Journal of Autism and Developmental Disorders (2020) 50:4433–4448
https://doi.org/10.1007/s10803-020-04501-8

ORIGINAL PAPER

Bilingualism in School-Aged Children with ASD: A Pilot Study

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Published online: 18 April 2020

Abstract
Preschool-aged bilingual children with autism spectrum disorder (ASD) can keep pace with their monolingual peers with ASD. However, can older children with ASD continue to do so as language demands become greater? Also, can they reach language levels similar to those of neurotypically developing (ND) bilingual children? The current study compares the language abilities of 3 school-aged bilingual children with ASD to those of 2 monolingual peers, and 19 ND bilingual and 12 ND monolingual peers. Using cluster analyses, we found that bilingual children with ASD had similar language to those of monolingual children with ASD and neurotypically developing bilingual and monolingual children. Results suggest that bilingual children with ASD can keep pace with their peers with similar intellectual abilities.

Keywords Autism spectrum disorder (ASD) · Bilingualism · Language development · School-age

Introduction

"Can I speak to my child in my native language?" This question is often asked by parents of children with developmental disabilities, including autism spectrum disorder (ASD), when there is a mismatch between parents' native language and the language used in the broader community. Unfortunately, many of these parents are advised to avoid using their minority language with their child (Kremer-Sadlik 2005). The rational for such recommendations may stem from the belief that using two languages will increase language delays in children with ASD, or that using two languages will confuse children (Kremer-Sadlik 2005; Yu 2013, 2016). Such recommendations run counter to research examining bilingual language development in neurotypically developing (ND) children (for review, see Beauchamp and MacLeod 2017; Hammer et al. 2014) and most recently have been shown to be unfounded with regards to children with ASD (Hambly and Fombonne 2012; Ohashi et al. 2012; Peterson et al. 2012). These types of recommendations can also have negative implications for children with ASD and their families, such as limiting children's opportunities to communicate with others, including family members, and limiting children's participation in their cultural community (Yu 2013). Even in the face of emerging evidence indicating that children with ASD can acquire more than one language (Hambly and Fombonne 2012; Ohashi et al. 2012; Peterson et al. 2012), the belief that two languages may hamper children's development persists (Yu 2013, 2016). Given such conflicts, along with the ramifications that may ensue when children do not speak their parents' language, it is important to better understand the language development of bilingual children with ASD and to build the body of evidence examining bilingual language development in these children. The following paragraphs will review research on bilingual language development among ND children. This will be followed by a review of the currently available research on bilingualism in children with ASD, as well as the identification of gaps in the current literature.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10803-020-04501-8) contains supplementary material, which is available to authorized users.

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Bilingualism in Neurotypically Developing Children

Bilingualism is a continuum of abilities, with at one end, speakers who are able to produce a few utterances in a language and, at the other end, speakers who are fully proficient in both of their languages (Grosjean 1993). Factors such as age of first exposure (AoE), amount of language exposure, a language's status within the broader community, and family use all contribute to varying degrees to language proficiency in bilingual individuals (Pearson 2007). Many ND toddlers and preschool-aged simultaneous bilingual children (children exposed to their two languages prior to the age of three-years, Thordardottir 2011) are able reach monolingual-like levels of proficiency in at least one, if not both of their languages. This is true for vocabulary size (MacLeod et al. 2013; Pearson et al. 1997; Thordardottir 2011), mean length of utterance (MLU; Paradis and Genessee 1996; Thordardottir 2015) and expressive morphology (Bedore et al. 2012; Thordardottir 2015). School-aged simultaneous and sequential bilingual children (those who we exposed to their second language after the age of three years, Thordardottir 2011) can also attain levels of vocabulary and grammatical knowledge similar to those of their monolingual peers, in at least one of their languages (Gathercole 2007; MacLeod et al. 2017; Thordardottir 2019; Unsworth 2016). Bilingual children may also have stronger metalinguistic abilities when compared to monolingual children (Bialystok et al. 2014).

Despite being able to reach similar levels of proficiency to those of their monolingual peers, bilinguals should not be viewed as two monolinguals within a single person. They may show language development patterns that differ from those of their monolingual peers. For example, bilingual children can have a receptive-expressive gap, such that receptive language abilities are stronger than their expressive language abilities (Gibson et al. 2012; Thordardottir 2011). This relative strength in receptive language has been reported in children from various language backgrounds including, English–Spanish simultaneous and sequential bilinguals in the USA (Gibson et al. 2012) and in French–English simultaneous bilinguals in Canada (Thordardottir 2011). Additionally, such gaps have been reported across language domains such as grammar (Thordardottir 2011), vocabulary, (Gibson et al. 2012; Thordardottir 2011) and semantics (Gibson et al. 2014). Bilingual children also tend to make more errors in their correct use of grammatical markers (Goldberg et al. 2008; Paradis et al. 2008), which can be influenced by their first language (Zdorenko and Paradis 2008). There is also evidence that bilingual children have smaller lexicon (Gollan et al. 2007) in each of their languages when compared to monolinguals.

A number of factors influence bilinguals' language abilities, including the amount of exposure received in each language. With as little as 20% exposure to a language, bilingual toddlers are able to use that language spontaneously (Pearson et al. 1997). For preschool-aged children, receiving approximately 40–60% exposure to a language appears to be sufficient to enable them to reach monolingual-like levels of proficiency on most language measures (Thordardottir 2011). However, there are large amounts of variability in the amount of exposure that children require to reach language levels similar to those of their monolingual peers. For school-aged simultaneous bilingual children, the picture is even less clear. Few studies have examined language development in bilingual school-aged children, and fewer still have directly examined the influence of exposure on language abilities solely in those who are simultaneous bilinguals. It may be the case that exposure and language abilities continue to be closely related (Thordardottir 2019). That said, factors beyond exposure may play an important role in their ultimate levels of proficiency, and some children may require smaller amounts of exposure (Beauchamp et al. in preparation). Indeed, the amount of exposure that children receive reflects only one part of their overall language experience (Carrol 2017; Pearson 2007). Factors such as daily exposure to both languages, language of schooling, family use, sociolinguistic standing, and improved metalinguistic awareness may mediate the amount of exposure that children require, especially as they get older (Bialystok and Barac 2012; Bialystok et al. 2014; Cummins 2008; MacLeod et al. 2013; Pearson 2007).

Bilingual Language Development in Children with ASD

Research examining bilingual language development in children with a developmental language disorder (DLD; Paradis et al. 2003; Samaleh et al. 2004) or Down syndrome (Burgoyne et al. 2016; Kay-Raining Bird et al. 2005; Trudeau et al. 2011) has shown that bilingualism does not inherently impede language development. Nevertheless, it has been suggested that deficits specific to ASD, particular in the area of social abilities (i.e., deficits in the ability to attend to others and in joint attention), would make it difficult for children with ASD to become bilingual (for example, see the hypothesis in Hambly and Fombonne, 2012). However, to date most research findings do not appear to support this hypothesis.

First, the development of vocabulary appears to be similar in bilingual and monolingual children with ASD of similar cognitive levels (Hambly and Fombonne 2012; Peterson et al. 2012). Notably, bilingual and monolingual children with ASD produce their first word and their first phrase at

approximately the same age (Hambly and Fombonne 2012; Ohashi et al. 2012). And by preschool age, bilingual and monolingual children with ASD are reported to have similar vocabulary size (Peterson et al. 2012). However, when compared to their ND bilingual peers, preschool and school-aged bilingual children with ASD may have weaker receptive vocabularies, (Gonzalez-Barrero and Nadig 2018) even in the presence of similar cognitive abilities.

Next, bilingual and monolingual individuals with ASD across a wide range of ages seem to perform similarly on measures of expressive and receptive language abilities (Hambly and Fombonne 2012; Kay-Raining Bird et al. 2012; Ohashi et al. 2012; Valicenti-McDermott et al. 2013). In a recent large-scaled study, Dai et al. (2018) examined receptive and expressive language scores of toddlers with either ASD, a global developmental delay, or a DLD. While group differences were reported along diagnostic lines, bilingual toddlers in all three groups obtained scores on language measures similar to those of their monolingual peers in the same diagnostic group. In their study of Hindi-English bilingual children with ASD (4- to 10-years-old), Sen and Geetha (2011) found that bilingual children with ASD performed as well as their monolingual peers in both Hindi and English. However, in their study, Gonzalez-Barrero and Nadig (2018) found that in children of preschool and school age, an ASD diagnosis negatively predicted children's performances on an expressive morphology task when compared to their ND peers. Again, it appears that while bilingual children with ASD may have similar performances to those of monolingual children with ASD, they lag behind their ND bilingual peers.

As in ND children, age of exposure and amount of language exposure may also influence the language development of bilingual children with ASD. Indeed, Hambly and Fombonne (2012) found that preschool and early school-aged children with ASD who were exposed to their two languages before the age of 12 months (simultaneous bilinguals) had similar performances to those of their monolingual peers with ASD. In contrast, children who had been exposed to their second language later in childhood (sequential bilinguals) lagged behind, although these differences were not statistically significant. For their part, Gonzalez-Barrero and Nadig (2018) found that the amount of exposure to French that children received was related to performances on a task of expressive morphology and receptive vocabulary in French. That is, bilingual children, both ND and with ASD, who received more exposure to French tended to have better scores on language measures than peers with less exposure to French.

In a recent meta-analysis, Lund et al. (2017) examined findings from seven studies investigating the influence of bilingualism on various aspects of language in children with ASD. Finding indicated that, for the most part, bilingual children with ASD developed structural language abilities similar to those of their monolingual peers with ASD, and differences found between the bilingual and monolingual groups were fairly small. Overall, these findings are commensurate with those from research on bilingual language development in children with other developmental disabilities, such as Down syndrome (Burgoyne et al. 2016) and DLDs (Paradis et al. 2003), and suggest that children with ASD can acquire two languages. Thus, bilingualism does not impede their language development, at least not when compared to other children with ASD. Additionally, bilingual children with ASD may benefit from their bilingual upbringing. Specifically, findings suggest that bilingual children with ASD may develop stronger overall social skills than those of their monolingual peers with ASD (Hambly and Fombonne 2012) and stronger precursors to communication (Valicenti-McDermott et al. 2013). These findings are especially encouraging given the deficits that individuals with ASD present in the domain of social communication.

While research at the intersection of bilingualism and ASD has taken off in the past decade, and findings are encouraging for bilingual families, the above studies have some limitations. First, most studies have examined the language abilities of young children with ASD (toddlers and preschool aged children). Although some studies have included school-aged children in their sample (Gonzalez-Barrero and Nadig 2018; Hambly and Fombonne 2012; Kay-Raining Bird et al. 2012; Sen and Geetha 2011) their groups also included preschool-aged children (which in Québec is up to 6-years-old). To our knowledge, an important gap remains, as no study has examined the language abilities of bilingual school-aged children with ASD exclusively. This is important because, as children become older, the changing language demands could make it more challenging for bilingual children with ASD to keep pace with their monolingual peers. Additionally, most studies, with the exception of Sen and Geetha (2011), have only examined the language abilities of bilingual children in one of their languages and it is often unclear whether or not children were assessed in their strongest language, a factor which could influence research findings. Moreover, other than Gonzalez-Barrero and Nadig (2018), studies have not examined the direct influence of exposure on the language development of bilingual children with ASD nor have they compared the bilingual language abilities of children with ASD to those of their ND bilingual peers, or to those of their ND monolingual peers. Crucially, since children with ASD who have intellectual abilities similar to those of ND children are integrated in ND classrooms, it is important to understand the language development of bilingual children with ASD relative to their ND bilingual and monolingual peers. Finally, by examining the bilingual language development in children with ASD who have neither a comorbid language disorder nor

intellectual disability we can examine whether a diagnosis of ASD itself impedes bilingual language development. This examination is important as previous research has shown that children with language disorders and typical cognition (i.e., DLD; Paradis et al. 2003; Samaleh et al. 2004) and children with cognitive impairment (i.e., Down syndrome; Burgoyne et al. 2016; Trudeau et al. 2011) can achieve language levels similar to those of their monolingual peers with similar diagnostic profiles.

Current Study

With those objectives in mind, the current study explores the language abilities of a subgroup of school-aged simultaneous bilingual children with ASD, who have neither a comorbid language disorder nor an intellectual disability and who are raised in an additive bilingual environment, where both of their languages are supported (Paradis et al. 2011). The goal of the current pilot study is to examine whether school-aged simultaneous bilingual children with ASD without an intellectual disability or language disorder are able to achieve similar language abilities, in both of their languages (French and English), to those of their ND French–English simultaneous bilingual and French ND monolingual peers, and to those of their French monolingual peers with ASD. This study focuses on children with ASD without a language disorder or an intellectual disability for three reasons. First, this profile of abilities represents a large subset of children with ASD (i.e., 44% of children with ASD have IQs in the average or higher than average range according to Baio et al. 2018). Second, by focusing on this subset of children, we can more readily examine the influence of bilingualism on language development in children with ASD by reducing confounding factors such as a language disorder or an intellectual disability. Third, since children with ASD who have this profile are often fully integrated into classrooms with ND children, it is important, both from a clinical and an educational perspective, to examine how these children perform when compared to their ND classmates. Therefore, the present study aims to fill three key gaps in the current literature by: (1) focussing solely on school-aged simultaneous bilingual children with ASD, (2) examining these children's language abilities (i.e., expressive and receptive language abilities, receptive vocabulary) in both of their languages (French and English), and (3) comparing the language abilities of bilingual children with ASD to those of monolingual children with ASD, as well as to those of their ND bilingual and monolingual peers. To this end, the two following questions were investigated:

1. Are there differences in the performances of bilingual children with ASD on French-language tasks of receptive vocabulary, receptive language and expressive language skills, when compared to (a) their French-monolingual peers with ASD, (b) to their ND bilingual peers, and (c) to their ND French-monolingual peers? And if so, how do bilingual children with ASD differ from these peers?

Based on the findings in younger children with ASD (e.g., Hambly and Fombonne 2012; Ohashi et al. 2012; Valicenti-McDermott et al. 2013), we hypothesize that bilingual children with ASD will have overall similar performances to those of their monolingual peers with ASD. Based on previous findings (Kjelgaard and Tager-Flusberg 2001; Boucher 2012), we expect that both bilingual and monolingual of children with ASD may have stronger vocabularies relative to their overall receptive language abilities, a pattern which we do not expect in ND monolingual children. We also expect that monolingual children with ASD will may have stronger expressive language than receptive language scores (similar to findings in Saalasti et al. 2008; Seung 2007). In addition, based on findings from Gonzalez-Barrero and Nadig (2018), we expect that bilingual children with ASD will have weaker language abilities when compared to their ND bilingual and monolingual peers.

2. When compared exclusively to their ND French–English bilingual peers, are there differences in the performances of bilingual children with ASD on tasks of receptive vocabulary, receptive language and expressive language skills in both of their languages (French and English)? If so, how do they differ?

Based on findings in Gonzalez-Barrero and Nadig (2018), we expect that bilingual children with ASD will have lower scores on measure of expressive language, receptive language and receptive vocabulary when compared to their ND bilingual peers. Moreover, since some research findings suggest that children with ASD perform better on expressive tasks than on receptive tasks (Saalasti et al. 2008; Seung 2007), but that ND bilingual children usually have stronger performances on receptive tasks than expressive language tasks (Gibson et al. 2012), we hypothesize that although the children with ASD may have stronger performances on expressive tasks, this performance will be modulated by the stronger performances on receptive tasks that bilingual children usually present—resulting in relatively balanced expressive and receptive abilities. In contrast we hypothesize that ND bilingual children will have higher performances on receptive tasks than expressive tasks (as found in Gibson et al. 2012).

Methodology

Participants

For this study, 39 participants from Greater Montréal Region and Greater Ottawa Region were recruited from both public and private schools, and through social media platforms, community organizations and intervention clinics. The children ranged in age between six and nine years (see Table 1 for age of first testing per group). Our study included three French–English simultaneous bilingual children with ASD and two French monolingual children with ASD. Our ND group was comprised of 19 simultaneous bilingual children (16 of whom were French–English bilinguals/multilinguals and three of whom spoke French plus a language other than English), and 12 French-monolingual children. Children were identified as *bilinguals* (based on parent report) if they had received exposure to two language prior to participating in the study and were able to use both of these languages. All of the bilingual children in this study were *simultaneous bilinguals,* which we defined as being those who had been exposed to a second language by the age of 36 months (Thordardottir 2011) as reported by their parents. Two ND participants were exposed to English, their third language, at 48 months. However, they had acquired their second language prior to the age of three years and therefore met our criteria for simultaneous bilingualism. Unlike other studies (Thordardottir 2011, 2019), no minimum amount of exposure was imposed for inclusion in the bilingual group. Instead, the amount of language exposure that all children received was measured through the the Montréal Bilingual Language Use and Exposure questionnaire (M-BLUE; see below) and used as a variable in the analyses. This method permitted for the direct examination of the role of language exposure on language abilities, even among children with low amounts of language exposure but who were identified as bilinguals by their parents. *Monolinguals* were defined as children who could not communicate in a second language, as identified by their parents. Additionally, based on parents' responses on the M-BLUE, all of the children identified as monolinguals had little or no exposure to a second language (1% or less).

Our ASD group was initially comprised of eight children. However, one bilingual and two monolingual children were excluded because they met the criteria for a language disorders in addition to ASD, as denoted by scores of 1.25 standard deviation below the mean on the Global Language Index (this threshold is the cut-off level for identification of a language disorder; Leonard 1998) of the *Clinical Evaluation of Language Fundamental-Version Canadienne Française* (Secord et al. 2009) or the *Clinical Evaluation of Language Fundamentals-Fifth Edition* (Wiig et al. 2013). One of these three children also had less intelligible speech, making expressive tasks very difficult to reliably score. Therefore, our final ASD groups consisted of two French monolingual children and three French–English bilingual children, none of whom presented with a speech or language disorder, thus bringing our total sample to 36 children. All three bilingual children with ASD attended French–English immersion school and therefore were exposed to both languages at school. Two of these children (AB1 and AB3) had a higher amount of lifetime exposure to English than French (86% and 65% respectively), and the third child (AB2) had fairly balanced exposure to French and English. Our ASD group included one pair of siblings, both of whom were diagnosed with ASD. According to practice in the community, children with ASD were diagnosed by a psychologist or a psychiatrist in the community. The *Social Communication Questionnaire* (SCQ; Rutter et al. 2003) was administered and the *Lifetime* score used to confirm the diagnosis of children in the ASD group. The *SCQ* is a parent questionnaire which examines communication and social abilities in children. The 40 questions included in the SCQ focus on core features of ASD and there are high levels of agreement between the SCQ and the *Autism Diagnostic Interview-Revised* (ADI-R; Le Couteur

Table 1 Demographic information (standard deviation, SD) for the entire sample, ND and ASD monolingual (ML) and bilingual (BL) groups

	Total sample (N = 36)	ND-ML (n = 12)	ND-BL (n = 19)	ASD-BL (n = 3)	ASD-ML (n = 2)
Age* at first testing (SD)	92.87 (14.02)	93.65 (14.11)	87.33 (11.25)	97.63 (14.53)	96.20 (14.19)
Age* of exposure to French in months (SD)	3.45 (8.52)	0	4.58 (10.11)	12.0 (12.0)	0
Proportion of French exposure (SD)	.72 (.32)	.99 (.008)	.58 (.30)	.30 (.14)	.99 (.001)
Age* of exposure to English in months (SD)	23.25 (24.57)	53.14 (19.42)	13.31 (18.30)	4.0 (6.93)	27 (4.24)
Proportion of English exposure	.20 (.29)	.006 (.007)	.26 (.30)	.66 (.19)	.01 (.001)
NVIQ	109.81 (15.31)	104.83 (14.06)	111.11 (14.47)	118.50 33.234)	115.67 (16.92)
SCQ				18 (1.0)	25.5 (3.54)

Since some children may have been exposed to a third language, some totals will therefore not equal 100%

*Mean age reported in months

et al. 2003). All of the children in the ASD group met the *SCQ Lifetime* criteria for ASD.

The non-verbal intellectual abilities (NVIQ) of all of the children was assessed using the *Perceptual Reasoning Index* (PRI) of the *Wechsler Intelligence Scale for Children* (*WISC*; Wechsler 2003). This index is calculated using three subtests: *Block Design, Picture Concepts* and *Matrix Reasoning*. Depending on the child's language preference, the PRI was administered in either French or English. Children with an intellectual disability (as indicated by a score of < 70 on the PRI) or a neurological disorder (as reported by parents) other than ASD were excluded from participation in this study.

Within our ND group, one child had a sibling with an ASD diagnosis. For all of the children in this study, maternal education level was reported as being either college level or higher. Information regarding age at testing, age of first exposure to each language, amount of language exposure and NVIQ by group can be found in Table 1. Table 1 also contains SCQ scores for children in the ASD groups.

Given the small number of children with ASD, it was not possible to complete statistical group comparisons regarding the participant's age, amount of language exposure, or NVIQ.

Materials and Procedures

Formal Language Assessment

Receptive and expressive language, and global language abilities were assessed using the *Clinical Evaluation of Language Fundamental-Version Canadienne Française* (Secord et al. 2009) and the *Clinical Evaluation of Language Fundamentals-Fifth Edition* (Wiig et al. 2013). A description of the subtests included in the *Clinical Evaluation of Language Fundamental-Version Canadienne Française* (henceforth the CELF-FR) and in the *Clinical Evaluation of Language Fundamentals-Fifth Edition* (henceforth the CELF-EN), and the age group to whom subtests were administered can be found in the online supplemental. Receptive vocabulary in French and in English were assessed through the *Évaluation de vocabulaire en image Peabody-deuxième édition* (ÉVIP-II; Dunn et al. 1993) and the *Peabody Picture Vocabulary Test-Fourth Edition* (PPVT-4; Dunn and Dunn 2007) respectively. For these two tasks, children were shown a series of four pictures (on a single page) and asked to point to a given picture.

The amount of language exposure that children received to each of their languages was determined through the *Montréal Bilingual Language Use and Exposure* questionnaire (M-BLUE; Beauchamp and MacLeod 2019). The M-BLUE is a parent questionnaire developed by the first and third authors (https://bilingualacquisition.ca/bab-lab-tools/). It includes questions regarding a child's language development, such as age of first exposure to each language, as well as demographic information. Parents also indicated the number of hours of language exposure that their child received to each of their languages with various interlocutors and in a number of different environments, including at school, at home, during different extracurricular activities and with their friends.

Each child was seen for two or three testing sessions of between 60 and 120 min each. For bilingual participants, language testing was first completed in their preferred language (as established by the parent and confirmed by the child), and then in their other language on a separate day. The majority of bilingual participants were tested in French and in English. However, three bilingual ND children who spoke French but not English were tested only in French. Monolingual children were all tested in French only. Testing sessions were conducted in a quiet room either at Université de Montréal, at Université d'Ottawa, or in the child's home. Sessions were also videotaped. Testing was completed by a speech-language pathologist or a trained research assistant. Informed consent was obtained prior to the first testing session.

Analyses

For the language and cognitive measures, testing and scoring were completed following the instructions in the testing manuals. Raw scores were converted to standard scores following scoring instructions in the testing manuals. Standardized scores were used in our analyses in order to enable us to compare the language abilities across participants of different ages. Table 2 includes the mean standard scores for the different language scales in French and in English, and for the NVIQ measure, as well as standard deviations (SD).

Children's language exposure proportion estimates were derived from parents' answers on the M-BLUE. Parents were asked to identify the number of hours of exposure that their child received to each of their languages across multiple interlocutors and environments during a regular 5-day-week and 2-day-weekend based on a 14-h day. For each child, amounts of total language exposure and of exposure to each language were first calculated based on a "regular" week and weekend. Based on those amounts and on the age of first exposure to each language, an estimate of the amount of lifetime exposure was derived. We then calculated the proportion of lifetime exposure that children received to each language. We chose to use proportions rather than total amounts in order to account for differences in chronological age of our participants. Additionally, we used lifetime proportions, as in a related study (Beauchamp et al. in prep.) they have been shown to be more strongly linked to language abilities than current exposure. A more detailed description of the way in which

Table 2 Group standard score means and standard deviations (SD) for overall language (CELF-Global) overall receptive (CELF-Rec, overall expressive (CELF-Exp), receptive vocabulary (PPVT and ÉVIP) in English and in French and NVIQ means (SD), for the neurotypically developing (ND) and ASD monolingual (ML) and bilingual (BL) groups

Cognitive and language measures	ND-ML (n = 12)	ND-BL (n = 19)	ASD-ML (n = 2)	ASD-BL (n = 3)
CELF-EN-Global (SD)		95.13 (18.55)		115.67 (15.01)
CELF-EN-REC (SD)		105.38 (16.10)		116.67 (10.97)
CELF-EN-EXP (SD)		92.00 (20.08)		117.67 (17.90)
CELF-FR-Total (SD)	104.33 (16.05)	98.84 (11.91)	100.00 (1.414)	89.00 (4.58)
CELF-FR-REC (SD)	101.58 (10.63)	100.68 (13.72)	95.00	102.33 (11.85)
CELF-FR-EXP (SD)	107.92 (18.15)	98.53 (12.14)	95.00 (0)	87.00 (3.46)
PPVT-4-SS (SD)		95.75 (16.59)		121.67 (23.12)
EVIP-2-SS (SD)	127.00 (16.13)	115.42 (12.06)	121.00 (8.485)	115.33 (11.55)

N = 36

exposure scores are calculated can be found in Beauchamp et al. (in prep.).

Given the small number of participants in the ASD groups, a series of *K-means cluster analyses* were completed using *R software* (R Development Core Team 2014) and the *mclust* package (Scrucca et al. 2016) to answer our research questions. The K-means cluster analysis has been described as an iterative partitioning method (Hammet et al. 2003, p. 37) that divides experimental observations into a specified number of clusters using the means of the targeted variables (i.e., the scores on the targeted language measures). In the first step of this method, a mean is generated for each cluster given the dataset. Then, clusters are formed by assigning each observation to the cluster with the closest mean. The mean of each cluster is then recalculated using its centroid (the geometric center between each observation in the cluster). These steps are repeated until clusters converge. By using this type of analysis, it is possible to determine the cluster to which different participants belong given a set of variables. In addition to identifying cluster association, the *mclust* function also identified the optimal number of groups for each analysis.

Results

The first question examined the similarities and differences between the French-language abilities of bilingual children with ASD compared to those of their monolingual peers with ASD and to their ND bilingual and monolingual peers. For these analyses, language abilities were compared across the following participants: three bilingual children with ASD (children AB1, AB2 and AB3), two monolingual children with ASD, (AM1 and AM2), 19 ND bilingual children, and 12 French-monolingual children. Analyses of their performances on French-language measures were completed using a series of *k-means cluster* analyses as described above.

To begin, we compared scores on the CELF-FR-Rec (receptive language) and the ÉVIP (receptive vocabulary). This analysis examined whether children with ASD presented a pattern of stronger vocabulary abilities (in French) compared to their overall receptive language abilities (in French) and revealed three clusters (Table 3). As shown in Table 3, all of the cluster means were within or above 1 SD of the normative mean (mean = 100; 1 SD = ± 15). Table 3 also shows the composition of each cluster. For all three

Table 3 Cluster distribution and number of children per cluster

Cluster number	Number of children in each cluster (individual children with ASD and number of children per ND group)	Tests	Cluster mean	SD
Cluster 1	12 (AB1; AM1; 7NDB; 3NDM)	CELF-FR-Rec	106.45	4.55
		ÉVIP	123.70	8.67
Cluster 2	21 (AB2; AB3; 11NDB; 7NDM)	CELF-FR-Rec	88.54	5.30
		ÉVIP	108.38	9.09
Cluster 3	3 (2NDB; 1NDM)	CELF-FR-Rec	119.67	16.50
		ÉVIP	140.67	23.16

Cluster analysis completed with French receptive language (CELF-FR-Rec) and French receptive vocabulary (ÉVIP)

NDB neurotypically developing bilingual; *NDM* neurotypically developing monolingual

clusters, there was a pattern of higher receptive vocabulary (ÉVIP) than receptive language (CELF-FR-Rec), including for cluster 3, which did not include children with ASD, suggesting that a pattern of higher receptive vocabulary compared to receptive language may not be specific to the children with ASD within the present study. It should however be noted that, for French monolinguals, the ÉVIP has been reported to overestimates vocabulary abilities (Thordardottir et al. 2010). This tendency for higher standard scores in receptive vocabulary among monolingual and bilingual French-speakers may also have occurred in the present study and may explain the differences in scores between the CELF-FR-Rec and the ÉVIP.

For the second cluster analysis, the children's performances on the CELF-FR-Rec (receptive language) and the CELF-FR-Exp (expressive language) was examined in order to assess whether (a) monolingual children with ASD showed higher expressive than receptive abilities, (b) bilingual children with ASD presented similar scores on both measures and (c) children in the ND bilingual group had an expressive-receptive gap, with stronger receptive than expressive abilities. As shown in Table 4, the analysis revealed three clusters, all of which had cluster means within 1 SD of the normative mean or higher.

An examination of the clusters in Table 4 revealed that for both clusters 1 and 2, scores on the expressive and receptive spheres were similar. Since these two clusters consisted of both bilingual and monolingual children and of children from both the ASD and ND groups, this suggests that monolingual children with ASD did not present with higher expressive than receptive scores and that bilingual ND children did not present with a receptive-expressive gap. Additionally, bilingual children with ASD grouped with ND bilingual and monolingual children, as well as with monolingual children with ASD in clusters 1 and 2, indicating similar language abilities across these groups. A visual inspection of clustering patterns also indicates that children with differing amounts of exposure to French clustered together. That is, bilinguals, including the two children with ASD who had lower levels of exposure to French (AB1 and AB3), clustered with ND monolinguals and monolingual peers with ASD.

The finding that bilinguals and monolinguals clustered together in both cluster analyses suggests that the amount of language exposure to French did not influence cluster membership. However, we were interested in directly investigating the relationship between exposure to French and proficiency in French as previous research has shown that language exposure is linked to language abilities in bilingual children (ex: Thordardottir 2011). Therefore, we completed an exploratory post-hoc hierarchical linear regression analysis to examine the extent to which the amount of language exposure that children received to French played a role in bilingual children's language abilities in French. Since children consistently clustered together, regardless of their diagnostic or linguistic grouping, and given the small size of the ASD groups, the linear regression analysis included all 36 children. Exposure to French was the independent variable, scores on the three language measures were the dependent variables. Additionally, NVIQ was controlled for since in a related study (Beauchamp et al. in prep.) it was found to interact with language exposure. It also permitted to control for differences in NVIQ across participants. The results of this post-hoc hierarchical linear regression (see Table 5) showed no significant relationships between exposure to French and any of the measures in French. Additionally, the ΔR^2 values indicate little change in the amount of variance explained when exposure to French was entered into the model suggesting that language exposure did not strongly influence language abilities in French in this group of children.

For the next series of analyses, we were interested in examining specifically how our two bilingual groups (i.e. bilingual children with ASD and ND bilingual children) compared to one another. To that end, we examined the similarities and differences in the performances of French–English simultaneous bilingual children with ASD (children AB1, AB2 and AB3) to those of their 16 ND

Table 4 Cluster distribution and number of children per cluster

Cluster number	Number of children in each cluster (individual children with ASD and number of children per ND group)	Tests	Cluster mean	SD
Cluster 1	20 (AB1; AM1; 11 NDB; 7 NDM)	CELF-FR-Rec	106.45	4.77
		CELF-FR-Exp	102.80	9.77
Cluster 2	13 (AB2; AB3; AM2; 7NDB; 3NDM)	CELF-FR-Rec	88.54	5.30
		CELF-FR-Exp	89.77	6.73
Cluster 3	3 (2NDB; 1NDM)	CELF-FR-Rec	119.67	16.50
		CELF-FR-Exp	131.67	19.53

Cluster analysis completed with French receptive (CELF-FR-Rec) and French expressive (CELF-FR-Exp) language measures

NDB neurotypically developing bilingual; *NDM* neurotypically developing monolingual

Table 5 Hierarchical linear regression analyses examining the influence of exposure to French on language scores, while controlling for NVIQ

Language measures		Model 1			Model 2		
	Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
CELF-FR-Rec	Constant	76.254***	14.163		81.396***	18.084	
	NVIQ	.226	.128	.290	.200	.141	.275
	Lifetime exposure French				− 3.129	6.713	− .084
	R^2		.084			.090	
	F		3.131				
	ΔR^2					.006	
	ΔF					.217	
CELF-FR-Exp	Constant	89.341***	18.245		74.741**	22.998	
	NVIQ	.102	.165	.105	.177	.179	.183
	Lifetime exposure French				8.884	8.537	.194
	R^2		.011			.043	
	F		.381				
	ΔR^2					.031	
	ΔF					1.083	
ÉVIP	Constant	106.756***	17.248		86.690***	21.340	
	NVIQ	.117	.156	.128	.220	.167	.240
	Lifetime exposure French				12.210	7.922	.281
	R^2		.016			.082	
	F		.564				
	ΔR^2					.066	
	ΔF					2.376	

All children were included in these analyses

N = 36. Model 1: df = 1, 34; Model 2: df = 1, 33

*$p < .05$. **$p < .01$, ***p = < .001

French–English simultaneous bilingual peers on standardised measures of receptive vocabulary, receptive language and expressive language in French and in English. Thus, this analysis examined the language abilities of these children in both of their languages. This analysis was important because previous research has shown that languages may be differentially influenced by language exposure (Bedore et al. 2012). Also, since two of the three children had less exposure to French than to English (AB1 and AB3), this analysis permitted an examination of their performances in both of their languages, including the language in which they received more exposure (English). Again, we completed a series of *k-means cluster analysis* to examine how bilingual children with ASD clustered compared to their ND bilingual peers on the different language measures.

First, we examined whether there were differences in the performances of bilingual children with ASD compared to their ND peers on receptive vocabulary measures in French and in English (ÉVIP and PPVT). This analysis produced a single cluster, suggesting that the children's performances were not sufficiently different from one another to form separate clusters. Based on this result, the two French and two English receptive language measures (CELF-FR-Rec, ÉVIP, CELF-EN-Rec and PPVT) were combined into the same analysis. As Table 6 shows, this analysis produced three clusters. An inspection of the cluster means revealed that for clusters 1 and 2, the cluster means for the four different language measures (two in French and two in English) fell within or above 1 SD from the normative mean (mean = 100; 1SD = ± 15), but that for cluster 3, cluster means on the English-language measures (CELF-EN-Rec and PPVT) fell below 1 SD from the normative mean.

A visual inspection of the cluster means also revealed that children in clusters 1 and 3 had higher scores on the ÉVIP than on overall receptive language in French (CELF-FR-Rec; i.e., a difference of 1 SD more more), but that children in cluster 2 had higher performances on overall receptive language in English (CELF-EN-Rec) than on PPVT (i.e., a difference of 1 SD more more). Since clusters 1 and 2 included both children with ASD and ND children, these results suggest that, for the children in this study, there was no "ASD pattern" when we examined the relationship receptive vocabulary and overall receptive language abilities. Interestingly, cluster 1, which had the highest mean scores on both French-language measures also included the two children with ASD who had lower levels of exposure to French (AB1 and AB3).

Table 6 Cluster distribution and number of children per cluster

Cluster number	Number of children in each cluster (individual children with ASD and number of children per ND group)	Tests	Cluster mean	SD
Cluster 1	7 (AB1, AB3, 5NDB)	CELF-FR-Rec	106.57	6.63
		ÉVIP	125.71	3.64
		CELF-EN-Rec	117.86	9.84
		PPVT	113.14	18.57
Cluster 2	9 (AB2, 8NDB)	CELF-FR-Rec	99.22	17.21
		ÉVIP	106.22	6.89
		CELF-EN-Rec	117.86	8.08
		PPVT	99.44	9.87
Cluster 3	3 (3NDB)	CELF-FR-Rec	87.33	7.57
		ÉVIP	107.67	12.66
		CELF-EN-Rec	78.67	7.10
		PPVT	70	8.19

Cluster analysis completed with French receptive language (CELF-FR-Rec), French receptive vocabulary (ÉVIP), English receptive language (CELF-EN-Rec) and English receptive vocabulary (PPVT)

NDB neurotypically developing bilingual

Next, the expressive language abilities in French and English were compared using scores on the CELF-EN-Exp and on the CELF-FR-Exp. As Table 7 shows, the analysis revealed two clusters. An inspection of the cluster means indicated that for cluster 1, cluster means for both measures fell within 1 SD from the normative mean (mean = 100; 1SD = ± 15) but for cluster 2, only the French measure fell within 1 SD from the normative mean. For the English measure, the cluster mean fell more than 1.5 SD from the normative mean. Again, children with ASD clustered with their ND peers in cluster 1, rather than form their own cluster.

It should be noted that a cluster analysis examining receptive language and expressive language abilities in English (similar to the one completed in the first set of analyses in French) was attempted. However, the clusters did not converge, suggesting that children's performances were not sufficiently dissimilar from one another to form separate clusters. The results suggest that, for the children in this study, there was no "ASD pattern" when we examined the relationship between expressive and receptive language abilities.

Again, an exploratory post-hoc hierarchical linear regression analysis was completed to investigate the relationship between language exposure and bilingual language development specifically in these bilingual children. By examining the influence of exposure to English on English language abilities in our bilingual participants, it was possible to explore whether the influence of language exposure was the same across both languages, or whether (as was reported in Bedore et al. 2012), the influence of language exposure differed between languages. Since the bilingual children with ASD consistently clustered with their ND peers, all 19 children (3 French-English bilingual children with ASD and 16 ND French–English bilingual children) were grouped together for this analysis. As exposure to French was used in the previous regression analysis, for this analysis exposure to English was used as the independent variable and scores on three English-language measures (CELF-EN-Rec, CELF-EN-Exp and PPVT) were used as the dependent variables. As in the first exposure analysis, NVIQ was controlled for by adding it in the first model. As Table 8 shows, no significant

Table 7 Cluster distribution and number of children per cluster

Cluster number	Number of children in each cluster (individual children with ASD and number of children per ND group)	Tests	Cluster mean	SD
Cluster 1	12 (AB1, AB2, AB3, 9NDB)	CELF-FR-Exp	99.25	12.75
		CELF-EN-Exp	106.67	13.19
Cluster 2	7 (7NDB)	CELF-FR-Exp	88.57	5.62
		CELF-EN-Exp	72.71	8.17

Cluster analysis completed with French expressive language measure (CELF-FR-Exp) and English expressive language (CELF-En-Exp)

NDB neurotypically developing bilingual; *NDM* neurotypically developing monolingual

Table 8 Hierarchical linear regression analyses examining the influence of exposure to English on language scores, while controlling for NVIQ

Language measures	Variable	Model 1			Model 2		
		B	*SE B*	*β*	*B*	*SE B*	*β*
CELF-EN-Rec	Constant	30.237	20.540		38.090	22.804	
	NVIQ	.689	.182	.676***	.589	.220	.578*
	Lifetime exposure English				8.985	10.863	.179
	R^2		.456			.479	
	F		14.278***			7.348**	
	ΔR^2					.022	
	ΔF					.684	
CELF-EN-Exp	Constant	− 15.156	26.744		15.602	24.047	
	NVIQ	.997	.238	.713***	.605	.232	.433*
	Lifetime exposure English				35.190	11.455	.511**
	R^2		.509			.691	
	F		17.603***			17.889***	
	ΔR^2					.182	
	ΔF					9.438**	
PPVT	Constant	− 3.312	23.757		25.191	20.797	
	NVIQ	.924	.211	.728***	.562	.201	.442**
	Lifetime exposure English				32.610	9.906	.521**
	R^2		.530			.720	
	F		19.195***			20.569***	
	ΔR^2					.190	
	ΔF					10.836**	

All bilingual children were included in these analyses

Note. n = 19. Model 1: df = 1, 17; Model 2: df = 1, 16

*$p < .05$. **$p < .01$, ***p = < .001

relationship was found between exposure to English and CELF-EN-Rec and ΔR^2 indicated little change in the amount of variance explained when exposure to English was entered into the model. However, a significant relationship was found between CELF-EN-Exp and PPVT and exposure to English. Moreover, ΔR^2 indicated a positive change in the amount of variance explained when exposure to English was entered into the model. This suggests that as exposure to English increased, overall expressive language, as well as for receptive vocabulary in English, also increased, which was not the case for overall receptive language in English, and could explain the weaker means reported for PPVT in cluster 3 in Tables 6 and for CELF-EN-Exp in cluster 2 in Table 7.

Discussion

The objective of this pilot study was to investigate whether three school-aged French–English bilingual children with ASD and neither a comorbid language disorder nor an intellectual disability could become proficient bilingual speakers, or whether bilingualism would be a burden on their language development. Overall our findings suggest that bilingualism did not hinder language development for these children with ASD, in either of their two languages.

This research is timely and addresses a number of gaps in the literature by examining the language development of bilingual school-aged children with ASD who have neither a language disorder nor an intellectual disability, in both of their languages, and comparing their abilities to those of their ND bilingual and monolingual peers. In doing so, it was possible to examine the influence of bilingualism on language development while limiting the impact of other confounding factors such as a language disorder or an intellectual disability. The influence of language exposure on these children's language development in both of their languages was also considered.

First, we focused on whether there were differences in the performances of bilingual children with ASD on French measures of receptive vocabulary, receptive language and expressive language skills when compared to their monolingual peers with ASD, and to their ND bilingual and monolingual peers. As expected, bilingual children with ASD clustered with their monolingual peers with ASD. But contrary to our hypothesis, bilingual children with ASD also clustered with both their ND bilingual and

monolingual peers on all of the French-language measures. These finding suggests that the bilingual children with ASD in this study had language abilities that were similar to those of children in the three other experimental groups. Additionally, we did not observe the hypothesized "ASD patterns". Specifically, the children with ASD in the present study had similar performances to those of their ND peers on tasks examining receptive vocabulary. And contrary to Saalasti et al. (2008) and Seung (2007) but in-line with Kwok, Brown, Smyth and Cardy (2015) and Pickles et al. (2014), children with ASD did not show stronger expressive abilities but rather had similar levels of expressive and receptive language abilities in French. Moreover, no significant relationship was found between the amount of exposure to French that children received and their scores on any of the French-language measures, when controlling for NVIQ. This latter finding was surprising given findings from studies of ND bilingual children (Bedore et al. 2012, 2016; Thordardottir 2011, 2019; Unsworth 2016) and of children with ASD (Gonzalez-Barrero and Nadig 2018) suggesting that exposure is a strong predictor of language abilities in bilingual children.

Next we focused specifically on our two bilingual groups and examined whether there were differences in the performances of the three bilingual children with ASD with regards to receptive vocabulary, receptive language and expressive language skills in French and in English, when compared to their 16 ND bilingual peers. And if differences were observed, how did these children differ? By focusing specifically on bilingual children, we were able to examine their performances in both of their languages.

Once again, bilingual children with ASD clustered with their ND bilingual peers on the different language measures, indicating that their language abilities did not differ from those of their ND peers, in either language. Also, at no time did children with ASD form their own group but rather, they consistently clustered with ND children. This finding suggests that the language patterns of bilingual children with ASD in this study were similar to those of their ND bilingual peers.

Finally, the influence of exposure to English on the English-language measures was examined. This time, our findings were somewhat similar to those of Gonzalez-Barrero and Nadig (2018). When controlling for NVIQ, a significant relationship was found between exposure to English and scores on overall expressive language and receptive vocabulary, but no significant relationship was found between overall receptive language and exposure to English, suggesting that these two facets of language development (i.e., expressive language and receptive vocabulary) are more sensitive to language exposure than is receptive language. This finding is commensurate with previous findings in the ND population (e.g., Thordardottir 2011).

Taken together, the results of this pilot study suggest that children with ASD who have neither a comorbid language disorder nor an intellectual disability can become proficient bilingual speakers. This finding is commensurate with previous findings examining bilingual language development in ND bilingual children (MacLeod et al. 2013, 2017; Thordardottir 2011, 2019; Unsworth 2016), children with Down syndrome who were compared to other children with Down syndrome or to ND peers matched on mental age (Burgoyne et al. 2016; Kay-Raining Bird et al. 2005; Trudeau et al 2011), and bilingual children with a DLD when compared to monolingual children with a DLD (Paradis et al. 2003).That is, the bilingual children with ASD in this study were able to develop language abilities, in both of their languages, that were similar to those of their monolingual peers with ASD, and to those of their ND bilingual and monolingual peers. Additionally, these children did not appear to require more exposure to a language than did their ND bilingual peers to reach similar language levels, as indicated by the fact that they often clustered with ND monolingual children on French-language measures. Therefore, core features of ASD (such as impairment in social abilities) did not appear to hinder these children's capacities to acquire two languages. These findings contribute to the growing body of evidence that show that bilingual children with ASD with various cognitive can develop similar language abilities to their ND monolingual peers with similar cognitive abilities (Hambly and Fombonne 2012; Ohashi et al. 2012).

While some of our findings are similar to those reported in Gonzalez-Barrero and Nadig (2018), others differ from those in the latter study in two important ways. First, the performances of children with ASD in the current study did not differ from their ND bilingual peers, contrary to findings in Gonzalez-Barrero and Nadig (2018). Second, unlike findings in Gonzalez-Barrero and Nadig (2018), we did not find a relationship between language exposure and scores on all of our language measures. Instead bilingual children with ASD clustered with their ND monolingual peers, even in the language in which they received less exposure (i.e., French). It is unclear why our findings are different from those of Gonzalez-Barrero and Nadig (2018). It may be due to the small number of participants in the present study. Alternatively, our findings may reflect differences in the bilingual experiences of the children in the two studies. For example, ND children in the current study and their peers with ASD were all simultaneous bilinguals. It is unclear if that was the case in the Gonzalez-Barrero and Nadig (2018) study. Additionally, there are a number of children in the Gonzalez-Barrero and Nadig (2018) study who received very low levels of exposure to French (approximately 5%), whereas for bilingual children (in the ND and ASD groups) in the current study the lower range of exposure to French was slightly higher (approximately 15%). Furthermore, many of the

bilingual children in the current study in both diagnostic groups attended French-immersion schooling. Previous findings have shown that children in immersion programmes tend to have better metalinguistics abilities (Bialystok and Barac 2012; Bialystok et al. 2014). It has been suggested that improved metalinguistic abilities could lead to more efficient language learning (Cummins 1981, 2008; Verhoeven, 2007), which may in turn diminish the need for direct language exposure. While the current study did not directly examine this possibility, it would explain why for two of the three bilingual children with ASD consistently clustered with some of their ND French-monolingual peers, even though French was the language to which they received the least amount of exposure. Minimally, this finding suggests that factors other than language exposure may be at play. Therefore, differences in language experiences could explain the differences in our findings with regards to the influence of language exposure on language acquisition in bilingual children with (and without) ASD. Language exposure is a complex multi-faceted construct (Pearson 2007), and one that may be difficult to capture (Carroll 2017). The same is likely true for language experience.

Understanding the influence of exposure on both languages is important given that it may not be the same across both languages and, as our findings show, may also be different across different facets of language (Bedore et al. 2012; Thordardottir 2011). Indeed, in the current study, we found that, while exposure did influence language abilities, overall receptive language was less influenced than expressive language and receptive vocabulary. By examining expressive language, receptive language and receptive vocabulary in both languages, and the influence of exposure on these different facets of language, we were able to give a more complete view of school-aged bilingual children's language development in the context of ASD, and the influence of exposure on the development of their two languages. To our knowledge, this has not previously been done and is a novel contribution.

The impetus for this study was the clinical observation by the first author that, to their chagrin, many parents of children with ASD received recommendations against bilingualism. It is noteworthy that one parent from the ASD group reported receiving one such recommendation because of their child's initial difficulties with language acquisition. However, given the family's bilingual context these parents were unable to follow this recommendation (first author, personal communication). Interestingly, this child currently functions quite well in both languages and successfully attends school in both languages. This example illustrates two important points. First, for children with ASD, a child's strengths and weaknesses as a toddler may not predict their eventual language abilities. Indeed, in a longitudinal study, Bennett et al. (2014) found that 76% of children who were initially diagnosed with ASD and a language disorder, no longer met the criteria for a language disorder one year later. Thus predicting future language abilities may be challenging early in achild's development as children's trajectories may change overtime. Second, children with ASD have the potential to become bilingual when they are brought-up in a supportive environment, just like their ND peers (MacLeod et al. 2017; Thordardottir 2011, 2015, 2019).

In sum, our findings, along with those of previous studies suggest that recommending against bilingualism is not warranted, especially when we consider the negative implications for children and their families when children from bilingual families do not speak their parents' language (Hampton et al. 2017; Kremer-Sadlik 2005; Yu 2013). While on their own the findings of this study are illustrative, taken together with those from previous research (Hambly and Fombonne 2012; Ohashi et al. 2012; Peterson et al. 2012; Valicenti-McDermott et al. 2013), they suggest that children with ASD can attain levels of proficiency similar to those of their monolingual peers with ASD with similar levels of NVIQ. This pilot study also contributes new data to the current body of literature that suggests that bilingual children with ASD with neither a language disorder nor an intellectual disability can also reach levels of proficiency that are similar to those of their ND bilingual peers, in both of their languages, and also similar to those of their ND monolingual peers, especially when they are brought-up in additive or supportive contexts. These preliminary findings are encouraging, especially since they suggest that bilingual children with ASD with profiles similar to those of children in this study can be schooled with and develop similar language abilities to those of their ND classmates.

Limitations and Future Directions

The present study has a number of limitations that restrict the generalisability of the findings. A key limitation is the small number of participants with ASD. However, this research lays groundwork for research that will include larger groups of bilingual children with ASD. Another limitation to the generalisability of our findings is the exclusion of children without a language disorder. Future research should aim to compare the abilities of children with ASD and a comorbid language disorder to those of children with a DLD. Additionally, there is a recruitment bias between the groups as children with ASD were recruited from a larger range of contexts than children in the ND groups. These different recruitment methods may have led to differences between the two diagnostic groups that extend beyond those due to differences between ASD and ND development. Future research with larger groups of both children with ASD and with ND will serve to

mediate this limitation. Group differences in the amount of exposure to French and English is also a limitation that may have had an influence on our findings. However, given the overall weak relationship between language exposure and language proficiency, and the clustering patterns, it is likely that such differences had little influence on our findings. Another limitation is the use of the ÉVIP, which has been found to over-inflate French vocabulary scores (Thordardottir et al. 2010). While this should not influence group differences, as all of the groups were assessed using the same measure (thus ensuring internal consistency), the authors recognize that this could influence findings regarding the relationship between the CELF-FR and the ÉVIP. Moreover, the present study focused on performances on standardised tests. While this permitted for a comparison of the performances of these children to standardised language ND norms and allowed for the examination of a number of different language facets, it did not permit for a more in-depth analysis children's performances, particularly with regards to their expressive abilities, nor did it permit for an investigation of expressive narrative skills. The authors also acknowledge that these tools, while widely used clinically, are not normed specifically with children with ASD or for bilingual children. Finally, the findings within this study do not speak to the paths to language learning in bilingual children with ASD, but rather suggest that bilingual children with ASD have the potential to acquire two languages. Future research could explore the mechanisms that underpin this bilingual language development, and whether these mechanisms align with typical bilingual language development. One such line of research could examine whether bilingual children with ASD also benefit from improve metalinguistic abilities and if so, whether improved metalinguistic abilities lead to more efficient bilingual language acquisition in these children.

Conclusion

The findings from the present pilot study contribute to the growing body of evidence indicating that all children, including children with ASD, can become bilingual and that bilingualism itself does not impede language development. Moreover, these findings will improve clinicians', teachers' and parents' understanding of how bilingual children with ASD perform relative to their monolingual peers with ASD and to their ND friends and classmates, and will contribute to the development of guidelines that clinicians can use to support families in bilingual contexts. Based on the findings from this and other studies, clinicians can and should support families of children with ASD who need or want to raise their child bilingually.

Funding This study was funded through a doctoral grant by the Social Sciences and Humanities Research Council of Canada Grant Number 767-2016-1749.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no known conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional (Comité d'éthique de la recherche en santé, Université de Montréal, 16-128-CERES-D) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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