Vocabulary and grammatical skills of bilingual children with Autism Spectrum Disorders at school age

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Authors' Contributions
AMGB conceived of the study, participated in its design and coordination, participated in the measurement, performed statistical analyses and interpretation of the data, and drafted the manuscript; AN participated in the design of the study, interpretation of the data, and drafted the manuscript. All authors read and approved the final manuscript.

Abstract

We examined the lexical and grammatical skills of monolingual and bilingual school-age children with Autism Spectrum Disorders (ASD). Thirteen monolingual and thirteen bilingual children with ASD without intellectual disability, were compared on standardized measures of vocabulary and morphology. Findings revealed that bilingual children performed in the average monolingual range on a standardized receptive vocabulary test and slightly below the average range on a standardized morphological task in their dominant language. Prior work indicates that bilingual exposure is not detrimental for early language development in children with autism. The current findings suggest that at school age, bilinguals with ASD show similar language development patterns as those described in the literature on typically-developing bilinguals.

Keywords: Bilingualism, Autism Spectrum Disorders, Language Skills, Vocabulary, Morphology, School-Age Children.

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In the present study we investigate how bilingual school-age children with ASD perform on standardized tests of receptive vocabulary and morphology relative to their monolingual peers with ASD. The available evidence, largely from pre-school and kindergarten-age children, unanimously suggests that bilingualism does not hinder language development in children on the autism spectrum. However, less is known about bilingual development in ASD at later ages, when language abilities become more complex and are used in academic settings. This knowledge is essential to inform childrearing and educational decisions for the growing number of families with a child with ASD living in bilingual contexts.

Bilingualism and Language Development in ASD

Since 2012 we have gained the first research evidence on the language development of children with Autism Spectrum Disorders (ASD) growing up in bilingual contexts (See Table 1 for a review of the most representative studies). Overall, findings from these studies have shown that bilingually-exposed children with ASD do not present with additional language delays when compared with monolingual children with ASD (for comprehensive reviews see Drysdale et al. 2015; Kay-Raining Bird et al. 2016; Lund et al. 2017). For instance, researchers have reported comparable performance for bilingual and monolingual toddlers with ASD on early language milestones such as age of first words (Hambly and Fombonne 2012; Valicenti-McDermott et al. 2013). While these findings are reassuring with respect to the potential for bilingual language acquisition in ASD, we lack important information on the ongoing development of language skills during the school years in bilingual children with ASD.

Table 1

Summary of Most Representative Studies Examining Language Skills in Bilingual Relative to Monolingual Children with ASD

Study	Age Range	Number of Children with ASD	Language(s) of Exposure	Definition of Bilingualism	Matching of Bilingual and Monolingual Groups	L1 Assessment Method, Measures	L1 Finding	L2 Assessment Method, Measures	L2 Data Available, Additional Findings
Zhou et al. (2017)	12 - 26 months	24 monolinguals and 13 bilinguals	English, Spanish, Ukrainian, Portuguese, Japanese, Vietnamese, Chinese, Tigrinya, Romanian, Hindi, and German.	Parent report of exposure to L2 > 20%	Age, NVIQ, sex, maternal education, family income, ethnicity, and hours of intervention	Parent report (VABS-II, MCDI); and Direct assessment (MSEL)	Bilingual = Monolingual (similar language gains after 2 years of intervention)	NA	NA
Valicenti-McDermott et al. (2013)	Approx. 20 - 32 months	40 monolinguals and 40 bilinguals	English, Spanish	Parent report of exposure to both languages in the home	Age, sex, maternal education, developmental level and autism severity	Parent report (language milestones) and Direct assessment (Rossetti Infant-Toddler Language Scale and clinical observation)	Bilingual = Monolingual; bilingual gestured more and produced more cooing	Parent report (language milestones) and Direct assessment (Rossetti Infant-Toddler Language Scale and clinical observation)	Not reported
Ohashi et al. (2012)	24 - 52 months	40 monolinguals and 20 bilinguals	L1 = English or French and L2 = Variety of languages	Parent report of lifetime and current exposure to both languages >= 20% in the home	Age and NVIQ	Parent report (VABS-II, ADI-R); and Direct assessment (PLS-4 and ADOS communication scores)	Bilingual = Monolingual	NA	NA

Hambly & Fombonne (2012)	36 - 78 months	30 monolinguals and 45 bilinguals	French, English, Chinese, Farsi, Hebrew, Italian, Romanian, Spanish and Tamil	Parent report of any lifetime exposure to second language	Age, sex, maternal education and family income	Parent report (MCDI, VABS-II and ADI-R)	Bilingual = Monolingual	Parent report (MCDI, VABS-II and ADI-R)	Number of words in L2
Petersen, Marinova-Todd, & Mirenda (2012)	43 - 73 months	14 monolinguals and 14 bilinguals	English, Chinese	Parent report of simultaneous exposure before age 3 and current daily use of both languages	Age and hours of therapy received	Parent report (MCDI and its Chinese version); Direct assessment (PPVT and its Chinese Version, PLS-3)	Bilingual = Monolingual	Parent report (MCDI and its Chinese version); Direct assessment (PPVT and its Chinese Version, PLS-3)	Bilingual children had similar vocabulary scores in their L1 and L2
Reetzke, Zou, Sheng, & Katsos (2015)	45 - 98 months	31 monolinguals and 23 bilinguals	Mandarin, Yue, Hakka, Xiang and Southern Min	Parent report of lifetime exposure to L1 and L2 > 20% and ongoing exposure to L1 and L2	Age, SES, and autism severity	Parent report (CCC-2 and SRS)	Bilingual = Monolingual	NA	NA

Note. ADI-R = Autism Diagnostic Interview-Revised; ADOS = Autism Diagnostic Observation Schedule; ASD = autism spectrum disorders; CCC-2 = Children's Communication Checklist–2; L1 = dominant language; L2 = non-dominant language; MCDI = MacArthur-Bates Communicative Development Inventory; MSEL = Mullen Scales of Early Learning; NA = not available; NVIQ = nonverbal IQ; PLS-3 = The Preschool Language Scale; PLS-4 = Preschool Language Scale, 4th edition; PPVT = Peabody Picture Vocabulary Test; SES = socioeconomic status; SRS = Social Responsiveness Scale; VABS-II = Vineland Adaptive Behavior Scales, 2nd edition.

The current work expands the evidence on bilingual language development in children with ASD in three novel ways. First, most studies on bilingualism and ASD have examined early language milestones (prior to age 6) while the current work investigates both vocabulary comprehension and morphological skills in school-age children. It is imperative to study more complex language abilities, such as the measure of expressive morphology studied here, because effects of bilingual exposure follow a developmental trajectory. For example, though bilingual infants follow a similar pattern of language development to that observed in monolingual infants (Byers-Heinlein, Burns, and Werker 2010), by the early school years, bilingual children tend to lag behind their monolingual peers in oral language abilities given their divided exposure to two languages (Hoff 2013; Paez, Tabors, and Lopez 2007). During the school-age years, children with ASD continue developing their language skills and more complex aspects of vocabulary and grammar are usually acquired at this stage (Tager-Flusberg, Paul, and Lord 2005). Accordingly, close examination of the language skills of older children with ASD is essential to understand the full effects of bilingualism, especially in a population that exhibits early language delays and thus tends to be delayed in acquiring more complex forms (Luyster, Lopez, and Lord 2007).

A second novel aspect of the current work is the nature of language assessment, which we obtained through direct assessment of the child's language on standardized language tests, importantly in both of the child's languages. We limited language exposure to French, English, and Spanish, where official equivalents of the same standardized tests were available. This also limited the range of typological differences between a bilingual's languages. In most prior work parent report or retrospective data were used to assess children's language skills, with only one study directly assessing both languages (i.e., Petersen, Marinova-Todd, and Mirenda 2012).

While the use of parent questionnaires and direct assessment of language skills correlates highly at early ages in children with ASD, particularly for the expressive domain (Luyster, Kadlec, Carter, and Tager-Flusberg 2008), as the child grows, it becomes more challenging for parents to accurately estimate a bilingual child's language proficiency. This is especially true when one language is spoken at home while the other is used in academic settings or with friends. Thus, direct language testing in both languages is warranted to obtain a veridical assessment of language skills in older children.

Finally, we included only carefully identified *proficient bilinguals* with ASD in our analysis, while prior studies have examined a broader group of children who are simply *bilingually-exposed* by parent report. Receptive bilingualism is different from productive bilingualism (Beardsmore 1982) and it is possible that, at early ages, *bilingually-exposed* children's language skills do not differ significantly from those of their monolingual peers with ASD because they in fact overlap significantly in terms of their language use and experience. That is, many *bilingually-exposed* children may be receptive bilinguals, who understand but do not speak a second language, or they may even function as monolinguals with only limited knowledge of their second language.

Methods

Twenty-six school-age children with ASD were compared on standard measures of receptive vocabulary and morphology. Participants were recruited in Montreal, Quebec, Canada, a multicultural city where French and English are used in everyday life. The rate of bilingualism in the province of Quebec is 45% (Statistics Canada, 2017) and the city of Montreal has French and English school boards. Parent consent and child assent were obtained from all participants. Thirteen bilingual children with ASD (mean age 7;9 years, age range: 4;9 years to 9;9 years) were closely matched to 13 monolingual children with ASD (mean age 8;3 years, age range: 5;4

years to 10;8 years) on nonverbal IQ (NVIQ), chronological age, maternal education and dominant language. There were no significant differences in the groups' scores on the Social Communication Questionnaire (SCQ; Rutter, Bailey, and Lord 2003), which was used to confirm autism symptomatology, or with respect to gender. Children with ASD and language impairment (LI) were included in each group to reflect the heterogeneity of language abilities found in this population (Kjelgaard and Tager-Flusberg 2001; Tager-Flusberg 2015). Language impairment was determined based on the recalling sentences sub-test from the CELF-4 and its French version (i.e., scores > 1 SD below the mean; Thordardottir et al., 2011) along with parent-report of persistent language difficulties. The proportion of children with ASD and LI was similar between groups. Demographic information is provided in Table 2.

Table 2

Demographic Characteristics and Matching of Children with ASD

Variable	**Monolingual ASD** (n = 13) *M (SD)*	**Bilingual ASD** (n = 13) *M (SD)*	***p* value**
NVIQ	108 (12.49)	109 (11.13)	.922
Chronological age in months	99 (20.70)	94 (14.83)	.499
Maternal education	15 (2.30)	15 (3.02)	.614
Dominant language	7 French 6 English	7 French 6 English	1.00
SCQ	18 (5.56)	19[a] (3.41)	.456
Gender	11 Males 2 Females	11 Males 2 Females	1.00
Percentage of children with LI	46%	38%	.691
Amount of exposure to L1 over lifetime	91% (6.19)	61% (14.83)	<.001

Current amount of exposure to L1	93%	(5.73)	64%	(21.04)	<.001

Note. ASD = autism spectrum disorders; NVIQ = nonverbal IQ; SCQ = Social Communication Questionnaire; LI = language impairment; L1 = dominant language.
[a] n = 11 due to missing data.

Proficient *bilingual* children were defined as those who: 1) had a history or current exposure to an L2 greater than 20%, 2) obtained a proficiency score from their parents of 3 (i.e., good proficiency) or 4 (i.e., excellent proficiency) in both languages on a 4-point scale ranging from limited to excellent proficiency, and 3) could complete at least 5 out of 8 tasks of the study protocol in both languages. Children who met the criteria just described were retained in the bilingual group, regardless of age of first exposure to an L2 or varied language exposure patterns. Bilingual participants' dominant language was defined as the language to which they had a greater exposure to or reported greater proficiency in. Conversely, *monolingual* participants were those who had a history of exposure to an L2 of less than 20%. In the multilingual context of testing, individuals generally have some degree of exposure to an L2, although they may not be proficient in that language. Thus, the term *functional* monolinguals might be more accurate to characterize this population.

Vocabulary skills were assessed via the Peabody Picture Vocabulary Test (PPVT-4; Dunn and Dunn, 2007) and its French (ÉVIP; Dunn, Thériault-Whalen, and Dunn, 1993) and Spanish versions (Test de Vocabulario en Imagenes Peabody-TVIP; Dunn, Padilla, Lugo, and Dunn, 1986). Morphological skills were assessed using the word structure sub-test from the Clinical Evaluation of Language Fundamentals in English (CELF-4; Semel, Wiig, and Secord, 2003), French (CELF CDN-F; Secord et al., 2009), and Spanish (CELF 4 Spanish Edition; Wiig, Semel, and Secord, 2006). In this sub-test children are prompted to apply specific grammatical rules such as use of pronouns, verb inflections, and derivations among others.

The performance of the bilingual children with ASD relative to their monolingual peers was examined on receptive vocabulary and morphology measures in the dominant language[1]. We provide data on language exposure for all participants' dominant (Table 3) and non-dominant language (Table 4). Language testing results are provided for both languages for bilinguals, and in the functional language for monolinguals.

Table 3

Individual Scores in Dominant Language of Bilingual and Monolingual Children with ASD

Participants with ASD	Dominant language (L1)	History of exposure to L1	Current exposure to L1	Vocabulary L1 (Standard score)	Morphology L1 (Scaled score)
Monolingual					
M1	English	97%	98%	107	7
M2	French	100%	97%	112	8
M3	French	91%	97%	125	12
M4	French	100%	96%	118	10
M5	French	84%	91%	85	9
M6	French	90%	85%	128	10
M7	French	80%	84%	126	12
M8	English	97%	100%	89	6
M9[b]	English	90%	100%	89	11
M10[b]	English	89%	95%	86	4
M11[b]	French	90%	91%	113	5
M12[b]	English	84%	90%	84	2
M13[b]	English	91%	85%	108	9
Bilingual					
B1	French	61%	94%	115	11
B2	English	68%	91%	106	10
B3	French	70%	80%	100	10
B4	French	72%	77%	84	5
B5	English	82%	69%	112	7
B6	English	61%	59%	84	4
B7	English	58%	58%	95	5
B8	French	21%	47%	120	11
B9	French	60%	44%	90	6
B10[b]	English	65%	89%	87	7
B11[b]	English	50%	57%	78	2
B12[b]	French	70%	36%	75	2

[1] The term dominant language is also used for monolingual children given that some of these children had minimal exposure to a second language as described in Table 4. Monolingual children can be considered as functional monolinguals, who can only function in one language.

B13[b]	French	50%	32%	64	2

Note. ASD = autism spectrum disorders; L1 = dominant language; B = bilingual; M = monolingual.
[a]One monolingual participant was exposed to a second language (lifetime history of 22% exposure); however, this child was not proficient in that language.
[b]Participants with language impairment.

Table 4

Individual Scores in Non-Dominant Language of Bilingual and Monolingual Children with ASD

Participants with ASD	**Non-dominant language (L2)**	**Age of exposure to L2**	**History of exposure to L2**	**Current exposure to L2**	**Vocabulary L2 (Standard score)**	**Morphology L2 (Scaled score)**
Monolingual					-	-
M1[c]	French	Birth	2%	2%	-	-
M2[c]	English	6 years	0%	3%	-	-
M3	Spanish	Birth	9%	3%	-	-
M4	English	NA	0%	4%	-	-
M5[c]	Spanish	Birth	15%	8%	-	-
M6[c]	English	2 years	8%	14%	-	-
M7[c]	English	Birth	19%	16%	-	-
M8	French	3 years	3%	0%	-	-
M9[bc]	French	2 years	4%	0%	-	-
M10[b]	French	Birth	11%	5%	-	-
M10[bc]	Arabic	Birth	10%	8%	-	-
M12[b]	French	Birth	15%	9%	-	-
M13[bc]	French	3 years	6%	15%	-	-
Bilingual						
B1	English	1 year	39%	6%	73	1
B2	French	2 years	32%	9%	100	6
B3	English	Birth	30%	20%	81	3
B4	English	2 years	24%	20%	83	4
B5	French	4 years	18%	31%	71	6
B6[c]	Spanish	Birth	36%	40%	99	6
B7[c]	French	Birth	42%	37%	60	3
B8[a]	Russian	Birth	79%	53%	-	-
B9[c]	Spanish	Birth	37%	45%	92	1
B10[bc]	French	Birth	34%	9%	59	1
B11[b]	French	Birth	50%	43%	65	2
B12[bc]	Spanish	Birth	20%	32%	97	2
B13[bc]	Spanish	Birth	46%	32%	<55	1

Note. ASD = autism spectrum disorders; L2 = non-dominant language; B = bilingual.
[a]For participant B8, L2 was not assessed because equivalent Russian measures were not available.
[b]Participants with language impairment.
[c]Participants had a history of exposure or a current exposure to a third language of less than 10%.

Results

Vocabulary

A *t*-test was conducted to examine receptive vocabulary scores in the participants' dominant language – either French or English; Spanish was never a dominant language. There were no outliers, as assessed by inspection of a boxplot. Vocabulary scores for each ASD group were normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$), and there was homogeneity of variances, as assessed by Levene's test ($p = .83$).

Results revealed that, although both groups performed within the average range (within 1 standard deviation of the test mean, $M = 100$, $SD = 15$) on the PPVT-4 or the EVIP, there was a trend towards significance with a medium to large effect size , $t(24) = 1.87$, $p = .074$, $d = .73$, where monolingual children with ASD exhibited higher scores ($M = 105$, $SD = 16.78$) compared to the bilingual children with ASD ($M = 93$, $SD = 16.82$). Boxplots are depicted in Figure 1.

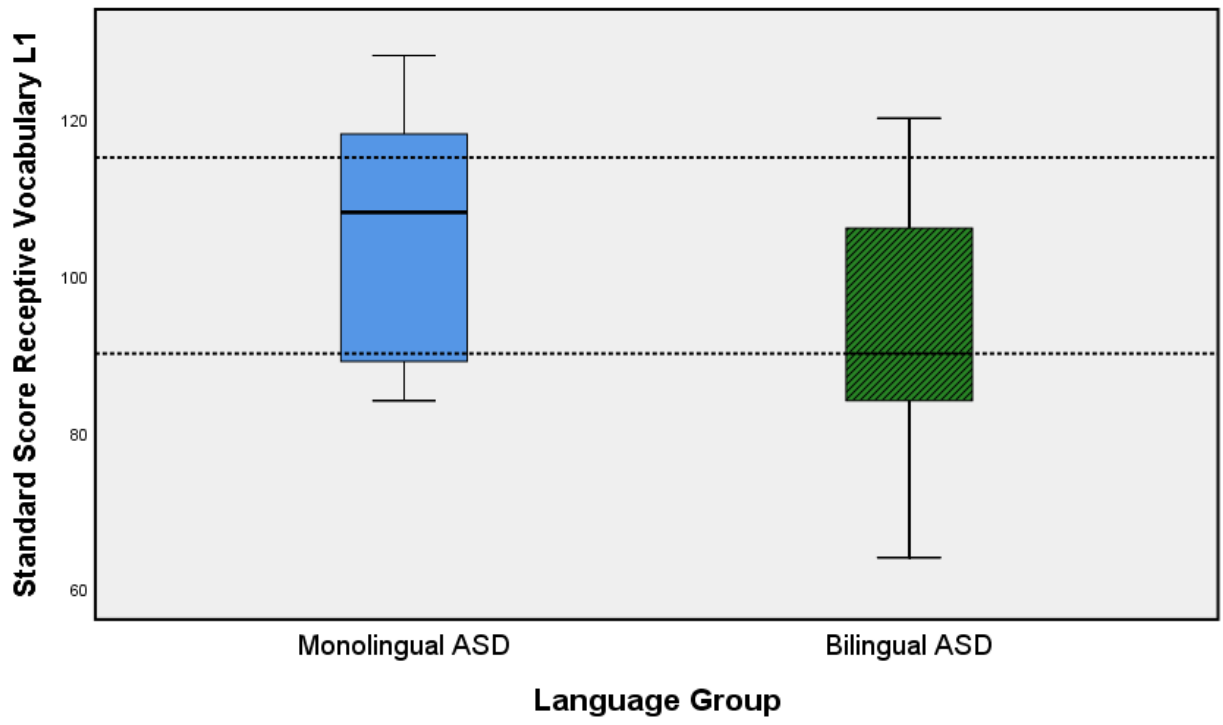

Figure 1. Boxplots of vocabulary scores from participants' dominant language by language group. ASD = Autism spectrum disorders; L1 = Dominant language. Dotted lines represent average range on standardized receptive vocabulary test.

Morphology

Concerning morphological skills, we conducted a *t*-test to examine whether scaled scores from the morphology subtest of the CELF (M = 10; SD = 3), in the dominant language, differed for the ASD groups depending on language status. The assumptions of normality, homogeneity of variance, and no outliers were met. Results showed no statistically significant differences between the monolingual (M = 8, SD = 3.12) and bilingual participants with ASD (M = 6, SD = 3.38), $t(24) = 1.39$, $p = .178$, $d = .54$, although there was a medium effect size. Results are presented in Figure 2.

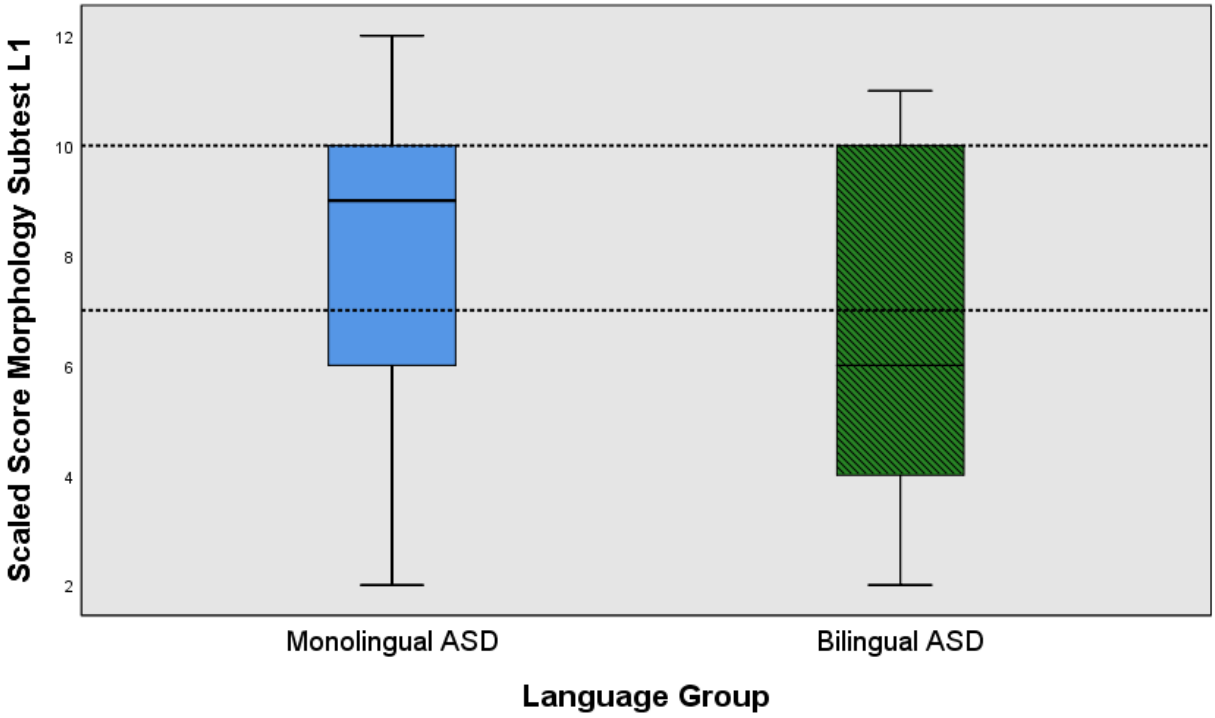

Figure 2. Boxplots of morphology scores from participants' dominant language by language group. ASD = Autism spectrum disorders; L1 = Dominant language. Dotted lines represent average range on scaled score of the CELF.

Discussion

In the current study, we extend prior findings demonstrating no additional language delay due to bilingualism in younger children with ASD (Hambly and Fombonne 2012; Ohashi et al. 2012; Peterson et al. 2012; Reetzke et al. 2015; Valicenti-McDermott et al. 2013), to school-aged bilingually proficient children with ASD who were directly assessed in both of their languages. Our bilingual participants performed in the average range (i.e., within 1 standard deviation of the population mean for the receptive vocabulary tests based on the tests norms) on a standardized receptive vocabulary test. However, they tended to score lower than their monolingual peers with ASD with a medium to large effect size (d = .73), replicating the pattern observed in typically-developing bilinguals at this age (Gathercole and Thomas 2009; Bialystok, Luk, Peets, and Yang 2010), given their reduced exposure to the language of testing. For instance, in a large sample of children (n = 1738), Bialystok and colleagues (2010) found that typically-developing bilingual children exposed to English and other languages (age range 3 to 10 years) scored consistently below their monolingual English peers at all ages on the PPVT. It is important to note that this reflects knowledge in only one of bilingual's two languages and does not reflect their *total* vocabulary. While total vocabulary can be assessed for toddlers and preschoolers by parental report on vocabulary checklists that are then summed for bilinguals' two languages, this method is more challenging for school-age children who have much more extensive vocabulary, and whose parents may not have knowledge of their child's vocabulary skills in one language that is

used primarily at school, for example.

Our findings differ from prior work on bilingualism in younger children (< 6 years) where differences were not found in the early language development of bilingual and monolinguals with ASD (e.g., Hambly and Fombonne 2012; Ohashi et al. 2012; Petersen et al. 2012; Valicenti-McDermott et al. 2013). Specifically, our results, in a small but very well-characterized sample of school-aged children with ASD, revealed a clear trend where monolinguals outperformed bilinguals on receptive vocabulary scores in the dominant language. These discrepant findings can be reconciled by taking into account the factors outlined in the introduction that set our study apart from prior work: the age of samples and complexity of language investigated, the methods employed to assess language, and how bilingualism was defined.

First, our participants were school-aged children between 5 to 10 years of age. While monolingual and bilingual children with ASD have been reported to reach very early language milestones, such as babbling (Valicenti-McDermott et al. 2012) and first words (Hambly and Fombonne 2012) at a similar age, more complex linguistic knowledge may depend more heavily on exposure to that language (Authors, 2018). Bilinguals' exposure to their L1 is reduced by definition, therefore it is expected (e.g., Bialystok et al. 2010) that some aspects of L1 knowledge will be reduced in bilinguals, when only one of their languages is considered, and depending on the amount of exposure to that language (e.g., Thordardottir, 2011). Second, we used direct assessment, whereas other studies (e.g., Hambly and Fombonne 2012) have used parent-report questionnaires. As discussed above, at school age parent-report may be less reliable, especially if one of the languages is not used in the home. Finally, we examined the abilities of *proficient bilinguals* as opposed to children who are *bilingually-exposed* by parent report alone. Therefore,

in our sample, compared to prior studies, there was greater difference in language use and experience (reflected in differences in amount of language exposure) between bilingual and monolingual groups.

We add to the literature on bilingualism in ASD an examination of expressive morphology skills measured at school age. We found that proficient bilinguals with ASD did not differ significantly from their monolingual peers, though the bilingual group tended to perform lower on this measure (i.e., slightly below the average range on a standardized morphological task in their dominant language). Although there was no statistically significant difference between bilinguals and monolinguals on the morphology subtest, monolinguals displayed higher scores than bilinguals with a medium effect size (d = .54), which may emerge as a significant difference in a larger sample. Yet, the overall pattern observed showed that the difference between monolinguals and bilinguals with ASD was less pronounced for morphology than vocabulary skills (d = .73).

Concerning performance in their non-dominant language/L2, shown descriptively in Table 4, some bilingual children with ASD scored within the average range on the standardized receptive vocabulary assessment whereas for morphology scores, most children scored below average. This is not surprising given that amount of exposure to the L2 was often one third of the time or less. These results highlight the central role amount of language exposure plays on language performance. For instance, Thordardottir (2011) found that for typically-developing 5-year-olds to perform within the average range on standardized expressive language tests, children needed to have more than 60% of exposure to that language. Children with ASD and LI had particular difficulty with morphology in both their dominant (Table 3) and especially non-dominant (Table 4) languages, as would be expected. Their receptive vocabulary was below the

average range for their dominant language and generally much lower for the non-dominant language. It is important to recall that the interpretation of bilingual children's language scores needs a careful consideration when using monolingual norms. Monolingual standards cannot be directly applied to bilingual children language performance given the strong relationship between amount of exposure and language skills (Authors, 2018; Thordardottir, 2011). For this reason, researchers have suggested different cut-offs when using standardized monolingual tests for the identification of language impairment in bilingual children (Thordardottir, 2015).

Conclusion

The present findings demonstrate that some children with ASD can become proficient bilinguals at school age. Our definition of proficient bilingual was very stringent: these children completed multiple receptive and expressive linguistic tasks in both of their languages and were able to communicate with others in both languages. These proficient bilingual children with ASD performed within the average range on a standardized test of receptive vocabulary in their dominant language. However, they tended to perform lower than monolingual children with ASD on receptive vocabulary, and to a lesser degree on morphology skills. Importantly, this pattern is consistent with findings for typically-developing bilingual children (Bialystok et al. 2010). In other work we show that vocabulary and morphology skills in children with ASD are significantly related to the amount of exposure they receive to that language (Authors, 2018).

Prior work indicates that bilingual exposure is not detrimental for early language development in children with autism. The current findings, against the background of other reports (e.g., Authors, 2018; in press), suggest that at school age, bilinguals with ASD follow similar language development patterns to bilinguals with typical development. Future studies should include larger samples of carefully matched bilingual children with ASD and track

multiple linguistic skills (e.g., phonology, syntax, and pragmatics, in addition to vocabulary and morphology) longitudinally.

Compliance with Ethical Standards

Conflict of Interests

The authors declare that they have no conflicts of interest.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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