tone) and 2 practice pictures. The participants' answers were recorded for analysis. Each participant took around 10-15 minutes to complete the

experiment. They were unaware of the experiment's purpose and received cash coupons as compensation.

(5) a. **Broad focus question:**
I cannot see the picture. Could you please tell me what is in the picture?
Correct answers:
("none" strategy)

maau1maau1	zap1	syu1baau1	
cat	pack	schoolbag	

'The cat packs the schoolbag.'

b. **Subject focus question:**
You said that the **dog** packs the schoolbag?
Correct answers:
("syntax" strategy)

hai6	[maau1maau1]$_F$	zap1	syu1baau1
FP	cat	pack	schoolbag

("prosody" strategy)

[MAAU1MAAU1]$_F$	zap1	syu1baau1	
cat	pack	schoolbag	

("both" strategy)

hai6	[MAAU1MAAU1]$_F$	zap1	syu1baau1
FP	cat	pack	schoolbag

'The **CAT** packs the schoolbag.'

c. ***Verb focus question*:** You said that the cat ***washes*** the schoolbag?
("syntax" strategy)

maau1maau1	**hai6**	[zap1]$_F$	syu1baau1
cat	FP	pack	schoolbag

("prosody" strategy)

maau1maau1	[ZAP1]$_F$	syu1baau1	
cat	pack	schoolbag	

("both" strategy)

maau1maau1	**hai6**	[ZAP1]$_F$	syu1baau1
cat	FP	pack	schoolbag

'The cat **PACKS** the schoolbag.'

d. ***Object focus question:*** You said that the cat packs the ***box***?
("syntax" strategy)

maau1maau1	zap1	**hai6**	[syu1baau1]$_F$
cat	pack	FP	schoolbag

("prosody" strategy)

maau1maau1	zap1	[SYU1BAAU1]$_F$	
cat	pack	schoolbag	

("both" strategy)

maau1maau1	zap1	**hai6**	[SYU1BAAU1]$_F$
cat	pack	FP	schoolbag

"The cat packs the **SCHOOLBAG**.'

Coding and analysis

Two native speakers of Cantonese with extensive training in linguistics, who were blind to the research hypothesis and group membership, judged all utterances (N=3,141) produced by the children. Unclear and incomplete utterances were excluded from the analysis, which resulted in the exclusion of 10.95% of all utterances. For each utterance, we coded the accuracy (0 = incorrect; 1= correct) based on whether the focus was correctly marked by syntax or prosody, as in (5). In addition, we coded the linguistic strategies used for focus production in each utterance, including four types of focus marking as illustrated in (5): "syntax" (only FP *hai6* was used), "prosody" (only prosodic prominence was used), "both" (both FP and prosodic prominence were used), and "none" (neither FP nor prosodic prominence was used). For example, if only FP *hai6* was used to mark focus in an utterance, the utterance was coded as 1 for 'syntax' and 0 for "prosody', 'both' and 'none'. Inter-rater reliability was around 95% agreement across all cases.

Statistical analyses were conducted in R (R Core Team, 2022). To examine how *Group*, *Focus Position*, and *Tone* affect children's accuracy of focus production (0 = incorrect; 1= correct), we used logistic mixed-effects models in the *lme4* package (Bates, Mächler, Bolker, & Walker, 2015). Regarding the types of focus marking, four separate logistic mixed-effects models were conducted on four focus-marking strategies. In the models, we included fixed factors of *Group* and *Focus Position* with *Participant*, *Item* and *Tone* as random intercepts. Effects were tested for significance by model comparison. To assess the goodness of the models, we compared the models using the $\chi 2$- distributed likelihood ratio and its associated *p*-value (Baayen, Davidson, & Bates, 2008). Significant effects were followed by pairwise comparisons with

"tukey" adjustment for multiple comparisons using the *emmeans* package (Lenth, 2018).

Community involvement statement

The Heep Hong Society was involved in the recruitment of autistic children for participation. It is a leading education and rehabilitation organization in Hong Kong that offers diverse support services to autistic children.

RESULTS

Accuracy of focus production

Figure 2 shows the mean accuracy of focus production in four groups of children. There was a significant main effect for *Focus Position* ($\chi^2(3) = 886.8$, $p < 0.001$), and a marginally significant effect for *Group* ($\chi^2(3) = 7.399$, $p = 0.060$) as predictors of the children's accuracy.

[Insert Figure 2 here]

The post-hoc comparisons showed that the difference in *Focus Position* lay crucially between broad focus and other foci across groups (broad – subject: *Estimate* = -3.264, z = -20.783, $p < 0.001$; broad – verb: *Estimate* = -3.137, z = -20.074, $p < 0.001$; broad – object: *Estimate* = -3.403, z = -21.530, $p < 0.001$). To unpack the marginally significant effect for *Group*, we examined the children's performance in each focus position, as shown in Table 2.

[Insert Table 2 here]

The results revealed no group difference in producing broad focus, indicating children's performance was similar regardless of autism and bilingualism. Regarding the production of subject focus, there was no significant difference between TD

monolingual children and the other three groups of children. However, there was a significant difference between bilingual autistic and bilingual TD children, as well as between monolingual autistic children and bilingual TD children, suggesting that autistic children's performance was significantly less accurate than TD bilingual children in the production of subject focus. There was no significant difference between monolingual autistic and bilingual autistic children. Regarding the verb focus production, all groups performed similarly. Finally, for the production of object focus, there were significant differences between monolingual autistic children and the other three groups of children, meaning that monolingual autistic children were significantly less accurate than TD children and their bilingual autistic peers. Although TD monolingual children performed slightly better than TD and bilingual autistic children, the difference was non-significant.

Focus marking strategies

Table 3 shows the mean percentage of focus-marking strategies used by the four groups of children across focus positions. We then examined the children's marking strategies in each focus position.

[Insert Table 3 here]

In the production of broad focus, there was no significant effect of *Group* in the application of the "syntax" ($\chi^2(3) = 3.621$, $p = 0.605$, n.s.), "prosody" ($\chi^2(3) = 1.825$, $p = 0.873$, n.s.), "both" ($\chi^2(3) = 5.028$, $p = 0.413$, n.s.), and "none" strategies ($\chi^2(3) = 0.0923$, $p = 0.993$, n.s.), indicating that all groups performed similarly in producing broad focus. The preference for the "none" strategy over other marking strategies across the groups suggests that children in our study relied on neither syntax nor prosody to produce broad focus.

To produce focus in other positions, all groups preferred the "prosody" and "none" strategies. There was no significant effect of *Group* in the use of syntactic means among the four groups (subject focus: $\chi^2(3) = 2.087$, $p = 0.837$, n.s.; verb focus: $\chi^2(3) = 2.726$, $p = 0.436$, n.s.; object focus: $\chi^2(3) = 4.826$, $p = 0.185$, n.s.). There was also no significant effect for *Group* in terms of the "both" strategy in subject focus ($\chi^2(3) = 1.225$, $p = 0.747$, n.s.), verb focus ($\chi^2(3) = 0.237$, $p = 0.971$, n.s.), and object focus ($\chi^2(3) = 0.596$, $p = 0.897$, n.s.). The results suggest that all children were similar in making use of the "syntax" and "both" strategies to realize focus in the subject, verb and object positions.

In the use of the "prosody" strategy, a significant effect for *Group* was observed across the three focus positions (subject focus: $\chi^2(3) = 8.789$, $p = 0.032$; verb focus: $\chi^2(3) = 8.745$, $p = 0.033$; object focus: $\chi^2(3) = 15.178$, $p = 0.002$). Specifically, bilingual autistic children performed significantly differently from bilingual and monolingual TD children in the production of subject focus (ASD bilingual – TD bilingual: *Estimate* = -1.187, $z = -2.561$, $p = 0.051$; ASD bilingual – TD monolingual: *Estimate* = -1.616, $z = -2.687$, $p = 0.036$) and verb focus (ASD bilingual – TD bilingual: *Estimate* = -0.957, $z = -2.630$, $p = 0.042$; ASD bilingual – TD monolingual: *Estimate* = -1.371, $z = -2.859$, $p = 0.022$). It seems that bilingual autistic children used prosody to produce subject focus and verb focus to a significantly less extent than monolingual and bilingual TD children. There was no significant difference among other groups in the production of focus in these two positions. In terms of object focus production, bilingual and monolingual autistic children significantly differed from monolingual TD children (ASD bilingual – TD monolingual: *Estimate* = -1.685, $z = -3.511$, $p = 0.003$; ASD monolingual – TD monolingual: *Estimate* = -1.668, $z = -3.373$, $p = 0.004$), indicating that autistic children used significantly less prosody to mark object focus than

monolingual TD children. Pairwise comparison showed no other group difference in this respect.

Finally, for the "none" strategy, the factor *Group* showed a marginally significant effect on the production of subject focus ($\chi^2(3) = 7.693$, $p = 0.053$), and a significant effect on the production of verb focus ($\chi^2(3) = 8.417$, $p = 0.038$) and object focus ($\chi^2(3) = 10.502$, $p = 0.015$). Crucially, the group difference mainly existed between bilingual autistic children and TD children in the production of subject focus (ASD bilingual – TD bilingual: *Estimate* = -0.996, z = -2.395, p = 0.017; ASD bilingual – TD monolingual: *Estimate* = -1.043, z = -1.841, p = 0.066) and verb focus (ASD bilingual – TD bilingual: *Estimate* = -0.853, z = -2.338, p = 0.019; ASD bilingual – TD monolingual: *Estimate* = -0.995, z = -1.988, p = 0.047), and between monolingual autistic and monolingual TD children in the production of object focus (*Estimate* = 1.227, z = 2.639, p = 0.042). The results imply that autistic children preferred neither syntactic nor prosodic means to mark focus to a greater extent than TD children.

Effects of bilingual exposure

The results of Spearman's correlation tests for each group in different settings are shown in Table 4 and Figure 3.

[Insert Table 4 here]

[Insert Figure 3 here]

Spearman's correlation analyses revealed that the total amount of English exposure positively correlated with the accuracy of focus production in autistic children. A closer look at English exposure in different contexts showed that the amount of English exposure at school and in the community positively correlated with autistic children's accuracy, whereas the English exposure at home negatively correlated with their

accuracy. In terms of TD children, only the English exposure at school positively correlated with their accuracy, leaving a negative correlation between the accuracy and the English exposure in other settings. However, all effects were not statistically significant, suggesting that there was no significant correlation between English exposure and the accuracy of focus production in autistic and TD children.

DISCUSSION

The current study examined the production of focus in 5- to 9-year-old Cantonese-English bilingual and Cantonese-speaking monolingual autistic children, compared with monolingual and bilingual TD children matched in nonverbal IQ, working memory, receptive vocabulary, and maternal education. Our first research question concerned how monolingual and bilingual autistic children produce focus in Cantonese. Although monolingual autistic children could produce broad focus and verb focus as accurately as TD children, they were less accurate than TD children in producing focus in the subject and object positions. The results for monolingual autistic children align with previous studies on focus production in autistic children (Diehl & Paul, 2013; Paul et al., 2005; Peppé et al., 2007; Terzi et al., 2016), indicating that the production of focus is a difficult domain for autistic children cross-linguistically.

Regarding bilingual autistic children, they could produce focus as accurately as TD children in the verb and object positions. The only difference observed between bilingual autistic and TD children lay in the production of subject focus, reflected in the lower accuracy of bilingual autistic children than bilingual TD children. Comparing bilingual autistic and monolingual autistic children, the two groups were aligned in the production of focus in broad, subject and verb positions. The two autistic groups only differed in the production of object focus, with bilingual autistic children being

significantly more accurate than their monolingual autistic children. Our findings in general indicated that bilingual autistic children performed similarly to TD children and monolingual autistic children, although they outperformed monolingual autistic children in the object-focus production.

Our study also provides novel information about the linguistic strategies used by monolingual and bilingual autistic children in the production of focus. The findings suggest that both autistic and TD children preferred the same linguistic strategy, namely, using neither syntax nor prosody, to mark broad focus. We also found that autistic children used syntactic means or both syntactic and prosodic means to realize focus in different sentence positions to the same extent as TD children. However, bilingual autistic children used prosody significantly less than TD children to produce focus in the subject, verb and object positions. Monolingual autistic children also showed less use of prosody to produce verb and object focus, compared to TD children. This finding is consistent with the previous work (Ge et al., 2022) suggesting that using prosody to comprehend focus correctly was difficult for Cantonese-speaking autistic children. Our production data provide further evidence to indicate that Cantonese-speaking autistic children may experience more difficulties than their TD peers in acquiring prosodically marked focus in general.

Our second research question addressed the effects of bilingual exposure on the focus production in Cantonese-English bilingual autistic children. Our findings demonstrate that bilingual autistic children were exposed to a similar amount of Cantonese input but significantly less English exposure when compared with matched bilingual TD children. Along with the previous studies on parents' concerns that bilingual autistic children may experience additional language deficits and delays in Western countries (Kay-Raining Bird et al., 2012; Yu, 2013), this observation also

reveals that many parents of autistic children in Hong Kong also received recommendations against bilingualism. However, our results show that the total amount of English exposure did not relate to the accuracy of focus production in autistic and TD children. The lower accuracy of subject focus production observed in bilingual autistic children was not related to their greater English exposure, since they aligned with monolingual autistic children. Crucially, bilingual autistic children even demonstrated higher accuracy than monolingual autistic children in producing object focus. Our overall findings are in line with the previous research that bilingual exposure had no detrimental effect on the language skills of autistic children (Beauchamp et al., 2020; Dai et al., 2018; Gonzalez-Barrero & Nadig, 2017; Hambly & Fombonne, 2011; Meir & Novogrodsky, 2020; Ohashi et al., 2012; Petersen et al., 2012; Valicenti-McDermott et al., 2012; Zhou et al., 2019). The current findings further indicate that bilingual exposure might have enhanced focus production in autistic children in some aspects of language acquisition, which is also consistent with some previous research showing a bilingual advantage in autistic children (Gonzalez-Barrero & Nadig, 2017; Peristeri et al., 2020; Petersen et al., 2012).

We now consider why monolingual autistic children exhibited lower accuracy in focus production than TD children. To correctly produce focus, children need to identify the focus question from the previous discourse and then use a relevant linguistic device to mark focus in their response. Therefore, autistic children could possibly have more general difficulties in integrating different levels of information than TD children. This explanation is consistent with the previous studies that offer evidence in favour of a domain-general difficulty in integrating multiple information in autism (Happé & Frith, 2006; Peristeri et al., 2020). Furthermore, the finding that bilingual autistic children outperformed their monolingual autistic peers is in line with

this explanation. Studies have shown that bilingualism improves cognitive abilities related to global information processing (Gonzalez-Barrero & Nadig, 2017; Peristeri et al., 2020). Therefore, it is possible that bilingualism may compensate for autistic children's weak abilities to integrate information globally, and thus facilitate bilingual autistic children's focus production. Another possibility is that bilingual autistic children's superior performance in object-focus production might be due to positive cross-linguistic influence from English to Cantonese. Given the prominent use of prosodic focus in the production of object focus in English, exposure to such constructions may give bilingual autistic children an advantage in this domain, even with limited exposure or proficiency.

A further observation concerns the non-significant difference between monolingual and bilingual TD children. Compared to autistic children, bilingualism seems to affect TD children in a different way in terms of focus production. There could be a developmental difference between autistic children and TD children. While autistic children generally have difficulty producing prosodically marked focus, TD children might have mastered it in Cantonese, their dominant language. Since monolingual TD and bilingual TD children may have hit a ceiling level of focus production at this age, observing bilingualism effects among TD children, normally manifested in the differences between the two TD groups, is more challenging.

Overall, our findings complement and extend the previous research in numerous ways. First, our study is the first investigation of the effects of bilingualism on the language development of autistic children in Cantonese-English bilingual contexts where Cantonese is the community language. Our findings provide new empirical evidence that bilingual autistic children exposed to two typologically different and genetically divergent languages would not experience additional language difficulties

in the production of focus compared to monolingual autistic peers. Second, our study is one of the very few that examined the impact of bilingual exposure on specific linguistic structures and the use of different linguistic strategies in experimental settings where confounding factors such as language ability, nonverbal IQ and working memory are adequately controlled (also see Meir & Novogrodsky, 2021; Skrimpa et al., 2022), apart from standardized language assessments. Our results highlight the importance of combining both approaches in measuring bilingualism effects on the language development of autistic children. Apart from shedding light on the relationship between bilingualism and language development in autism, the findings of the current study can inform evidence-based practice and provide essential guidance to parents, clinicians, educators and other professionals who make language decisions for autistic children in bilingual communities. Crucially, parents and educators should be encouraged to engage their autistic children in rich bilingual environments. Interventions and training may also consider including bilingual programmes to support families raising bilingual autistic children.

The current study has a number of limitations. First, we examined bilingualism effects on ASD in only one linguistic structure in one language. Further research is warranted to extend to a larger variety of linguistic structures in both languages of bilingual children. Second, this study focused on autistic children with relatively strong language and cognitive abilities, which might result in a normative performance in most aspects of the experimental paradigm and thus fail to capture language differences in autistic children. Further work should explore the effects of bilingual exposure on autistic children struggling with verbal communication in language development. Additionally, the current study only used judgement to measure children's

performance. Acoustic measures of prosodically marked focus to compare autistic children to matched TD peers are desirable in further research.

CONCLUSION

This study investigated the production of focus in 5- to 9-year-old Cantonese-English bilingual autistic children and Cantonese-speaking monolingual autistic children, and how English exposure influences their focus production in Cantonese, compared to their TD monolingual and bilingual peers. Our findings reveal that bilingual autistic children aligned with monolingual autistic children in the production of focus in general, although bilingual autistic children outperformed monolingual autistic peers in object focus production. Our results also revealed autistic children's difficulty using prosodic means to produce focus. Our findings shed new light on the effects of bilingualism on the focus production of autistic children, showing that exposure to two languages does not impede bilingual autistic children's L1 development. Rather, bilingualism may even enhance the production of focus in autistic children.

References

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, *59*(4), 390-412.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using *lme4*. *Journal of Statistical Software*, *67*(1), 1–48.

Beauchamp, M. L. H., Rezzonico, S., & Macleod, A. A. N. (2020). Bilingualism in School - Aged Children with ASD : A Pilot Study. *Journal of Autism and Developmental Disorders*, 0123456789.

Bialystok, E. (2001). *Bilingualism in development: Language, literacy, and cognition*. Cambridge: Cambridge University Press.

Chafe, W. (1976). Givenness, contrastiveness, definiteness, subjects, topics, and point of view. In C. N. Li (Ed.), *Subject and topic* (pp. 225–255). Academic Press.

Chao, Y. R. (1947). *Cantonese primer*. Harvard University Press.

Cheung, P. S., Lee, K. Y., & Lee, L. W. (1997). The development of the 'Cantonese receptive vocabulary test' for children aged 2–6 in Hong Kong. *European Journal of Disorders of Communication*, *32*(1), 127–138.

Dai, Y. G., Burke, J. D., Naigles, L., Eigsti, I. M., & Fein, D. A. (2018). Language abilities in monolingual- and bilingual-exposed children with autism or other developmental disorders. *Research in Autism Spectrum Disorders*, *55*, 38–49.

De Houwer, A. (1995). Bilingual language acquisition. In P. Fletcher, & B. MacWhinney (Eds.), *The handbook on child language* (pp. 219–250). Oxford: Blackwell.

Deuchar, M., & Quay, S. (2000). *Bilingual acquisition: Theoretical implications of a case study*. Oxford: Oxford University Press.

Diehl, J. J., & Paul, R. (2013). Acoustic and perceptual measurements of prosody production on the profiling elements of prosodic systems in children by children with autism spectrum disorders. *Applied Psycholinguistics*, *34*(1), 135–161.

Ehrler, D. J., & McGhee, R. L. (2008). *PTONI: Primary test of non- verbal intelligence*. Pro-Ed.

Eigsti, I. M., De Marchena, A. B., Schuh, J. M., & Kelley, E. (2011). Language acquisition in autism spectrum disorders: A developmental review. *Research in Autism Spectrum Disorders*, *5*(2), 681–691.

Ge, H., Liu, F., Yuen, H. K., Chen, A., & Yip, V. (2022). Comprehension of prosodically and syntactically marked focus in Cantonese-speaking children with and without Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *53*, 1255-1268.

Genesee, F., Nicoladis, E., & Paradis, J. (1995). Language differentiation in early bilingual development. *Journal of Child Language*, *22*, 611–631.

Gonzalez-Barrero, A. M., & Nadig, A. (2017). Verbal fluency in bilingual children with Autism Spectrum Disorders. *Linguistic Approaches to Bilingualism*, *7*, 460–475.

Gonzalez-Barrero, A. M., & Nadig, A. S. (2019). Can Bilingualism Mitigate Set-Shifting Difficulties in Children With Autism Spectrum Disorders? *Child Development*, *90*(4), 1043-1060.

Gotham, K., Pickles, A., & Lord, C. (2009). Standardizing ADOS scores for a measure of severity in Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *39*, 693–705.

Gu, W., & Lee, T. (2007). Effects of tonal context and focus on Cantonese F0. *Proceedings of 16th international conference phonetic science*. pp. 1033–1036.

Gussenhoven, C. (1983). *On the grammar and semantics of sentence accents*. Foris.

Gussenhoven, C. (2006). Types of focus in English. In C. Lee, M. Gordon, &D. Büring (Eds.) *Topic and focus: Cross-linguistic perspectives on meaning and intonation* (pp. 83–100). Kluwer.

Hambly, C., & Fombonne, E. (2012). The impact of bilingual environments on language development in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *42*, 1342- 1352.

Hampton, S., Rabagliati, H., Sorace, A., & Fletcher-Watson, S. (2017). Autism and Bilingualism: A Qualitative Interview Study of Parents' Perspectives and Experiences. *Journal of Speech, Language, and Hearing Research*, *60*, 435–446.

Happé, F. G. E., & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *36*(1), 5–25.

Howlin, P. (2004). *Autism and Asperger syndrome: Preparing for adulthood* (2nd ed.). New York, NY: Routledge.

Iarocci, G., Hutchison, S. M., & O'Toole, G. (2017). Second language exposure, functional communication, and executive function in children with and without autism spectrum disorder (ASD). *Journal of Autism and Developmental Disorders*, *47*(6), 1818-1829.

Kay-Raining Bird, E., Lamond, E., & Holden, J. (2012). Survey of bilingualism in autism spectrum disorders. *International Journal of Language & Communication Disorders*, *47*, 52-64.

Kidd, E., Chan, A., & Chiu, J. (2015). Cross-linguistic influence in simultaneous Cantonese–English bilingual children's comprehension of relative clauses. *Bilingualism: Language and Cognition*, *18*(3), 438-452.

Krifka, M. (2008). Basic notions of information structure. *Acta Linguistica Hungarica*, *55*(3), 243–276.

Lee, P. P. L. (2019). *Focus manifestation in Mandarin Chinese and Cantonese: A comparative perspective*. Routledge.

Lenth, R. (2018). *Emmeans: Estimated marginal means, aka least-squares means. R package version 1.1.3*.

Leung, K. M. L., & Peng, G. (2015). Prosodic correlates of focus production in Hong Kong Cantonese. *Experimental Linguistics* [*实验语言学*], *4*(1), 4–11.

Lord, C., Rutter, M., DiLavorce, P. C., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) Manual (Part I): Modules 1-4*. Torrance, CA: Western Psychological Services.

Man, V. C. (2002). Focus effects on Cantonese tones: An acoustic study. *Proceedings of 1st international conference on speech prosody*. Aix-en-Provence, pp. 467–470.

Matthews, S., & Yip, V. (2011). *Cantonese: A comprehensive grammar*. Routledge.

McCann, J., & Peppe, S. (2003). Prosody in autism spectrum disorders: A critical review. *International Journal of Language & Communication Disorders*, *38*(4), 325–350

McCarthy, D. (1972). *McCarthy Scales of Children's Abilities.* The Psychological Corp.

Meir, N., & Novogrodsky, R. (2020). Syntactic abilities and verbal memory in monolingual and bilingual children with High Functioning Autism (HFA). *First Language*, *40*(4), 341-366.

Meir, N., & Novogrodsky, R. (2021). Referential expressions in monolingual and bilingual children with and without Autism Spectrum Disorder (ASD): A study of informativeness and definiteness. *Journal of Child Language*, 1-30.

Mok, P. K. P., Zuo, D., & Wong, W. Y. P. (2013). Production and perception of a sound change in progress: Tone merging in Hong Kong Cantonese. *Language Variation and Change*, *25*(3), 341–370.

Müller, N., & Hulk, A. (2001). Crosslinguistic influence in bilingual language acquisition: Italian and French as recipient languages. *Bilingualism: Language and Cognition*, *4*(1), 1-21.

Ohashi, J. K., Mirenda, P., Marinova-Todd, S. H., Hambly, C., Fombonne, E., Szatmari, P., . . . Thompson, A. (2012). Comparing early language development in monolingual- and bilingual-exposed young children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *6*, 890-897.

Paradis, J., & Genesee, F. (1996). Syntactic acquisition in bilingual children: Autonomous or interdependent?. *Studies in Second Language Acquisition*, *18*(1), 1-25.

Paul, R., Augustyn, A., Klin, A., & Volkmar, F. R. (2005). Perception and production of prosody by speakers with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *35*(2), 205–220.

Peppé, S., & McCann, J. (2003). Assessing intonation and prosody in children with atypical language development: The PEPS-C test and the revised version. *Clinical Linguistics and Phonetics*, *17*(4–5), 345–354.

Peppé, S., Hare, A. O., & Rutherford, M. (2007). Receptive and expressive prosodic ability in children with High-Functioning Autism. *Journal of Speech, Language, and Hearing Research*, *50*, 1015–1028.

Peristeri, E., Baldimtsi, E., Andreou, M., & Tsimpli, I. M. (2020). The impact of bilingualism on the narrative ability and the executive functions of children with autism spectrum disorders. *Journal of Communication Disorders*, *85*, 105999.

Petersen, J. M., Marinova-Todd, S. H., & Mirenda, P. (2012). Brief report: An exploratory study of lexical skills in bilingual children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *42*, 1499-1503.

R Core Team (2022). R: a language and environment for statistical computing. R Foundation for Statistical Computing. https://www.R-project.org/

Ratto, A. B., Potvin, D., Pallathra, A. A., Saldana, L., & Kenworthy, L. (2020). Parents report fewer executive functioning problems and repetitive behaviors in young dual-language speakers with autism. *Child Neuropsychology*, *26*(7), 917-933.

Reetzke, R., Zou, X., Sheng, L., & Katsos, N. (2015). Communicative development in bilingually exposed Chinese children with autism spectrum disorders. *Journal of Speech, Language, and Hearing Research*, *58*, 813-825.

Sharaan, S., Fletcher-Watson, S., & MacPherson, S. E. (2021). The impact of bilingualism on the executive functions of autistic children: A study of English–Arabic children. *Autism Research*, *14*(3), 533-544.

Skrimpa, V., Spanou, V., Bongartz, C., Peristeri, E., Andreou, M., & Papadopoulou, D. (2022). Bilingualism effects in pronoun comprehension: Evidence from children with autism. *Autism Research*, *15*(2), 270–283.

Tager-Flusberg, H., Paul, R., & Lord, C. (2005). Language and communication in autism. In F. R. Volkmar, R. Paul, A. Klin, & D. Cohen (Eds.), *Handbook of*

Autism and Pervasive Developmental Disorders (3rd ed., pp. 335–364). New York: Wiley.

Terzi, A., Marinis, T., & Francis, K. (2016). The Interface of Syntax with Pragmatics and Prosody in Children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *46*(8), 2692–2706.

The Curriculum Development Council. (2006). *Guide to Pre-primary Curriculum*. Hong Kong: Hong Kong Government Printer.

Valicenti-McDermott, M., Tarshis, N., Schouls, M., Galdston, M., Hottinger, K., Seijo, R., . . . Shinnar, S. (2013). Language differences between monolingual English and bilingual English-Spanish young children with autism spectrum disorders. *Journal of Child Neurology*, *28*, 945-948.

Wu, W., & Xu, Y. (2010). Prosodic focus in Hong Kong Cantonese without post-focus compression. *Proceedings of the 5th international conference speech prosody*. pp. 1–4.

Yip, V., & Matthews, S. (2007). *The bilingual child: Early development and language contact*. Cambridge, UK: Cambridge University Press.

Yu, B. (2013). Issues in bilingualism and heritage language maintenance: Perspectives of minority-language mothers of children with autism spectrum disorders. *American Journal of Speech-Language Pathology*, *22*, 10-24.

Zhou, V., Munson, J. A., Greenson, J., Hou, Y., Rogers, S., & Estes, A. M. (2019). An exploratory longitudinal study of social and language outcomes in children with autism in bilingual home environments. *Autism*, *23*(2), 394-404.

Figure 1. Example of pictures for the elicitation task

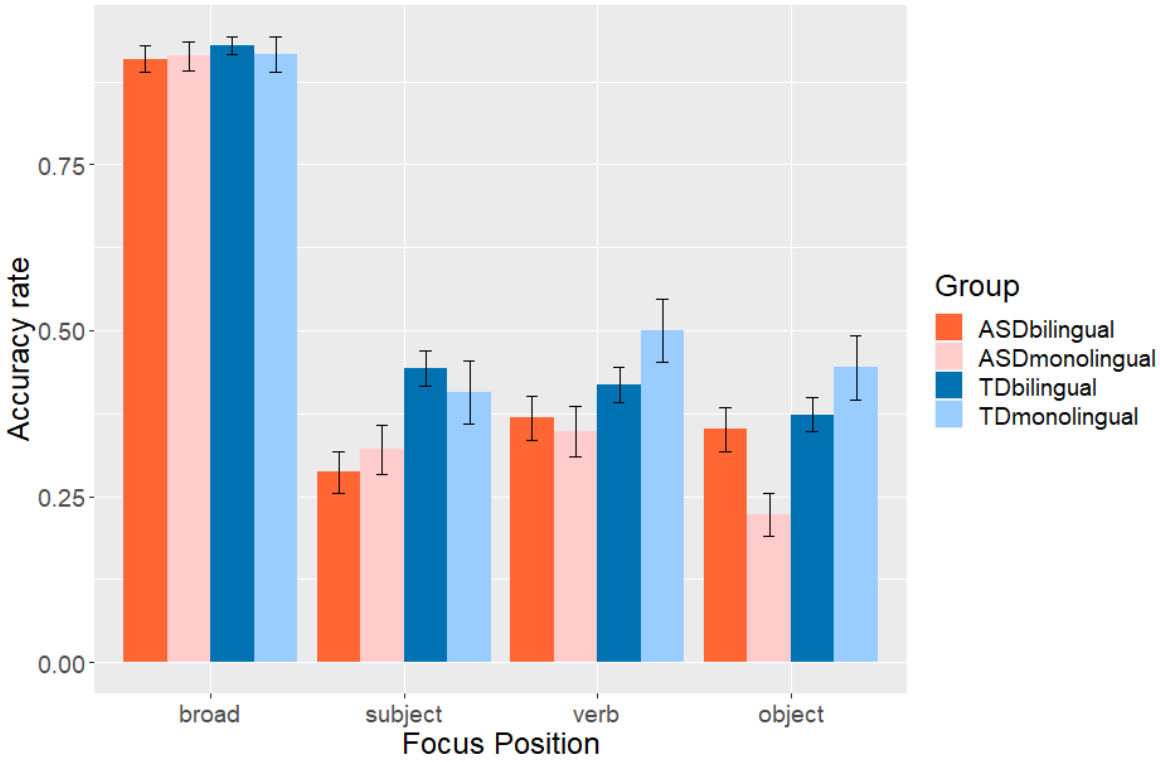

Figure 2. Accuracy of focus production in bilingual and monolingual autistic and TD children. Error bars indicate ±1SE.

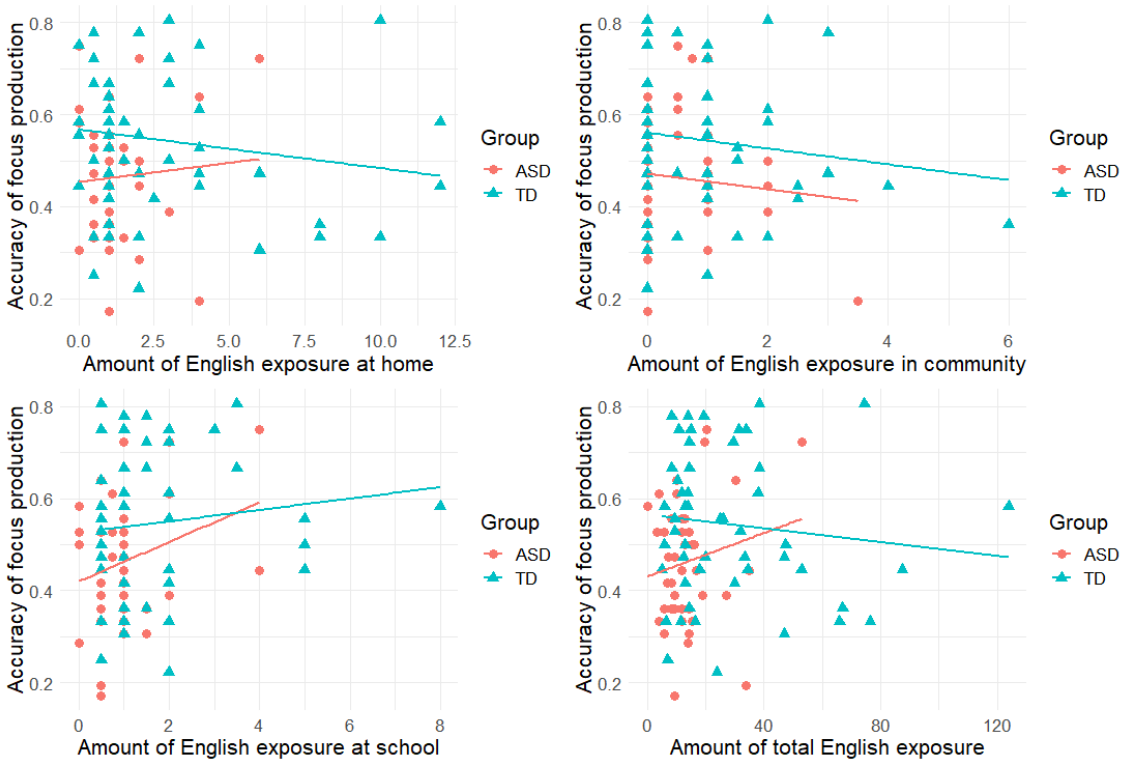

Figure 3. Relationship between English exposure and the accuracy of focus production in ASD and TD children

Table 1. Information on monolingual and bilingual autistic and TD children (SD in parentheses)

	ASD monolingual	**ASD bilingual**	**TD monolingual**	**TD bilingual**
Number	18	24	14	42
Gender (M:F)	8:1	3:1	11:3	26:17
Age (months)	82.56 (15.15)	84.04 (13.99)	71.07 (11.11)	76.90 (5.00)
Age range	60 – 115	62 – 106	56 – 98	51 – 107
Age of starting learning English (months)	27.00 (15.97)	18.10 (11.79)	27.82 (12.66)	10.44 (11.60)
Maternal education [a]	2.00 (1.19)	2.38 (1.10)	2.00 (1.11)	2.50 (1.09)
Nonverbal IQ (PTONI)	100.06 (19.97)	105.42 (26.14)	112.23 (17.62)	114.00 (23.13)
Working Memory	5.65 (1.90)	5.05 (2.11)	4.82 (1.60)	5.31 (2.31)
Cantonese vocabulary (CRVT)	59.44 (6.03)	59.00 (5.88)	60.46 (2.93)	60.54 (4.04)
ADOS-2 total score	8.57 (0.86)	8.34 (0.98)	NA	NA
Cantonese input				
Home (number of hours per day)	8.42 (2.33)	8.44 (3.46)	10.79 (3.36)	8.65 (3.43)
School (number of hours per day)	3.83 (1.38)	4.04 (1.82)	5.07 (2.67)	2.88 (2.31)
Community (number of hours per day)	1.00 (1.34)	2.08 (2.95)	1.45 (0.98)	1.31 (1.58)
Total (number of hours per week)	79.08 (18.17)	81.35 (26.09)	102.30 (24.37)	76.30 (28.71)
English input				
Home (number of hours per day)	0.50 (0.34)	1.90 (1.26)	0.50 (0.34)	3.92 (3.34)
School (number of hours per day)	0.69 (0.45)	1.24 (1.00)	0.79 (0.43)	1.83 (1.53)
Community (number of hours per day)	0.22 (0.39)	0.69 (0.89)	0.64 (0.72)	1.01 (1.28)
Total (number of hours per week)	7.08 (2.77)	20.21 (9.37)	8.07 (1.84)	37.85 (25.21)

[a] Maternal education on a 1 – 4 scale: 1 = high school; 2 = associate degree; 3 = university; 4 = master/doctorate degree

Table 2. Pairwise comparisons of accuracy rate by focus position among bilingual and monolingual autistic and TD children (*** $p < 0.001$; ** $p < 0.01$)

Focus Position	***Groups***	***Estimate***	***SE***	***z***	***p***
Broad	ASD bilingual - ASD monolingual	0.062	0.489	0.126	0.999
	ASD bilingual - TD bilingual	-0.113	0.422	-0.269	0.993
	ASD bilingual - TD monolingual	0.031	0.543	0.057	0.999
	ASD monolingual - TD bilingual	-0.175	0.446	-0.393	0.923
	ASD monolingual - TD monolingual	-0.031	0.562	-0.055	0.999
	TD bilingual - TD monolingual	0.144	0.504	0.286	0.992
Subject	ASD bilingual - ASD monolingual	-0.212	0.352	-0.602	0.931
	ASD bilingual - TD bilingual	-0.683	0.187	-3.439	<0.001***
	ASD bilingual - TD monolingual	-0.633	0.390	-1.621	0.367
	ASD monolingual - TD bilingual	-0.522	0.199	-2.629	0.004**
	ASD monolingual - TD monolingual	-0.421	0.401	-1.049	0.721
	TD bilingual - TD monolingual	0.155	0.355	0.437	0.972
Verb	ASD bilingual - ASD monolingual	-0.024	0.345	0.069	0.999
	ASD bilingual - TD bilingual	-0.397	0.294	-1.350	0.531
	ASD bilingual - TD monolingual	-0.734	0.386	-1.901	0.227
	ASD monolingual - TD bilingual	-0.373	0.310	-1.203	0.625
	ASD monolingual - TD monolingual	-0.710	0.399	-1.782	0.282
	TD bilingual - TD monolingual	-0.338	0.354	-0.952	0.777
Object	ASD bilingual - ASD monolingual	0.638	0.238	2.676	0.005**
	ASD bilingual - TD bilingual	-0.397	0.294	-1.350	0.531
	ASD bilingual - TD monolingual	-0.734	0.386	-1.901	0.227
	ASD monolingual - TD bilingual	-0.372	0.310	-3.352	0.007**
	ASD monolingual - TD monolingual	-0.710	0.399	-3.675	<0.001***
	TD bilingual - TD monolingual	-0.338	0.354	-0.952	0.777

Table 3. Mean percentage of focus marking types in monolingual and bilingual autistic and TD children (SD in parentheses)

Focus position	Group	Syntax	Prosody	Both	None
Broad	ASD bilingual	3.35% (0.18)	5.26% (0.22)	0.48% (0.07)	90.91% (0.29)
	ASD monolingual	4.32% (0.20)	4.32% (0.20)	0.00% (0.00)	91.36% (0.28)
	TD bilingual	3.11% (0.17)	3.95% (0.20)	0.00% (0.00)	92.94% (0.26)
	TD monolingual	0.00% (0.00)	8.33% (0.28)	0.00% (0.00)	91.67% (0.28)
Subject	ASD bilingual	13.88% (0.35)	21.53% (0.41)	5.26% (0.22)	59.33% (0.49)
	ASD monolingual	10.49% (0.31)	33.95% (0.48)	5.56% (0.23)	50.00% (0.50)
	TD bilingual	13.56% (0.34)	37.85% (0.49)	7.63% (0.27)	40.96% (0.49)
	TD monolingual	6.48% (0.25)	46.30% (0.50)	6.48% (0.25)	40.74% (0.49)
Verb	ASD bilingual	6.22% (0.24)	37.80% (0.49)	7.18% (0.26)	48.80% (0.50)
	ASD monolingual	6.21% (0.24)	41.61% (0.49)	6.21% (0.24)	45.96% (0.50)
	TD bilingual	8.19% (0.27)	51.98% (0.50)	6.78% (0.25)	33.05% (0.47)
	TD monolingual	0.93% (0.10)	61.11% (0.49)	7.41% (0.26)	30.56% (0.46)
Object	ASD bilingual	10.10% (0.30)	37.02% (0.48)	4.33% (0.20)	48.56% (0.50)
	ASD monolingual	5.56% (0.23)	34.57% (0.48)	5.56% (0.23)	54.32% (0.50)
	TD bilingual	5.65% (0.23)	50.56% (0.50)	4.80% (0.21)	38.98% (0.49)
	TD monolingual	0.00% (0.00)	67.59% (0.47)	2.78% (0.17)	29.63% (0.46)

Table 4. Correlation between the accuracy of focus production and English exposure in different settings in ASD and TD children

	ASD		TD	
	r	*p*	*r*	*p*
English exposure at home	-0.091	0.566	-0.199	0.157
English exposure at school	0.127	0.422	0.187	0.184
English exposure in community	0.124	0.433	-0.094	0.507
Total English exposure	0.087	0.583	-0.097	0.495