This is the pre-peer reviewed version of the following article: [Gonzalez-Barrero, A.M., and Nadig, A. (2018). Bilingual children with autism spectrum disorders: The impact of amount of language exposure on vocabulary and morphological skills at school age]
Bilingual children with Autism Spectrum Disorders: The impact of amount of language exposure on vocabulary and morphological skills at school age

Ana Maria Gonzalez-Barrero and Aparna Nadig

1School of Communication Sciences and Disorders, McGill University, Montreal, Canada
2Centre for Research on Brain, Language, and Music (CRBLM), Montreal, Canada

Acknowledgments
We acknowledge the contributions of many research assistants with testing and data coding: Betsheba Ananng, Chloe Benson, Stefanie Cortina, Laura Khalil, Edwige Lafontune, Sarya Majdalani, Mrinalini Ramesh, Andrea Rezendes, Cynthia Santacroce, Marie-Hélène Tcheuffaka-Kamo, and Leah Terrini. Finally, we would like to thank the families who participated for their time and involvement.
Lay Summary

We studied typically-developing children and children with ASD living in a bilingual society who had varying exposure to French (ranging from bilinguals to monolinguals). We investigated the impact of amount of language exposure, nonverbal IQ, age, and working memory on their vocabulary and morphological skills. Current amount of language exposure was the strongest predictor of language skills, in both groups of children. Findings indicate that when provided with adequate opportunity, many children with ASD are capable of acquiring two languages.
ABSTRACT

Studies of bilingual children with Autism Spectrum Disorders (ASD) have focused on early language development using parent report measures. However, the effect of bilingualism on more complex linguistic abilities is unknown. In the current study we examined the impact of amount of language exposure on vocabulary and morphological skills in school-aged children with ASD who did not have intellectual disability. Forty-seven typically-developing children and 30 children with ASD with varying exposure to French participated in the study. Via regression analyses we investigated the impact of amount of language exposure, nonverbal IQ, age, and working memory on language abilities. Current amount of language exposure was the strongest predictor of language abilities for both typically-developing children and children with ASD. These findings highlight the central role amount of language exposure plays in vocabulary and morphological development for children with ASD, like other children. In addition, they provide further evidence that, when provided with adequate opportunity, many children with ASD are capable of acquiring two languages.

Keywords: Bilingualism, School-Age Children, Amount of Language Exposure, Autism Spectrum Disorder, Vocabulary, Morphology
Language Skills in Bilingual Children with ASD

Introduction

Imagine you speak one language at home but live somewhere where another language is used in public life. You have a child with an Autism Spectrum Disorder (ASD), which is often associated with language delays (Luyster, Kadlec, Carter, & Tager-Flusberg, 2008). Should you raise your child bilingually? Moreover, how much exposure to each language does your child need to have a good chance at developing optimal language skills? While we have solid evidence regarding the impact of bilingual exposure on typical language development (e.g. De Houwer, 2007; Hoff et al., 2012; Paradis & Genesee, 1996; Elin Thordardottir, 2011), less is known about the effects of bilingual exposure on children with neurodevelopmental disorders (Kay-Raining Bird, Genesee, & Verhoven, 2016; Uljarević, Katsos, Hudry, & Gibson, 2016). This is a question of growing clinical import, as families of children with neurodevelopmental disorders are often advised by professionals to restrict their language input to only one (typically the societally dominant) language (Hudry, Rumney, Pitt, Barbaro, & Vivanti, 2017; as reported by Jegatheesan, 2011; Kay-Raining Bird, Lamond, & Holden, 2012). This advice stems from the belief that bilingualism may be harmful for language acquisition in children with ASD (Kay-Raining Bird et al., 2012). Yet, the available evidence on language development in bilingual children with ASD demonstrates that, when appropriately matched for potential confounds, bilingual children with ASD do not lag behind their monolingual peers with ASD on early language milestones (for a comprehensive review see Drysdale, van der Meer, & Kagohara, 2015 and Kay-Raining Bird et al., 2016).

For the increasing number of families living in a bilingual context, the decision to raise children bilingually or not has significant repercussions. For instance, parents report that they are less at ease interacting in a non-native language (Hampton, Rabagliati, Sorace, & Fletcher-
Language Skills in Bilingual Children with ASD

Watson, 2017). Consequently, communicating in a less proficient language may impact the quantity of language input and the quality of interactions (e.g., parent-child synchrony and verbal expansions on child utterances; Hudry et al., 2017). This could be detrimental, as both the quantity and complexity of language input (e.g., Bang & Nadig, 2015) and the quality of parent-child interactions (Siller & Sigman, 2002) are important facilitators of language development. The current study examines the impact of amount of language exposure on the vocabulary and morphological skills of children with ASD growing up in a bilingual context, enabling evidence-informed decisions to be made by families and professionals.

**Amount of Language Exposure as a Predictor of Language Skills**

Multiple studies have investigated the relationship between amount of language exposure and language acquisition in typically-developing (TYP) monolingual and bilingual children (e.g., Elin Thordardottir, 2011; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Pearson, Fernandez, Lewedeg, & Oller, 1997). Overall, these studies have shown that amount of exposure to a language is closely related to both vocabulary and morphological skills in that language. For instance, in a large (n = 611) study with Welsh-English bilinguals and monolinguals, Gathercole and Thomas (2009) found that vocabulary scores of school-age bilingual children (age range 7;0 to 11;0) were highly correlated with the input they received in each language. Therefore, monolingual Welsh children (who had a greater amount of Welsh exposure) outperformed their bilingual counterparts on vocabulary. Similar findings with respect to vocabulary skills have been reported for multiple languages (e.g., Elin Thordardottir, Rothenberg, Rivard, & Naves, 2006; Umbel & Oller, 1994).

To date, only one study (Hambly & Fombonne, 2014) has examined the relationship between amount of language exposure and language skills in bilingual children with ASD. These
authors examined potential predictors of non-dominant language (L2) vocabulary in bilingually
exposed children with ASD (e.g., current language exposure; dominant language skills). Thirty-
three bilingually-exposed children (mean age 5;0) were included in the study, 23 of whom had
some expressive vocabulary in their L2. Results demonstrated that current amount of language
exposure accounted for more than 60% of the variance in L2 expressive vocabulary, highlighting
its crucial role. Although this is a logical relationship, it has often been assumed that children
with ASD cannot pick up two languages; this evidence suggests that they can, given adequate
exposure.

What amount of exposure can be considered “adequate”? This key question has been
investigated in TYP bilingual children. In a carefully designed study with 5-year old French-
English bilinguals, Elin Thordardottir (2011) established that when exposed to both of their
languages between 40% to 60% of the time, TYP bilingual children did not differ significantly
from their monolingual peers on receptive vocabulary. Yet, a higher amount of exposure (> 60%)
was required for bilingual children to exhibit comparable performance to monolingual children
in the expressive domain. We hypothesized that a similar pattern would hold for bilingual
children with ASD, that is, that they have better language outcomes with increasing amounts of
exposure to a language.

There are many ways amount of language exposure can be quantified (e.g., Bedore et al.,
2012). Research with TYP bilinguals has shown that current amount of language exposure is a
stronger predictor of language skills than lifetime exposure (Cohen, 2016) or age of first
exposure (Bedore et al., 2012). For children with ASD, Hambly and Fombonne (2014)
demonstrated that only current, but not lifetime L2 exposure was related to L2 expressive
vocabulary. Accordingly, we focus on current amount of language exposure in the present study,
though we also provide results using lifetime language exposure for comparison.

**Other Predictors of Language Skills**

We also examined the role of other potential predictors of language skills. Prior work has demonstrated positive relationships between nonverbal IQ (NVIQ) as well as chronological age and language skills in monolingual children with ASD (e.g., Anderson et al., 2007; Luyster, Lopez, & Lord, 2007). Similarly, working memory has been reported to be an important factor for language learning especially at school age (Gathercole, Tiffany, Briscoe, Thorn, & The ALSPAC team, 2004). Hence, we investigated the predictive value of these factors for the vocabulary and morphology skills of children with ASD. That is, what factors predict whether children with ASD become bilingual (within the limits of language impairment in some cases)? Are these factors similar or different to those important for language development in typically-developing children?

For this study we took advantage of the unique linguistic environment of Montreal to select a sample of children with ASD or with typical development who represented a full range of amount of exposure to French (from monolinguals who are exposed to French nearly all of the time, through a range of bilinguals, to speakers of English with minimal exposure to French). This allowed us to investigate the contribution of the predictors just mentioned to variation in the vocabulary and morphological skills of children with ASD for the first time.

**Methods**

**Participants**

Seventy-seven school-age children participated in this study, including 47 TYP participants (age range 5;1 to 8;11 years) and 30 participants with ASD (age range 4;11 to 10;10 years). The study was conducted in Montreal, Canada, a multicultural city where French is the
Language Skills in Bilingual Children with ASD

official language of the province, while both English and French are official languages of the
country, and there is a large immigrant population with 32% of the population reporting a first
language other than French or English (Statistics Canada, 2013). Participants were speakers of
one or more of the following languages: French, English, or Spanish (aside from one bilingual
ASD participant who was a speaker of French and Russian). Participants’ dominant language
was either French or English; this was determined by a combination of participants’ self-report,
parent report, and by the child’s history of language exposure (i.e., lifetime language exposure).
In Montreal there are separate French- and English-language school boards, but public education
involves significant French instruction as it is the official and majority language of the province.
As all participants were exposed to some amount of French, this language was used to
investigate effects of amount of language exposure. Participants’ current amount of exposure to
French (i.e., current exposure to a language in a typical week) ranged from 6% to 99%.

Participants with ASD were recruited from autism organizations, therapy clinics, schools,
and a database from previous studies. The ASD group included children who had NVIQ greater
than 80 and who did not have any medical conditions associated with ASD (e.g., Fragile X) or a
physical, visual or hearing impairment. Only verbal children were recruited, given the
communication demands of the study. However, some children with ASD had concomitant
language impairment (n = 8), reflecting the heterogeneity of language abilities in ASD
(Kjelgaard & Tager-Flusberg, 2001). Language impairment (LI) was determined based on low
performance (-1SD) on a sentence repetition subtest in the dominant language (recalling
sentences subtest from the Clinical Evaluation of Language Fundamentals in English: CELF-4;
Semel, Wiig, & Secord, 2006 or French: CELF CDN-F; Secord et al., 2009), along with parent
report of persistent language difficulties. Sentence repetition is considered an accurate marker for
For Peer Review

Language Skills in Bilingual Children with ASD

LI (Conti-Ramsden, Botting, & Faragher, 2001; Elin Thordardottir & Brandeker, 2013), with a
cutoff of -1SD showing adequate sensitivity and specificity for the identification of LI (Elin
Thordardottir et al., 2011).

Children with ASD had a formal clinical diagnosis obtained from multidisciplinary teams
at public hospitals or from licensed psychologists or psychiatrists, which was confirmed within
the study by administration of the Social Communication Questionnaire (SCQ; Rutter, Bailey, &
Lord, 2003). This is a 40-item parent-report questionnaire on social communication in early
development; a cut-off of 15 or higher is consistent with ASD.

Typically-developing participants were recruited through flyers and from a university
child research database. Inclusion criteria for the TYP group were the absence of learning,
language, or developmental disorders; absence of physical, visual or hearing impairments; and
absence of first- and second-degree family members diagnosed with ASD.

Demographic characteristics are presented in Table 1. As expected, SCQ scores were
significantly higher in the ASD group than in the TYP group, \( t(74) = -13.689, p < .001 \). While all
children were between 5 to 10 years old, the ASD group was significantly older on average.
NVIQ, maternal education and gender distribution did not differ significantly between groups.

Procedure

This study was part of a larger project examining the cognitive and linguistic abilities of
bilingual and monolingual children with ASD. Ethics approval was obtained from a university
Institutional Review Board, and parent consent as well as child assent were obtained prior to
testing. Monolingual participants were assessed in one session lasting approximately 2 hours, while bilingual participants completed two sessions approximately two weeks apart, one in their dominant language and one in their non-dominant language (aside from the one exception mentioned previously). Although data on language measures (e.g., PPVT-4, Dunn & Dunn, 2007; subtests of the CELF-4, Semel et al., 2006 in their English, French, or Spanish versions) was collected in both languages for bilingual children, to address our research question on amount of language exposure, only French language results are analyzed here.

Children were tested in a quiet research lab at a university or at the participants’ home. Parents were asked to fill out questionnaires concerning their child’s communication abilities and behaviours, including their lifetime language exposure (described in more detail below) and the child’s early social communication behaviors. Information on parental education (i.e., highest academic degree attained) was also gathered as a proxy for socio-economic status. Trained research assistants who were native speakers of each of the languages of interest (i.e., French, English, or Spanish) administered the tasks to the participants. Breaks and snacks were provided as needed during the assessment, and participants received a small gift at the end of each session as a token of appreciation for their participation.

**Predictor Variables.**

*Nonverbal IQ.* The Leiter-R (Roid & Miller, 1997) was used to examine nonverbal IQ (NVIQ). This nonverbal test can be used with children from different language backgrounds as well as with children who have developmental disabilities. Standard scores were used in analyses.

*Current amount and lifetime language exposure.* The Child Language Exposure Questionnaire (Authors, 2013; see Appendix) was employed to capture factors central to the
assessment of language background, as discussed in Elin Thordardottir et al. (2006) and Elin Thordardottir (2011), and on advice from an expert in bilingual language development (F. Genesee, personal communication, October 25, 2013). Trained research assistants conducted this approximately 15 minutes interview in person with the child’s parents. The questionnaire consisted of: 1) Questions about the child’s current language use in different contexts with respect to the languages of exposure, such as “What language(s) does the child use when speaking with friends?” and “In what language(s) does the child watch television?” 2) An estimate of the current total number of hours of exposure per week to each language was calculated. Parents reported the amount of exposure to each language per day during a typical weekday and the weekend, excluding hours when the child was asleep. Parents were encouraged to consider all settings when making these reports (e.g., home, school, sport classes, etc.). 3) Information concerning the child’s lifetime language exposure was gathered from birth until current age. Parents were asked about the child’s age of first exposure to each language along with questions concerning the child’s patterns of exposure year by year (e.g., from birth to 12 months, 1 to 2 years, etc.). A percentage of exposure per year was then calculated and an average across total years of life was obtained for each language. 4) The child’s current proficiency in each language was estimated by the parent on a 4-point scale (i.e., From 1 = Limited to 4 = Excellent), separately for listening and speaking skills. 5) Finally, parents were asked to report any relevant events concerning their child’s language exposure that was not previously mentioned (e.g., “switch from French/English to mostly English for speech therapy from age 4 onwards”).

Working memory. To examine phonological short-term and working memory skills, the number repetition subtest from the CELF was administered; dominant language results were
analyzed here. This test includes two tasks: first, children are asked to repeat verbatim a series of
numbers of increasing length (i.e., number repetition forward), a measure of short-term memory.
Afterwards, participants have to repeat backwards the numbers said by the experimenter (i.e.,
number repetition backwards), which is considered a measure of working memory (Engel de
Abreu, 2011). Scaled scores for number repetition backwards were entered in analyses.

**Outcome Variables.**

**Vocabulary.** Receptive vocabulary skills were examined via the Peabody Picture
Vocabulary Test in English (PPVT-4; Dunn & Dunn, 2007), French (Échelle de vocabulaire en
images Peabody - ÉVIP; Dunn, Thériault-Whalen, & Dunn, 1993), and Spanish (Test de
Vocabulario en Imagenes Peabody-TVIP; Dunn, Padilla, Lugo, & Dunn, 1986), as appropriate.
In this test the examiner names an object, action, or person and the participant is asked to select
the corresponding picture from an array of four options. Standard scores were used for analyses.

**Morphology.** The word structure subtest from the CELF-4 (Semel et al., 2006), and its
French (CELF CDN-F; Secord et al., 2009; 32 items) and Spanish versions (CELF 4 Spanish
Edition; Wiig et al., 2006; 29 items) were used to assess morphological skills. In this task, the
child is asked to complete sentences using a specific morphological form (e.g., prepositions,
plural, reflexive pronouns, etc.) prompted by the experimenter (e.g., “This is a book, here there
are two ____ ”). Raw scores are calculated (1 = correct response, 0 = incorrect response) and
then a scaled score can be derived based on the child’s age. The scaled score was used in
analyses.

**Results**

**Preliminary Analyses**
We conducted a Pearson’s correlation to examine the relation between current amount of lifetime language exposure (i.e. language exposure over lifetime) of language exposure. Results showed that these two variables were highly correlated \((r = .85)\). Given this fact, and to avoid multicollinearity in the multiple regressions later conducted, we ran two separate regressions to identify which of these variables was a better predictor of language skills. Results showed that in our data, current amount of language exposure had a stronger predictive value for vocabulary \((F(1,75) = 77.93, p < .001, R^2 = .51, R^2_{Adjusted} = .50)\) and morphology scores \((F(1,75) = 38.15, p < .001, R^2 = .34, R^2_{Adjusted} = .33)\) than lifetime language exposure (vocabulary, \(F(1,75) = 38.64, p < .001, R^2 = .34, R^2_{Adjusted} = .33\); morphology, \(F(1,75) = 20.00, p < .001, R^2 = .21, R^2_{Adjusted} = .20\)). Accordingly, current amount of language exposure was used in further analyses.

To investigate the relation between amount of language exposure and language proficiency, Pearson’s correlations were first conducted between current amount of language exposure and scores from the two standardized language tests. In addition, multiple regression analyses were performed to examine the contribution of amount of language exposure, chronological age, NVIQ, working memory, and diagnosis to vocabulary and morphological skills.

**Vocabulary**

*Correlation analysis.* A Pearson’s correlation was run to assess the relation between current amount of language exposure and receptive vocabulary, as measured by the EVIP standard score, for each diagnostic group (i.e., TYP and ASD). Results revealed that, as expected, there was a strong positive correlation between these two variables for TYP children, \(r(45) = .70, p < .001\). Similarly, the Pearson’s correlation for the ASD group showed a strong significant correlation between current amount of language exposure and EVIP standard scores,
Language Skills in Bilingual Children with ASD

$r(28) = .74, p < .001$. To examine whether these two correlations were significantly different in TYP children and in ASD, a Fisher’s z-transformation was calculated. Results showed that the two correlations were not significantly different from each other ($p = .73$). Figure 1 shows a scatterplot of EVIP scores and current amount of language exposure.

---

**Regression analysis.** To investigate the strongest predictors of vocabulary in TYP children and in children with ASD who have different amounts of language exposure to French, a multiple linear regression was conducted using the *enter* method. The predictors were: current amount of language exposure (percentage of current exposure to French), chronological age, NVIQ (standard score from the Leiter-R), working memory (scaled score from the CELF number repetition backwards subtest), and diagnosis (TYP or ASD). The assumptions of multiple regression were evaluated. There was linearity as assessed by a plot of studentized residuals against the predicted values and by partial regression plots. A Durbin-Watson test statistic of 2.09 showed independence of residuals. In addition, other assumptions required for multiple regression (e.g., no multicollinearity, normality, homoscedasticity, etc.) were met.

The full model explained a significant amount of variance, $F(5, 71) = 36.971, p < .001$, $R^2 = .722$, $R^2_{\text{Adjusted}} = .703$. The analysis revealed that current amount of language exposure, working memory, and diagnosis were all significant predictors of vocabulary, $p < .05$. The strongest predictor was current amount of language exposure, which accounted for 62% of the variance in vocabulary skills. Diagnostic group had a significant negative weight in this model, indicating that, after accounting for the other variables, children with ASD performed lower on
vocabulary, relative to TYP children. NVIQ did not significantly predict vocabulary. Regression coefficients can be found in Table 2. The same model was run excluding children with ASD who had LI (n = 8). The pattern of significant results was parallel to those reported when children with ASD who had LI were included.

Morphology

Correlation analysis. A Pearson’s correlation was conducted to examine the relation between current amount of exposure to French and morphology scores (CELF-4 word structure subtest) for each diagnostic group. A significant correlation was found between current amount of language exposure for TYP children, \( r(45) = .55, p < .001 \), as well as for children with ASD, \( r(28) = .58, p = .001 \). After a Fisher’s z-transformation was computed to compare these correlations, results revealed that correlations for TYP children and children with ASD were not significantly different (\( p = .86 \)). Figure 2 is a scatterplot of the relation between morphology scores and current amount of language exposure.

Regression analysis. A multiple regression analysis using the method enter was conducted to investigate which factors (as above for vocabulary) predicted variation in morphology scores. The assumptions of multiple regression were assessed and met. Results showed that there was linearity, independence of residuals (Durwin-Watson = 1.7), as well as
homoscedasticity as assessed by visual inspection of a plot of studentized residuals versus unstandardized predicted values. There was also absence of multicollinearity, as assessed by tolerance values greater than 0.1, absence of outliers as well as absence of highly influential points, and no leverage values greater than 0.2. Finally, the assumption of normality was met as assessed by a Q-Q Plot.

The model explained a significant amount of the variance in morphology scores, $F(5,71) = 22.274, p < .001, R^2 = .611, R^2_{Adjusted} = .583$. The analysis demonstrated further that current exposure, age, working memory, and diagnostic group were all significant predictors of the morphology scores, $p < .05$. NVIQ was not a significant predictor. Similar to the results for vocabulary skills, current amount of language exposure was the strongest predictor of morphological abilities, accounting for 49% of the variance in the model. Diagnostic group was a significant negative predictor, indicating once again that children in the ASD group performed lower than those in the TYP group. Regression coefficients are presented in Table 3. Once again, the same model was run excluding children with ASD who had LI ($n = 8$). The pattern of significant results was parallel to those reported when children with ASD who had LI were included.

---

Insert Table 3 about here

---

Discussion

In this study we directly assessed vocabulary and morphological skills in bilingual school age children with ASD, whereas most research on bilingual children with ASD has studied early childhood with parent-report measures. Results demonstrated that current amount of language
exposure was the strongest positive predictor of receptive vocabulary and expressive morphological skills in French for TYP children as well as for children with ASD. In addition, working memory and diagnostic group were significant predictors of both vocabulary and morphology skills, while age was a significant predictor of morphology only. These findings corroborate those reported by Hambly and Fombonne (2014) demonstrating the important relation between amount of language exposure and language proficiency in children with ASD.

Furthermore, they support the claim that vocabulary is highly dependent on amount of language exposure (Hart & Risley, 1992; Hoff et al., 2012; Huttenlocher et al., 1991; Pearson et al., 1997; Elin Thordardottir, 2011), while at school age children’s internal characteristics, such as maturation, are also important for the development of morphological skills (Paradis, 2011).

Interestingly, we found a similar strength of correlation between amount of language exposure and both vocabulary and morphological skills across TYP children and children with ASD. In addition, it was observed (see Figure 1) that after reaching 40% of exposure to French, most children with ASD tended to perform at or above the average range on receptive vocabulary. However, to perform in the average range on the CELF morphology subtest (see Figure 2), children with ASD needed approximately 60% of current amount of exposure to French. These results are similar to those reported for TYP bilingual children (e.g., Elin Thordardottir, 2011). This preliminary observation deserves further investigation with larger sample sizes to establish the amount of language exposure required for the ASD group to perform within the average range on language measures, as this has clinical implications. For instance, if a bilingual child with ASD has levels of exposure that are expected to develop functional proficiency in his or her non-dominant language and still is not able to communicate in that language, further investigations might be conducted to explore other factors (e.g.,
Language Skills in Bilingual Children with ASD

presence of LI, lack of identification with the language, etc.) that impede development of the non-dominant language.

Returning to our initial question, can children with ASD become bilingual? Our findings suggest that some children with ASD are able to understand and proficiently use two languages, although crucially their abilities will depend on the amount of language exposure they receive in each of their languages, as well as whether or not they have concurrent language impairment. Taken together with prior findings, our results argue that there is no reason to avoid bilingual language exposure for fear it is detrimental. In fact, there are additional reasons to promote bilingual language exposure for children with ASD growing up in bilingual societies. Early parent-child interaction positively influences children with ASD’s communication skills later in life (Siller & Sigman, 2002). It is important that parents are able to provide optimal language interactions to their children in a language they feel most comfortable in (Hudry et al., 2017). In addition, the number of languages a person speaks is an important factor for educational and career opportunities later in life. Accordingly, the longer-term implications of deciding for or against bilingual exposure should be given appropriate consideration.

Nonetheless, it is important to highlight that not all children with ASD who were exposed to two languages at some point in life became proficient bilinguals. One contributing factor is discontinuity in the amount of language exposure, e.g., decisions to limit language input to one language only, after the child had been bilingually-exposed earlier in life. It is possible that this decision, in the name of protecting language development in children who have challenges, may inadvertently hinder the attainment of L2 proficiency which would otherwise have been possible. However, amount of language exposure is clearly not the only factor at play: Some bilingually-exposed children with ASD had histories of language exposure of almost 40% to an L2, yet they
were not able to communicate in that language. In contrast, some children who had exposures of only 30% to an L2 over their lifetime were proficient bilinguals and could maintain a conversation in this language. These results reveal the heterogeneity of language outcomes for bilingually exposed children with ASD. More research is needed to understand the specific factors, beyond language exposure, that lead to proficient bilingualism in children with ASD.

An imperative area for future work is developing bilingual education and treatment options for children with neurodevelopmental conditions (Kay-Raining Bird et al., 2016). A recent international study indicates that many child development professionals in fact hold favorable opinions of bilingual language exposure for children with developmental disorders (Marinova-Todd et al., 2016), but cite lack of bilingual educational programs or treatment options as obstacles to putting this into practice. The development and provision of bilingual educational and treatment options for children with neurodevelopmental disorders will be critical to opening the door to “ideal” bilingual input conditions (e.g., 40-60% exposure to each language).

Limitations

Although this study provides new insight into the role current amount of language exposure plays in the language proficiency of children with ASD, our findings need to be interpreted with respect to the characteristics of our sample and their bilingual context. Accordingly, generalization is limited to children with ASD who do not have intellectual disability, and who live in a context in which bilingualism is highly valued and supported. Preliminary data indicates that intellectual disability does not prevent children with ASD from acquiring a second language (Hambly & Fombonne, 2014), but more research is needed on this question. Furthermore, while the age range of participants in this study is narrower than that used
in other studies that have examined language skills in ASD (e.g., 4 to 14 years-olds, Kjelgaard & Tager-Flusberg, 2001), it still spanned a number of years (5 to 10) where the attainment of language skills may differ. We addressed this by using standardized tests, which account for the child’s age, and chronological age was also included in our regression models as a predictor. Finally, other language skills such as phonology and syntax need to be studied in bilingual children with ASD. Future work should overcome these limitations by elucidating the characteristics and contexts that impact bilingual language development in children with ASD.

**Conclusion**

We found that current amount of language exposure was the strongest predictor of vocabulary and morphology skills in school-age children with ASD who did not have intellectual disability. What are the implications of these findings for children with ASD who are growing up in bilingual environments? They show that many children with ASD who do not have intellectual disability can function proficiently in two languages when provided with optimal opportunities to do so (e.g., approximately 40-60 % exposure to have language skills in the average range). This provides strong counter-evidence to the blanket view that children with ASD should be exposed to one language only. We argue that there are a number of important reasons (e.g., quality of input they receive, ease of social interaction, access to vocational opportunities) to promote both languages of children with ASD, particularly when children live in bilingual families or societies. Future work will need to clarify how these finding generalize to other contexts of bilingualism (e.g., where a home language is not an official language in broader society), as well as to the full spectrum of children with ASD, including those with intellectual disability.
References


Authors (2013). *The Child Language Exposure Questionnaire*. 


Language Skills in Bilingual Children with ASD

spectrum disorders. *International Journal of Language & Communication Disorders, 47*, 52-64.


### Table 1

**Demographic Characteristics of Participants by Diagnostic Group**

<table>
<thead>
<tr>
<th>Variable</th>
<th>TYP Group</th>
<th></th>
<th>ASD Group</th>
<th></th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 47)</td>
<td>M (SD)</td>
<td>(n = 30)</td>
<td>M (SD)</td>
<td></td>
</tr>
<tr>
<td>SCQ</td>
<td>4 (3.05)</td>
<td>20 (5.96)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronological age in months</td>
<td>85 (13.62)</td>
<td>94 (17.53)</td>
<td>.015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NVIQ</td>
<td>111 (10.78)</td>
<td>110 (12.13)</td>
<td>.578</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal education in years</td>
<td>16 (2.03)</td>
<td>15 (2.53)</td>
<td>.160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>35 Male</td>
<td>27 Male</td>
<td>.093</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 Females</td>
<td>3 Female</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. TYP = typically-developing group; ASD = autism spectrum disorders; NVIQ = nonverbal IQ; SCQ = Social Communication Questionnaire.*

### Table 2

**Summary of Multiple Regression Analysis for Vocabulary Skills**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE&lt;sub&gt;<em>B</em>&lt;/sub&gt;</th>
<th>Beta</th>
<th>t</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>14.45</td>
<td>18.36</td>
<td>.79</td>
<td>.434</td>
<td></td>
</tr>
<tr>
<td>Current exposure</td>
<td>.61</td>
<td>.06</td>
<td>.62</td>
<td>9.62</td>
<td>.000</td>
</tr>
<tr>
<td>Chronological age</td>
<td>.20</td>
<td>.11</td>
<td>.12</td>
<td>1.80</td>
<td>.076</td>
</tr>
<tr>
<td>NVIQ</td>
<td>.22</td>
<td>.15</td>
<td>.09</td>
<td>1.40</td>
<td>.166</td>
</tr>
<tr>
<td>Working memory</td>
<td>1.88</td>
<td>.66</td>
<td>.20</td>
<td>2.84</td>
<td>.006</td>
</tr>
<tr>
<td>Diagnostic group</td>
<td>-19.00</td>
<td>3.70</td>
<td>-.35</td>
<td>-5.14</td>
<td>.000</td>
</tr>
</tbody>
</table>

*Note. B = unstandardized regression coefficient; SE<sub>_B_</sub> = standard error of the coefficient; Beta = standardized coefficient; NVIQ = nonverbal IQ.*
**Table 3**

*Summary of Multiple Regression Analysis for Morphological Skills*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE_{B}</th>
<th>Beta</th>
<th>t</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-7.71</td>
<td>3.22</td>
<td>-2.40</td>
<td>6.46</td>
<td>0.000</td>
</tr>
<tr>
<td>Current exposure</td>
<td>0.07</td>
<td>0.01</td>
<td>0.49</td>
<td>6.46</td>
<td>0.000</td>
</tr>
<tr>
<td>Chronological age</td>
<td>0.06</td>
<td>0.02</td>
<td>0.23</td>
<td>2.91</td>
<td>0.005</td>
</tr>
<tr>
<td>NVIQ</td>
<td>0.03</td>
<td>0.03</td>
<td>0.09</td>
<td>1.21</td>
<td>0.230</td>
</tr>
<tr>
<td>Working memory</td>
<td>0.37</td>
<td>0.12</td>
<td>0.26</td>
<td>3.21</td>
<td>0.002</td>
</tr>
<tr>
<td>Diagnostic group</td>
<td>-2.62</td>
<td>0.65</td>
<td>-0.33</td>
<td>-4.04</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Note.* B = unstandardized regression coefficient; SE_{B} = standard error of the coefficient; Beta = standardized coefficient; NVIQ = nonverbal IQ.
Language Skills in Bilingual Children with ASD

**Figure Legends**

*Figure 1.* Scatterplots for amount of language exposure and vocabulary scores. EVIP = Échelle de vocabulaire en images Peabody; TYP = typically-developing group; ASD = autism spectrum disorder group; ASD+LI = participants with autism spectrum disorders and concomitant language impairment (included for illustrative purposes, not a separate group in analyses). Regression lines are plotted separately for each subgroup of participants. They show the positive relationship between current amount of language exposure and vocabulary in typically-developing children and children with ASD who do not have language impairment. Dotted lines represent average range of performance on EVIP.

*Figure 2.* Scatterplots for amount of language exposure and performance on the CELF. CELF = Clinical Evaluation of Language Fundamentals; TYP: typically-developing group; ASD = autism spectrum disorder group; ASD+LI = participants with autism spectrum disorders and concomitant language impairment (included for illustrative purposes, not a separate group in analyses). Regression lines are plotted separately for each subgroup of participants. They show the positive relationship between current amount of language exposure and morphological skills in typically-developing children and children with ASD who do not have language impairment. Dotted lines represent average range of performance on the CELF.
Figures

Figure 1

![Figure 1](image1)

Figure 2

![Figure 2](image2)
Appendix

The Child Language Exposure Questionnaire

Child ID: ______________ Gender: M ___ F ___ Language exposure: Monolingual ___ Bilingual ___
D.O.B: ___________________________ Age: __________________ Date of testing: _____________

<table>
<thead>
<tr>
<th>Child’s Current Language Use</th>
<th>Language 1</th>
<th>Language 2</th>
<th>Language 3</th>
<th>Language 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What language or languages are spoken at home?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. What language(s) does the mother use to communicate with the child?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. What language(s) does the father use to communicate with the child?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. What language(s) do the siblings use to communicate with the child?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. If the child lives with other relatives, what language(s) is (are) used for them to communicate with the child?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. What language(s) does the child use when speaking with friends?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. What language(s) are spoken at school?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. In what language(s) does the child watch television?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. In what language(s) does the child listen to music?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. In what language(s) does the child play videogames (Ipad, Wii, etc.)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. If you read books to your child, in which language(s)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. If your child reads books, in which languages he/she reads?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please fill out the following information:

13. How often do you read to your child (times per week)?
14. Please estimate how often your child currently hears each language per week (from Monday to Sunday), including all settings (home, school/daycare, and other activities). Do not include the hours when the child is asleep.

<table>
<thead>
<tr>
<th>Total hours per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language 1</td>
</tr>
</tbody>
</table>

15. At what age was your child first exposed regularly to the language(s) he/she speaks?

**Birth – 1st year**

16. If your child attended daycare at this age, which language(s) was used in the daycare?

17. What language(s) was used at home at this age?

18. Could you estimate how often your child heard each language per week, including all settings (such as home, relatives, and daycare)? For example, 70% of the time English, 30% of the time French.

**1st – 2nd year**

19. If your child attended daycare at this age, which language(s) was used in the daycare?

20. What language(s) was used at home at this age?

21. Could you estimate how often your child heard each language per week, including all settings (such as home, relatives, and daycare)? For example, 70% of the time English, 30% of the time French.

**2nd – 3rd year**

22. If your child attended daycare at this age, which language(s) was used in the daycare?

23. What language(s) was used at home at this age?

24. Could you estimate how often your child heard each language per week, including all settings (such as home, relatives, and daycare)? For example, 70% of the time English, 30% of the time French.
<table>
<thead>
<tr>
<th>Year Range</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd – 4th year</td>
<td>25. If your child attended daycare at this age, which language(s) was used in the daycare? 26. What language(s) was used at home at this age? 27. Could you estimate how often your child heard each language per week, including all settings (such as home, relatives, and daycare)? For example, 70% of the time English, 30% of the time French.</td>
</tr>
<tr>
<td>4th – 5th year</td>
<td>28. If your child attended daycare at this age, which language(s) was used in the daycare? 29. What language(s) was used at home at this age? 30. Could you estimate how often your child heard each language per week, including all settings (such as home, relatives, and daycare)? For example, 70% of the time English, 30% of the time French.</td>
</tr>
<tr>
<td>5th – 6th year</td>
<td>31. If your child attended daycare at this age, which language(s) was used in the daycare? 32. What language(s) was used at home at this age? 33. Could you estimate how often your child heard each language per week, including all settings (such as home, relatives, and daycare)? For example, 70% of the time English, 30% of the time French.</td>
</tr>
<tr>
<td>6th – 7th year</td>
<td>34. If your child attended daycare at this age, which language(s) was used in the daycare? 35. What language(s) was used at home at this age?</td>
</tr>
<tr>
<td>Question</td>
<td>Response Options</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>36. Could you estimate how often your child heard each language per week, including all settings (such as home, relatives, and daycare)? For example, 70% of the time English, 30% of the time French.</td>
<td></td>
</tr>
<tr>
<td>7th–8th year</td>
<td></td>
</tr>
<tr>
<td>37. If your child attended daycare at this age, which language(s) was used in the daycare?</td>
<td></td>
</tr>
<tr>
<td>38. What language(s) was used at home at this age?</td>
<td></td>
</tr>
<tr>
<td>39. Could you estimate how often your child heard each language per week, including all settings (such as home, relatives, and daycare)? For example, 70% of the time English, 30% of the time French.</td>
<td></td>
</tr>
</tbody>
</table>

**Child’s Current Language Proficiency**

Please rate your child’s proficiency in each language he/she speaks:

Language 1: ____________________

<table>
<thead>
<tr>
<th>Speaking</th>
<th>Excellent ___</th>
<th>Good ___</th>
<th>Gets by ___</th>
<th>Limited ___</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Language 2: ____________________

<table>
<thead>
<tr>
<th>Speaking</th>
<th>Excellent ___</th>
<th>Good ___</th>
<th>Gets by ___</th>
<th>Limited ___</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Language 3: ____________________

<table>
<thead>
<tr>
<th>Speaking</th>
<th>Excellent ___</th>
<th>Good ___</th>
<th>Gets by ___</th>
<th>Limited ___</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Language 4: ____________________

<table>
<thead>
<tr>
<th>Speaking</th>
<th>Excellent ___</th>
<th>Good ___</th>
<th>Gets by ___</th>
<th>Limited ___</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>