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The influence of bilingualism in school-aged children: An examination of language development in neurotypically developing children and in children with ASD

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Résumé

Étant donné que le bilinguisme et le multilinguisme sont la norme plutôt que l'exception, plusieurs enfants, y inclus plusieurs enfants ayant un trouble du spectre de l'autisme (TSA) sont élevés dans des contextes bilingues. Cependant, il y a actuellement peu de recherche examinant le développement langagier d'enfants ayant été exposés à deux langues, de la petite enfance à l'âge scolaire. Cette thèse a pour objectif d'examiner l'influence du bilinguisme sur le développement d'habiletés langagières d'enfants bilingues ayant un développement neurotypique à l'âge scolaire, ainsi que chez leurs pairs ayant un TSA. Cet objectif est atteint par l'entremise de trois manuscrits.

Le premier manuscrit est une revue de la littérature dans le cadre de laquelle nous avons examiné le développement langagier d'enfants bilingues ayant un DN d'enfants ayant d'autres troubles de développement et finalement d'enfants ayant un TSA. Cette revue révéla que, tout comme leurs pairs ayant un DN, les enfants ayant un TSA peuvent devenir des locuteurs bilingues, et que le bilinguisme n'est pas néfaste à leur développement langagier. Cependant, certaines limites dans la littérature existante ont aussi été révélées. Dans un premier temps, la majorité des études publiées ont examiné les habiletés langagières d'enfants bilingues d'âge préscolaire. Toutefois, peu d'études ont examiné leur développement langagier une fois qu'ils atteignent l'âge scolaire, et ce, tant chez les enfants ayant un DN que chez les enfants ayant un TSA. Par ailleurs, peu d'études ont comparé les capacités langagières d'enfants ayant un TSA à celles de leurs pairs bilingues ayant un DN et aucune étude n'a comparé leurs capacités langagières à celles de leurs pairs unilingues ayant un DN. Les résultats qui découlent de cette revue ont menés à deux études expérimentales examinant

l'influence du bilinguisme sur le développement langagier chez les enfants d'âge scolaire ayant un DN, ainsi que chez leurs pairs ayant un TSA.

Notre revue de littérature suggère que l'exposition langagière pourrait jouer un rôle déterminant vis-à-vis les capacités langagières d'enfants bilingues. Le second manuscrit a donc comme objectif d'examiner la relation entre le développement langagier d'enfants étant des bilingues simultanés (exposés à leurs deux langues avant l'âge de trois ans) d'âge scolaire, et la quantité d'exposition langagière reçue dans chacune de leurs langues (le français et l'anglais). Globalement, nos résultats ont démontré une interaction entre la quantité d'exposition à l'anglais et la performance sur certaines mesures de langage expressif, mais pas avec les mesures de langage réceptif en anglais. En français, aucune interaction entre la quantité d'exposition au français et les performances sur les différentes mesures langagières n'a été trouvée. Ces différences sont potentiellement dues à des différences dans les montants d'exposition au français et à l'anglais, mais d'autres explications sont aussi discutées. De plus, les résultats suggèrent qu'en ayant approximativement 20% de leur exposition à une langue, ces enfants bilingues peuvent obtenir des scores dans la tranche moyenne sur toutes les mesures langagières. Par ailleurs, les enfants qui se servent de leurs deux langues tous les jours semblent nécessiter un moins grand pourcentage d'exposition pour développer des capacités langagières dans la moyenne. Ces résultats pourraient être expliqués par le transfert positif et une amélioration des capacités métalinguistiques plus généralement. Ce type d'amélioration pourrait permettre aux enfants qui se servent de leurs deux langues tous les jours de développer de meilleures capacités d'acquisition langagière.

Les résultats de la revue de littérature ont aussi démontré que peu est connu en ce qui a trait aux capacités langagières d'enfants bilingues ayant un TSA lorsqu'ils atteignent l'âge

scolaire. Conséquemment, pour le troisième manuscrit j'ai complété une étude pilote ayant comme objectif d'examiner si trois enfants bilingues simultanés d'âge scolaire et ayant un TSA (sans trouble de langage ou de déficiences intellectuelles) pouvaient atteindre des niveaux d'habiletés langagières semblables à celles de leurs pairs unilingues ayant un TSA. J'ai aussi cherché à savoir si ces trois enfants bilingues ayant un TSA pouvaient atteindre des seuils langagiers semblables à ceux de 19 pairs bilingues et 12 pairs unilingues ayant tous un DN. Les résultats ont démontré que ces bilingues simultanés ayant un TSA ont eu des performances semblables à celles de leurs pairs unilingues ayant un TSA sur des mesures langagières normées. Ils ont aussi eu des performances semblables à celles de leurs pairs bilingues et unilingues ayant un DN.

L'ensemble de ces résultats démontrent que les enfants bilingues simultanés d'âge scolaire avec et sans TSA peuvent atteindre des niveaux d'habiletés langagières semblables à ceux de leurs pairs unilingues, du moins, dans une de leurs langues, sinon dans les deux. Bien que les bilingues ne sont pas deux unilingues en une seule personne, les résultats de nos recherches concordent avec ceux de recherches antécédentes et démontrent que le bilinguisme n'est pas néfaste pour le développement langagier oral d'enfants d'âge scolaire ayant un DN ou ayant un TSA.

Mots clés: Âge scolaire, bilinguisme, développement neurotypique, trouble du spectre de l'autisme (TSA), exposition langagière, capacités langagières.

Abstract

Since bilingualism and multilingualism are the norm rather than the exception, many children, including children with autism spectrum disorder (ASD), live in bilingual or minority-language households. However, little research has examined the language development of school-aged children who have been exposed to two languages since early childhood, and fewer still have examined bilingual school-aged children with ASD. In this thesis, I examine the influence of bilingualism on language development in both school-aged ND children and in their peers with ASD. This objective will be achieved through the three manuscripts making up this thesis.

For the first manuscript, we completed a review of the literature in which we examined the language development of ND bilingual children, of bilingual children with various developmental disorders, and of bilingual children with ASD. This review revealed that, as with neurotypically developing (ND) children, children with ASD can become bilingual speakers, and that bilingualism is not detrimental to their language development. Our review also revealed some of the limits of the existing literature. First, the majority of existing studies had examined bilingual language development in preschool-aged children with and without ASD, but had not examined the language development of these bilingual children once they reached school age. Second, few studies had compared the language abilities of bilingual children with ASD to those of their ND bilingual peers, and at time of publication, none had compared them to those of ND monolingual children. The results from this review lead to two studies examining the influence of bilingualism on language development in school-aged ND children and in children with ASD.

Our review of the literature suggested that language exposure may play an important role in determining bilingual children's language ability. However, little was known about its

influence in school-aged children. Therefore, for the second manuscript, I examined whether there was a relationship between language development and the amount of language exposure that ND simultaneous bilinguals (i.e. children having been exposed to both languages before the age of three years) received in each of their languages (French and English). I found a relationship between lifetime exposure to English and performances on some English-language expressive language measure, but not on receptive language measures. In French, no relationship between the amount of exposure to French and performances on any of the French-language measures was found. These differences in findings could be due to differences in language exposure ranges across both languages but other potential explanations are also discussed. Findings also show that when receiving 20% of their exposure to a language, most children were able to obtain scores within the average range on the language measures. Moreover, children who were exposed to both of their languages on a daily basis often had stronger performances on language measures than children who did not receive daily exposure to both of their languages. I hypothesized that positive transfer and improved metalinguistic abilities more generally may have contributed to improved language learning abilities in children who used both of their languages on a daily basis.

Findings from the literature review also revealed that little was known about the language abilities of bilingual children with ASD once they reached school-age. With that in mind, the third manuscript reports on a pilot study that examined whether three simultaneous bilingual school-aged children with ASD (without a comorbid language disorder or an intellectual disability) could achieve language levels similar to those of their two French-monolingual peers with ASD. I also explored whether these bilingual children with ASD could reach language proficiency levels similar to those of their 19 ND simultaneous bilingual peers, in both of their languages (French and English), and whether they had similar abilities to those

of their 12 ND French-monolingual peers. I found that the simultaneous bilingual children with ASD performed similarly on standardized language measures to their two monolingual peers with ASD, in both of their languages. They also had similar performances to those of their ND bilingual peers, as well as to those of their ND monolingual peers.

Overall, these findings reveal that ND school-aged simultaneous bilinguals and their simultaneous bilingual peers with ASD (without a language disorder or intellectual disability) can achieve language proficiency levels similar to those of their monolingual peers, in at least one, if not both of their languages. While bilingual children are not two monolinguals within one child, our findings are similar to previous findings and show that bilingualism does not appear to impede the language development of school-aged ND bilingual children and bilingual children with ASD.

Key words: School-age, bilingualism, neurotypically developing children, autism spectrum disorder (ASD), language exposure, language ability.

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List of Abbreviations

ADI-R: Autism Diagnostic Interview-Revised

AoE: Age of first exposure

ASD: Autism spectrum disorder

ASHA: American Speech, Language and Hearing Association

CELF-EN-Exp: Clinical Evaluation of Language Fundamental-Expressive Language Score

CELF-EN-Global: Clinical Evaluation of Language Fundamental-Global Language Score

CELF-EN-Rec: Clinical Evaluation of Language Fundamental-Receptive Language Score

CELF-FR-Exp: Clinical Evaluation of Language Fundamental-Version Canadienne Française-Expressive Language Score

CELF-FR-Global: Clinical Evaluation of Language Fundamental-Version Canadienne Française- Global Language Score

CELF-FR-Rec: Clinical Evaluation of Language Fundamental-Version Canadienne Française-Receptive Language Score

CPA: Canadian Psychological Association

DLD: Developmental language disorder

ÉVIP: Échelle de vocabulaire en image Peabody

IQ: Intellectual quotient

M-BLUE: Montréal Bilingual Language Use and Exposure Questionnaire

MCDI: MacArthur-Bates Communicative Development Inventories

MLU: Mean Length of Utterance

ND: Neurotypically developing

NVIQ: Non-verbal intellectual quotient

PPVT: Peabody Picture Vocabulary Test

PRI: Perceptual Reasoning Index

SCQ: Social Communication Questionnaire

SD: Standard deviation

SLI: Specific Language Impairment

VABS: Vineland Adaptive Behaviour Scales, Second Edition-Expressive and Receptive Scales

WISC: Wechsler Intelligence Scale for Children

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General Introduction

Imagine that everyone in your community spoke a language that you did not speak or understand. Imagine that you had difficulty communicating with your parents because you only spoke the language used at school, but that their abilities in that language were not as strong as those in their native language. What if you could not communicate with extended members of your family such as your grandparents, aunts and uncles or cousins, because they spoke a language that you did not speak or understand? Unfortunately, this is the reality for many children, both neurotypically developing (ND) and especially in children with neurodevelopmental disorders, such as autism spectrum disorder (ASD), who grow up in bilingual or minority-language contexts. In fact, parents of children with ASD often receive recommendations against raising their child as a bilingual speaker, because it is assumed that bilingualism is detrimental to their child's language development (Yu, 2013). These recommendations are made despite evidence that later language abilities are often difficult to predict in these children (Bennett et al., 2014).

Our research focuses on the Canadian context. Over the past 50 years, Canada has come to value bilingualism, with French and English as its two official languages. Within this context, the cities of Montréal and Ottawa are particularly interesting environments to study bilingual language acquisition. In Montréal, while French is the official language of the province of Québec, English is also frequently used throughout the Greater Montréal area. In Ottawa, we find a mirror image with English the official language of the province of Ontario, and French being frequently used throughout the city. In these additive bilingual environments, where both languages are supported (Paradis, Genesee & Crago, 2011) children can access both languages at school, through extra-curricular activities, and in the broader community. Thus, from a sociolinguistic perspective both French and English could be considered "majority" languages at the city level. Moreover, in both of these cities, the majority/minority status (i.e. the language that is used most/least commonly) can change from one neighbourhood to another. Consequently, French-

English bilingual children in these two cities have the opportunity to develop both languages in an environment that supports the development of both of their languages.

The following sections will define bilingualism, review the language abilities of young bilinguals, and discuss explanatory models of childhood bilingual language learning. This will be followed by a review of bilingual language abilities among children with autism. The final section will provide an overview of this thesis.

Bilingualism

Although researchers often compare bilinguals to monolinguals, bilingualism is a not a binary construct. Rather, it can be viewed as a continuum of abilities, with at one end individuals who are very proficient in one language and who can get by in their other language, and at the other end individuals who are highly proficient in both of their languages (Grosjean, 1993). In addition to proficiency, bilingual speakers are often sub-divided into two groups, *simultaneous bilinguals* and *sequential bilinguals*, based on the age at which exposure to the second language began. Simultaneous bilinguals are generally defined as bilingual individuals who were exposed to both of their languages in early childhood, usually before the age of three years, while sequential bilinguals are typically bilinguals who were exposed to a second language after the first language has been mostly acquired, often after the age of three years (Paradis et al., 2011). However, the age cut-off used to define simultaneous bilinguals is not agreed upon. Indeed, some authors consider that only children exposed to both of their languages from birth fit the definition of simultaneous bilinguals (De Houwer, 2009). Others have used a cut-off of three years of age (Thordardottir 2011), or four years of age (Unsworth 2016), while others have defined simultaneous bilinguals as those children who acquired their two languages in early childhood (Meisel, 2001). These differences in age of first exposure (AoE) may be important during early childhood, as they are likely to influence language abilities in early childhood. However, as simultaneous bilingual children become older, AoE may influence their language abilities less

than does the amount of language exposure that they receive (Thordardottir, 2011, Unsworth 2016). Therefore, the distinction between whether acquisition occurred from birth or by the age of three may be less important as children become older (Thordardottir, 2011). This hypothesis appears to be supported by findings from Bedore and colleagues which showed that AoE to English had an influence on children's performances in English in grade 1, but that by grade 3, AoE in English no longer influenced their performances in English (Bedore, Pena, Griffin & Hixon, 2016). Other findings suggest that the influence of AoE could significantly diminish in simultaneous bilinguals as early as 5-years-old (Thordardottir, 2011). Indeed, for preschool-aged simultaneous bilinguals the amount of exposure has been found to be a better predictor of performances on language tasks than AoE (Thordardottir, 2011). However, AoE may still be important in later language learners, and its influence may vary depending on the area of language examined (Granena & Long, 2012). In keeping with the traditional cut-offs used in previous research (Thordardottir, 2011) and to facilitate comparisons across studies, this thesis will apply the cut-off of three years to define "simultaneous" bilinguals.

Younger Simultaneous Bilinguals

Research examining the language development of simultaneous bilinguals has mostly focused on the language development of toddlers and preschool-aged children. Findings suggest that these children are able to acquire overall language skills that are similar (without being identical) to those of their monolingual peers, in at least one of their languages. Such findings have been reported when examining both grammar (Paradis & Genesee, 1996; Thordardottir, 2015) and vocabulary (MacLeod, Fabiano-Smith, Boegner-Pagé, & Fontolliet, 2013; Pearson, Fernandez, Lewedeg, & Oller, 1997; Thordardottir, 2011). For example, when examining the language abilities of bilingual toddlers, research suggest that with less than 20% of their exposure to a language, they are able to use their second language, although they may not be as proficient in that language as are their monolingual peers (Pearson et al.,1997). For their part, preschool-

aged children have also been found to attain similar levels of overall proficiency to those of their monolingual peers when they receive between 40% and 60% of their exposure to a language, especially when examining receptive language abilities (Thordardottir, 2011). When examining expressive grammar, preschool-aged children can achieve levels of proficiency similar to those of monolinguals provided they receive approximately 50% of their exposure in that same language (Thordardottir, 2015). However, they may require more language exposure to attain such level when it comes to expressive vocabulary (Thordardottir, 2011).

Although simultaneous bilingual children are frequently able to reach similar language levels to those of their monolingual peers, that is not to say that bilinguals perform exactly like monolinguals. It is often the case that bilinguals are more proficient in one language than in the other (Grosjean, 1993). Bilinguals may also have smaller lexicon (Gollan, Fennema-Notestine, Montoya & Jernigan, 2007) than monolinguals, and sequential bilinguals children have been found to make errors in their use of grammatical markers either because of incomplete acquisition (Paradis, Rice, Crago & Marquis, 2008) or due to insufficient knowledge of morphology (Goldberg, Paradis & Crago, 2008). In addition, bilingual speakers' productions in their second language are at times influenced by their L1 (Zdorenko & Paradis, 2008). Nevertheless, within the range of bilingual abilities, many simultaneous bilinguals are able to reach overall language abilities that are, for the most part, similar to those of monolinguals, especially in their strongest language.

School-Aged Bilinguals

While numerous studies have examined the language development of toddler and preschool-aged simultaneous bilinguals (for review, see Hammer, Hoff, Uchikoshi, Gillanders, Castro, & Sandilos, 2014), Thordardottir (2019) has noted that little research has examined the language development of simultaneous bilinguals once they reach school age. Indeed, most studies examining the language development of school-aged bilinguals have tended to focus on sequential bilinguals (or second-language learners).

For these second-language (L2) learners, the amount of exposure that they receive in a language, and the age at which they are exposed to their L2 are important factors in predicting outcomes (Hakuta, 2000; Granena & Long, 2012). It also appears that, in sequential bilinguals, aspects of language may be differentially influenced by AoE, with pronunciation being most influenced by AoE, followed by vocabulary and then morphosyntax (Granena & Long, 2012). All things being equal, younger L2 learners are more likely to achieve levels of proficiency that are similar those of monolinguals on most, if not all, spheres of languages (Hakuta, 2000). While, this outcome is less likely in late L2 learners, many do become quite proficient in their L2, achieving what Abrahamsson and Hyltenstam (2008) refer to as "near native-like" abilities, and are able to complete advanced levels of schooling and have careers that require them to be proficient in their L2. These outcomes are in addition to benefiting from the many advantages of being able to communicate in two (or more) languages.

For school-aged simultaneous bilinguals, the few studies that have been conducted report that these children are often able to attain language proficiency levels similar to those of their bilingual peers, in at least one of their languages, provided they receive a sufficient amount of exposure (Thordardottir, 2019). The evidence suggests that exposure continues to play an important role in the language development of simultaneous bilinguals once they've reach school age (Thordardottir, 2019; Unsworth, 2016). However, researchers have yet to examine the relationship between exposure and proficiency in both of these children's languages. Only one study has compared school-aged simultaneous and sequential bilinguals' abilities in both of their languages and found that exposure did not influence both languages in the same way (Bedore et al., 2016). Similar findings were reported in preschool children (Bedore et al., 2012). It may be that differences in the relationship between language exposure and proficiency reflect the language's status in the community (MacLeod et al., 2013), although this explanation would need to be further examined.

Language exposure is an important factor in the language development of bilingual children. However, factors such as language of schooling and the socio-linguistic status of each language (i.e., minority versus majority language) may also influence language proficiency, in both simultaneous and sequential bilingual children (Gathercole, 2007; Gathercole & Thomas, 2009; MacLeod, Castellanos-Ryan, Parent, Jacques, & Séguin, 2017; Pearson, 2007). Such factors may directly or indirectly influence the amount of exposure that children receive to each of their languages, and may influence how often they are required to use each of their languages, and the number of contexts in which each language is used. As research in this area is fairly new, how best to account for these factors is currently not well understood. Nevertheless, bilingual children are often able to reach high levels of proficiency even though they receive less exposure to each of their languages than do monolingual children.

How Do Simultaneous Bilinguals Become Proficient in Two Languages?

It may be surprising, and even counter intuitive, that bilingual children are able to achieve high levels of proficiency while receiving less language exposure to each of their languages than do their monolingual peers. Pearson, et al. (1997) proposed three possible explanations for this phenomenon. First, they suggested that since bilingual children receive a reduced amount of language exposure, they become more efficient learners and are more proficient in "internalizing information" (Pearson, et al., 1997, p.53) than are their monolingual peers. Second, it may be that the rate at which children acquire a language is determined by developmental stages and therefore, more exposure does not lead to better or faster language development. The authors also suggested that children may learn in "fits and starts" (p.53), and thus do not make maximal use of this language exposure at all moments throughout development. Here, we will focus on the first two arguments as, in our view, there is overlap between the developmental stages and the "fits and starts" hypotheses, both of which suggest periods of growth and plateaus.

Pearson and colleagues' (1997) first hypothesis suggests that bilingual children may be efficient language learners. This efficiency could come from the development of strategies permitting them to use linguistic knowledge from one language to support the acquisition of their other language, otherwise known as positive transfer (Scheele, Leseman, & Mayo, 2010). Positive transfer is an important component of the larger concept of the *interdependence hypothesis* (Cummins, 1981) which states that instruction in one language can help the development of both languages, provided that children receive sufficient amounts of exposure to each of their languages. Verhoeven (2007) builds on this definition of the interdependence hypothesis by proposing that "optimal input in one language leads not only to better skills in that language but also to a deeper conceptual and linguistic proficiency that can clearly facilitate the transfer of various cognitive and academic language skills across languages" (Verhoeven 2007, p.426). These language skills include transferring knowledge of concepts, morphology, phonology, syntax and pragmatics, and also includes the ability of bilinguals to develop metalinguistic strategies (Cummins 2008, 2014). These metalinguistic strategies help bilinguals identify similarities and differences across their languages such that they are able to transfer their knowledge of one language to the other. Together, positive transfer and metalinguistic strategies may be important in permitting bilingual children to reach monolingual-like levels of proficiency even though they receive less exposure to a given language.

Interestingly, sequential bilingual children have been found to have better performances on tasks measuring metalinguistic abilities when compared to their monolingual peers (Bialystok & Barac, 2012; Bialystok, Peets, & Moreno, 2014). Moreover, there appears to be a positive relationship between increased amounts of experience using two languages and improved metalinguistic abilities. For example, Bialystok, et al. (2014) examined the development of metalinguistic abilities in English-speaking children from monolingual English-speaking homes who attended a grade-2 or a grade-5 class in a French-immersion school. After two years of

French-immersion schooling, bilingual children in grade-2 began to demonstrate stronger metalinguistic skills than their monolinguals peers. After five years of immersion schooling, bilingual children's metalinguistic abilities were significantly stronger than those of their monolingual peers (Bialystok et al., 2014). Others have also found improved phonological awareness abilities (Kuo & Anderson, 2010), and improved acquisition of vocabulary (Cunningham & Graham, 2000) in bilingual children.

While experience using two languages may positively influences metalinguistic abilities, it is unclear how much bilingual language exposure is required for children to benefit from improved metalinguistic abilities or positive transfer. Although Verhoeven (2007) speaks of "optimal input", neither he nor Cummins quantify the amount of exposure that is required to benefit from these metalinguistic advantages. Moreover, studies examining the link between bilingualism and metalinguistic abilities rarely report the amount of exposure that children receive to each of their languages. That said, Kuo & Anderson (2010) report improved metalinguistic abilities in children receiving between 10-30% of their exposure to their L2. Also, children who participated in both the Bialystok et al. (2014) and the Cunningham and Graham (2000) studies are reported to attend immersion schooling (although little information is given about these programmes). It is therefore likely that the children received less than 50% exposure to their L2[1] thus suggesting that with less than 50% exposure to their L2 children are able to benefit from improved metalinguistic abilities.

Taken together, the evidence suggests that bilingual children make use of positive transfer and metalinguistic strategies to support dual-language acquisition. It may be that with practice, bilingual children become more proficient in using these strategies, which in turn leads to them

[1] Since children in both of these studies, children were native speakers of English, and lived in an English environment it is likely that they received less than 50% exposure to their L2 overall, when one accounts for the time spent outside of school on weekdays and weekends.

becoming more proficient dual-language learners. Such abilities may explain why children are able to acquire two (or more) languages from a reduced amount of language exposure.

The second hypothesis put forth by Pearson and colleagues (1997) is based on developmental constraints, such that children may only be able to use a portion of the language to which they are exposed during the process of language acquisition. Research evidence in support of this hypothesis can be found in the work of de Villiers and de Villiers (1973) who have shown that, in English-speaking monolingual children, the acquisition of *Brown's morphemes* followed a fairly similar developmental path across children. For example, morphemes such as the progressive *-ing* and the plural *–s* are generally acquired early in development, while other morphemes such contractible auxiliaries develop later. This developmentally-based acquisition pattern was observed even in cases where parents used more advanced morphemes more frequently when speaking to their child (Villiers and de Villiers, 1973). Such findings suggest that, for young monolingual children, the amount of language exposure that they receive does not influence the order or the relative rate at which they acquire morphology. Similar findings have been reported for the acquisition of question words (Brown, 1968) and the acquisition of the different sentence structures (Menyuk, 1964) in monolingual speakers. In the case of bilingual children, developmental constraints may explain why many, particularly simultaneous bilinguals, develop language abilities that are similar to those of their monolingual peers despite the reduced exposure that they receive (MacLeod et al., 2017; Thordardottir, 2011).

It is of course quite possible that both of these hypotheses are correct and that bilingual advantages (i.e., improved metalinguistic abilities and the ability to use positive transfer) and developmental constraints together play a role in bilingual language development. Collectively, these adaptations appear to allow bilingual children to develop overall language abilities that are similar to those of their monolingual peers, in at least one of their languages.

As this section demonstrates, many factors influence many children's abilities to reach high levels of proficiency in both of their languages. Nevertheless, simultaneous bilinguals are able to reach overall language levels that are similar (without being identical) to those of their monolingual peers in at least one of their languages, provided they receive sufficient amounts of exposure. That said, little research has examined language development of simultaneous bilinguals once they reach school age, especially not in their two languages. And as the next section will show, this gap in the literature extends to bilingualism in the context of ASD.

Autism, Language and Bilingualism

ASD is a neurodevelopmental disorder affecting one in 59 children (Baio et al., 2018). At its core, ASD is associated with deficits in social communication, such as difficulty using eye contact, turn-taking, attending to others, and using and attending to gestures (American Psychiatric Association (APA; 2013). Children with ASD also present repetitive behaviours (e.g., stacking block over and over), restrictive interests (e.g., having a perseverative interest such as dinosaurs) and stereotyped behaviours (e.g., hand flapping; APA, 2013).

While not all children with ASD will have deficits in the area of structural language (i.e., morphology, syntax, phonology and vocabulary), a large number of children with ASD will initially present delays in developing language milestones (Bennett et al., 2014). In fact, it is often because of such delays that parents start the diagnostic process (De Giacomo & Fombonne, 1998). However, for many of these children, their language delay often resolves itself (Bennett et al., 2014). That said, children with ASD who develop language abilities similar to those of their ND peers have been reported to present language profiles that are particular to ASD. For example, vocabulary can be a relative strength in these children when compared to their overall language abilities (Boucher, 2012; Kjelgaard & Tager-Flusberg, 2001; Pickles, Anderson & Lord, 2014). Some children with ASD have been reported to have stronger expressive language abilities than receptive language abilities (Kjelgaard & Tager-Flusberg, 2001; Saalasti et al., 2008; Seung,

2007), although this is not always the case (Kwok Brown, Smyth & Cardy 2015; Pickles et la., 2014).

Although a subset of children who present a language disorder have an underlying cognitive deficit, other children will present a language deficit in the presence of typical cognitive abilities (APA, 2013; Boucher, 2012; Pickles et al., 2014). This latter group often present structural language deficits similar to those of children with developmental language disorders (Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg, 2006), with morphosyntax often being more impaired than other aspect of structural language. However, children with ASD appear to have stronger phonological abilities than children with developmental language disorders, suggesting that the underlying mechanisms of the language disorders found in children in ASD may be different than in their peers with a developmental language disorder (Williams, Payne & Marshall, 2013).

Because of the frequent presence of language delays in young children with ASD (and of on-going language disorders), parents of children with ASD who live in bilingual or minority language contexts are often told to refrain from using two languages with their child with ASD (Hampton Rabagliati, Sorace, & Fletcher-Watson, 2017; Yu, 2013), even though evidence does not support this recommendation (Hambly & Fombonne, 2012; Ohashi et al., 2012).

As with research on bilingual language development in ND children, most of the research on bilingual children with ASD has examined language development in toddlers and preschool-aged children, with few studies examining school-aged children (see Gonzales-Barrero & Nadig, 2018; Hambly & Fombonne, 2012; Kay-Raining Bird, Lamond & Holden, 2012; and Sen & Geetha, 2011 for studies that include school-aged children). Studies examining the language development of young bilingual children with ASD have found that these children generally develop similar language abilities to those of their monolingual peers with this disorder who have similar cognitive abilities. Such findings have been reported in language areas such as vocabulary (Peterson,

Marinova-Todd & Mirenda, 2012), receptive and expressive language (Hambly & Fombonne, 2012; Ohashi et al., 2012), and social communication (Reetzke, Zou, Sheng, & Katsos, 2015). In some cases, children with ASD have been found to have even stronger social communication abilities than those of their monolingual peers (Hambly & Fombonne, 2012; Valicenti-McDermott et al., 2013).

This latter result is particularly interesting for children with ASD since social deficits are a hallmark of ASD (APA, 2013). Indeed, an important part of being bilingual is the ability to attend to one's interlocutor and to adjust to the interlocutor's language. ND children as young as two years of age have shown this ability (Genesee, Nicoladis, & Paradis, 1995). It may, therefore, be that bilingualism positively influences children' early abilities to attend to their interlocutors' various languages, thus providing an advantage (rather than a disadvantage) for bilingual children with ASD, although this hypothesis has yet to be examined. Of course, bilingualism does not preclude children from having a language disorder. However, as these studies show, bilingualism does not appear to exacerbate language delays in children's language development, even in the context of ASD.

In addition to showing that bilingualism is not an additional barrier to the language development for children with ASD, research has shown that there are important repercussions for children when they do not speak their parents' language. These include difficulty for parents who speak a minority-language to easily communicate with their child, challenges for the child when communicating with extended family members who may not speak the same language, and exclusion from their cultural community (Hampton et al., 2017; Kremer-Sadlik, 2005; Yu, 2013). Moreover, children who live in a bilingual household but who do not speak the family's minority language could be unintentionally excluded from conversational opportunities at home (Hampton et al., 2017; Kremer-Sadlik, 2005). Since difficulties with social communication are a core feature

of ASD, and that these deficits negatively influence conversational skills (APA, 2013), it is possible that this exclusion could be detrimental to these children's language development.

Findings regarding language development in bilingual children with ASD indicate that children with ASD are able to acquire two languages in a manner that is parallel with their peers of similar cognitive abilities, in at least one of their languages. However, as previously noted, few studies have examined bilingual language development in school-aged children with ASD. Moreover, few studies have examined these children's language abilities in both of their languages, and few have compared them to those of their ND bilingual and monolingual peers.

As this literature review demonstrates there are important gaps in the literature examining the language development of ND simultaneous bilingual children and of simultaneous bilingual children with ASD, once they have reached school age. This is particularly true when examining these children's abilities in both of their languages. It is within this context that this thesis was developed.

The Current Thesis

The overarching research aim of this thesis is to examine bilingual language development in ND school-aged simultaneous bilingual children, and in their peers with ASD who present neither an intellectual disability, nor a language disorder. This was completed through three manuscripts: first a literature review followed by a group study, and finally, a pilot study.

Throughout this thesis, simultaneous bilingualism is defined as children who were exposed to their two languages by the age of three years. We have chosen this age as a cut-off as it has been frequently used in the literature (ex: Thordardottir 2011, 2019), while recognizing that this cut-off may be somewhat arbitrary. Additionally, for our experimental studies, we did not impose a minimum amount of language exposure for children to be considered bilingual. There are numerous reasons for this choice. First, a key goal of manuscript 2 (and of manuscript 3 to a

lesser extent) was to examine the influence of language exposure on bilingual language development. By not setting a minimum threshold, it was possible to examine how children with lower amounts of exposure performed. Second, in an on-going study examining language abilities in French-English bilingual pre-schoolers, it was found that some children were able to complete language testing in English even though parent reports indicate little direct exposure to English (Beauchamp, MacLeod, Trudeau, Sutton, Lefebvre, & Schneider, in preparation). This preliminary finding suggests that parent questionnaires do not capture all of the opportunities for language exposure that a child may experience. Finally, given the amount of variability in bilingual children's language abilities, there is currently no clear minimum threshold to apply, particularly in school-aged simultaneous bilingual children. Therefore, we only required that children be identified as bilinguals by their parents.

In reading this thesis, readers will notice a change in the use of the term *dominance* from manuscript 1 to manuscripts 2 and 3. This reflects my development in understanding this concept. Initially, I understood *dominance* to mean more exposure to a specific language. However, overtime, I observed that this term was also used to refer to numerous other concepts. For example, Bedore et al. (2012) state that language dominance "describes the relative proficiency [that a person has in a language] (Gathercole & Thomas, 2009) or the language to which the child has had the most exposure (Grosjean, 2010)" (p.617), although for Bedore and colleagues, their description of dominance seems to lean towards Grojean's definition of the construct. It has also been used to refer to the more "active" language (p. 167, Heredia & Altarriba, 2001), the language in which the child is most proficient (Paradis et al., 2011), the language that is most often used by a speaker (Gathercole & Thomas, 2007), or the speaker's preferred language (Carroll, 2017). Adding to the confusion, some studies do not define their use of the term *dominance* (ex. Dunn & Fox Tree, 2009). Further readings have not clarified this ambiguity. Thus, to avoid additional confusion, I have opted to refrain from using the term *dominance* in manuscripts 2 and 3. Instead,

I will speak directly to the amount of language exposure and to children's language proficiency, which are both measured systematically in these studies.

To measure language exposure systematically, the Montréal Bilingual Use and Exposure (M-BLUE) questionnaire was developed. While a number of language exposure questionnaires already exist, none met the needs of the present study for the following five reasons. First, few questionnaires were appropriate for use with both preschool and school-aged children (ex: Paradis, 2011 and Byers-Heinlein et al., 2018 for toddlers; Gutierrez-Clennan and Kreiter, 2003 for school-aged children). This age range was important since we wanted to create a tool that clinicians could easily use with as many of their clients as possible. Second, many questionnaires assume a majority language (usually English, ex: Paradis, 2011). Given our context in Montréal, Québec, we required a language neutral questionnaire. Third, most questionnaires only gather information from a few settings (for example home and school), and do not examine language exposure elsewhere or with other interlocutors such as friends (ex: Pearson et al., 1997 and Ribot, Hoff, & Burridge, 2018 only gathered information about the home context). For this study, we aimed to obtain as complete a picture of the child's language exposure as possible, which required that we examine language exposure across multiple individuals and across multiple contexts (e.g., home, school, extracurricular activities) and across different interlocutors (i.e. parents, siblings, grand-parents, nannies, friends). Fourth, many questionnaires (ex: Gutierrez-Clennan & Kreiter, 2003) only allowed for two languages to be examined (i.e. assume that children only speak two languages), making it difficult to gather information about language exposure in multilingual children. Finally, while some language questionnaires were available either as an annex in research articles or electronically, most studies only provided a very brief description of their questionnaire but did not make it available to researchers and clinicians (ex: Bedore et al., 2012; Bedore et al., 2016 [only available commercially]; MacLeod et al., 2013; Thordardottir,

Rothenberg, Rivard & Naves (2006); Thordardottir, 2011; 2015 and 2019; Unsworth 2013 and 2016).

In developing the M-BLUE, we addressed these issues in the following ways: First, the M-BLUE can be used with children of all ages. Second, it does not presume a majority language. Third, our questionnaire examines language exposure in a number of different contexts, including home, school and extra-curricular activities, and across different interlocutors (i.e. parents, siblings, grand-parents, nannies, friends). In addition, the M-BLUE asks whether the child receives instruction in their minority language. Fourth, the M-BLUE is formatted to gather information for up to three languages but could easily be adapted to gather information about a fourth language as needed. Fifth, we have made the M-BLUE freely available electronically at https://bilingualacquisition.ca/bab-lab-tools/. It is also included in Appendix 1 at the end of this thesis. Additionally, by asking questions about AoE of the L2 and about changes in the child's language exposure, the M-BLUE permits for the estimation of both current and lifetime language exposure. Finally, the M-BLUE permits for the gathering of information regarding the amount of language exposure that children receive through media and through literacy. While this exposure is not used in calculating amounts of overall language exposure, it can give clinicians and researchers extra insight into a child's language experience in each language.

Manuscript 1 of this thesis consists of a review of the literature that focused on the language development of bilingual children with ASD, of children with other developmental delays such as Down's syndrome and developmental language disorder (formerly specific language impairment), and in their ND peers. The literature showed that children with different cognitive and language abilities, including children with ASD, could become bilingual and that they could attain proficiency levels similar to those of their monolingual peers of similar cognitive or language age. We also examined the recommendations made to bilingual and minority-language families of children with ASD, and the repercussions of the recommendations against bilingualism for

these children. Guidelines available to clinicians who work with bilingual populations were also discussed and important gaps in the guidelines offered by professional associations and governing bodies were identified. Finally, the responsibilities of clinicians were discussed relating to how they can support bilingual and minority-language families in raising their child with ASD in bilingual and minority-language contexts.

Next, in manuscript 2, bilingualism in ND school-aged simultaneous bilinguals was explored. In particular, the relationship between language exposure and these children's language abilities were analysed with a focus on the following two research questions. First, is exposure related to language abilities in school-aged simultaneous bilinguals, when examining both of their languages? Based on previous research (ex: Thordardottir, 2011), it was expected that these children's language abilities, particularly expressive language, would be influenced by language exposure. Second, how much exposure do children require to obtain scores within standardised test norms in each of their languages? Based on previous research (ex: Thordardottir 2011), it was expected that children would require approximately between 40% and 60% exposure to a language to reach monolingual norms, but that this level may be high for expressive language tasks.

When this thesis was undertaken, there was a paucity of research in the area of bilingualism in school-aged simultaneous bilingual. Quite recently, studies examining language abilities specifically of these bilingual children have been published; however, there are still important gaps in the literature. For example, both Thordardottir, 2019 and Unsworth (2016) examined language development in school-aged simultaneous bilinguals, separately from that of sequential bilinguals but only did so in one of the participants' languages. In their study Bedore et al. (2016) compared the language abilities of school-aged bilingual children in both of their languages but their sample included both simultaneous bilinguals and sequential bilinguals, which may have influenced some of their findings. Finally, only Thordardottir (2019) compared the

language abilities of simultaneous bilinguals to those of their monolingual peers, but findings are difficult to interpret clinically as raw scores were used (Bedore et al. 2016 did use a standardized tool, the BESOS, that the authors developed. However, it is unclear how this tool was normed).

Manuscript 2 reports on a study that aimed to fill these gaps by examining the language abilities of simultaneous school-aged bilinguals, in both of their languages, through standardized language tests that are widely used clinically. By examining children's language abilities in both of their languages, it was possible to investigate whether simultaneous bilinguals, living in an additive context, required the same amount of exposure to both of their languages to achieve similar levels of proficiency in each language. It was also possible to examine whether certain aspects of language were more sensitive to exposure than others, and whether these aspects were the same across both languages in bilingual children. Moreover, based on the current literature, it was unclear whether the relationship between exposure and language abilities would remain the same in school-aged simultaneous bilingual children as found in preschool-aged simultaneous bilingual children, or if this relationship changed in older children. The findings from the second manuscript improve our comprehension of the influence of language exposure on the development of children's two languages. Through these findings, we gained a better understanding of whether bilingual children's two languages (French and English) are similarly influenced by exposure and how additional factors, such as daily exposure to two languages, play a role in simultaneous bilingual children's language development.

From a clinical perspective, these findings will help speech-language pathologists adjust their expectations regarding the language abilities of school-aged simultaneous bilinguals relative to their language exposure, and, therefore, help to reduce over or under identifying bilingual children with language disorders. Moreover, these findings will increase clinicians' understanding of the link between exposure and performances on standardised language tools. Indeed, understanding the relationship between exposure and language abilities as measured by

standardised tools is essential for clinicians. In previous studies, the language abilities of school-aged simultaneous bilingual children have been examined through the use of experimental tasks (Unsworth, 2016) or by using raw scores on tests (Thordardottir, 2019). These types of comparisons are difficult to interpret clinically. And although Bedore and her colleagues (2012; 2016) used a normed measure that they developed to assess English-Spanish bilinguals, (the BESOS) little is known about the norming procedures for this tool. While using standardised measures as the sole measure is not recommended when assessing bilingual children's language abilities, they can be part of a broader language assessment and can provide useful information. Additionally, many government agencies require that standardised scores be reported in order for children to receive services or financial support. It is, therefore, important that clinicians better understand the relationship between exposure and scores on standardised language measures. By examining the language abilities of school-aged simultaneous bilingual children in both of their languages and comparing their results on standardised language measures to their levels of exposure in each language, the second manuscript fills an important gap in the literature, and will help researchers and clinicians better understand the relationship between exposure and language abilities in school-aged children. Having gained a better understanding of language abilities in ND school-aged simultaneous bilinguals, clinicians and researchers will be in a better position to understand the language abilities of school-aged simultaneous bilingual children.

In manuscript 3, previous findings on bilingual children with ASD were expanded upon by examining the language abilities of three school-aged simultaneous bilingual children with ASD, without a comorbid language disorder or intellectual disability. In this pilot study, these children's language abilities were compared to those of their monolingual peers with ASD (n=2), as well as to those of their bilingual ND peers (n=19), and monolingual ND peers (n=12). For bilingual children, language abilities were examined in both of their languages (French and English). This manuscript begins with a short review of the literature on bilingualism in ND children to provide

background for the research hypotheses. The paper then turns to focus on the language abilities of school-aged bilingual children with ASD, but who do not have a language disorder or a cognitive disability. The rationale for this narrow focus was driven by the need to examine the influence of ASD on bilingual language development in the absence of other confounds such as an intellectual disability or a language disorder. In other words, by focusing on this subgroup, the goal was to examine the influence of ASD on bilingual language development and thus, whether or not ASD characteristics, such as the social deficits, would impede bilingual language development. This focus also permitted an examination of how bilingual children with ASD would perform when compared to their ND classmates. Indeed, children with ASD who have profiles similar to those of the children in this study are often fully integrated in classes with their ND bilingual and monolingual peers. It is, therefore, important to examine their language performances vis-à-vis those of their classmates.

When examining the groups of bilingual and monolingual children, there appears to be a difference between the NVIQ of the children in the ND monolingual group and children in the ASD groups, with the latter obtaining higher scores than the former. Given the number of children in the ASD groups, parametric and non-parametric statistics could not be reliably completed. Instead, a Bayesian analysis was completed to examine whether there were differences between the groups. Bayesian statistics examine the probability that a hypothesis is true. Bayes Factor scores above 3 denote that the hypothesis is supported whereas scores below .333 indicate that the null hypothesis is supported. Bayes Factor scores between .333 and 3 are considered anecdotal evidence. Such scores indicate that "the data is not sensitive enough to draw a strong conclusion" (p.4524, Brydges & Gaeta, 2019). In this case, the hypothesis was that there were group differences in the NVIQ scores (as measured by the Perceptual Reasoning Index; PRI), and the null hypothesis was that there were no differences in the NVIQ scores. Results from the Bayesian ANOVA revealed a Bayes Factor of .363, thus falling in the lower range of *anecdotal*

evidence range. Although the trend points toward supporting the null hypothesis (i.e. no differences between the groups), this result remains inconclusive. Given this inconclusive result, and the difficulty in its interpretation, it was not reported in the published article. Rather a statement explaining the rational for not completing traditional statistics was included, as were the group means for NVIQ. In doing so, the reader is not misled into following unreliable, inconclusive or tenuous statistics regarding group differences. Additionally, NVIQ was used as a co-variate in a post-hoc analysis. Nevertheless, it is unclear what role, if any, these higher scores on NVIQ for the bilingual children with ASD played and whether they influenced these children's abilities to cluster with their ND monolingual peers.

Although the findings of this study will not be generalizable to the entire spectrum of children with ASD, by investigating this subgroup of children with ASD, this pilot study provides important preliminary information regarding the link between ASD and bilingualism, without confounds such as a language disorder or an intellectual disability. Based on previous research (Hambly & Fombonne, 2012; Peterson et al., 2012, Ohashi et al., 2012), it was expected that bilingual children with ASD would have similar performances to those of their monolingual peers with ASD but that bilingual and monolingual children with ASD would perhaps present language patterns specific to ASD when compared to their ND bilingual and monolingual peers. It was also expected that bilingual children with ASD may have weaker performances than those of ND bilingual and monolingual children (Gonzalez-Barrero & Nadig, 2018).

The findings from the third manuscript fill a gap in the literature and increase our understanding of how school-aged bilingual children with ASD with a profile similar to that of the children in this study develop bilingual language abilities. In particular, this research documents how these children's language abilities compare across their two languages, how they compare to those of their monolingual peers with ASD, and to those of their bilingual and monolingual ND peers. Again, this is important since it permits an exploration of whether ASD symptomatology

(i.e. social deficits) itself could prevent bilingual children from becoming as proficient as their ND bilingual peer. Also, this pilot study allows for the comparison of different groups of children who are often schooled together. Finally, given the preliminary nature of this study, this study will help establish the testing protocol used here for a future larger study.

From a clinical perspective, these findings contribute to increasing clinicians' understanding of bilingual language development in school-aged children with ASD who do not present an intellectual disability or a language disorder. This knowledge will provide clinicians with the further evidence to support their work with bilingual and minority language families wanting to raise their children in both of their languages. Results from this study, together with those from other studies, will also help inform assessment results by providing clinicians with the information needed to more confidently interpret the assessment results of school-aged bilingual children with ASD without a language disorder or intellectual disability.

Overall, this thesis makes three novel contributions to the fields of bilingualism research and speech-language pathology. First, by examining the language development of ND school-aged simultaneous bilinguals in both of their languages, it was possible to examine how two languages develop side by side, and the influence of exposure on both languages when children are raised in an additive linguistic context. This is novel as, to my knowledge, this has not yet been examined in school-aged children. Indeed, while research examining best-practices in assessment has shown the importance of assessing bilingual children in both of their languages (for example Thordardottir et al., 2006) it is not always possible to do so. By examining the language abilities in both languages, it will be possible to examine whether both languages developed similarly when simultaneous bilinguals are raised in additive contexts. It was also possible to observe whether factors other than exposure play a role in simultaneous bilingual children's language development one they reach school-age.

A second novel contribution was the examination of the abilities of simultaneous bilingual children with ASD who have neither a comorbid intellectual disability nor language disorder, compared to those of their ND bilingual and monolingual peers, in both of their languages. By doing so, this research builds a better understanding of the relationship between ASD and bilingualism without confounds such as language disorders or intellectual disabilities. It also permits the comparisons of bilingual language abilities compared to those of bilingual and monolingual ND classmates, and an understanding of how both of their languages develop when supported.

A third novel contribution is the development of the Montréal Bilingual Use and Exposure (M-BLUE) questionnaire. This parent questionnaire was developed to measure of language exposure in bilingual and multilingual children resulting in detailed description of current and lifetime language exposure. This questionnaire also gathers information regarding the amount of language exposure that children receive through media and books. Together, this questionnaire can provide clinicians and researchers insight into a child's language experience in both of their languages.

On the whole, the findings from this thesis shed light on the language development and proficiency of simultaneous school-aged ND bilingual children and of their bilingual peers with ASD. The results within these pages also serve to improve our understanding of the relationship between exposure and language proficiency, in both of these children's language, and increase our comprehension of the relationship between language exposure, proficiency and other factors such as AoE and daily exposure to each language.

From a clinical perspective, these findings will help clinicians better assess language exposure in bilingual and multilingual children (through the M-BLUE). They may also assist them in interpreting more confidently the language test scores thus, helping clinicians identify more

accurately children with language disorders versus children with language delays caused by the incomplete acquisition of their L2. Finally, the results from our studies, along with those of others, are important in supporting parents who want to raise their ND child or their child with ASD as a bilingual speaker.

Preamble Manuscript 1

In this first manuscript, we ask whether children with autism (ASD) can become bilingual speakers. We do so by reviewing the literature on bilingualism in neurotypical children, in children with developmental disability and in children with ASD. Evidence suggests that minority-language parents of children with ASD, often receive the recommendation to avoid using their minority language with their child. In this manuscript, we discuss the reasons for such recommendations, as well as the possible consequences for children with ASD when they do not have access to their family's minority language. Finally, we consider the possible impacts that such recommendations could have on language development in children with ASD.

Overall, the evidence reviewed in Manuscript 1 suggests that children with ASD can become bilingual, and that bilingual children with ASD can reach levels of proficiency similar to those of their monolingual peers with ASD. Based on the available evidence, we make recommendations to professionals and parents regarding access to bilingualism for children with ASD. We also discuss the ethical responsibility of professionals to support families from minority language backgrounds.

Bilingualism in Children with Autism Spectrum Disorder:

Making evidence-based recommendations

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Abstract

Many professionals working with bilingual families of children with autism spectrum disorder (ASD) are concerned that the bilingual language context may lead to further language learning difficulties. As a result, it is often recommended that children with ASD be raised as monolingual speakers. The purpose of this article is to review the research on (a) bilingualism in neurotypical children and in children with developmental disabilities and language disorders, (b) the language development of bilingual children with ASD and (c) the implications of recommending that these children be brought up as monolinguals when they live in bilingual contexts. Based on current evidence, children with ASD can become bilingual, and bilingualism does not lead to further language delays. Furthermore, research has shown detrimental effects for both the child and their family when children with ASD from bilingual contexts are raised as monolinguals. Current evidence therefore supports the recommendation that children with ASD from bilingual contexts be raised bilingually.

Keywords: autism, bilingualism, language development

Introduction

Over half of the world's population speaks more than one language (Ansaldo, Marcotte, Scherer, & Raboyeau, 2008), and thus many children with autism spectrum disorder (ASD) will be raised in bilingual families. ASD is among the most common neurodevelopmental disorders, affecting 1 in 68 children (Wingate et al., 2014). It is characterized by deficits in social communication, as well as restrictive, repetitive and stereotyped behaviors (American Psychiatric Association, 2013). Since many children with ASD also present language deficits (Rapin & Dunn, 1997), it is often recommended that bilingual families of children with ASD focus on the language of schooling and refrain from using the family's home language with their child in order to avoid language confusion or further language delays (Jegatheesan, Fowler & Miller, 2010). Recent research has questioned whether these recommendations are well founded. Does bilingualism truly increase language delays in children with ASD? Will bilingualism lead to language confusion in these children? What are the implications of recommendations that discourage bilingualism, both for the child's development and for the family's overall well-being? The goal of this paper is to answer these important questions by reviewing the literature available in the field of autism specifically and within the broader field of bilingual language development. By doing so, we aim to assist professionals working in the field of ASD in providing recommendations that are evidence-based to bilingual families affected by ASD.

Bilingualism in Neurotypical Children

Broadly speaking, bilingualism refers to an individual's ability to communicate in two languages. Bilinguals can be placed on a continuum that ranges from individuals who know a few phrases in a second language to those who are equally proficient in their two languages. When speaking about bilingualism, the term *majority language* is used to refer to the language spoken by the majority of individuals in a given community, while the terms *minority, home,* or *heritage*

language refer to the language spoken by a minority of speakers in a given community. For many bilingual speakers, their languages are closely linked to the culture associated to each language they speak (Kremer-Sadlik, 2005). Given the importance and, for some families, the necessity of bilingualism, multiple studies have examined the effects of bilingualism on language development in neurotypical bilinguals, and more recently, in children with language, cognitive and/or developmental delays, including children with ASD. Overall, research suggests that neurotypical children can become proficient in their two languages, even attaining abilities similar to those of monolinguals. That said, although bilingual children share many similarities with their monolingual peers, bilingual children should not be considered to be two monolinguals in one child. Indeed, several differences exist between bilinguals and monolinguals, particularly during the first few years of language acquisition. The following paragraphs will address these issues and discuss some of the factors that influence language acquisition and proficiency in neurotypical bilingual children.

Several factors including (a) age of language acquisition, (b) amount of language input, and (c) social factors tied to the language context can affect the pace of language development in one or both of a bilingual child's languages. (MacLeod, Castellanos-Ryan, Parent, Jacques, & Séguin, 2017; MacLeod, Fabiano-Smith, Boegner-Pagé, & Fontolliet, 2013; Thordardottir, 2011). When addressing differences in age of language acquisition, bilinguals are often divided into two groups reflecting the age at which they began to learn their second language. Simultaneous bilinguals are individuals who acquired both languages more or less at the same time, usually before the age of 3 years, whereas sequential bilinguals are those who acquired their second language after having acquired their first language, usually after 3 years of age (Paradis, Genesee, & Crago, 2011), although there is considerable variability within the literature with regard to the age cut-off that defines these two groups (see Paradis et al., 2011 for discussion). In many cases, age of acquisition has an impact on the level of proficiency in both languages.

However, simultaneous bilingual adults will generally be more proficient in their non-dominant language (the language in which the speaker is less proficient) than will be sequential bilinguals (Flege, Yeni-Komshian, & Liu, 1999). (MacLeod et al., 2013; Thordardottir, 2011).

The amount of time a child is exposed to each of his languages plays an important role in a child's language acquisition. That said, children do not require 100% of their exposure to be in a given language in order to acquire abilities similar to those of monolinguals. Thordardottir (2011) demonstrated that the development of receptive vocabulary in five-year-old simultaneous bilinguals to be similar to that of monolinguals, even though bilinguals actually receive less exposure to each of their languages than do monolinguals. In fact, when examining their receptive vocabularies, simultaneous bilinguals have been found to keep pace with their monolingual peers when they receive as little as 40% of their weekly input in that language (Thordardottir, 2011). Moreover, typically developing children receiving as little as 20% of their weekly input in a language can acquire that language but do so at a slower pace than their monolingual peers, and are unlikely to acquire native-like abilities (Pearson, Fernandez, Lewedeg, & Oller, 1997).

Social factors tied to language contexts also have significant impacts on a bilingual child's language proficiency and are closely linked to input. When considering the total amount of input a child receives in a particular language, one should not only include languages spoken at home by the parents, but also languages used by siblings, at school and by those in the broader community (including during extracurricular activities, TV, electronic games and books). In their study investigating the correlation between input and environment, MacLeod et al. (2013) examined the impact of the "one-parent-one-language`" strategy in subtractive environments (an environment where the minority language is not supported). The "one-parent-one-language" strategy requires that one parent speak one language to the child and the other parent speak the other language. MacLeod and colleagues found that children growing-up in a subtractive environment may receive much less input in the minority language. Consequently, when

considering the child's language input from a variety of sources, children in this study received between 17 and 29% of their weekly input in the minority language, even though they received roughly the same amount of input from each parent. These children were therefore less proficient in the minority language (German) than monolingual speakers of German, while their proficiency in the majority language (French) was within normal limits. As this study demonstrates, a child's language environment can greatly influence language development, and subtractive environments may pose greater challenges to bilingual language development, even in simultaneous bilinguals (MacLeod et al., 2013).

The amount of input a child receives in each language, the age at which a child acquires these languages and the sociolinguistic context in which a child is raised are important factors in the acquisition, maintenance and level of proficiency attained in both languages, particularly in the case of minority languages (MacLeod et al., 2013, 2017; Thordardottir, 2011). However, such factors do not explain how bilingual children acquire two languages. Research has shown that bilinguals have two separate language systems that are present from the time they begin to acquire both of their languages (Genesee, 1989). Evidence to support the Dual Language System Hypothesis comes from children's vocabularies, grammars and phonological abilities. First, when examining bilingual infants' vocabularies, researchers have consistently found that they contain translational equivalents. That is, bilingual infants and toddlers are able to acquire a word in each one of their languages for a single concept (i.e., "dog" and "chien" [dog in French] for the concept "dog"). However, this ability violates the *Mutual Exclusivity Assumption*, which proposes that infants and young toddlers do not initially have two words for a given concept within a given lexicon (Hoff, 2005). Were bilingual children to collapse the vocabulary in their two languages into a single lexicon, they would be unable to have such translational equivalences (i.e., they would have the word "dog" but not "chien" or vice versa). That bilingual children have translational equivalences supports the hypothesis that their languages are stored into separate lexicons.

Second, studies have shown that children do not generally mix the syntax from their two languages. For example, French-English bilingual children generally respect the noun-adjective word order, which is different in French and in English. That is, while in French, the adjective follows the noun that it modifies (i.e., "un chien bleu"), in English, the adjective precedes the noun (i.e., "a blue dog"). French-English bilingual children rarely violate such rules and are able to apply the appropriate rules depending on the language they are using (Nicoladis, 2006). Studies have also shown that even when children code-switch (i.e., use both languages within a given utterance or discourse), they tend to do so following the syntactic rules of each one of their languages used to produce the utterance in question (Paradis, Nicoladis, & Genesee, 2000). Consequently, in a sentence such as "I want de l'eau" ("I want water"), the child replaces the English word "water" for the French word "eau". However, in order to avoid violating rules of French grammar, the child uses the appropriate nominal phrasing "*de l'eau*". In this example, even though the overarching phrase follows the rules of English, the nominal phrase follows the rules of French. In fact, contrary to popular belief, code-switching is not a sign of language confusion but rather an indication of language proficiency. Studies have shown that, the more proficient the bilingual speaker is in both of his languages, the more proficient the speaker will be when code-switching. (Paradis et al., 2000).

Third, studies have examined the way in which bilingual children omit syllables in each of their languages. In a paradigm where children were required to repeat nonsense words that followed either the phonological rules of English or French, bilingual children omitted syllables differently based on the truncation and omission rules of each of their languages (Paradis, 2001). As such, based on the phonological rules of each language, French-English bilingual children will omit certain syllables when speaking in French and different syllables when speaking in English, and will do so following patterns similar to those seen in their monolingual peers.

Although bilingual speakers' languages are contained in separate systems, that is not to say that language transfer never occurs (Nicoladis, 2002). Indeed, a bilingual speaker's productions in a given language are at times affected by the phonology, vocabulary or syntax from their other language, usually from the dominant to the weaker language (the dominant language being the speaker's stronger language or the language in which the speaker receives the most input). It should be noted though, that such transfers are, for the most parts, relatively infrequent in proficient adult bilinguals, particularly in their dominant language (Flege et al., 1999; also see discussion in Paradis et al., 2011).

Since bilingual children are acquiring two languages and therefore are required to manage two language systems, it should not be surprising that there would be both similarities and differences in their language development when compared to their monolingual peers. Such similarities and differences can be observed at all levels of their language system including phonology, vocabulary, morphology and syntax. From a phonological perspective, some researchers have found that bilingual infants' babbling will change depending on their interlocutor's language. For example, a French-English bilingual infant may produce babbling that contains French phonological features when "speaking" to a French speaker and babbling with English phonological features when "speaking" to an English speaker (Maneva & Genesee, 2002). As children age, they must learn to produce the speech sounds from each of their languages in order to generate speech that can be understood by others (i.e., phonology). When examining speech sound production and the use of various word shapes, bilinguals between the ages of one-and-a-half and three-and-a-half years have been found to keep pace with their monolingual peers of the same age, in their dominant language (MacLeod, Laukys & Rvachew, 2011). Moreover, when attempting complex words, children between the ages of two and three years of age generally use language-specific phonological principles, but also show an interaction between their two languages. They tend to simplify complex words based on strategies developed

in their dominant language (Paradis, 2001). Among bilingual children who are learning their second language in school, children aged four to seven years were found to produce errors that were present in one language but not in the other. And even when the error pattern was present in both languages, it was not necessarily applied in the same way or at the same rate in each language (Holm, Dodd, Stow, & Pert, 1999). Together, these findings indicate that, for the most part bilingual children can acquire the phonology of each of their languages. Although they may show some signs of interaction during their development with regards to error patterns, the pace of development parallels what is observed for monolingual children.

With regard to vocabulary, it appears that bilingual and monolingual infants go through the various early stages of vocabulary development at roughly similar ages. For example, bilingual and monolingual children start to recognize words at approximately the same age (between nine and twelve months old; Vihman, Thierry, Lum, Keren-Portnoy, & Martin, 2007). The distribution of the types of words that make-up children's vocabularies is also similar in bilingual and monolingual children. That is, an English-bilingual child's vocabulary will contain a larger percentage of nouns, followed by verbs, as is found in English-monolinguals (Pearson et al., 1997). However, as children develop their language skills, bilingual children can present some lags with regards to vocabulary knowledge in each one of their languages compared to their monolingual peers. Indeed, some children may fall in the low average range, even in their dominant language (Bialystok, Barac, Blaye, & Poulin-Dubois, 2010; Hammer et al., 2014; Pearson, Fernandez, & Oller, 1993), while others may fall within normal limits (MacLeod et al., 2013). As discussed earlier, factors such as age of acquisition, amount of input and environment may explain some of the differences in children's bilingual language acquisition, as can socioeconomic status (Hammer et al., 2014; Hoff, 2003) and maternal education (MacLeod et al., 2017). Although rates of vocabulary growth in each language appear to be somewhat slower in bilingual children, their abilities to develop concepts (i.e., to link the mental representation of a

dog to the word “dog”) are similar to those found in monolingual children (Pearson et al., 1993). It should also be noted that the total vocabulary (the total number of words in both languages combined) of bilingual children is generally greater than that of their monolingual peers (Pearson et al., 1993). Consequently, bilingual children end up with more words with which to express themselves and have the capacity to communicate with a far greater number of individuals when both languages are considered.

Studies have also examined the development of morphology and syntax in bilingual children and have found similarities and differences here as well. First, in their dominant language, simultaneous bilingual children appear to have mean length of utterances (MLU) similar to those of their monolingual peers. For example, Paradis and Genesee (1996) examined the utterances of three French-English bilingual children at three different time points between the ages of one year 11 months and three years three months. They found that two of the three children in this study had MLUs similar to those of monolinguals of similar ages, at least in their dominant language. Interestingly, the child who did not reach monolingual MLU thresholds was later identified as having a language disorder (Paradis et al., 2011). And although simultaneous bilingual children can present some lags, they generally catch-up to their monolingual peers in their dominant language, provided they receive sufficient amounts of input (Hakuta, 2000).

In addition to these similarities and differences, bilingualism also brings with it unique advantages: studies examining the link between bilingualism and cognition and more specifically between bilingualism and executive functions (EF) appear to suggest that bilingualism may have a positive impact on EF (see Adesope, Lavin, Thompson, & Ungerleider, 2010 and Bialystok, 2011 for review; also, see Paap, Johnson, & Sawi, 2015 for counterargument). It is believed that this bilingual advantage stems from the fact that, for bilingual speakers, both languages are always activated (see Kroll, Bobb, & Hoshino, 2014 for discussion). The bilingual speaker must therefore inhibit one linguistic system in order to attend to and access their other system, a

process that must be completed online, every time a bilingual speaker uses one of his languages. Bilingual speakers must also flexibly change from language to the other depending on their interlocutor and on the context in which they find themselves. In turn, EFs are constantly being recruited. This on-going practice appears to have positive impacts on EF that leads to a bilingual advantage. In their meta-analysis of 63 studies on bilingualism and EF, Adesope et al., (2010) found that bilingualism requires the use of specific EF that lead to better performances in attentional control (inhibition) and working memory. It may also have a positive impact on metalinguistic awareness and metacognitive awareness, as well as better symbolic reasoning and better problem-solving skills because of increased cognitive flexibility.

Studies have also shown that there may be differences in the types or amounts of advantages that bilinguals enjoy, and that the amount of time spent as a bilingual may have an impact on the extent of this bilingual advantage (Bialystok & Barac, 2012; Carlson & Meltzoff, 2008). Overall, performances on EF tasks appear to be positively correlated with length of time a child has spent as a bilingual, at least in sequential bilinguals. That said, in simultaneous bilinguals, the bilingual advantage has been found in seven-month-old infants. In their study, Kovács and Mehler (2009) found that those infants who had grown-up in bilingual households had better performances on switch-tasks (using spoken and visual stimuli) when compared to monolingual infants. Given these findings, it may be the case that for sequential bilinguals, the amount of time spent as a bilingual has a positive impact for EF performances (potentially up to a certain ceiling), and that this time is required in order for cortical changes to occur. Simultaneous bilinguals may show a bilingual advantage early on given that they have always been exposed to two language systems and do not need to undergo cortical changes (Berken, Chai, Chen, Gracco, & Klein, 2016).

Researchers have also examined the effects of bilingualism on theory of mind, the ability to understand mental states and use that information to decode social information from other

people's behaviors and understand how our own behaviors affect others (Premack & Woodruff, 1978). Findings have shown improved theory of mind abilities in bilinguals compared to their monolingual peers. For example, in her study of English-Chinese bilinguals, Goetz (2003) found that when controlling for language ability, bilingual children had better performances on at least one of the theory of mind tasks presented. Farhadian et al., (2010) also found similar results in Kurdish-Persian preschoolers. Interestingly, researchers have found a positive correlation between performances on EF and on theory of mind tasks, both in children (Carlson, Moses, & Claxton, 2004) and in adults (Rubio-Fernandez & Glucksberg, 2012), suggesting a link between these cognitive functions.

All things being equal, bilingual children can become proficient speakers in their two languages, even when they do not reach the same level of proficiency as monolingual speakers (see Hammer et al., 2014 for a more complete review). Moreover, the management of two languages also appears to yield other cognitive benefits above and beyond the ability to communicate in two languages. This is good news for bilingual families, but what about children with developmental disorders? Can they become bilinguals? Or could bilingualism lead to further language deficits in these children?

Bilingualism in Children with Developmental Delays

Bilingual language development in children with various developmental disabilities has been examined, including in children with specific language impairment (Paradis, Crago, & Genesee, 2006; Paradis, Crago, Genesee, & Rice, 2003) and in children with Down Syndrome (Feltmate, & Kay-Raining Bird, 2008; Kay-Raining Bird et al., 2005)

Children with specific language impairment (SLI) present language impairments, particularly with regards to grammar, even though they present nonverbal IQs within normal limits

(Leonard, 1998). Paradis and colleagues have examined whether bilingual children with SLI would be negatively impacted by the acquisition of two languages compared to their monolingual peers with SLI. In a study examining the use of tense marking in French-English bilingual and monolingual children with SLI, as well as in MLU-matched controls (without SLI), findings revealed no differences in the performances of bilingual and monolingual children with SLI with regards to the use of tense marking. (i.e., *he walk-s*). However, children with SLI in both language groups were more impaired in their use of tense marked verbs than the MLU-matched peers without SLI (Paradis et al., 2003). In a separate study, Paradis et al., (2006) compared the use of direct object pronouns in French-bilingual and French-monolingual children with SLI compared to MLU-matched controls without SLI. They found that bilingual and monolingual children with SLI were less accurate in using the direct object pronouns (i.e. *"*Il mange *le biscuit"* / "Il **le** mange": which translates to "He eats *the cookie"* / "He eats **it")** than typically developing children. Moreover, children with SLI were more successful in using definite articles appropriately (i.e., "le", "la", "les", ("the" in English) than they were in using the direct object pronouns (also "le", "la", "les") even though these articles and pronouns are homophonous. Crucially, the authors found no significant differences between the performances of bilingual and monolingual children with SLI. Results from these studies indicate that, although children with SLI may have different cross-linguistic difficulties, bilingualism does not exacerbate their difficulties.

Bilingualism in children with Down Syndrome has also been investigated, although to a lesser extent than in children with SLI. Two studies by Kay-Raining Bird and colleagues (Feltmate & Kay-Raining Bird, 2008; Kay-Raining Bird et al., 2005) have examined the language abilities of bilingual children with Down Syndrome compared to neurotypical controls matched on mental age. Using standardized measures and language samples, both of these studies found that overall, bilingualism did not have a detrimental impact on the language development of children with Down Syndrome (Feltmate & Kay-Raining Bird, 2008; Kay-Raining Bird et al., 2005).

However, the authors found a significant amount of variability in the language abilities of the children with Down Syndrome, which could not be explained by language status (bilingual vs monolingual), mental verbal age, or parental education. The authors suggest that this latter finding is further evidence that bilingualism does not increase deficits in children with Down Syndrome. If bilingualism had a negative effect on language development, monolingual children would have had consistently better performances than their mental-age matched bilingual peers, which was not the case (Feltmate & Kay-Raining Bird, 2008).

Together, the findings from these studies indicate that bilingualism does not appear to be detrimental to language development in children with developmental deficits in language or cognition. We may therefore expect that families of children with ASD would receive support from professionals when wanting to raise their child bilingually.

Consequences of Recommending Against Bilingualism

Although research has demonstrated that bilinguals with various developmental disabilities do not experience additional language delays when compared to their monolingual peers, research has also shown that professionals in the fields of healthcare and education often recommend that bilingual families raise their children with ASD as monolinguals. As noted by Yu (2013), many parents from minority language backgrounds report that they would have liked to raise their child as a bilingual. Unfortunately, they often do not do so because many view bilingualism as a barrier to language development in light of their child's diagnosis, based in large part on recommendations against bilingualism made by professionals such as doctors, psychologists, teachers and speech and language pathologists. Indeed, many parents report being told that their child with ASD would make greater and faster language gains if he or she was exposed to a single language rather than being raised bilingually. In addition, many families report consistently being discouraged from raising their child bilingually, (Kay-Raining Bird,

Lamond & Holden, 2012; Kremer-Sadlik, 2005). Parents have also reported being told by professionals that bilingualism would lead to language confusion in their children and that their child with ASD would be "fine" if families refrained from using their home language and instead only used the majority language with their child. (Jegatheesan et al., 2010). The belief that exposure to a second language will put further strain on the acquisition of one language or that it will lead to language confusion appears to be prevalent (Jegatheesan et al., 2010; Kay Raining-Bird et al., 2012; Kremer-Sadlik, 2005; Yu, 2013). It should be noted that, the assumption that bilingual children get confused is not uncommon, even in typically developing children; however, evidence does not support this assumption. For example, Genesee, Boivin, and Nicoladis (1996) examined whether bilingual toddlers were able to switch from one language to another depending on their interlocutor, even when required to use the language in which they were less proficient. Of the four children in the study, three children were able to adjust their language use based on the language used by the interlocutor. Furthermore, as noted earlier, even when code-switching, bilingual children are able to follow the rules which govern both of their languages (Paradis et al., 2000). Although language transfer can occur (Nicoladis, 2002), children do not generally mix the grammatical rules of their languages (Nicoladis, 2006). Such findings indicate that bilingualism does not lead to language confusion.

Recommendations against raising children with ASD bilingually, particularly when combined with intervention services that are often limited to the majority language, may lead families to feel that they need to make the difficult choice of raising their child solely in the majority language. This is especially true when parents believe that avoiding bilingualism will decrease language confusion, increase language skills in their child, and increase their child's access to intervention services. It is therefore not surprising that parents often choose to raise their child with ASD solely in the majority language. However, there are important implications for minority language families who raise their child with ASD as monolinguals.

In her study, Filmore (1991) discusses a number of the negative consequences linked to parents' inability to communicate effectively with their children in the parents' native language, particularly when parents are less fluent in the majority language. In this study, interviews were conducted with over one thousand immigrant parents of typically developing children in the United-States, whose first language was not English. Results obtained revealed most notably that the inability for parents and children to communicate proficiently had a negative effect on the parent-child relationship. Similar difficulties can also be observed in children with ASD from bilingual families when they have been raised as monolinguals. In children with ASD who are fluent speakers, communication between a child who only speaks the majority language and a parent who may not be proficient in this language can be quite difficult. Minority language parents, particularly those who are less proficient in the majority language, may find it difficult to fully express themselves solely in the majority language. They also often lack the correct grammar and vocabulary to communicate proficiently with their child in everyday contexts (Kremer-Sadlik, 2005; Yu, 2013,). As reported by parents in Yu (2013), this can make communications between the parent and their monolingual child quite challenging. These difficulties may increase over time as the child's language abilities in the majority language increases (Yu, 2013).

Moreover, recommendations that children with ASD be raised as monolinguals do not take into consideration bilingual families' every day realities or values. Many families believe that it is important for them to raise their children bilingually. Parents who participated in the Kay Raining-Bird et al., (2012) study indicated several reasons for raising their child as a bilingual speaker including: communication with family members, individuals in the family's neighbourhood and at the child's school; living in a bilingual city or country; and the belief that being bilingual provides more life opportunities and may be important for the job market.

Notably, for many bilingual and minority language families, bilingualism is a necessity. These families may have extended family members who only speak the family's heritage

(minority) language. In such families, a child's inability to speak the family's heritage language can lead to his or her inability to speak with extended family members like aunts and uncles, cousins and grandparents. In addition, immediate family members may use their heritage language amongst themselves in everyday conversations. As a result, children from bilingual families who are raised as monolinguals are often excluded from conversational and social interactions. They are consequently unable to benefit from extra language exposure and from much needed opportunities to practice conversational skills, a particularly affected area in children with ASD.

Finally, languages are also often closely linked to cultural identities (Jegatheesan et al., 2010). Families from minority backgrounds may participate in religious and/or cultural communities where they are required to speak their home language and follow that community's socio-cultural norms, which may be significantly different from majority-language socio-cultural norms (Filmore, 1991). When children from a bilingual family do not speak or understand the family's heritage language, their ability to participate in their cultural community is limited. In turn, they will inevitable and inadvertently be excluded from many social learning and practice opportunities (Kremer-Sadlik, 2005; Yu, 2013). This is particularly problematic for children with ASD given that they inherently present social pragmatic deficits and could benefit from increased practice in order to improve these skills.

For many bilingual families, bilingualism is an essential part of their daily lives. By recommending that a child be raised as a monolingual speaker we, as clinicians, are reducing opportunities for these children to learn how to function linguistically and socially within their cultural communities. Recommendations against bilingualism may also have an impact on the parent-child relationship and on the ability of parents and children to communicate proficiently. Given the evidence regarding bilingual language development found in other developmental disabilities and the negative impacts of recommending against bilingualism, it is somewhat

surprising that bilingual families of children with ASD do not receive more support. However, there appears to be a belief among some professionals that findings demonstrating that bilingualism does not lead to further language delays in other developmental disorders are not generalizable to children with ASD (Hambly & Fombonne, 2012). The research reviewed in the following paragraphs will show that this assumption may in fact be erroneous.

Language Acquisition in Children with ASD

Until recently, language delays were considered a diagnostic feature of autism. (American Psychiatric Association, 2000). However, research has demonstrated that not all children with ASD present with language delays. (Anderson et al., 2007; Landa & Garrett-Mayer, 2006; Norbury, 2005; Smith, Mirenda, & Zaidman-Zait, 2007) and recent changes in diagnostic criteria reflect that fact (DSM-5; American Psychiatric Association, 2013), although deficits in social communication remain a core feature of ASD. In younger children with ASD, social communication deficits include difficulties using and following joint attention, using and following a point, appropriate use of eye contact, responding to one's name, attending to others and directing vocalizations. In older and more verbal children with ASD, sociopragmatic deficits may manifest themselves through difficulties with conversational and narrative skills, in varying one's register to the social context, understanding social relationships (i.e., understanding what a friend is), as well as difficulties in understanding and using prosodic information. (American Psychiatric Association, 2013; Boucher, 2003; Kjelgaard & Tager-Flusberg, 2001; Peppé, McCann, Gibbon, O'Hare, & Rutherford, 2007). While such deficits may be present to varying degrees, social communication deficits are always present in individuals with ASD (American Psychiatric Association, 2013).

The research on structural language development (i.e., vocabulary, morphology and syntax) is considerably less straightforward than the research on social communication in

individuals with ASD and presents far more variability. Findings from a number of studies suggest that there may in fact be two separate groups of children with ASD: one group with a language impairment and another group who present language abilities within normal limits (Anderson et al., 2007; Landa & Garrett-Mayer, 2006; Norbury, 2005a; Smith et al., 2007). In fact, children with ASD + language impairment often have performances similar to those of their peers with SLI, while children with ASD and no language impairment perform more similarly to their neurotypical peers on language tasks. For example, Kjelgaard and Tager-Flusberg (2001) examined the language abilities of 89 children with ASD aged four- to 14-years-old. The children, all of whom had some verbal abilities and varying levels of intellectual abilities, were tested using a variety of standardized measures, as well as a normed nonword repetition task. Results showed that approximately one quarter of their participants presented language abilities within normal limits, as measured by performance on standardized language tests. Moreover, the authors found no significant differences between expressive and receptive language abilities in children with ASD and found that across group, articulation skills were not affected but that some children in the language impaired group also presented deficits in phonological awareness. In addition, the authors found a correlation between full-scale IQ and receptive vocabulary. Interestingly, while the vocabulary knowledge of children in the language impaired group far exceeded their semantic and syntactic knowledge, in children without language impairments vocabulary knowledge appeared commensurate with semantic and syntactic knowledge. Given the link between vocabulary and full-scale IQ, it would seem that IQ cannot fully explain the language abilities found in some children with ASD. The findings of this study support findings in other studies (Tager-Flusberg, 2006), whereby language deficits found in children with ASD + language impairments appear to be similar to those found in children with SLI (i.e., affecting grammar to a greater degree than vocabulary). The authors note that such findings are not surprising given the familial and genetic links reported to exist between SLI and ASD (see Kjelgaard & Tager-Flusberg, 2001 for discussion).

Researchers have examined whether certain characteristics of children with ASD could predict the eventual presence or absence of a language impairment (Anderson et al., 2007; Norbury, 2005a; Smith et al., 2007). In a longitudinal study examining language development of children with ASD from the age of two years old to nine years old, Anderson et al., (2007) examined the impact of a joint-attention measure on language development. In this study, joint attention included the use of gestures, pointing, showing and spontaneous initiation of joint attention in verbal children; and gestures, response to name, the use of other's body to communicate (not doing so) and response to joint attention in nonverbal children. Findings indicate that scores on the joint-attention measure at two years old were predictive of language abilities at nine years old. In fact, those with better scores on the joint-attention measure at two years old had language abilities near to or within normal limits by nine years old. The authors also found that scores at two years old on the *Restricted and Repetitive Behaviours* scale of the *Autism Diagnostic Observation Schedule* (ADOS; Lord, Rutter, DiLavore, & Risi, 2003) were not predictive of language abilities at nine years old. This last finding is commensurate with findings reported in Loucas et al., (2008) and in Smith et al., (2007) who reported that the amount of ASD symptomatology was not predictive of whether or not a child would develop a co-occurring language impairment. This is particularly important since clinicians may be erroneously basing their recommendations against bilingualism on overall symptomatology or scores on *Restricted and Repetitive Behaviours* scale at the time of diagnosis.

Overall, research indicates that there is a large amount of variability in the language abilities of children with ASD, whereby some children will present significant levels of language impairment while other children will develop language abilities within normal limits. Moreover, as a group, children who do develop a language impairment have similar presentations to those of children with SLI, with stronger vocabularies compared to their grammatical abilities. Finally, factors such as joint-attention and other precursors to language development (along with IQ and

parental education) are predictors of future language ability, while level of ASD symptomatology, and particularly restricted and repetitive behaviors are not. Crucially, although these predictive behaviors do exist, they do not explain the totality of the variability seen in the language development of children with ASD. It is therefore difficult to predict with certainty how language will develop over time in these children.

Bilingual Language Development in Children with ASD

The belief that bilingualism will have a negative impact on language development in children with ASD stems not only from the belief that bilingualism creates an extra burden on language acquisition but also because of deficits specific to children with ASD. First, children with ASD do not generally attend to others as well as children with other developmental disorders and second, they often present deficits in joint attention abilities. It has been hypothesized that such deficits, along with others, may make bilingual language development more challenging for children with ASD (Hambly & Fombonne, 2012). Given the deficits that children with ASD present, researchers have recently begun to examine bilingualism in children with ASD (Hambly & Fombonne, 2012; Kay-Raining Bird et al., 2012; Ohashi et al., 2012; Peterson, Marinova-Todd, & Mirenda, 2012; Reetzke, Zou, Sheng, & Katsos, 2015; Valicenti-McDermott et al., 2013). In the following section, we review this growing body of literature.

Studies investigating bilingualism in children with ASD have for the most part assessed their overall expressive and receptive language. In their 2012 study, Kay-Raining Bird and colleagues examined the language abilities of bilingual children with ASD. Parents of bilingual and monolingual individuals with ASD (ranging in age between two and 22 years, with varying intellectual abilities) were asked to answer questions regarding their child's language exposure and proficiency with respect to expressive and receptive language, writing and reading abilities, via a parent questionnaire. Based on these parent reports, children in the monolingual and

bilingual groups were found to have similar overall expressive and receptive language, writing and reading abilities (Kay-Raining Bird et al., 2012). For their part, Hambly and Fombonne (2012) reported on the language abilities of three to six-and-a-half-year-old simultaneous and sequential bilingual and monolingual children with ASD. Using the *Vineland Adaptive Behaviour Scales, Second Edition-Expressive and Receptive Scales* (VABS-II; Sparrow, Cicchetti, & Balla, 2005), the authors demonstrated that simultaneous and sequential bilingual children with ASD had similar language abilities to those of monolingual children with ASD. Additionally, the development of precursors to language was similar across groups, indicating that bilingual children's development of these important skills was similar to that of their monolingual peers with ASD. Similarly, Peterson et al. (2012), Ohashi et al. (2012) and Valicenti-McDermott et al. (2013) all found comparable expressive and receptive abilities across bilingual and monolingual language groups.

Vocabulary has often been used as a measure of language abilities. Using both the *Peabody Picture Vocabulary Test* (PPVT-III; Dunn & Dunn, 1997) and the *MacArthur-Bates Communicative Development Inventories* (MCDI; Fenson et al., 1993), Peterson et al. (2012) examined the lexical abilities of bilingual and monolingual children with ASD (aged three years old to six years old). They found that bilingual children had significantly larger total vocabulary sizes. Additionally, conceptual vocabularies and English vocabularies were similar across language groups when controlling for nonverbal IQ. In their study, Hambly and Fombonne (2012) examined vocabulary knowledge using the *MacArthur-Bates Communicative Development Inventories*, as well as the *age of first word* and *age of first phrase* questions from the *Autism Diagnostic Interview-Revised* (ADI-R; Le Couteur, Lord, & Rutter, 2003). They found no differences between simultaneous bilinguals, sequential bilinguals and monolinguals on any of the vocabulary measures. Finally, Ohashi et al. (2012) also used scores from the *age of first word* and *age of first phrase* questions (from the ADI-R) and found no differences across language

groups in children three to six years of age.

An important part of being bilingual is the ability to acquire the social communication and pragmatic abilities surrounding a given linguistic community and to adjust one's language use accordingly. These abilities have not been extensively studied in neurotypical children. However, both Goetz (2003) and Farhadian et al. (2010) found better theory of mind abilities in typically developing bilinguals. Moreover, as discussed in the previous section, Genesee et al. (1996) demonstrated that bilingual children are able to switch to their interlocutor's language, even when this language is not the child's dominant language. Although this skill cannot be directly compared in monolingual children, it does demonstrate that early on, typically developing bilingual children learn to attend to the language spoken to them and adjust their language use appropriately, which is an important social skill for bilingual speakers. Furthermore, Filmore, (1991) found that neurotypical children of minority language parents who are raised solely in the majority language may have difficulty with pragmatic abilities linked to their minority culture when required to partake in their minority language community. With regards to children with ASD, in their study, Valicenti-McDermott et al. (2013) examined the language and pragmatic abilities of children with ASD, in this case English-Spanish bilingual and English monolingual toddlers. Children in the bilingual group outperformed their monolingual peers on a number of measures used to evaluate communicative abilities, including more frequent examples of pretend play and more frequent use of proto-imperative gestures (e.g., pointing to show) both positively linked to language abilities in ASD children (Anderson et al., 2007). They also found better scores on the VABS-*Composite Score* (although the authors did not report scores in the various domains and it is thus unclear why children in the bilingual group had better performances). Hambly and Fombonne (2012) also looked at social communication using the VABS-*Interpersonal Scale* and the early social communication questions on the ADI-R. They found no statistically significant differences between bilinguals and monolinguals with regards to early social communication skills. That is,

bilingual and monolingual children were equally proficient in acquiring the precursors to language development (i.e., initiating and following a point and attending to other's voices). However, they found that simultaneous bilinguals had better scores on the *Interpersonal Scales* on the VABS-II, a scale which looks specifically at social abilities in children. More recently, Reetzke et al. (2015) examined pragmatic skills of bilingual and monolingual children with ASD using the *Child Communication Checklist* (CCC-2; Bishop, 2003). They also found similar pragmatic skills in bilingual children with ASD compared to their monolingual peers. These results indicate that bilingual children with ASD are not only as proficient as their monolingual peers with respect to language acquisition, but that bilingualism may lead to increased abilities in certain facets of social communication. Given these findings, the extra 'burden' of a second language does not appear to have a negative impact on pragmatic development in bilingual children with ASD and may in fact, have a positive impact on their socio-communicative abilities.

As discussed in an earlier section, amount of exposure to each language have an impact on one's language knowledge and fluency. However, across the studies discussed here, language input was not systematically reported. Of the three studies that did report on language input (Hambly & Fombonne, 2012; Ohashi et al., 2012 and Reetzke et al., 2015), there were significant differences in the way in which this information was calculated. While Ohashi et al. (2012) and Reetzke et al. (2015) both defined bilingual children as those children receiving a minimum of 20% of input in their weaker language, Ohashi et al. (2012) required that this level of input be consistent throughout the child's lifetime, whereas Reetzke et al. (2015) required that children have a minimum of 20% exposure to both language on the *Lifetime Score* from the *Language Environment Interview* (LEI; Hambly & Fombonne, 2012) although the amount of input could have fluctuated over the course of the child's life. And while Hambly and Fombonne (2012) calculated both current and lifetime exposure, they seem to have included children who currently (in the past six to 12 months) received less than 20% input in their less dominant language. They

also included children in their bilingual groups who had only received indirect exposure to the minority language following their diagnosis, whereas Ohashi et al. (2012) focused only on children who had received constant direct exposure to both of their languages. Additionally, none of these studies appear to use their language input scores to examine the relationship between amount of input and proficiency in language and socio-communicative abilities.

As noted previously, age of exposure also plays an important role in bilingual language development; however, here, as in the neurotypical research, there is variability with regards to the age cut-offs used in the studies reviewed. For example, Hambly and Fombonne (2012) defined a simultaneous bilingual as having contact with their second language before the age of 12 months, whereas Ohashi et al. (2012) define that cut-off as being 24 months. In their study, Reetzke et al. (2015) did not report age of second language acquisition. Given that their participants lifetime ratios were close to the 70% mark (indicating that, as a group, they received more input in one of their languages over the course of their lifetime) while their recent ratio was closer to the 57% mark (indicating that they received roughly the same amount of input in both of their language over the past year), it is unclear when these children began to acquire their second language and what impact this may have had on the results. In their study, Valicenti- McDermott et al. (2013) only report that children were English-Spanish bilinguals and that they were tested before the age of three years old, but the authors do not provide any other information regarding their participants' amount of bilingual input or age of acquisition. Since the children in these studies were tested at such a young age, the age at which they started to acquire their second language may have an impact on their language proficiency in each of their languages and therefore on the results obtained. For example, children who acquired their second language at the age of two years will, at the age of three years, only have had one year of experience in the second language and should not be expected to perform as well as children who acquired both languages from birth. Such differences in age of acquisition, especially at an early age could have

an impact on the results, highlighting the importance of controlling such variables.

In their study Peterson et al. (2012) note that while their bilingual participants mostly spoke Chinese at home, in the wider community participants spoke English. Although the authors report on the amount of intervention each child received, it is unclear whether the intervention was complete in English or in Chinese, nor is it clear in which language the children were dominant. Such information is important to consider because, while the PPVT and the MCDI were completed in both of the child's languages, it is unclear in which language the *Preschool Language Scales* (PLS; Zimmerman, Steiner, & Pond, 1992 - used to calculate expressive and receptive language) and the *Mullen Scales of Early Learning* (Mullen, 1995 - used to calculate nonverbal IQ) were administered. Why is this important? Let us imagine that some of the bilingual children received approximately 20% of their weekly input in English, making English their nondominant (i.e., their weaker language). If these children were tested in their dominant (minority) language (i.e., Chinese) and performed as well as their monolingual peers (in Chinese), then we can say that bilingual and monolingual children with ASD are similarly proficient in the acquisition of their dominant language. However, if testing was completed in their nondominant language (English) and these bilingual children performed as well as their monolingual English-speaking peers, one could wonder how much better these bilingual children would have performed had they been tested in their dominant language (Chinese).

Given the lack of consistency across these studies, it is difficult to ascertain the impact of age of acquisition and input on language development in children with ASD. Nevertheless, on the whole, bilingual children with ASD performed as well or better than their monolingual peers on a variety of language and socio-communicative measures. Taken together, these findings indicate that preschoolers and young school-aged bilingual children with ASD develop language abilities at similar rates to those of their monolingual peers with ASD. Interestingly, unlike neurotypical children, who around preschool-age sometimes show slight delays compared to their monolingual

peers, bilingual children with ASD in these studies perform as well as their monolingual peers. The reason for this enhanced ability is unclear, although, given that social communication skills have been positively linked to language abilities later on in monolingual children with ASD (Anderson et al., 2007), it may be that bilingualism leads to improved social communication skills, which may in turn help with language acquisition. It is important to note that these findings are consistent across a variety of tools, a variety of languages and across varying definitions of bilingualism and inclusion criteria. Research has also shown that children with SLI and children with Down Syndrome can become bilingual and that bilingualism is not detrimental to language development, even in the presence of a language or cognitive deficits. Given the similarities in performances between children with ASD and SLI and the potential genetic link between ASD and SLI (Kjelgaard & Tager-Flusberg, 2001), as well as the presence of comorbid intellectual disabilities (American Psychiatric Association, 2013), such findings can inform researchers, parents and clinicians as to the ability for children with ASD to become bilingual. Together, these studies indicate that children with ASD can become bilingual speakers and that bilingualism does not seem to have a detrimental effect on language development in these children.

Recommendations for Families and Professionals

Research examining bilingualism in ASD is still in its infancy. It is therefore difficult to make recommendations specific to this population. However, given the findings discussed above, broad recommendations can be made to help both families and clinicians working with bilingual children with ASD (and other developmental disabilities). First, it is important to remember that for bilingual individuals, access to their minority language implies access to their minority culture. When professionals fail to support minority language parents in raising their children in both the majority and minority languages, they prevent these children from having access to their minority culture, which goes against best practice guidelines set out by professional bodies such as the Canadian Psychological Association (CPA; Canadian Psychological Association, 2000; Crozier, Harris,

Larsen, Pettifor, & Sloan, 1996, 2001), Speech and Audiology Canada (SAC, formerly CASLPA; Crago & Westernoff, 1997) and American Speech and Hearing Association (ASHA; American Speech and Hearing Association, 2013). For example, ASHA's document entitled *Issues in Ethics: Cultural and Linguistic Competence* states that "Competent care is providing service that is respectful of, and responsive to, an individual's values, preferences, and language" (ASHA, 2013). And the CPA's *Guidelines for Non-Discriminatory Practice* states the following: "Psychologists do not impose the dominant culture world view on those who are different. Psychologists continually monitor how they demonstrate respect when working with diverse populations" (Crozier et al., 1996, 2001, p. 2). These statements make it clear that professionals working with minority language individuals are required to respect and support minority language clients and their families.

For professionals assessing bilingual children, it is important that testing be completed in the child's dominant language whenever possible. Dominance can be determined using a parent questionnaire such as the *Alberta Language Environment Questionnaire* (ALEQ; Paradis, 2011), the Gutiérrez-Clellen & Kreiter (2003) questionnaire or the *Montréal Bilingual Language Use and Exposure Questionnaire* (M-BLUE; Beauchamp & MacLeod in progress). Such questionnaires can help clinicians assess the child's dominance by assessing the amount of input the child receives across a variety of individuals and settings in each language. This information is invaluable in helping professional interpret test scores. Clinicians may also find it useful to use a tool such as the *MacArthur-Bates Communicative Development Inventories*, which is available in a number of languages, in order to better understand a child's language ability in both of the child's languages. Moreover, when language testing is not possible in the child's dominant language, clinicians can work with parents or interpreters in gathering and analyzing language samples in the child's dominant language. This may help clinicians better understand whether the child's delays are caused by a language deficit or by the process of second language acquisition.

It is important to remember that bilingual children with language impairments will present similar types of deficits in both of their languages. Crucially, practitioners who work with bilingual individuals should be very familiar with the literature regarding bilingualism and have the necessary competences to assess and work with this population. Consequently, it may be helpful for practitioners who are less familiar with bilingualism to enlist the assistance of a speech and language pathologist knowledgeable in bilingualism and in ASD.

As with typically developing bilingual children, parents of children with ASD should ensure that their child receives sufficient amounts of input in each language in order to become proficient in both languages, particularly in subtractive environments. Remembering that children require 40% to 70% of their weekly input in a given language in order to acquire monolingual abilities may help parents adjust their expectations with respect to their child's proficiency in the less dominant language (Thordardottir, 2011). It is also important to remember that, while children with language and intellectual deficits can become as proficient as their nonverbal IQ-matched monolingual peers, they will nevertheless present language deficits, regardless of their language status. As such, expectations regarding a bilingual child's level of proficiency in each language should be commensurate with that of monolingual children with similar nonverbal IQs.

Although research has not specifically addressed language confusion in bilingual children with ASD, it is noteworthy that none of the articles discussed in this paper reported language confusion in their participants. Also, basing ourselves on the research done with typically developing children (Genesee et al., 1996; Nicoladis, 2006; Paradis et al., 2000), it is perhaps unwise to assume that children with ASD will show language confusion.

For bilingual children receiving intervention services, it is ideal that the intervention be provided in both of the child's languages (Seung, Siddiqi, & Elder, 2006). However, when this is not possible, interventionists and parents are encouraged to work together to implement

intervention goals in the minority language either through the use of an outside interpreter or by working directly with parents. For families whose children are not schooled in their minority language, it is particularly important to assure that sufficient amounts of input be provided in the home language. Parents are encouraged to speak the minority language at home as often as possible and to create opportunities for their child to acquire and use their minority language. Reading to children in their minority language may be a useful strategy to increase input in the minority language. Finally, whenever possible, parents can enroll their child in weekend academic programs offered in their minority languages where the child can acquire academic knowledge in the minority language and increase reading and writing abilities. Of course, such programs will not be adequate for all children with ASD, particularly those children more severely affected, but may be appropriate for many other children, particularly when adaptations are available.

A question often asked by parents is whether or not their child with ASD can attend an immersion school program. To our knowledge, there is no research regarding this question pertaining specifically to children with ASD. However, in typically developing children, bilingual immersion does not appear to have a negative impact on language learning (see Paradis et al., 2011 for discussion). As such, particularly for children with ASD who do not have significant language delays, immersion can be an option. Although again, factors such as amount of input and environmental context will have an impact on level of proficiency in the less dominant language.

Overall, given the evidence currently available, children with ASD can become bilingual. As with neurotypical children and with children who present other developmental disabilities, there are numerous factors that will affect a child's level of proficiency in each language. These include amount of input, environment, and age of acquisition. As professionals, it is important to remember that language is intimately linked to culture. We are mandated by our professional bodies to provide services that respect cultural and linguistic differences, as well as our clients'

values, and to avoid imposing the dominant culture onto our clients (ASHA, 2013; Canadian Psychological Association, 2000; Crozier et al., 1996, 2001). Given the currently available evidence regarding language development in bilingual children with ASD and the negative impacts of recommending against bilingualism in minority language families, professionals have a responsibility to support minority language parents who want or need to raise their child with ASD as a bilingual.

Future Directions

Research on the language abilities of bilingual children with ASD is recent and numerous questions remain unanswered. More research is needed in order to better understand the development of language in bilingual children with ASD, particularly with respect to school-age children. Research should also examine language development in simultaneous versus sequential bilinguals with ASD compared to neurotypical children and children with other language and developmental disabilities. Factors that impact language development in these populations, such as the amount and type of input and age of acquisition should also be examined. Furthermore, research should examine the effects of bilingualism on cognition, particularly in the domains of executive functioning and theory of mind abilities, and the impact of these enhanced abilities (should they exist) on daily functioning.

As ASD is a disorder that affects multiple aspects of development, there is an increased need for a multidisciplinary approach to research. Moreover, it is important to ensure that those who complete research on bilingualism in ASD be well versed in both of these areas. Finally, it is important that research findings be disseminated beyond the academic community to bilingual families and clinicians across a variety of fields, notably speech and language pathology, psychology, education and medicine.

Conclusion

Research in the field of autism has shown that bilingualism does not have a negative impact on language development in children with ASD, and may in fact have a positive impact on their socio-communicative abilities. Overall findings from studies examining bilingualism in children with ASD parallel those of previous studies investigating bilingualism in children presenting with language and other developmental disorders (e.g., Feltmate & Kay- Raining Bird, 2008; Paradis, Crago, & Genesee, 2006). Moreover, research has shown that raising a child as a monolingual in a bilingual household or community can have detrimental impacts not only for the child in question, but also for the family as a whole. When children are raised as monolingual speakers in a bilingual context, their ability to communicate proficiently with their parents in the family's home language is limited, creating a communication barrier between children and their parents, as well as with the extended family and cultural community (Filmore, 1991). The available research provides compelling evidence that recommendations against bilingualism are not appropriate for children with ASD, particularly for those children from bilingual contexts, and may in fact be harmful. As clinicians, it is therefore crucial that we support families in bilingual contexts who want to raise their children bilingually.

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Preamble Manuscript 2

This second manuscript is the first of two experimental studies included in this thesis. In the first manuscript, we discussed bilingualism in ND children, and in children with ASD and other developmental disorders. This review revealed that most of the studies examining the bilingual language development in ND simultaneous bilinguals who were either toddlers or preschool-aged children. Additionally, studies that examine abilities in school-aged bilinguals generally examine the abilities of sequential bilinguals. However, as noted by Thordardottir (2019), few studies have examined the language development of simultaneous bilinguals once they reach school age. The current study's aim is to tackle this gap in the literature. Thus, in this study, we will examine the language abilities of ND school-aged French-English simultaneous bilinguals who grow-up in an additive context. More specifically, we examine the influence of exposure on these children's language abilities. We also investigate whether there is a difference between the influence of lifetime and current language exposure on the language abilities of school-aged French-English simultaneous bilinguals in both of these languages. Finally, we explore the amount of language exposure that these children require to obtain scores on language tests that are within these tests' average ranges. That is, do school-aged simultaneous bilingual children require the same amount of language exposure as younger simultaneous bilingual children to obtain scores in the average range, and do they require the same amount of language exposure across all language tasks? Or, might the amount of language exposure that these children require be different than what younger children are reported to require, and might they require different amounts of exposure for different types of language tasks?

The answers to these questions are important. Language assessments with bilingual children can be difficult and bilingual children are at risk of being either misdiagnosed with a language disorder or of falling between the cracks. By examining the relationship between language exposure and language development in school-aged simultaneous children, we aim to

better understand how exposure influences language abilities in these children as they reach school age. These findings will serve to inform clinicians, teachers and parents as to what is typically expected of these children and what might be a deviation from typical bilingual language development. Thus, these findings will help clinicians better identify those children who require more support and those who require direct intervention.

How much exposure is enough exposure?

Language development in school-aged simultaneous bilinguals

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Abstract

Purpose: Few studies have focused on bilingual language development in school-aged simultaneous bilingual children, particularly in both of their languages. The current study tackles this gap in the literature by examining the influence of language exposure on the development of both languages in school-aged simultaneous bilingual living in additive bilingual contexts.

Method: The language abilities of 19 school-aged simultaneous bilingual children (aged six to nine years) were assessed using standardised language measures in both French and English. Their amount of language exposure was also measured using a parent questionnaire.

Results: Only expressive language abilities were significantly correlated with lifetime exposure to English. No other correlations were found between language abilities in French or in English and language exposure. Difference in exposure patterns to French and to English may explain some of our findings. Also, most of the children who received as little as 20% of their lifetime exposure to a language, obtained scores within the test average range on all of the measures for this language. Finally, we found that children who were exposed to both of their languages on a daily basis were more likely to have better performances than their peers who used one of their languages less frequently. This effect was observed even when children receive less exposure to each of their languages than children who were not exposed to both of their languages daily.

Conclusion: While exposure is important, other factors such as frequency of use may lead to positive language transfer and improved metalinguistic abilities, which might also play a role in simultaneous bilinguals' language proficiency levels.

Introduction

Around the world, bilingualism and multilingualism are common (Tucker, 1998) and numerous countries are officially bilingual (e.g., Canada and Belgium) or multilingual (e.g., India, Switzerland and South Africa). As such, many children are raised in contexts where they are regularly exposed to more than one language, and their exposure often begins in early childhood. Research examining language development in these early bilinguals has focused on the early period of bilingual language development, prior to entry into school. However, little research has examined the language development of simultaneous bilinguals once they reach school age (Thordardottir, 2019). Consequently, we do not have a good understanding of the language development of simultaneous bilingual children as they get older, nor do we understand how different factors influence this bilingual and multilingual language development. As the literature review in the following paragraphs will show, bilingual language acquisition is complex and numerous factors influence bilingual children's language acquisition.

Bilingual Language Acquisition in Simultaneous Bilinguals

The age at which bilinguals are exposed to their second language is often used as a cut-off to differentiate between simultaneous and sequential bilinguals. Traditionally, *simultaneous bilingual* are individuals who were exposed to both of their languages before the age of three-years (Paradis, Genesee and Crago, 2011) whereas as *sequential bilinguals* are children who acquired their second language after having mostly acquired their first language, generally after the age of three years (Paradis et al., 2011, Thordardottir, 2011; 2019). However, various other cut-offs have been used in research. Some have used an age cut-off of four years of age (Unsworth, 2016), others have suggested that simultaneous bilinguals must be exposed to both of their languages from birth (De Houwer, 2009), and others still define simultaneous bilinguals as children who acquired both languages in early childhood without specifying a specific age (Meisel, 2001). Thus, this cut-off may be somewhat arbitrary, at least in children who are exposed

to both of their languages in early childhood, and the distinction between simultaneous and sequential bilinguals may not be as important in early second-language (L2) learners as it is in later L2 learners (Granena & Long, 2012; Hakuta, 2000). Faced with this fluidity, we have chosen, for this study, to apply the commonly used cut-off of three-years of age when differentiating between the two groups, unless otherwise noted.

Many studies examining bilingual language development in simultaneous bilinguals have focused on the abilities of younger children. Overall, results suggest that toddlers and preschool-aged simultaneous bilinguals can develop language abilities that are similar to, although not necessarily exactly the same as, those of their monolingual peers, in at least one of their languages. This finding has been observed in studies examining the bilingual development of vocabulary (MacLeod, Fabiano-Smith, Boegner-Pagé, & Fontolliet, 2013; MacLeod, Castellanos-Ryan, Parent, Jacques, & Séguin, 2017; Pearson, Fernandez, Lewedeg, & Oller, 1997; Thordardottir, 2011) and grammar (Paradis & Genesee, 1996; Thordardottir, 2015).

Although few studies have focused solely on the language development of school-aged simultaneous bilingual children, recent contributions have emerged from Canada (Thordardottir, 2019), the USA (Bedore, Pena, Griffin and Hixon, 2016) and the Netherlands (Unsworth 2016). In this latter study (Unsworth, 2016), the language abilities of English-Dutch simultaneous and sequential bilinguals were compared to one another on tasks measuring vocabulary, morphosyntax and syntax-semantics in Dutch. Overall, by the time they reached school age, the children in these two groups performed similarly. Additionally, results suggest that the current amount of language exposure that they received to Dutch best predicted children's language proficiency. In their study, Bedore and colleagues (2016) examined the language abilities of simultaneous and sequential bilinguals on morphosyntactic and semantic abilities (using a normed test which examines the abilities of Spanish-English bilinguals). These authors also found that current exposure was a better predictor of language abilities than lifetime exposure even

though, in contrast with Unsworth (2016), simultaneous and sequential bilinguals were grouped together. Only Thordardottir (2019) has examined the language abilities of simultaneous bilinguals and sequential bilinguals compared to those of monolingual children. Findings from this study show that school-aged bilingual children were able to reach language levels similar or fairly similar to those of their monolingual peers, provided they received sufficient amounts of language exposure over the course of their lifetime (Thordardottir 2019). Moreover, in this study, differences in language proficiency that initially existed across participants disappeared when exposure was controlled, and proficiency did not appear to be influenced by age of exposure (AoE; Thordardottir, 2019). This latter finding is in-line with results reported in Unsworth (2016).

While exposure is an important factor in children's bilingual language development, there appears to be large amounts of variability in the amount of exposure that children require to reach monolingual levels of proficiency (Thordardottir, 2011; 2019). Such results suggest that other factors may influence bilingual language development. Furthermore, the amount of language exposure that children require to reach such levels of proficiency in both languages may not be the same from one language to the other (Bedore et al., 2012) and may vary depending on the language construct examined (Thordardottir, 2011; Bedore et al., 2012).

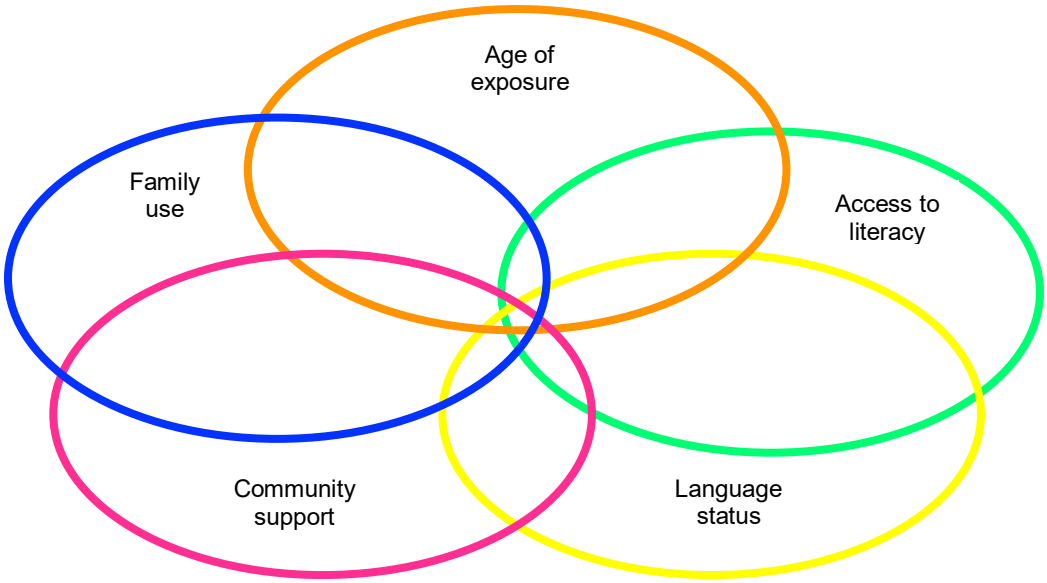
Although bilingual individuals can reach communicative abilities (Abrahamsson & Hyltenstam, 2008), as well as proficiency levels similar to their monolingual peers on standardized language measures (Bedore et al., 2012; Bedore et al., 2016; Thordardottir, Rothenberg, Rivard & Naves, 2006; Thordardottir, 2011; 2019), on experimental tasks (Unsworth, 2013; 2016) and in natural language productions (Thordardottir, 2015), that is not to say that bilinguals are two monolinguals in one individual. As Grosjean (1993) notes, bilingual individuals often have imbalances in their language abilities, with one language being stronger than the other and, simultaneous bilingual children do not always reach monolingual levels of proficiency in both of their languages. This is particularly true when examining children's abilities in their weaker

language, or when examining the abilities of children raised in lower socio-economic status households (see Hammer, Hoff, Uchikoshi, Gillanders, Castro, & Sandilos, 2014 for discussion). Additionally, differences between bilinguals and monolinguals have been reported in specific areas of language. For example, bilingual speakers have been reported to have smaller lexicons in each of their individual languages than their monolingual peers (Gollan, Fennema-Notestine, Montoya & Jernigan, 2007). Differences have also been reported in the accurate use of grammatical markers, especially in second-language (L2) learners (Paradis, Rice, Crago and Marquis, 2008), or early on in language development (Goldberg, Paradis & Crago, 2008). However, there are important differences in the levels of proficiency that different bilingual speakers achieve (Thordardottir, 2011 & 2019). Why all this variability? It may be understood by considering bilingualism as a continuum of abilities (Luk & Bialystok, 2013) and by understanding that proficiency is influenced by a number of factors.

Understanding Language Exposure

Bilingualism is multidimensional construct and bilingual speakers' experiences influence the amount of exposure that they receive to each of their languages. Numerous factors influence language exposure, including: AoE, language status (minority versus majority languages), family language use, community support (for example access to schooling in the minority language) and access to literacy (Pearson, 2007). As Figure I illustrates, when present, such factors each contribute to varying degrees to the total amount of language exposure that a child will receive.

Figure I. Illustration of the factors that influence language exposure.



Age of exposure

AoE is an important factor in bilingual children's language development, particularly for younger bilinguals. Indeed, in early bilinguals, language scores are influenced by AoE (Hammer, Lawrence, & Miccio, 2008). Differences in children's performances based on AoE are likely related to differences in overall language exposure that these bilinguals received over the course of their short lives. That is, whether a child is exposed to a language at 12 months or at 36 months of age may make more of a difference in the language abilities of a four-year-old child, as this would represent a substantial difference in the amount of exposure to the second language that the child has received relative to its age. However, as these young simultaneous bilinguals become older, the influence of AoE is likely to change depending on a child's age at time of testing.

As noted above, while the role of AoE may be important in younger children, its influence appears to diminish as the children age. In fact, by five years of age, simultaneous bilingual and early sequential bilingual children's language abilities seem more strongly influenced by the

amount of exposure that they received to each of their languages than by AoE (Bedore et al., 2012, Thordardottir, 2011). Although the influence of AoE on bilingual language development appears to diminish in simultaneous bilinguals and early sequential bilinguals (Thordardottir, 2019), AoE remains an important factor for late sequential bilinguals (Abrahamsson & Hyltenstam, 2008; Granena & Long, 2012). In these L2 learners, AoE differentially influence different spheres of language with research findings suggesting that phonology is most influenced by AoE, followed by vocabulary and then grammar (Granena & Long, 2012). Additionally, the age at which children acquire their L2 may be important for other aspects of cognition (Berken et al., 2016).

Together these studies bring into question the role of AoE in simultaneous bilinguals as children get older. This distinction appears to be important in early childhood, when the amount of language exposure that children receive in a single year represents a large proportion of their overall language exposure. However, as simultaneous bilinguals get older, the difference in AoE represents a much smaller proportion of the total amount of lifetime exposure they have received, and thus may not be as important, all things being equal. Therefore, as simultaneous bilinguals enter school, AoE may no longer be a main factor influencing language proficiency. Instead, language exposure may be a more important factor for these children.

Majority-minority language distinctions

The larger social context in which a language is used is another important factor in the acquisition of children's language(s) as it can influence a child's language (Hammer et al., 2008; Hoff, Quinn, & Giguere, 2018; MacLeod et al., 2013; MacLeod et al., 2017). A majority language can be defined as the language(s) most spoken by individuals in a given environment and that hold a high linguistic status within a community (Paradis et al., 2011). This language contrasts with minority languages, which are languages not spoken by most individuals in a given community and which are usually associated with a minority cultural group (Paradis et al., 2011). Children who live in subtractive bilingual contexts, where one of their languages (usually the

minority language) is not well supported and not easily accessed within the broader community (Paradis et al., 2011), are likely to receive more indirect exposure (i.e., language exposure that is overheard rather than directly addressed to an individual) to the majority language than to their minority language. On the other hand, when children grow-up in an additive environment, where both of their languages are supported (Paradis et al., 2011), they are more likely to receive indirect exposure to both of their languages, which in turn supports the development and maintenance of these two languages. In a longitudinal study, Hoff et al. (2018) found significantly different rates of growth between English and Spanish vocabulary and grammar in English-Spanish bilingual toddlers, even when controlling for exposure. They suggest that these results may stem from the fact that in these children's context, English was the majority language, making the acquisition of Spanish more precarious. Similar findings were reported by Hammer et al. (2008), with regards to the language growth of Spanish in Spanish-English bilingual children growing-up in the USA and by MacLeod et al. (2013) when examining the development of German in French-German speaking children in Québec.

The influence of literacy

Activities that support the development of literacy skills in the minority language have been positively linked to proficiency in that language in younger simultaneous bilingual and in sequential bilinguals (Patterson, 2002; Zaretsky, 2014). In young bilingual speakers, being read to in a given language has been linked to higher vocabulary size in that language when compared to children who were less frequently read to (Patterson 2002). This pattern has been reported in bilingual children's two languages and was found above and beyond the influence of language exposure (Patterson 2002). In older bilinguals, a positive correlation between minority language use and reading in the minority language has been found. That is, the more children read in their minority language, the more proficient they were in using that language. Such findings suggest that reading in one's minority language may also counter language attrition (Zaretsky, 2014).

School and other sources of language exposure

The amount of language exposure that bilingual children receive at home, at school and through other activities also influences the acquisition of each of their languages. In a longitudinal study, MacLeod et al. (2017) found that bilingual children who spoke a minority language had smaller vocabularies in the majority language (either French or English) and smaller growth rates in that same language than majority-language bilinguals and monolingual peers prior to entering school, likely due to these children having more exposure to their minority language at home. However, once these children entered school, their growth rates became similar to those of their majority-language peers. Gathercole (2007) also demonstrated that the amount of exposure to Welsh that Welsh-English bilingual children received, both at home and at school, positively influenced their language abilities in Welsh. In addition to the influence of exposure at school, language exposure from other sources, such as interactions with friends and through extra-curricular activities, may represent an important proportion of a child's overall exposure and influences children's overall language abilities (Bridges & Hoff, 2014; MacLeod et al., 2013).

Metalinguistic abilities

In addition to the environmental factors discussed above, improved metalinguistic abilities might also play an important role in bilingual language development. According to Cummins (1981), these improved metalinguistic abilities are linked the *interdependence hypothesis,* which states that knowledge of (or instruction in) one language supports the development of another language, as long as children receive a sufficient amount of exposure to each language. Indeed, research findings suggest that bilingual children who attended immersion schools were more proficient in completing tasks measuring metalinguistic abilities when compared to their monolingual peers (Bialystok & Barac, 2012; Bialystok, Peets, & Moreno, 2014). There is also evidence that the longer children spend in immersion schooling (in years), the stronger their metalinguistic abilities appear to be (Bialystok et al., 2014). While it is unclear how much language

exposure is a “sufficient amount” for children to acquire these improved metalinguistic abilities, there is evidence suggesting that this level may be as low as between 10-30% (Kuo & Anderson, 2010).

The research reviewed above highlights that language exposure is a complex construct influenced by several factors. The overall amount of exposure that a child receives is influenced by factors such as AoE, language spoken by family, friends, the language of schooling, and in the larger environment, as well as the language used during literacy activities. In addition to the factors that influence exposure, improved metalinguistic abilities might also play an important role in bilingual language acquisition and proficiency. While this review illustrates that children are exposed to language from a variety of contexts, it is unclear the extent to which each factor discussed above influences children’s language exposure and language proficiency, and whether the influence of these factors is stable across a bilingual speaker’s lifetime.

How Much Exposure is Enough?

The answer to the question “how much exposure is enough” is complex. In order to answer this question, two elements of the equation need to be defined: “how much” or what amount of time is needed, and “enough”, what thresholds are we expecting children to meet. Some research has shown that with as little as 20% direct and consistent exposure to their L2, toddlers are able to acquire a sufficient amount of linguistic knowledge to use this language spontaneously (Pearson et al., 1997). That said, it is important to remember that there is a difference between acquiring a sufficient amount of knowledge in a language in order to use it and reaching levels of proficiency similar to those of monolingual children. Therefore, young children may require more than 20% exposure to attain monolingual-like levels of proficiency (Bedore et al., 2012; Thordardottir, 2011). However, what that exposure threshold truly is may depend on the sphere of language examined (Thordardottir, 2011) and perhaps also on the languages examined (Bedore et al., 2012; Thordardottir, 2011).

In preschool-aged children, it appears that different spheres of language are differentially influenced by language exposure. For example, Thordardottir (2011) found that five-year-old simultaneous bilingual children were able to reach monolingual levels of proficiency (within 1SD from the mean) on a test of concept knowledge with approximately 35% to French, and required 35% exposure to French to obtain scores similar to those of their monolingual peers for receptive vocabulary task. Expressive vocabulary, however, required more exposure, with children requiring approximately 70% exposure to French to reach monolingual norms (Thordardottir, 2011). Additionally, preschool-age bilingual children who are balanced bilinguals have been found to develop language abilities at a similar pace when compared to their monolingual peers in the area of expressive morphology, suggesting that with around 50% exposure to a target language, preschool-aged children can become as proficient as their monolingual peers in the area of expressive morphology (Thordardottir, 2015). Importantly, there is great variability across children, with some children attaining monolingual levels of proficiency with smaller amounts of exposure to a language, while others required much more exposure to reach similar levels of proficiency (Thordardottir, 2011). And as previously discussed, while bilingual children may receive similar scores on language tasks, their performances may not be necessarily identical to those of monolingual children.

Difference in the amount of exposure that children require might also depend on the language examined. For instance, Bedore et al. (2012) found that five-year-old children's performances on tasks measuring expressive morphosyntax and expressive semantics were positively linked to the amounts of current exposure received in each of their languages (English and Spanish). However, language exposure did not have the same influence on both of their languages. Specifically, in English, children's abilities plateaued when they received approximately 75% exposure to English, whereas in Spanish, this plateau appeared when children received approximately 60% exposure to Spanish. This suggests that a bilingual's

languages may be differentially influenced by the amount of exposure received. This is similar to findings from Thordardottir (2011) where children consistently required more exposure to French than to English to reach monolingual norms. Interestingly, in both cases these language differences do not seem to reflect the sociolinguistic standing of the languages in the children's greater environment.

While researchers have focused both on AoE and amounts of exposure (i.e., proportion or number of hours of current or lifetime exposure to a language), few researchers have explored the influence of daily exposure to both languages (i.e. whether a child is exposed to both of their languages every day). Indeed, to our knowledge, no study has examined the influence of the daily exposure to both languages versus the overall amount of exposure that children receive on their language proficiency. Specifically, no study has examined whether there are differences in the language abilities of children who are exposed to both of their languages on a daily basis compared to children who receive a similar amount of overall exposure but who are not exposed to both languages every day. However, studies examining the influence of language switching on executive functioning have found that individuals who switched more often had lower switching costs than individuals who switched from one language to the other less frequently and compared to monolinguals, suggesting better switching abilities (Prior & Gollan, 2011). They were more proficient in performing inhibition tasks than other bilinguals (Verreyt, Woumans, Vandelanotte, Szmalec & Duyck, 2016; but see Paap, Johnson & Sawi, 2015 for argument against the bilingual advantage on executive functioning). Such results suggest that different types of bilingual experiences can potentially influence cognitive abilities. In particular, frequently switching from one language to the other (thus using both languages frequently during a day) can lead to improved executive functioning. In parallel, children who attend immersion schooling have been shown to have better metalinguistic abilities when compared to their monolingual peers. It is likely that children in immersion programmes use both of their languages on a daily basis. Thus, it may

be that daily exposure (or use) explains, at least in part, the improved metalinguistic abilities reported in bilingual children.

Taken together, the literature suggests that while simultaneous bilingual and monolingual children may not be exactly the same, bilingual children are able to develop overall language abilities similar to those of their monolingual peers provided that they receive a sufficient amount of language exposure. It may also be the case that language experiences play an important role in these children's levels of proficiency.

Calculating Language Exposure

Historically, researchers have measured language exposure using different questionnaires and calculation methods, which may influence our understanding of the relative importance of exposure on bilingual language development. Thus far, there has been little consensus as to the most appropriate method of calculating language exposure with differences in the time period examined, the contexts included, and differing ways in which the amounts of language exposure are quantified.

First, studies differ in the time period on which they focus when calculating exposure. Although many studies have used current exposure (Bedore et al., 2012; MacLeod et al., 2013; Thordardottir et al., 2006), some have used cumulative or lifetime exposure (Thordardottir, 2011, 2015, 2019; Thordardottir & Brandeker, 2013) and others still have included both types of exposure in their analyses (Unsworth, 2016; Bedore et al., 2012). Studies that have compared the predictive value of lifetime versus current language exposure, have found current exposure to a better predictor of language proficiency in school-aged children, although this may be due to the inclusion of both simultaneous and sequential bilinguals in some of these samples (Unsworth, 2016; Bedore et al., 2012).

Studies also differ in the speakers and environments included when calculating language exposure. For example, based on the available information, Pearson et al. (1997) and Ribot, Hoff, and Burridge (2018) seem to have only included exposure at home in their calculations of toddlers and preschool-aged children's language exposure. On the other hand, Bedore et al. (2012) appear to have considered language exposure from a number of interlocutors and in different environments. And in their study, Gutierrez-Clennan and Kreiter (2003) collected exposure information from both parents and teachers but not from other contexts. These differences in the number of environments and interlocutors included in the exposure calculations may lead to differences in the amounts of language exposure calculated.

In addition to the aforementioned differences, researchers have used a variety of methods to represent the amounts of exposure children receive. Some researchers have used Likert-type scales (Bialystok et al., 2014; Unsworth, 2013, 2016). Others have used windows of time increments (Thordardottir et al., 2006). Still others have collected language exposure information on an hour-by-hour basis (Bedore et al., 2012; Bedore et al., 2016). In addition, Bedore and colleagues attempted to calculate output and input separately using parent report (Bedore et al., 2012; Bedore et al., 2016) and found that in late preschool and school-aged children these measures were strongly correlated (input and output measures were therefore combined to create a single "exposure" score; Bedore et al., 2012; Bedore et al., 2016). This suggests that, at least when using parent report, it is difficult to capture input and output separately.

Adding to the confusion, few researchers have made their questionnaires available (for exceptions, see Gutierrez-Clennan & Kreiter, 2003; Paradis, 2011; Byers- Heinlein et al., 2019. The questionnaire used in Bedore et al., 2012 and Bedore et al., 2016 is only commercially available). It is, therefore, difficult to compare language exposure results across studies and it is unclear the degree to which the differences in the methods used to calculate language exposure across studies have influenced research findings. Finally, it is also important to note that certain

aspects of bilingualism are difficult to capture quantitatively. For example, how does one quantify the influence of being in a majority language context versus a minority language context, the influence of socio-cultural membership or of a child's general preference for a language? While such factors may have an influence on language exposure, it is difficult, if not impossible, to accurately calculate their value quantitatively.

Current Study

Following findings from previous research, the overarching goal of this study is to examine how much exposure is enough. More specifically, we aim to better understand how current versus lifetime exposure relate to children's language abilities, and whether one is a more accurate representation of children's language experiences or whether they are equivalent when examining simultaneous bilingual school-aged children. Second, we aim to examine how much language exposure bilingual school-aged children require in order to attain levels of proficiency that fall within the average range on standardised language measures. For this study, children will be examined in both of their languages since bilingual children may require different amounts of exposure to each language to reach similar levels of proficiency (Bedore et al., 2012), and including both languages provides a more complete picture of these bilingual children's abilities.

We, therefore, ask two specific questions:

(1) For each language, *is there a relationship between receptive vocabulary, overall language, expressive and receptive language abilities and the amount of language exposure (either current or lifetime) that children received?* Following Thordardottir (2011), we hypothesized that expressive language abilities would be more strongly influenced by amounts of exposure than receptive language. If a relationship does exist between language abilities and language exposure, *are language abilities more strongly linked to an individual's lifetime exposure or to*

their current exposure to a language? Following Unsworth (2016), we hypothesized that current exposure will more strongly influence language abilities than lifetime exposure.

(2) If language exposure is linked to language ability, we asked *how much exposure do school-aged children require to obtain scores within average range (defined here as being between +/–1 standard deviation from the mean) on standardised language measures?* Following Thordardottir (2011), we hypothesized that children would need approximately 40% to 60% exposure to a given language to develop language abilities within the average range of monolingual normative data. Following findings in Thordardottir (2011), we also predict that the amount of exposure required will vary depending of the sphere of language assessed, with expressive language tasks being more sensitive to exposure than receptive language tasks.

A third objective of this project was to develop a language exposure tool that was appropriate for use with school-aged children, that permitted us to collect information about children's language exposure in multiple settings across multiple interlocutors and that could be used clinically. To that end, we developed the Montréal Bilingual Language Use and Exposure questionnaire (M-BLUE). For the current study, we used the M-BLUE to calculate children's language exposure to each of their languages, thus permitting for the careful examination of the question of "how much exposure is enough". Measures such as the AoE, lifetime language exposure, and current language exposure were compared to children's levels of language proficiency in both French and English. In doing so, this examination sheds light on the variability that is observed across bilingual children, and will lead to a better understanding of bilingual language development once simultaneous bilingual children reach school age.

Our rational for examining abilities in both languages has two-fold. First as noted above, Bedore et al., 2012 and Thordardottir (2011) found that, when testing children in both languages, children required different amounts of exposure to each language to reach similar levels of

proficiency. Second, by testing children in additive context in both of their languages, it gives a more complete picture of these bilingual children's abilities.

Methodology

I. Participants

The children were recruited from private and public schools, and through social media platforms. Since all of the children resided in the Greater Ottawa Area or the Greater Montréal Area, these bilingual children were raised in contexts where both of their languages (French and English) were supported. For the present analyses, we focused on 19 simultaneous bilingual children aged six to nine years with a neurotypical development, as determined through a short parental interview. Additionally, all of the children received scores above -1.25 SD from the mean on the *Global Language Scale* of the *CELF* (either the CELF-5 or the CELF-CND-FR) in at least one of their languages (cut-off level for identification of a language disorder, Leonard, 1998), thus confirming that they did not present a language disorder. Additionally, none of the participants presented an intellectual disability (as indicated by scores $\geq$70 on the Perceptual Reasoning Index from the WISC-IV, see below). In line with previous studies (Thordardottir, 2011 and 2015), we defined a "simultaneous bilingual" as a child who was exposed to their L2 before the age of three years, based on parent report. Our sample included: 11 French-English bilinguals, five trilinguals (French, English + another language), two children French-Spanish bilinguals, and one French-Arabic bilingual. The three children who did not speak English were tested in French, and the trilingual children were only tested in French and English. While all of the participants were exposed to two of their languages before the age of three years, English was the third language for two participants who were exposed to English at 48 months. We opted to keep these two children in our analysis since they both met our criterion for a simultaneous bilingual, having acquired their L2 (French) prior to the age of three years. Additionally, since the children were 96-months and 97-months of age at the time of testing, they had received 48 and 49 months of

exposure to English by that time respectively. This amount of exposure (in months) was greater than what a six-year-old child exposed to English at 36 months would have received. Moreover, when examining these children's amount of lifetime exposure to English, the amount was within the range of exposure of other children in this study. Since previous research has found that the amount of exposure is a more important factor than the AoE of simultaneous bilinguals and young sequential bilinguals (Thordardottir, 2011; Unsworth, 2016), it was appropriate for these children to be included in the present analyses.

In addition to early acquisition of two languages, we required children to be identified by their parents as "bilingual". Beyond this, we did not impose an exposure cut-off as has been done in previous studies (Thordardottir, 2011), but rather we measured the amount of language exposure that each child received and included this amount as a variable in the analyses. In doing so, we were able to examine how children with very low amounts of exposure to a language performed in that language once they reached school age, thus permitting us to objectively measure and document this variable. For all of our participants, mothers' education was at or above college level. All children in this study either attended French-language schooling or French-immersion schooling. Finally, our participants included four sets of siblings. Information on the participants' age at testing and age of French and English exposure can be found in table 1.

Table 1. Mean AoE to French and English, mean age at first testing and standard deviations (SD).

	Minimum	Maximum	Mean	SD
Age of acquisition French (months)	0	36	4.58	10.118
Age of acquisition English (months)	0	48	11.83	17.477
Age at first testing (months)	77	119	97.63	14.530

Note. N for French= 19; n for English = 16

II. Materials

Standardised tests.

Language and cognitive abilities were measured using standardised tests that were similar in French and English. *L'Évaluation de vocabulaire en image Peabody-deuxième édition* (EVIP-II; Dunn, Dunn, & Thériault-Whalen, 1993) and the *Peabody Picture Vocabulary Test-Fourth Edition* (PPVT-4; Dunn & Dunn, 2007) were used to measure receptive vocabulary in French and in English respectively. The *Clinical Evaluation of Language Fundamental-Version Canadienne Française* (CELF-CND-FR; Wiig, Secord, Semel, Bouliane, & Labelle, 2009) and the *Clinical Evaluation of Language Fundamentals-Fifth Edition* (CELF-5; Wiig, Semel, & Secord, 2013) were used to assess the childen's global language abilities, as well as their overall expressive and receptive language abilities in French and in English respectively. A list of the various subtests included in the two versions of the CELF, along with the ages of administration and a description of each subtest, can be found in appendix 1 at the end of this manuscript. To simplify the text, we will refer to the following acronyms when discussing the following language measures: CELF-EN for the English version (i.e., *Clinical Evaluation of Language Fundamentals-Fifth Edition*), and CELF-FR for the French version (i.e., *Clinical Evaluation of Language Fundamental-Version Canadienne Française).*

Non-verbal IQ (NVIQ) was assessed through the *Perceptual Reasoning Index* (PRI) of the *Wechsler Intelligence Scale for Children* (WISC; Wechsler, 2003). This Index consists of three subtests from the WISC: *Block Design*, which requires that children use bi-coloured blocks to reproduce pictures they are shown; *Matrix Reasoning*, which requires that children identify a missing picture from a series of pictures that form a sequence or follow a specific pattern; and *Picture Concepts* which asks children to identify pictures that go together based on similar characteristics. Children were tested in either French or English, per the child's language preference as identified by the parent and confirmed by the child.

Language exposure questionnaire

For this study, we were interested in developing a questionnaire that could mitigate the shortcomings of previous questionnaires, meet the needs for the present study, and that could be used in clinical practice. To that end, we developed the M-BLUE which is a parent questionnaire that can also be completed as an interview. It examines children's language exposure in a number of different contexts and with a number of different interlocutors, rather than in one setting or with a small number of interlocutors (as is the case with the questionnaires, in Pearson et al., 1997 and Ribot, et al., 2018). In contrast with other questionnaires (for example, Paradis, 2011), the M-BLUE does not presuppose a majority language. It is also appropriate for use with children of all ages, and could also be adapted for use with adults (in contrast with questionnaires in Byers-Heinlein et al., 2018; Gutierrez-Clennan and Kreiter 2003; Paradis 2011). With the knowledge that many children are multilingual, this questionnaire allows exposure information to be gathered in up to three languages, and could be easily adapted for more languages, which is not the case with all questionnaires (for example, Paradis, 2011). In addition, through the M-BLUE, clinicians and researchers can gather information about a child's language exposure through literacy and media, and about parents' perceptions of their child's abilities in comparison to other children of the same age, in each of the child's languages. Although this information is not scored, it may help clinicians further understand a bilingual child's language exposure. The questionnaire also includes questions regarding children's language milestones and experience, and demographic information. Finally, as noted above, many questionnaires are not made freely available (Bedore et al., 2012; Bedore et al., 2016; MacLeod et al., 2013; Thordardottir 2011, 2015, 2019; Thordardottir et al., 2006; Unsworth 2013 and 2016). By contrast, the M-BLUE has been made freely available for clinicians and researchers (https://bilingualacquisition.ca/bab-lab-tools) and is available in the General Appendix of this thesis. In so doing, we aim to support research transparency and provide clinicians with the tools they need to assess the language abilities of bilingual and multilingual children.

To calculate children's current and lifetime language exposure, parents were also asked to indicate the number of hours that their child was exposed (used or heard) to a given language in a variety of different environments and with numerous different interlocutors. These included at home (with each parent and with siblings), at school, with friends, and during extracurricular and religious activities. Given the difficulty in obtaining information about output and input measures separately, we did not differentiate between the two. Rather, our *exposure* measure reflects input and output. This is consistent with what other studies of exposure appear to have done (ex: Gutierrez-Clennan & Kreiter, 2003; MacLeod et al., 2013).

III. Procedure

Children were tested in two sessions each lasting between 90 and 120 minutes. Language assessments were first completed in the child's preferred language as reported by the child or the parent, and in their other language on a separate day. For most participants, testing was completed in both French and English. As previously noted, for three bilingual children who spoke French but not English, testing was only completed in French, their primary home language. Children were assessed by a licenced speech-language pathologist or a trained research assistant. Testing sessions were conducted in a quiet room at the Université de Montréal, the Université d'Ottawa, or in the child's home. Informed consent was obtained prior to the first testing session. All sessions were videotaped for off-line coding and analyses following the sessions where needed. Since most of the children (16 of 19) were tested in both French and English, throughout we report the results for performances in English and in French of the same group of children, and not of two different groups of children.

IV. Analyses

For the normed language and cognitive measures, children's raw scores were converted to standard scores following the scoring instructions for each test. Standardised scores were used as they allowed for comparisons across children of different ages. In addition, standardised scores

provided a point of reference with regards to the normative sample of each test. Table 2 provides the group mean for the various language scales in English and French, and NVIQ scores. As the table shows, the children in this study have greater amounts of variability in their English-language abilities than in their French-language abilities, particularly with regards to expressive measures.

Table 2. Group means, standard deviations (SD) and group minimum and maximum on the CELF-EN, CELF-FR, PPVT, ÉVIP and NVIQ.

	CELF-EN-Global	CELF-FR-Global	CELF-EN-REC	CELF-FR-REC	CELF-EN-EXP	CELF-FR-EXP	PPVT	EVIP	NVIQ
Group Mean	95.13	98.84	105.38	100.68	92.00	98.53	95.75	115.42	111.11
SD	18.55	11.913	16.10	13.72	20.08	12.14	16.587	12.057	14.47
Min-max	64-127	80-120	71-127	82-136	62-126	79-120	61-120	94-132	76-130

Note. N=19 French-language measures; n= 16 English-language measures

Language exposure estimates were calculated based on parents' answers to the M-BLUE. Based on this information, two exposure scores were calculated for each language: proportion of current exposure and proportion of lifetime exposure. Current exposure represents the amount of language exposure (assuming a 14-hour day) that the child presently receives to each language during a regular week and weekend. For this score, the number of hours reported by parents (across multiple environments and individuals) was calculated for each language. These two amounts were then added to obtain a total amount of language exposure (L1+L2). The total for each language (e.g., L1) was then divided by the total amount of language exposure (L1/L1+L2) from which we obtained a proportional score. The same process was completed to calculate the proportion of exposure that a child received in each language.

To calculate lifetime exposure, we used current exposure (hours per week in each language), multiplied that amount by 52 (weeks) and then divided it by 12 (months) to obtain a monthly number of hours for each language. We then multiplied the monthly amounts of exposure for each language by the number of months of exposure that the child has received. Next, for the children who were not exposed to their second language from birth, we calculated the number of

hours during which the child did not receive exposure to their L2 and added that amount to the amount of the L1. The reason for this added amount is that during those months when the child was not exposed to their L2, it is presumed that the child received exposure to their L1. Similar calculations were completed for any changes in language exposure that the parents noted in the questionnaire. Finally, lifetime scores in the L1 and L2 were added, which gave a total amount of language exposure. To obtain lifetime proportion scores in each language, we then divided the lifetime exposure for each language by the total lifetime of language exposure (i.e., L1 lifetime/([L1 lifetime + L2 Lifetime]). Proportions were used in order to compare across our participants as they differed in age. Table 3 contains group exposure proportions for each of their languages. An example of a language exposure calculation can be found in appendix 2.

Table 3. Group means for the proportions of current and lifetime exposure to French and to English, and standard deviations (SD).

	Proportion current exposure to English	Proportion current exposure to French	Proportion lifetime exposure to English	Proportion lifetime exposure to French
Group Mean	.248	.623	.271	.592
SD	.268	.278	.296	.302

Note. N=19 French-language measures; n= 16 English-language measures. Since some children were trilingual, some group exposure levels do not reach 100%.

A Pearson's correlation was completed to examine the relationship between current and lifetime proportions. In both English and French, the correlation between current and lifetime language exposure was very robust (English: r=.965, p= .001; French: r=.975, p=.001) suggesting that children's exposure patterns were fairly stable throughout their lives. For ease of reading here, we will be discussing exposure in percentages rather than proportions. When examining exposure patterns in French and in English, different patterns emerged. In French, children's language exposure was continuous (from approximately 15% to approximately 95% French exposure, appendix 4 provides illustration via scatterplots) and none of the children had exposure levels below approximately 15%. In contrast, exposure to English was not continuous but rather

a gap in children's English exposure occurred between 21% and 48%. Thus, in English, the children in this study appear to fall into one of two exposure profiles (appendix 3 provides illustration via scatterplots). The first exposure profile group was comprised of ten children who received less than 20% of their lifetime exposure to English. The second exposure profile group was comprised of six children who had received 48% or more of their lifetime exposure to English. This difference in exposure patterns was likely due to the fact that some of the children in the sample were trilingual.

Results

Our first question asked *whether a relationship between receptive vocabulary, overall language, expressive and receptive language abilities and the amount of language exposure (either current or lifetime) was observed and if so, whether language abilities were more closely linked to lifetime or current language exposure.* To answer this question, we compared children's language exposure to their language abilities in English and in French. Since children were assessed in both of their languages, we will discuss their performances in these two languages separately.

Pearson's correlations were completed to examine the relationship between the amount of language exposure that children received and their scores on the global, expressive and receptive language scales of the CELF-EN and of the CELF-FR, as well as on the PPVT and the ÉVIP. As results in table 4 show, when examining results for the English-language measures, current and lifetime exposure proportions were significantly correlated with standard scores on the global language scale (CELF-EN-Global), the expressive language scale (CELF-EN-Exp) and receptive vocabulary (PPVT). These English-language measures were also significantly negatively correlated with the current and lifetime exposure to French. However, current and lifetime exposure measures in English (or in French) were not significantly correlated with scores

on the overall receptive language scale (CELF-EN-Rec). When the results for the same children were analysed in French, no significant correlation was found between either measure of French exposure (current or lifetime) and any French-language measure. In fact, with the exception of the (non-significant) relationship between the ÉVIP and current exposure to French, all of the other correlations between language measures and exposure to French were (non-significantly) negative.

Table 4. Correlations between language measures and lifetime and current language exposure proportions to English and to French.

Language Measure	Current Proportion English	Lifetime Proportion English	Current Proportion French	Lifetime Proportion French
CELF-EN-Global	.533*	.633**	-.501*	-.566*
CELF-EN-Rec	.252	.407	-.241	-.331
CELF-EN-Exp	.659**	.721**	-.671**	-.718**
PPVT	.623**	.694**	-.485	-.543*
CELF-FR-Global	-.019	.112	-.293	-.399
CELF-FR-Rec	.160	.226	-.245	-.302
CELF-FR-Exp	-.103	.008	-.267	-.349
ÉVIP	-.328	-.182	.023	-.141

Note. N=19 French-language measures; n=16 English-language measures
* $p < .05$. ** $p < .01$. (2-tailed)

A Pearson's correlation examining the relationship between NVIQ was completed in order to determine whether there was a relationship between NVIQ and language ability. We chose to use the global language scales in English (CELF-EN-Global) and in French (CELF-FR-Global), as they are designed to be representative of overall language abilities. We also used vocabulary measures in English (PPVT) and in French (ÉVIP), as they are often used as a language ability measure in research (ex: MacLeod et al., 2013). The analysis revealed that NVIQ was significantly and strongly correlated with scores on the CELF-EN-Global (r=.693**, p=.003) and with scores on the PPVT (r= .859**, p=<.001), but that NVIQ was not significantly correlated with either the CELF-FR-Global (r= .174, p=.475) or the ÉVIP (r=.094, p=.701).

Given the correlation between scores on the English-language measures and NVIQ, next we completed a partial correlation with the three English-language measures that were initially correlated with exposure (CELF-EN-Global, CELF-EN-Exp and PPVT) whilst controlling for NVIQ. As Table 5 shows, when controlling for NVIQ, only CELF-EN-Exp remained significantly positively correlated with lifetime exposure to English and significantly negatively correlated to lifetime exposure to French. However, it was no longer correlated with either English or French current exposure. Additionally, once NVIQ was controlled, the CELF-EN-Global and PPVT were no longer correlated with any of the language exposure measures.

Table 5. Partial correlations between CELF-EN-Global, CELF-EN-Exp and PPVT, and exposure proportions (current and lifetime) to English and to French, while controlling for NVIQ.

	Current proportion English	Lifetime proportion English	Current proportion French	Lifetime proportion French
CELF-EN-Global	.239	.392	-.187	-.284
CELF-EN-EXP	.444	.537*	-.467	-.538*
PPVT-4	.330	.468	-.006	-.118

Note. n=16. Control variable=NVIQ; df=0, 13
* $p < .05$. ** $p < .01$. (2-tailed)

Since the subtests used to calculate the global, expressive and receptive language scales of the CELF are different in the English and French versions, a post-hoc analysis was completed using the three subtests that were common across the French and English versions of the CELF and across all of our age groups: *Following Directions/Concepts et directions, Recalling Sentences/Répétition de phrases* and *Formulating Sentences/Formulation de phrases*. Since NVIQ was strongly correlated with CELF-EN-Global, we completed this post-hoc analysis using partial correlations with scores on language subtests in English and in French as dependant variables, language exposure as the independent variable, and NVIQ scores as a control variable. When controlling for NVIQ, only the English *Recalling Sentences* subtest was significantly positively correlated with lifetime exposure to English and significantly negatively correlated with lifetime exposure to French, but not with current exposure in either French or English. None of

the other subtests in French or English were significantly correlated with either lifetime or current language exposure to French or to English. Results can be found in Table 6.

Table 6. Partial correlations between language subtests and exposure proportions (current and lifetime) to French and to English.

	Current proportion English	Lifetime proportion English	Current proportion French	Lifetime proportion French
Following Directions	-.166	-.019	-.084	-.181
Formulating Sentences	.293	.359	-.408	-.440
Recalling Sentences	.406	.515*	-.490	-.578*
Concepts et directions	.144	.322	-.166	-.284
Répétition de phrases	-.129	.036	-.271	-.370
Formulation de phrases	-.169	-.023	-.302	-.398

Note. N=19 French-language measures; n=16 English-language measures.
Control variable=NVIQ; df=0, 13
* $p < .05$. ** $p < .01$. (2-tailed)

While partial correlations showed that, when controlling for NVIQ, only lifetime exposure was significantly correlated with CELF-EN-Exp and the English *Recalling Sentences* subtest, the relative influence of lifetime exposure was still unknown. Therefore, to investigate the relative influence of lifetime exposure to English, we completed two hierarchical linear regression analyses, first with scores on the CELF-EN-Exp scale and second with scores on the *Recalling Sentences* subtest as dependant variables. Lifetime exposure to English was our independent variable and NVIQ scores were used as a co-variate. When examining the CELF-EN-Exp scale, there was a significant relationship between lifetime exposure to English and expressive language, with lifetime exposure explaining 14.2% of the variance and β suggesting a moderate-to-strong effect size, after controlling for NVIQ. A significant relationship was also found between *Recalling Sentences* and lifetime exposure to English, with lifetime exposure explaining 15.5% of the variance and again, β suggesting a moderate-to-strong effect size, after controlling for NVIQ. Results can be found in Table 7.

Table 7

Our second question explored *how much exposure school-aged children require to score within standardised tests' average range.* To answer this question, we examined the relationship between language scores as measured by the CELF (in English and in French) and lifetime exposure to each language. We considered children to be within the average range if they obtained standard scores that were within 1 standard deviation of the mean (i.e., +/- 15 points from the mean of 100). We focused on the lifetime exposure measure as it was the only exposure measure that was significantly correlated with some of the scores on the English-language measures, after controlling for NVIQ. Again, since most children were tested in both French and English, and since different patterns emerged in when examining exposure to French and English, we will report results for each language separately.

We first examined the performances of children on the different English-language measures relative to lifetime exposure to English. Given the language exposure pattern in English, our sample was divided into two groups: those children receiving less than 20% exposure to English (n=10) and those children receiving more than 48% exposure to English (n=6; appendix 3 provides illustration via scatterplots). As shown in Table 8, all of the children who received an amount of lifetime exposure to English of more than 48% obtained scores on all of the English-language measures that were within the average test range (+/- 1SD from the test mean) or higher. When examining children who received less than 20% exposure to English, most of the children obtained scores within average range for the English global language measure, overall English receptive language measure (CELF-EN-Rec) and English receptive vocabulary measure. However, when examining the two expressive language measures, half of the children obtained scores below the average range on the *Recalling Sentences* subtest in English and most children in this group obtained scores below the average range on the overall English expressive language measure (CELF-EN-Exp).

Table 8. Percentage of exposure to English and number of children whose language scores fell within the average range or higher on the different English-language measures.

Language Measures	Number of children who received less than 20% English exposure and obtained score within the average range (n=10).	Number of children who received 48% or more English exposure and obtained score within the average range (n=6).
CELF-EN-Global	6 of 10	6 of 6
CELF-EN-Exp	3 of 10	6 of 6
CELF-EN-Rec	8 of 10	6 of 6
PPVT	7 of 10	6 of 6
Recalling Sentences	5 of 10	6 of 6

Note. n=16

Although no significant correlation was found between exposure to French and French-language measures, we were nevertheless interested in examining the performances of bilingual children on these language measures relative to their exposure to French. Specifically, we examined the relationship between lifetime exposure to French and scores on the various French-language measures (appendix 4 provides illustration via scatterplots). Results are reported in Table 9. Given the continuous range of exposure to French from approximately 15% to almost 100%, participants were divided into four exposure groups: French exposure levels of less than 20% (n=2), French exposure levels between 21% and 40% (n=6), French exposure levels between 41% and 80% (n=4) and French exposure levels above 80% (n=7).

An examination of children's scores indicates that in this sample, all of the children receiving between 21% and 80% of their exposure to French obtained scores at or above the average range on all of the French-language measures. When examining the performances of the children in the *more than 80% French exposure* group, it was noted that while they all obtained scores at or above the average range on the *Répétition de phrases* subtest and on the ÉVIP and that most of the children in this subgroup also obtained scores within or above the average range on the CELF-FR-Global, the CELF-FR-Exp and on the CELF-FR-Rec, some of the children in this subgroup obtained scores below the average range on these three measures. As for the two children in the *below 20% French exposure* group, they obtained scores in the average range on the two French-

receptive language measures (CELF-FR-Rec and ÉVIP). On the other French-language measures, one child obtained scores at or above the average range and one did not.

Table 9. Percentage of exposure to French and number of children whose language scores fell within the average range or higher on the different French-language measures.

Language Measures	Number of children who received less than 20% French exposure and obtained score within the average range (n=2)	Number of children who received between 21-40% French exposure and obtained score within the average range (n=6)	Number of children who received between 41-80% French exposure and obtained score within the average range (n=4)	Number of children who received more than 80% French exposure and obtained score within the average range (n=7)
CELF-FR-Global	1 of 2	6 of 6	4 of 4	6 of 7
CELF-FR-Exp	1 of 2	6 of 6	4 of 4	5 of 7
CELF-FR-Rec	2 of 2	6 of 6	4 of 4	4 of 7
ÉVIP	2 of 2	6 of 6	4 of 4	7 of 7
Répétition de phrases	1 of 2	6 of 6	4 of 4	7 of 7

Note. N=19

Since lifetime exposure can be linked to AoE, we completed a post-hoc analysis exploring the role of AoE on language scores in French and in English. To do so, we carried out a partial correlation with scores on the various language measures as the dependent variable, AoE as the independent variable and lifetime proportion as a control variable. As Table 10 shows, AoE was not significantly correlated with any of the language measures in either language, when controlling for lifetime exposure.

Table 10. Partial correlations between language measures in French and in English and AoE.

	CELF-Global	CELF-REC	CELF-EXP	PPVT/EVIP
AoE English[a]	.132	.052	.267	.317
AoE French[b]	.120	-.047	.115	.140

Note. n for English=16; N for French=19. Control variable: English lifetime exposure[a], df= 1;13. Control variable: French lifetime exposure[b], df= 1;16

While it is possible that the lack of significant correlation in French was due to the lack of participants in the lower range of exposure, we were interested in examining whether other factors could also have influenced the lack of correlation. We, therefore, conducted a series of post-hoc analyses in order to identify whether factors other than language exposure might play a role in bilingual children's acquisition of their two languages and explain why we did not see any significant correlations between language exposure and French-language measures. First, we examined whether children's primary home language had an influence on language abilities. We did so by dividing our sample into two groups based on whether children's primary home language was French or another language. We chose to examine French since it is the language in which we found no correlation between French-language proficiency levels and exposure to French, and it is the language used at school across all children. However, this choice should not be viewed as an indication that the authors believe that the development of French à priori is different than the development of English as our data cannot answer that question. We completed an independent samples t-test to ensure that our two subgroups were similar on NVIQ, and found that our they did not significantly differ from one another (NVIQ $t(17)=-2.490$, $p=.595$). We also completed an independent sample t-test, to examine whether there were any significant differences in language scores in French between these two groups. The t-test revealed that there were no significant difference on any of the French-language measures between children for whom French was the primary home language and those for whom it was not (Global CELF-FR $t(16)=-1.829$, $p=.677$; CELF-FR-Rec $t(16)=-1.845$, $p=.847$; CELF-FR-Exp $t(16)=-1.460$, $p=.925$; ÉVIP $t(16)=-.502$, $p=.932$). Next, we completed a two-tailed Point-Biserial Pearson's correlation between scores on the CELF-FR-Global, the CELF-FR-Rec, the CELF-FR-Exp and the ÉVIP and primary home language (French versus English or Other) to examine whether the language spoken at home was correlated with performances on language measures in French. These results were consistent with those of the t-test. That is, we found no significant correlation between language scores on any of the French-language measures and children's primary home language

(CELF-FR-Global *r*=.331, *p*=.166; CELF-FR-Rec *r*=.315, *p*=.190; CELF-FR-Exp *r*=.279, *p*=.248; ÉVIP *r*=.002, *p*=.994). That is, primary home language was not correlated with scores in French, although for some of these results (particularly scores on the CELF-FR-Global and on the CELF-FR-Rec) the lack of correlation could perhaps be due, in part, to a lack of power (given the *r* and *p* values). Figure II shows the distribution of French exposure score by scores on the CELF-FR-Global.

Figure II

We next examined the influence of the daily exposure to both languages on French-language scores. To do so, we created a dichotomous variable reflecting whether children were exposed to their two languages on a daily basis or not (based on parent reports on the M-BLUE). We then completed a two-tailed Points-Biserial Pearson's correlation between daily exposure to both languages and scores on the four French-language measures. The analysis revealed a correlation between daily exposure to both languages and the following French-language measures: CELF-FR-Global (*r*=.545, *p*=.016)., CELF-FR Rec (*r*=.464, *p*=.045) and CELF-FR-Exp (*r*=.533, *p*=.019). However, scores on the ÉVIP were not correlated with daily exposure to both languages (*r*=.316, *p*=.188). As Figure III shows, nine of the 12 children who received daily exposure to both languages obtained scores in the upper half of, or above the average range, while six of the seven children who did not receive daily exposure to both of their languages obtained scores in the lower half of, or below the average range.

Figure III

Given the correlations between scores French-language measures and daily exposure to both languages, we were interested in examining whether there were similar correlations in English. We, therefore, completed the same analysis as above but with the four English-language

measures. We found a correlation between daily exposure to both languages and the following measures: CELF-EN-Global (r=.630, p=.009), CELF-EN-Exp (r=.765, p=.001) and PPVT (r=.559, p=.024), but not with the CELF-EN-Rec (r=.361, p=.170). Figure IV depicts the distribution of English global language scores and exposure to English. As can be seen in Figure IV, in English, most of the children who received daily exposure to both of their languages also received between 50% and 85% of their exposure to English, while most the children who did not receive daily exposure to both of their languages also received little exposure to English. Thus, the relationship between daily exposure and language abilities (above and beyond proportion of exposure) is less clear in English than it is in French.

Figure IV

Finally, we examined whether there were correlations between scores in one language and scores in the other language. We completed this post-hoc Pearson's correlation to examine whether underlying language abilities could account for the lack of correlation between language scores and language exposure, particularly in French. With the exception of receptive vocabulary (PPVT and ÉVIP), there was a significant correlation between scores on language tests in one language and scores in the other language (CELF-EN-Global & CELF-FR-Global, r=.647, p=.007; CELF-EN-REC & CELF-FR-REC, r=.639, p=.008; CELF-EN-EXP & CELF-FR-EXP, r=.522, p=.038; PPVT & ÉVIP, r=.219, p=.416). These results suggest that language proficiency levels were similar in both languages. That is, children who had higher scores in one language tended to also have higher scores in their other language, and children who had lower scores in one language tended to have lower scores in their other language, with receptive vocabulary being the exception to this rule. These correlations also appear to reflect the distribution of our participants in the two sets of scatterplots (Figures III and IV).

Discussion

The goal of this study was to examine the relationship between language exposure and language abilities in school-aged simultaneous bilingual children. Specifically, we examined the extent to which language exposure influenced language development in school-aged simultaneous bilingual children from sociolinguistic additive contexts, in both of their languages.

First, we asked whether, there was a relationship between performances on language measures and the amount of language exposure (either current or lifetime) that children receive in each of their languages (French and English), and whether lifetime or current amounts of language exposure would be more strongly correlated with these performances. Following Thordardottir (2011), we hypothesized that there would be a relationship between language abilities and exposure, and following Unsworth (2016), we hypothesized that current exposure would have a stronger influence on language abilities than lifetime exposure. Our first hypothesis was partially confirmed. We observed a significantly positive correlation between *lifetime* exposure to English (as well as a significantly negatively correlated with lifetime exposure to French) and scores on two expressive language measures (CELF-EN-Exp and the *Recalling Sentences* subtest) in English, but not on any of the other English-language measures, when we controlled for NVIQ. Contrary to our initial hypothesis, current exposure to English was not significantly correlated with language measures when controlling for NVIQ, even though lifetime and current exposure were significantly correlated to one another. Additionally, when we examined the performances of the same children in French, we did not find a relationship between either *current* or *lifetime* exposure to French (or English) and scores on any of the French-language measures. Differences in exposure patterns in French and in English could possibly explain the differences in the influence of exposure on language abilities.

Our second question asked, how much exposure do school-aged French-English bilingual children require to obtain score within the average range on standardised language measures? Following Thordardottir (2011), we hypothesized that children would need approximately 40-60% exposure to a given language to develop language abilities within the average range, but that the amount of exposure required would vary depending of the sphere of language assessed, with expressive language tasks being more sensitive to exposure than receptive language tasks. Again, our hypotheses were partially confirmed. In English, children who received 50% or more lifetime exposure to that language obtained scores within or above average range on all of the English-language measures. However, children with less than 20% of their exposure to English were less likely to obtain scores within the average range, especially on expressive language measures. Because of the discontinuity of the exposure data in English, we were unable to examine how children receiving between 21and 49% exposure would perform in English, but we were able to examine the performances of children in this exposure group in French. Since the distribution of language exposure in French was more continuous, we were able to divide our sample into four exposure range groups (compared to two in English because of the discontinuity in the mid-range). We found that all of the participants who received between 21% and 80% of their exposure to French obtained scores within or above the average range on all of the French-language measures, including on expressive language measures. This suggests that with as little as 21% lifetime exposure to a language, it is possible for simultaneous bilingual children to obtain scores within the average range. However, as was the case in English, children in the 20% or less exposure range were less likely to obtain scores within the average range on expressive language measures. While these findings further support our hypothesis that expressive language is more strongly influenced by exposure than receptive language, they also show that simultaneous bilinguals may not require as much exposure to a language to obtain scores within the average range as we had predicted that they would require once they reach school age.

When we examined findings in performances on French-language measures, another interesting pattern emerged. While children who received between 21% and 80% of their exposure to French obtained scores within the average range (+/- 1SD from the mean) or above on all of the language measures, the children at either end of the exposure continuum were more likely to obtain lower scores than children in the middle of the continuum. That is, the children with the least amount of exposure (less than 20%) and those with the most amount of exposure (more than 80%) were more likely to obtain scores in the lower half of the average range or below average range, while children in the middle of the continuum (receiving between 21 and 80%) obtained scores in the high end of average range or above. While such performances were expected for the former group, they were not for the latter group. It is unclear why children in the higher range obtained lower scores. However, this may speak to individual factors that contribute to language learning and suggests that exposure may be only one of the many pieces of the bilingualism puzzle.

Given that language exposure on its own did not explain performances on all of the language measures, we were interested in examining whether other factors such as primary home language or AoE had an influence on language abilities. Interestingly, neither of these factors correlated with language scores. We did, however, find significant correlations when we examined the link between scores on language measures and daily exposure to both languages. That is, children who were exposed to both of their languages on a daily basis appeared to have higher languages scores than children who were exposed to one language frequently and to their other language less frequently (i.e. not daily). This was true even when children in the *daily exposure* group received a smaller amount of exposure to the target language than children in the *not daily exposure* group. Finally, we also found a correlation between scores on language measures in one language and scores in the other language.

The findings from the present study are similar to those of previous studies in some respects. First, as was reported by Thordardottir (2011 and 2019), we found that many language measures (in English) were correlated with language exposure prior to controlling for NVIQ. However, after controlling for NVIQ, only overall expressive language and *Recalling Sentences* remained significantly correlated with lifetime exposure, and lifetime exposure to English accounted for a much smaller portion of the explained than did NVIQ. In the Thordardottir studies (2011, 2019), NVIQ was used as a descriptive variable rather than a covariate, which may explain some of the differences in findings between the current study and the Thordardottir studies. The present results also suggest that bilingual children's NVIQ may have a stronger influence on children's language abilities than does language exposure, although this hypothesis will require further testing by including NVIQ as a co-variable in future studies examining the influence of exposure. Second, as was the case in Thordardottir (2011), children in this study also required more language exposure to reach average range on expressive-language tasks than what was required to reach similar levels of proficiency on receptive tasks. This is consistent with other previous findings suggesting that bilinguals often present a gap between their expressive and receptive abilities, with receptive abilities being relatively stronger (Gibson, Oller, Jarmulowicz and Ethingthon, 2012; Yan & Nicoladis, 2009), be it an actual difference in ability or an artefact of testing (Gibson, Jarmulowicz & Oller, 2018).

While a number of our finding were similar to those of previous studies, other results in the present study run counter to previously reported research. First, unlike Unsworth (2016) and Bedore et al (2012), we found lifetime exposure to be more closely correlated to scores on language measure. These differences may be the result of the different ways in which lifetime exposure was calculated in each study and/or of the population included in the different samples. For example, in our study we calculated both current and lifetime exposure in proportion of exposure, whereas Unsworth (2016) calculated cumulative exposure in years and months but

current exposure in percentage of exposure as we did. Since the questionnaire used in the Unsworth study is not available it is difficult to analyse whether such differences in calculating exposure influenced research findings. Moreover, while our sample included only simultaneous bilinguals, the sample in the Unsworth study includes both simultaneous and sequential bilinguals (this is also the case for Bedore et al., 2012). This difference in participants inclusion could also explain differences in findings with regards to the influence of lifetime versus current exposure.

Another difference is in the amount of exposure that children in the present study required to reach average range compared to amounts previously reported. For example, in her 2011 study, Thordardottir found that most children obtained scores within one standard deviation from monolingual means when they received approximately 40-60% of their language exposure to a given language (that amount was higher in the 2019 study, perhaps because the sample also included sequential bilinguals). In our study, most of the children obtained scores within or above one standard deviation from test means when receiving as little as 21% of their exposure to a given language, and at times, as low as approximately 15%. The difference between the findings in the current study and those in the Thordardottir study may be due to four factors. First, the present study included a smaller sample size. Second, we used different points of comparison: children in this study were compared to test norms, whereas children in the Thordardottir studies were compared to a group of monolingual peers. While the use of standardised measures is clinically useful, these tests often include bilingual children in their samples. Consequently, standardised measures do not necessarily reflect monolingual norms. Additionally, the definitions of bilingualism used in these different standardised measures can differ from one test to the other and their samples of bilingual children are often poorly defined. Thus, the standard against which children are compared is not always clear. Therefore, while the performances of the children in this study reflect how children perform versus test norms, it is not necessarily the case that this reflects how they would perform when compared to monolingual children exclusively, as was the

case in the Thordardottir (2011) study. Third, the children in the Thordardottir study were of pre-school age and thus may have required a greater proportion of their lifetime exposure to a given language to attain monolingual norms. It is possible that, as children become older, they require a smaller proportion of language exposure (particularly lifetime exposure) to a given language compared their younger peers. In other words, the total number of accumulated hours of lifetime exposure to a language required to achieve standardized norms may be similar in older and younger children, but in the former group, this amount may represent a smaller lifetime proportion of language exposure when compared to the proportion that it represents in younger children. Fourth, it is possible that differences were due to the way in which proportion of exposure was collected and calculated in each study. As Carroll (2017) and Grüter and colleagues (Grüter, Hurtado, Marchman & Fernald 2014) discuss, capturing children's levels of exposure is quite challenging as it is difficult to quantify the richness of children's language environments (although see Paradis' 2017 response to Carroll, 2017). However, since the questionnaire used in the Thordardottir study is not available, it is difficult to examine whether the differences in our respective questionnaires or calculation methods could explain differences in our respective findings.

Another important difference between findings in the current study and those in previous research is that, even prior controlling for exposure, we did not find a correlation between language exposure and French-language measures. A number of reasons could explain this difference. One possible explanation for the absence of a significant correlation between language exposure and French-language measures may be due to the relatively high amounts of exposure to French (most children were above 20% of their lifetime exposure) that children in this study received. In our sample, only two children received language exposure amounts below 20%, and one of these children consistently obtained scores above the mean in French. Thus, the lack of exposure at the lower end of the continuum may have influenced our findings.

However, this can only explain some of the lack of influence of exposure to French, as the children who received high amounts of French (over 80% of their lifetime exposure to French) tended to obtain lower scores than those of their peers who had smaller amounts of exposure to French.

One final difference between our findings and those of previous studies is that, unlike Bedore et al., (2012) who found a correlation between language exposure and language abilities in both languages studied (English and Spanish), we only found this correlation between performances on English-language measures and English exposure but not between exposure to French and performances on French-language measures. There may be a few reasons behind the difference between our findings in French and in English. First, because our sample included trilingual children, there were differences in the ranges of language exposures in each language. That is, in English, there were lower ranges of exposure (approximately 5% to 85%) than in French, but English exposure was discontinuous between 21% and 49%, while in French, the range of exposure was higher, but it was also continuous (ranging from approximately 15% to 95%). It is unclear to what extent these differences influenced our findings. In both of the Thordardottir (2011 and 2019), as well as in the Bedore et al., (2012) and the Bedore et al., (2016) studies, language exposure seems continuous and appear to range between approximately 5%-95% exposure to the target language(s). However, in the Unsworth (2016) study, the range of exposure that the children in this sample received is unclear. It that study, the mean amounts of current exposure was reported to be 34% for the simultaneous bilingual group and 23% for the sequential bilingual group. However, given that English was the language spoken at home (either solely or mostly) and Dutch exposure was obtained through school, during extra-curricular activities and out in the environment, it is unlikely that this sample included a full range of exposure to either language. This is of course speculative as the full range of exposure is not reported. It is also unclear whether this sample is continuous or whether there are gaps in the ranges of exposure as scatterplots have not been made available. Additionally, while it does not appear that

these studies have included trilingual or multilingual children, it is not explicitly stated. Indeed, the inclusion of trilingual children could influence the exposure patterns in the respective samples.

Interestingly, even with these differences across studies, previous studies have reported a correlation between exposure and language abilities. Therefore, in the current study, if the reason behind the lack of correlation between language exposure and French-language measures, but not expressive English-language measures, is explained by the lack of exposure in the low ranges in French, then this would suggest that the amount of exposure that children receive is important in the lower ranges but that past that point, which in school-aged simultaneous bilinguals could be as low as 20% exposure (based on findings in Table 9), exposure may be less important. Another reason for the language differences that we found could reflect differences in the amount of exposure required from one language to another to reach standardized norms. For example, in their study, Bedore et al. (2012) found that English-Spanish bilingual preschool children did not require that same amount of exposure to each of their languages that could not be explained by sociolinguistic factors. Similar findings were reported in Thordardottir (2011) for French and English. It is therefore possible that different languages may require more exposure than others. It is also possible that differences in French and English testing materials could have led to these differences. Given our sample, it is difficult to identify a single explanation for the differences in our findings in French and in English.

The correlation between performances on language measures and daily exposure to children's two languages, the correlations between scores on language measures across languages, as well as the lack of correlation between language measures and language exposure (especially in French) may be indirect evidence of improved metalinguistic abilities or positive language transfer more broadly. As previously discussed, the interdependency hypothesis states that bilingual children can benefit from language transfers and develop metalinguistic strategies and abilities that help them acquire a language from a smaller amount of exposure than do their

monolingual peers (Cummins, 1981; 2008; 2014). Indeed, previous research has found an association between language proficiency and metalinguistic abilities such that, children who had stronger metalinguistic abilities also had higher language proficiency levels (Bialystok & Barac, 2012). While it has been suggested that children require an "optimal" amount of exposure in order to benefit from positive transfer (Verhoeven, 2007), it is unclear how much exposure is an "optimal" amount. One possibility is that children may not only need a sufficient amount of language exposure to develop these metalinguistic strategies but rather (or additionally), it may be the frequency with which children are exposed **to both** of their languages that is important. Indeed, most studies examining metalinguistic abilities in bilingual children have examined this phenomenon in children attending immersion schooling who are likely exposed to both of their languages on a daily basis (Bialystok et al., 2014). In the present study, it is possible that children who were exposed to both languages every day had better language scores than children who were less frequently exposed to both languages because they benefited from stronger metalinguistic abilities. As a result, the lower amount of language exposure may have had a smaller influence on their performances on language measures because of their increased metalinguistic abilities. On the other hand, children who received very high amounts of exposure to one language but who were infrequently exposed to their other language may not have benefitted (or may have benefitted less) from improved metalinguistic abilities and may, therefore, require more exposure to that language in order to obtain language scores within the average range in both of their languages. This hypothesis is further supported by the significant correlations between scores in the two languages (with the exception of receptive vocabulary). This finding seems to support an interdependence between children's languages and improved underlying language proficiency. Interestingly, Gollan and colleagues (2015) found that children who used their minority language with multiple interlocutors had better performances in this language than children who used their minority language with fewer interlocutors, even when considering language exposure. (Gollan, Starr & Ferreira, 2015). It is possible that children who

have multiple minority language interlocutors, therefore, have access to their minority language more frequently (i.e. on a daily basis) than children who have few interlocutors with whom they can speak their minority language. More research will be required to further examine the influence of daily exposure to both languages, improved metalinguistic abilities and language proficiency.

Clinical Implications

Assessing the language abilities of bilingual children is challenging. As Figure I shows, bilingual language exposure is quite complex and exposure measures are insufficient to fully understand a child's bilingual experience. When examining bilingual children's language abilities, it is essential to keep in mind that multiple factors other than exposure play a role in children's language proficiency, and that these may not be captured in a language exposure questionnaire (for example, the influence of passive exposure or code-switching; Carroll, 2017). Additionally, we know relatively little about the influence of metalinguistic abilities on bilingual language acquisition. Therefore, while exposure is an important variable in the present study, our findings highlight that it is not the only factor that influences bilingual children's language proficiency. While language exposure questionnaires may be helpful in understanding children's language exposure, as Carroll (2017) suggests, such exposure measures omit information about the overall quality and variety of the exposure that a child receives, and about learner's beliefs regarding the acquisition and maintenance of their languages. Moreover, exposure measures themselves cannot account for differences in additive versus subtractive environments and the indirect exposure to the majority language that one may receive (MacLeod et al., 2013), access to literacy (Zaretsky, 2014) or parents' level of education (MacLeod et al., 2017), which studies have shown is positively linked to children's language ability. These factors each play a role in a bilingual child's language development, which may not be reflected in the amount of language exposure derived from exposure questionnaires. It is also important to remember that within children's performances, there are large amounts of variability (Thordardottir, 2011; 2019). Therefore, while

clinicians should obtain information pertaining to a child's language exposure, it is important to remember that exposure is at best a raw estimate of the amount of a child's overall language experience. Exposure measures are certainly informative and important to consider, but they do not reflect the entirety of a child's language story.

Another interesting clinical finding from this study relates to the role of sentence repetition tasks in assessment of bilingual children. As noted above, we found that the English version of the *Recalling Sentences* subtest was strongly influenced by language exposure, even when controlling for NVIQ. Previous studies have suggested that sentence repetition tasks may be less sensitive to exposure and, therefore, appropriate to use when assessing bilingual children (see Marinis & Armon-Lotem, 2015 for review). However, our findings show that sentence repetition tasks, or at least the one in the English version of the CELF-5 (Semel et al., 2013), can be sensitive to exposure. In the present study, when children received approximately 50% or more of their lifetime language exposure to English, they performed within the average range. However, when children received less than 20% of their lifetime exposure to English, they were less likely to obtain scores within the average range in English. In their study, Thordardottir & Brandeker (2013) found that, while their sentence repetition was sensitive to language exposure, it could nevertheless discriminate children with a language disorder from ND children (although specificity was low). Consequently, it has been suggested that sentences repetition tasks may help clinicians differentiate between bilingual children who have language delays because they have not yet fully acquired their second language, and bilingual children who have a developmental language disorder. However, given this task's sensitivity to language exposure and it's lack of specificity, clinicians may need to use caution when interpreting results from these types of tasks as they may lead to falsely identifying a bilingual child who is in the process of acquiring the tested language as having a language disorder. This is particularly true when clinicians are assessing children who receive less than 20% of their exposure to a given language, although that cut-off

may be higher, as we did not have participants in the 20-50% exposure range. Thus, these findings illustrate the need for more research in this area before sentence repetition tasks can be used reliably to identify bilingual children who have a developmental language disorder.

Limitations & Future Directions

Our study has a number of limitations. First, our sample size was small, limiting some of the correlations that we may have seen with a larger sample size. Second, our sample did not include a group of English-dominant children who were schooled in English. Because of education policies in Québec, children attended either French-immersion or French-language schooling, (as there are no English-immersion schools in Montréal) regardless of their home language. Thus, it was also not possible to examine whether French-speaking children who attend English immersion schooling would perform as well as English-speaking children attending French immersion schooling. In addition, children in Ottawa all attended French-language schooling. Unfortunately, due to regulations linked to recruitment, we were unable to recruit in English-language schoolboards in Ottawa. Our sample was also quite heterogeneous and included bilingual and trilingual children, including trilingual children for whom English was their third language. While this fact reflects the diverse nature of Montréal, our trilingual sample was not sufficiently large to examine the impact of acquiring a third language on language abilities. Additionally, it is unclear what influence, differences in exposure distribution between French an English had on our findings in English. Another limit is that the M-BLUE does not gather information regarding the parents' or children's beliefs about their languages, which may also have been informative. Future studies should rectify such limitations.

The findings from this study suggest the presence of a relationship between daily exposure and language abilities. However, as this study did not aim to test positive transfer or metalinguistic abilities, future studies should examine the influence of daily of exposure to two languages in

simultaneous and sequential bilinguals and do so in larger scale cross-sectional and longitudinal studies. Specifically, how much exposure do children require in order to benefit from positive transfer and improved metalinguistic abilities? Is there a difference between the amount of lifetime exposure that simultaneous and sequential bilinguals require to gain these benefits? Are these benefits maintained over time? Is there an age past which second-language learning no longer leads to metalinguistic benefits? This information will help clinicians and educators better understand language development in bilingual populations.

Conclusion

The aim of this study was to examine the language abilities of school-aged simultaneous bilingual children and the influence of language exposure on their language abilities. First, our results seem to suggest that these children can reach levels of proficiency that place them in the average range on normed language measures, in at least one of their languages, and in many cases, in both of their languages. Our findings also appear to suggest that while the amount of language exposure that bilingual children receive is an important factor, it may not be the only factor to influence their language abilities. Factors such as daily exposure to both languages, the language(s) in which children are schooled, along with their overall linguistic environment may play a larger role than previously presumed, and may mitigate the amount of exposure that children require. Indeed, these factors may have a positive influence on metalinguistic abilities, which may in turn, have a positive impact on the language development of both languages. A more complete understanding of this relationship will increase our comprehension of the factors that can influence bilingual language development.

Additional Figures and Tables

Table 7. Regression analysis between lifetime exposure to English and scores on the CELF-EN-Exp measure and the Recalling Sentences subtest, while controlling for NVIQ.

Language measures	Variable	Model 1			Model 2		
		B	*SE B*	*β*	*B*	*SE B*	*β*
CELF-EN-Exp	Constant	-9.617	27.034		19.250	26.794	
	NVIQ	.917	.242	.712	.570	.260	.433
	Lifetime exposure				30.711	13.373	.464
	R^2		.507			.649	
	F		14.391**			12.029***	
	ΔR^2					.142*	
	ΔF					5.274*	
Recalling Sentences	Constant	-9.043	5.812		-3.089	5.853	
	NVIQ	.165	.052	.646	.093	.057	.365
	Lifetime exposure				6.334	2.921	.483
	R^2		.417			.572	
	F		10.021**			8.686**	
	ΔR^2					.155*	
	ΔF					4.701*	

Note. N=16. Model 1: df=1, 14; Model 2: df=1, 13
*p < .05. **p < .01. ***p < .001. (2-tailed)

Figure II. Scatterplots of scores on Global CELF-FR relative to lifetime exposure to French and primary home language (French in blue circles; English or other language in green squares).

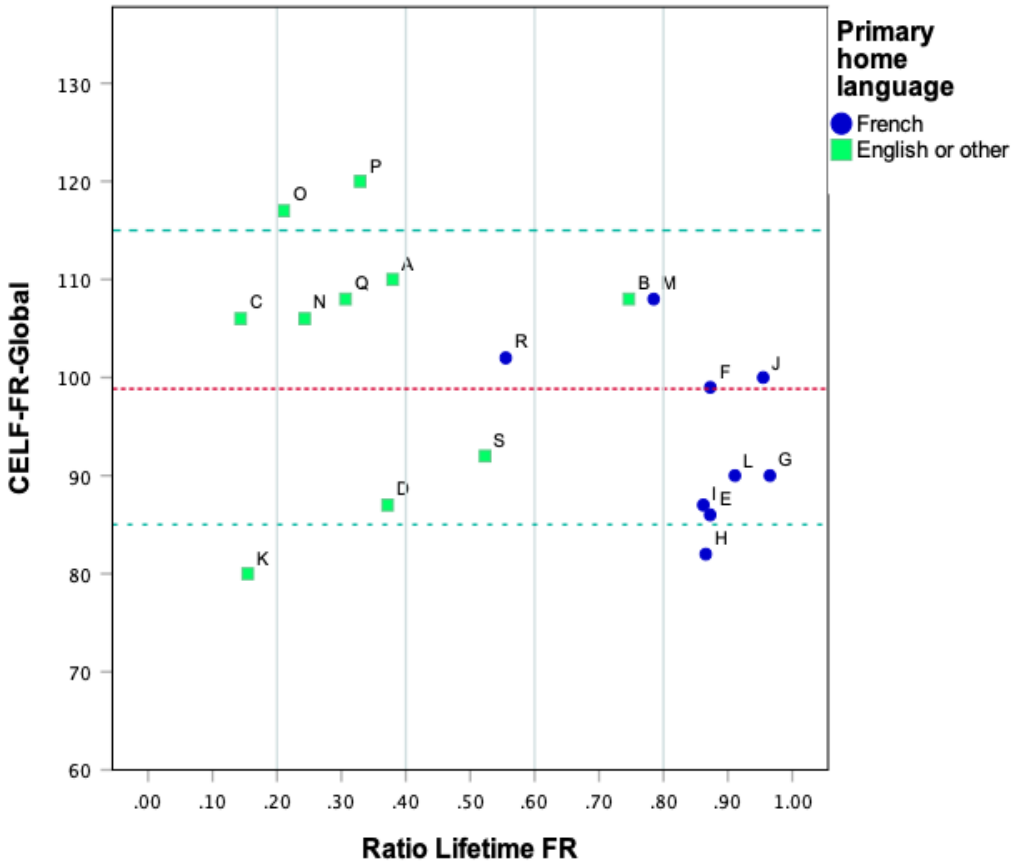


Figure III. Scatterplot depicting the relationship between scores on the CELF-FR-Global (y-axis) relative to lifetime proportion of exposure to French (x-axis). Participants have been divided into two groups based on whether their primary home language was French or whether it was English or another language (other than French). Letters have been assigned to each participant for identification purposes. The letter code assigned to each participant is the same for all scatterplots.
Note. N=19. Solid purple = group mean; dashed red line= standardised test mean (100); dashed green lines= +1 and -1 SD for the test mean (115 and 85 respectively).

Figure III. Scatterplot depicting scores on CELF-FR-Global relative to lifetime exposure to French, and daily exposure to both languages.

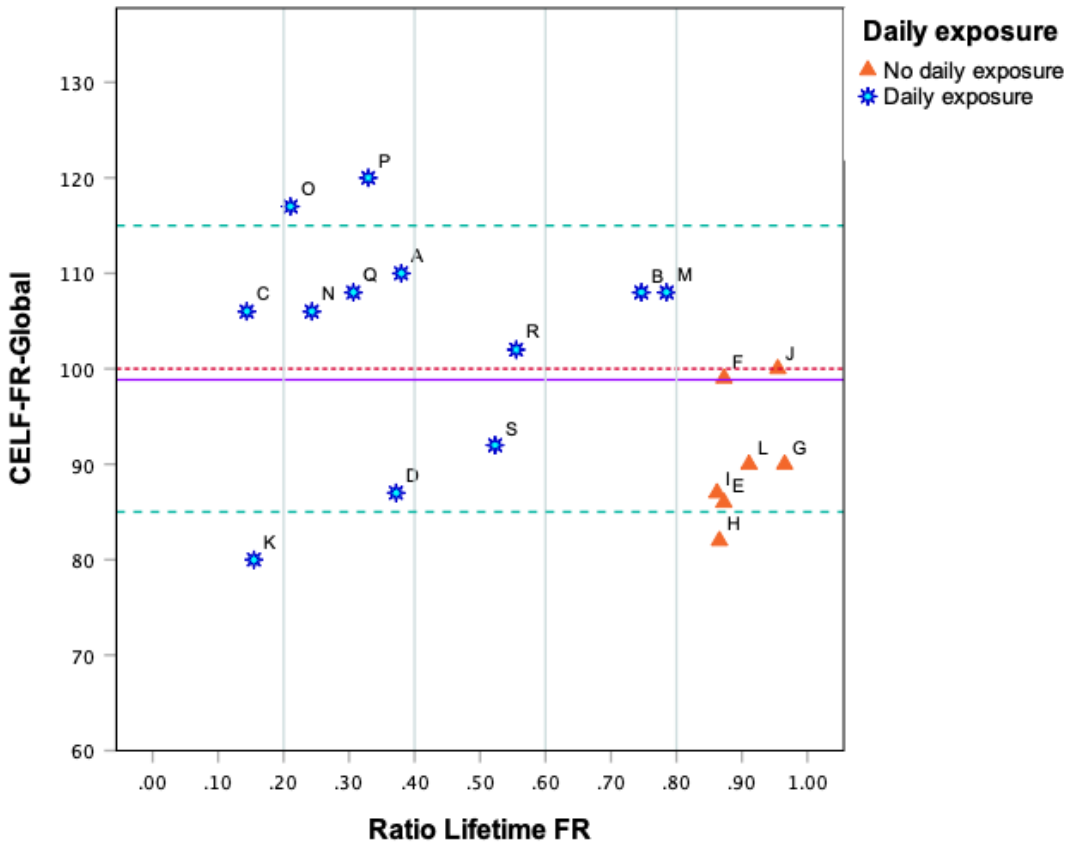


Figure IV. Scatterplot depicting the relationship between scores on the CELF-FR-Global (y-axis) relative to lifetime proportion of exposure to French (x-axis). Participants have been divided into two groups based on whether or not they received daily exposure to both of their languages. Letters have been assigned to each participant for identification purposes. The letter code assigned to each participant is the same for all scatterplots.
Note. N=19. Solid purple = group mean; dashed red line= standardised test mean (100); dashed green lines= +1 and -1 SD for the test mean (115 and 85 respectively).

Figure IV. Scatterplot depicting scores on CELF-FR-Global relative to lifetime exposure to French, and daily exposure to both languages.

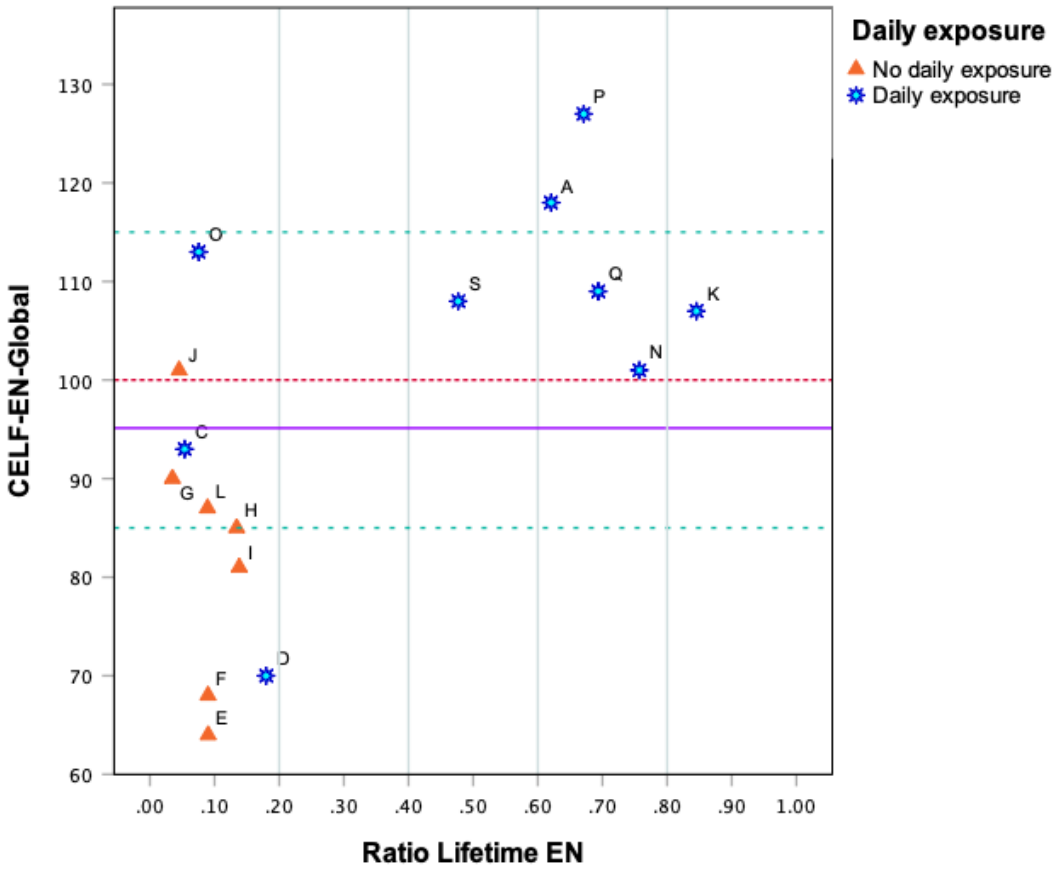


Figure V. Scatterplot depicting the relationship between scores on the CELF-EN-Global (y-axis) relative to lifetime proportion of exposure to English (x-axis). Participants have been divided into two groups based on whether or not they received daily exposure to both of their languages. Letters have been assigned to each participant for identification purposes. The letter code assigned to each participant is the same for all scatterplots.
Note. N=16. Solid purple = group mean; dashed red line= standardised test mean (100); dashed green lines= +1 and -1 SD for the test mean (115 and 85 respectively).

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Appendix 1

List and descriptions of the various subtests in the CELF-FR and in the CELF-EN, and the age groups for which they are administrated.

Subtests (Language of administration)	Descriptions of the Subtests	Ages of administration Language 6-8	9-21
**Concepts et Directives (FR) **Following Directions (EN)	This receptive language subtest requires that children listen to a verbally presented instruction and complete the instruction by pointing to the correct images in the correct order. Used to calculate the Receptive Language Index in French and in English, and Global Language Index in French.	X	X
Morphologie (FR) Word Structures (EN)	This expressive language subtest requires that children complete a verbally presented sentence using the correct morphology. Used to calculate the Expressive and Global Language Indices in French and in English.	X	
**Répétition de phrases (FR) **Recalling Sentences (EN)	This expressive subtest requires that children repeat sentences they have just heard. Used to calculate the Expressive and Global Language Indices in French and in English.	X	X
**Formulation de phrases (FR) **Formulated Sentences (EN)	This expressive language subtest requires that children produce a sentence that is related to a picture they are shown using a target word. Used to calculate the Expressive and Global Language Indices in French and in English.	X	X
Structure de phrases (FR) Sentence Comprehension (EN)	This receptive language subtest requires that children listen to a sentence and identify the picture (out of an array of four pictures) that depicts the sentence in question. Used to calculate Receptive Language Indices in French and in English, and the Global Language Index in English.	X	
Famille de mots (FR)	This expressive and receptive language subtest requires that children identify words that go together and then explain why they go together. Used to calculate the Global Language and the Receptive Language Indices in French.		X
Relation sémantique (FR) Semantic Relationship (EN)	This receptive language subtest requires that children identify statements that are semantically related. Used to calculate both the Global and the Receptive Language Indices in English and for the Receptive Language Index in French.		X

Compréhension de paragraphes à l'oral (FR)	This receptive language subtest requires that children listen to a short story and then answer questions about the story. Used to calculate the Receptive Language Index in French.	X	
Word classes (EN)	This receptive language subtest requires that children identify words that are related based on their semantic features Used to calculate Global Language Index and in the Receptive Language Index in English.		X
Sentence Assembly (EN)	This expressive language subtest requires that children create sentences from jumbled words and phrases. Used to calculate Expressive Language Index in English.		X

** indicates subtests administered to all participants and administered in both the CELF-FR and the CELF-EN

Appendix 2

Example of the Calculations to Obtain the Lifetime Proportion Scores

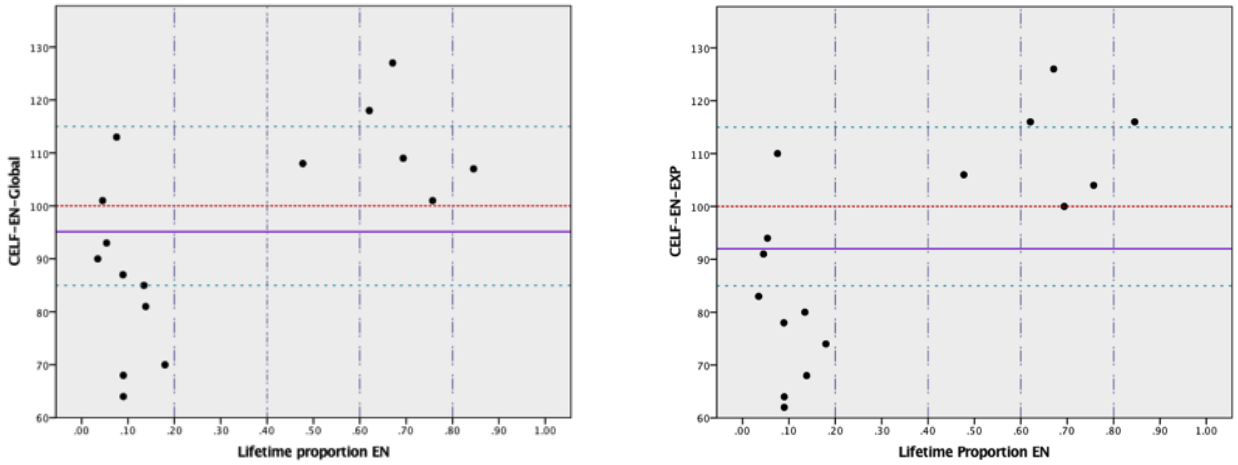
The example of the lifetime calculations for a child who is 107 months of age, currently receives 250 monthly hours of exposure in French and 350 monthly hours in English and was 36 months when L2 exposure began.

1) 350h X 107months= 37 450
2) 250h X (107-36) =17 750 (L2 lifetime exposure in hours)
3) 250h X 36 months= 9 000
4) 37 450 + 9 000= 46 450 (L1 lifetime exposure in hours)
5) 46 450/(46 450+17 750)=0,72 (proportion for L1)
6) 17 750/(46 450+17 750)=0,28 (proportion for L2)

Appendix 3

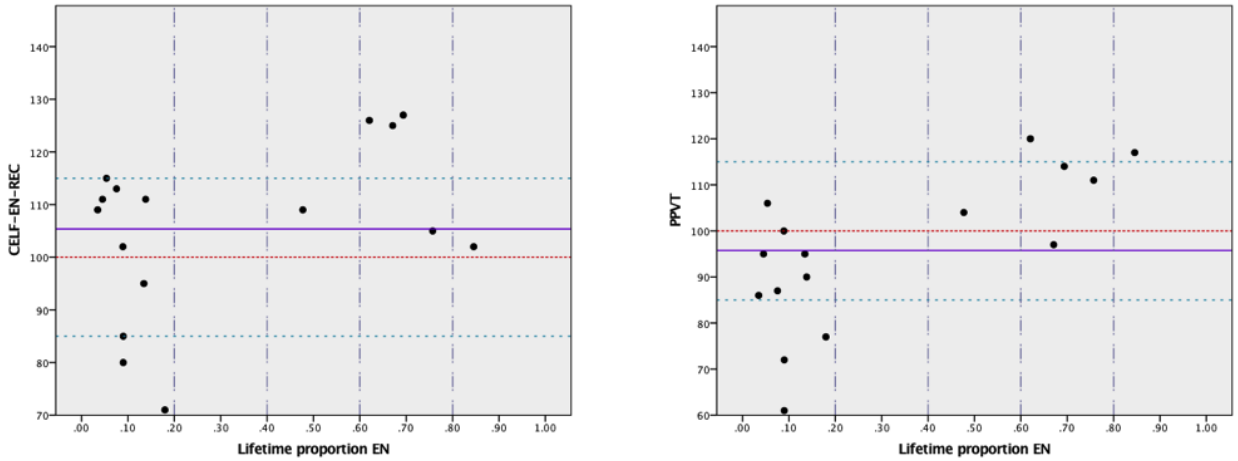
Scatterplots in English

Standardised scores on Global CELF-EN (left scatterplot; y-axis) and to the CELF-EN-EXP (right scatterplot; y-axis) relative to the proportion of lifetime exposure to English (x-axis).



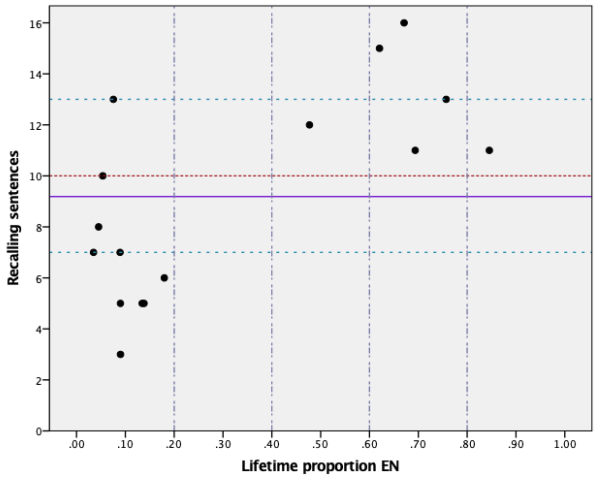
Note. n=16. Solid purple = group mean; dashed red line= standardised test mean (100); dashed blue lines= +1 and -1 SD for the test mean (115 and 85 respectively).

Standardised scores on CELF-EN-REC (left scatterplot; y-axis) and on the PPVT (right scatterplot; y-axis) relative to the proportion of lifetime exposure to English (x-axis).



Note. n=16. Solid purple = group mean; dashed red line= standardised test mean (100); dashed blue lines= +1 and -1 SD for the test mean (115 and 85 respectively).

Scaled scores on the *Recalling Sentences* subtest (y-axis) relative to the proportion of lifetime exposure to English (x-axis).

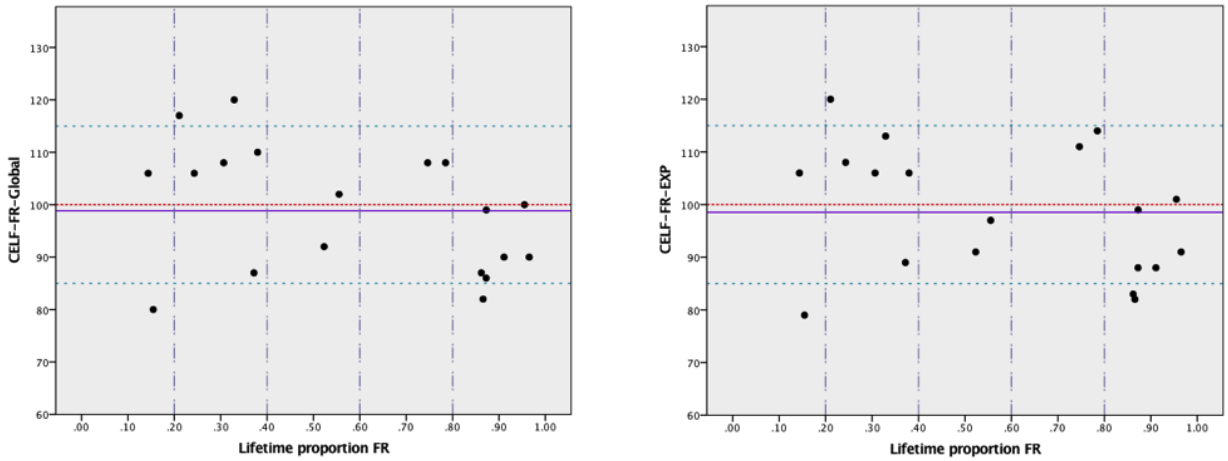


Note. n=16. Solid purple = group mean; dashed red line= standardised test mean (10); dashed blue lines= +1 and -1 SD for the test mean (13 and 7 respectively).

Appendix 4

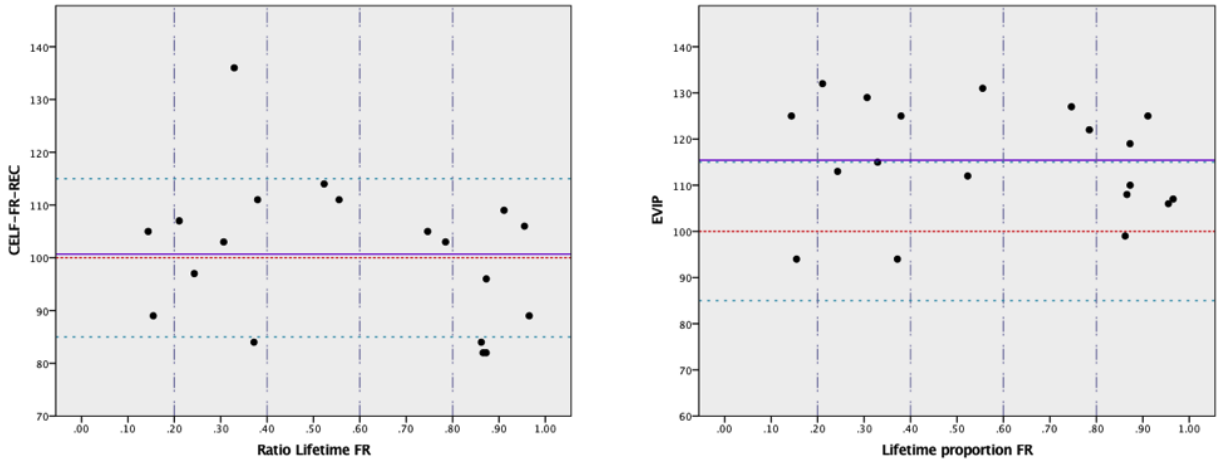
Scatterplots in French

Standardised scores on CELF-FR-Global (left scatterplot; y-axis) and to the CELF-FR-EXP (right scatterplot; y-axis) relative to the proportion of lifetime exposure to French (x-axis).



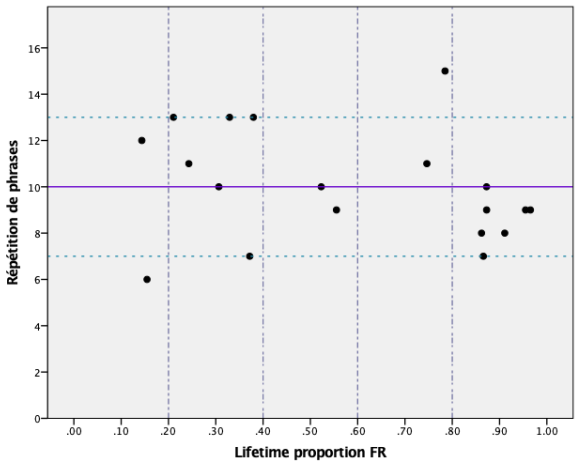
Note. N=19. Solid purple = group mean; dashed red line= standardised test mean (100); dashed blue lines= +1 and -1 SD for the test mean (115 and 85 respectively).

Standardised scores on CELF-FR-REC (left scatterplot; y-axis) and to the ÉVIP (right scatterplot; y-axis) relative to the proportion of lifetime exposure to French (x-axis).



Note. N=19. Solid purple = group mean; dashed red line= standardised test mean (100); dashed blue lines= +1 and -1 SD for the test mean (115 and 85 respectively).

Scaled scores on the *Répétition de phrases* subtest (y-axis) relative to the proportion of lifetime exposure to French (y-axis).



Note. N=19; solid purple = group mean (here, the group mean is the same as the test mean); dashed blue lines= +1 and -1 SD for the test mean (13 and 7 respectively).

Preamble Manuscript 3

Findings from manuscript 2 suggest that bilingualism does not negatively influence ND children's language development once they reach school age. They also suggest that, although language exposure remains an important factor, as children become older, other factors, such as daily exposure to both languages, may also influence proficiency. Indeed, it may be that daily exposure to both languages leads to improved metalinguistic abilities which in turn, support bilingual children's language development, thus lessening the need for language exposure in these children.

Just like ND children, children with ASD come from a variety of different linguistic and cultural backgrounds and, for many of these children, bilingualism is necessary. As discussed in manuscript 1, it is often recommended that families of children with ASD who come from minority-language backgrounds refrain from using their minority language with their child for fear that it will exacerbate their language deficits (Hampton et al., 2017; Kremer-Sadlik, 2005; Yu, 2013). However, there are negative implications for children with ASD when they do not have access to their minority language, including being excluded from conversational opportunities (Kremer-Sadlik, 2005). Recent research has also shown that preschool-aged children with ASD can become bilingual speakers, and that bilingualism does not impede their language development (Ohashi et al., 2012; Peterson et al., 2012).

But, what about school-aged simultaneous bilingual children with ASD? Can these children reach language abilities similar to those of their monolingual peers with ASD and of their ND bilingual and monolingual peers? In this third manuscript, we aimed to answer these questions through a pilot study that focused on a subgroup of children with ASD without a language disorder or an intellectual disability. Specifically, the first goal was to examine whether three bilingual school-aged children with ASD were able to develop similar language abilities to those of 19 ND

bilingual school-aged children on a number of standardised language measures. The second goal was to examine whether they could also develop language abilities similar to those of two monolingual school-aged children with ASD, as well as with their 12 ND monolingual peers. By focusing on children with ASD without a comorbid language disorder or intellectual disability, we were able to examine the influence of ASD itself on bilingual language development and, thus limiting the influence of confounding disorders on our findings. Additionally, since many children with ASD who have typical cognitive abilities are schooled with their ND peers, it is important to understand how they perform relative not only to their monolingual peers with ASD, but also to both their ND bilingual and monolingual peers. By doing so, we aim to better inform clinicians, teachers and parents as to the language development of bilingual children with ASD once they enter school.

Bilingualism in school-aged children with ASD: A pilot study

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Abstract

Preschool children with autism spectrum disorder (ASD) have been shown to develop similar language abilities when compared with their monolingual peers with ASD (Hambly & Fombonne, 2012). However, can they continue to do so as language demands change during their school years? Also, can these children reach language levels similar to those of neurotypical bilingual and monolingual children? To answer these questions, a pilot study was conducted that focuses on three children with ASD with neither a comorbid language disorder nor an intellectual disability. These children were compared to two monolingual peers with ASD, 19 neurotypical bilingual children, and 12 neurotypical monolingual peers. Using *k-means cluster analyses,* we found that bilingual children with ASD showed similar performances on language measures to those of monolingual children with ASD and neurotypically developing bilingual and monolingual children. In this small-scale study of a subgroup of bilingual children with ASD, our findings indicate that these children had developed similar language abilities to those of their peers with ASD, and of their ND peers, be they monolingual or bilingual.

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 & MacLeod, 2017; Hammer, Hoff, Uchikoshi, Gillanders, Castro, & Sandilos, 2014) and most recently have been shown to be unfounded with regards to children with ASD (Hambly & Fombonne, 2012; Ohashi et al., 2012; Peterson, Marinova-Todd, & Mirenda, 2012). These types of recommendations can also have negative implications for children with ASD and their families, including limiting children's opportunities to communicate with others, such as 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 & Fombonne, 2012; Ohashi et al., 2012; Peterson et al., 2012), the belief that two languages may hamper children's development continues to exist (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.

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 proficiency in at least one, if not both of their languages. This is true for vocabulary size (MacLeod, Fabiano-Smith, Boegner-Pagé, & Fontolliet, 2013; Pearson, Fernandez, Lewedeg, & Oller, 1997; Thordardottir, 2011), mean length of utterance (MLU; Paradis & Genessee, 1996; Thordardottir, 2015) and expressive morphology (Bedore et al., 2012; Thordardottir, 2015). School-aged simultaneous and sequential bilingual children (those who were 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, Castellanos-Ryan, Parent, Jacques & Séguin, 2019; Thordardottir, 2019; Unsworth, 2016). Studies have also shown bilingual children to have stronger metalinguistic abilities when compared to monolingual children (Bialystok, Peets & Moreno, 2014).

Despite being able to reach similar levels of proficiency, 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. These include a receptive-expressive gap such that receptive language abilities are stronger than their expressive language abilities (Gibson, Oller, Jarmulowicz, & Ethington, 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, Pena & Bedore, 2014). Bilingual children also tend to make more errors in their correct use of grammatical markers (Goldberg, Paradis & Crago, 2008; Paradis, Rice, Crago & Marquis, 2008), which can be influenced by their first language (Zdorenko & Paradis, 2008). Additionally, there is evidence that bilingual children have smaller lexicon (Gollan, Fennema-Notestine, Montoya & Jernigan, 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 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, Kay-Raining Bird & MacLeod, in preparation). Indeed, the amount of exposure that children receive reflects only one part of children's overall language experience (Carroll, 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 & Barac, 2012; Bialystok, Peets & Moreno, 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, Crago, Genesee & Rice, 2003; Samaleh, Håkansson, Nettelbladt, 2004) or Down syndrome (Burgoyne, Duff, Nielsen, Ulicheva, & Snowling, 2016; Kay-Raining Bird, Cleave, Trudeau, Thordardottir, Sutton, & Thorpe, 2005; Trudeau, Kay-Raining Bird, Sutton & Cleaves, 2011) has shown that bilingualism does not inherently impede language development. Nevertheless, it has been suggested that deficits specific to ASD, particularly in the area of social abilities (ex: 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 & Fombonne, 2012). However, to date most research findings do not appear to support this hypothesis.

First, bilingual children with ASD have been found to have similar vocabularies to those of monolingual children with ASD of similar cognitive levels (Hambly & 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 & 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 have been found to perform similarly on measures of expressive and receptive language abilities

(Hambly & Fombonne, 2012; Kay-Raining Bird, Lamond, & Holden, 2012; Ohashi et al., 2012; Valicenti-McDermott et al., 2013). In a recent large-scaled study, Dai, Burke, Naigles, Eigsti, and Fein (2018) examined receptive and expressive language scores of toddlers with either ASD or a global developmental delay. While group differences were reported along diagnostic lines, bilingual toddlers in all three groups obtained scores on language measures similar to those of their 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, Kohlmeier, and Durán (2017) examined the findings from seven studies investigating the influence of bilingualism on various aspects of language in bilingual children with ASD. Findings 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 developmental language disorders (DLD; 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 & Fombonne, 2012). In particular, they appear to develop 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 & Nadig 2018; Hambly & Fombonne 2012; Kay-Raining Bird et al., 2012; Sen & Geetha, 2011), their groups also included preschool-aged children (which in Québec is up to six-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. 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. Also, with the exception of Gonzalez-Barrero and Nadig (2018), the bilingual language abilities of children with ASD have not been compared to those of their ND bilingual peers, nor have they been compared 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, Genesee & Crago, 2011). The goal of the current pilot study is to examine whether simultaneous bilingual school-aged 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 average or higher than average IQ 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 classes 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 bilingual children with ASD, 2) examining bilingual 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 & Fombonne, 2012; Ohashi et al., 2012; Valicenti-McDermott et al., 2013), we hypothesize that bilingual children with ASD will overall have similar performances to those of their monolingual peers with ASD. Based on

previous findings (Kjelgaard & 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 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 & 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 & 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

I. 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 as children who had received exposure to two languages prior to participating in the study and who were able to use both of these languages. All of the 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; Thordardottir 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 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 a

language exposure questionnaire (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, Wiig, Bouliane, Semel, & Labelle, 2009) or the *Clinical Evaluation of Language Fundamentals-Fifth Edition* (Wiig, Semel, & Secord, 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 (86% and 65% respectively) than French, and the third child (AB2) had fairly balance 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, Bailey, & Lords, 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, Lord, & Rutter, 2003). All of the children in the ASD group met *SCQ Lifetime* criteria for ASD.

The non-verbal intellectual abilities (NVIQ) of all of the children were 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. This measure was used to identify children with intellectual disabilities. Children with an intellectual disability (as indicated by a score of $\leq$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 and 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.

[Table 1 HERE]

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.

II. 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 was assessed through the *Évaluation de vocabulaire en image Peabody-deuxième édition* (ÉVIP-II; Dunn, Dunn & Thériault-Whalen, 1993) and the *Peabody Picture Vocabulary Test-Fourth Edition* (PPVT-4; Dunn & 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). 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 minutes 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.

III. 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 again 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 on the different language scales in French and in English and the NVIQ measure, as well as standard deviations (SD).

[Table 2 HERE]

Children's language exposure proportion estimates were derived based on 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-hour 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 of 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 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, 2008)* and the *mclust* package (Scrucca, Fop, Murphy, & Raftery, 2016) to answer our research questions. The K-

means cluster analysis has been described as an iterative partitioning method (Hammet, Kleeck, & Huberty, 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 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, Keheyia, Lessard, Sutton & Trudeau, 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.

Table 3. Cluster distribution and number of children per cluster. Cluster analysis completed with French receptive language (CELF-FR-Rec) and French receptive vocabulary (ÉVIP).

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; AM2; 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

Note: NDB=neurotypically developing bilingual; NDM=neurotypically developing monolingual.

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.

Table 4. Cluster distribution and number of children per cluster. Cluster analysis completed with French receptive (CELF-FR-Rec) and French expressive (CELF-FR-Exp) language measures.

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

Note: NDB=neurotypically developing bilingual; NDM=neurotypically developing monolingual.

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 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 $\triangle R^2$ 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.

[Table 5 HERE]

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 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 language, including the language in which they received more exposure. Again, we completed a series of *k-means cluster analysis* to examine how

bilingual children with ASD clustered when compared to their ND bilingual peers on the different language measures.

First, the analysis 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 the 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 2 in English) fell within or above 1 SD from the normative mean (mean =100; 1SD = +/- 15). However, for cluster 3, cluster means on the English-language measures (CELF-EN-Rec and PPVT) fell below 1 SD from the normative mean.

Table 6. Cluster distribution and number of children per cluster. 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).

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

Note: NDB=neurotypically developing bilingual

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.

Next, the expressive language abilities in French and English were compared using scores on the CELF-EN-Exp and those 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 rather than form their own group.

Table 7. Cluster distribution and number of children per cluster. Cluster analysis completed with French expressive language measure (CELF-FR-Exp) and English expressive language (CELF-En-Exp).

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

Note: NDB=neurotypically developing bilingual; NDM=neurotypically developing monolingual.

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 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 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 relationship was found between exposure to English and CELF-EN-Rec and $\triangle R^2$ 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 the CELF-EN-Exp and PPVT measures and exposure to English. Moreover, $\triangle R^2$ 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 of tables 6 and for CELF-EN-Exp in cluster 2 of table 7.

[Table 8 HERE]

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, Anderson and Lord (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; Bedore, Pena, Griffin & Hixon, 2016; Thordardottir 2011; 2019; Unsworth 2016) and of children with ASD (Gonzalez-Barrero & Nadig, 2018) suggesting that exposure is a strong predictor of language abilities in bilingual children.

Next we focused on whether there were any 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 & 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 may be more sensitive to language exposure than is receptive language. This finding is in-line with previous findings in the ND population (ex: 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. These findings are similar to previous findings examining bilingual language development in ND bilingual children (MacLeod et al., 2013; MacLeod et al., 2017; Thordardottir 2011; 2019; Unsworth 2016), in 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 abilities can develop similar

language abilities to their ND monolingual peers with similar cognitive abilities (Hambly & 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 those of 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 & 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, the ND children in the current study and their peers with ASD were all simultaneous bilinguals, but it is unclear if that is the case in the Gonzalez-Barrero & Nadig (2018) study. Additionally, there are a number of children in the Gonzalez-Barrero & Nadig (2018) study who received very low levels of exposure to French (approximately 5%), whereas for the bilingual children (in the ND and ASD groups) in the current study, the lowest 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 higher metalinguistic abilities (Bialystok & 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). This 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, although French was the language to which they received the least amount of exposure, they

consistently clustered with some ND French-monolingual peers. Minimally, this finding suggests that factors other than language exposure may be at play. Therefore, differences in language experience 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, when 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 bilingual school-aged 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 the recommendation to avoid using more than one language with the child because of the 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. Predicting future

language abilities, children's trajectories may change overtime. 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. 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, Rabagliati, Sorace & Fletcher-Watson, 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 & 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. Its findings suggest 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 finding 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 ASD groups and ND peers 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 of children's performances, particularly of 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. Rather, they suggest that bilingual children with ASD who have similar profiles to the children in this study 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 improved metalinguistic abilities and if so, whether improved metalinguistic abilities lead to more efficient bilingual language acquisition in these children.

Conclusion

The findings from this pilot study suggest that children with ASD without an intellectual disability or a language disorder have the potential to become proficient in both of their languages, and that they can be schooled with their ND monolingual peers. Our findings also 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. Additionally, 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. They will also 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.

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.

Additional Tables

Table 1. Demographic information (standard deviation, SD) for the entire sample, ND and ASD monolingual (ML) and bilingual (BL) groups. Mean age reported in months.

	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)

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

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		95.13		115.67
(SD)		(18.55)		(15.01)
CELF-EN-Rec		105.38		116.67
(SD)		(16.10)		(10.97)
CELF-EN-Exp		92.00		117.67
(SD)		(20.08)		(17.90)
CELF-FR-Global	104.33	98.84	100.00	89.00
(SD)	(16.05)	(11.91)	(1.414)	(4.58)
CELF-FR-Rec	101.58	100.68	95.00	102.33
(SD)	(10.63)	(13.72)		(11.85)
CELF-FR-Exp	107.92	98.53	95.00	87.00
(SD)	(18.15)	(12.14)	(0)	(3.46)
PPVT-4		95.75		121.67
(SD)		(16.59)		(23.12)
EVIP-2	127.00	115.42	121.00	115.33
(SD)	(16.13)	(12.06)	(8.485)	(11.55)

Note. N=36

Table 5. Hierarchical linear regression analyses examining the influence of exposure to French on French-language scores, while controlling for NVIQ. All children were included in these analyses.

Language measures	Variable	Model 1			Model 2		
		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	

Note. N= 36. Model 1: df=1,34; Model 2: df=1, 33.
*p < .05. **p < .01, ***p= < .001

Table 8. Hierarchical linear regression analyses examining the influence of exposure to English on English-language scores, while controlling for NVIQ. All bilingual children were included in these

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**	

Note. n= 19. Model 1: df= 1, 17; Model 2: df= 1, 16
*p < .05. **p < .01, ***p= <.001

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On-line Supplemental

List and descriptions of the various subtests in the CELF-FR and in the CELF-EN, and the age groups for which they are administrated.

Subtests (Language of administration)	Descriptions of the Subtests	Ages of administration Language 6-8	Ages of administration Language 9-21
**Concepts et Directives (FR) **Following Directions (EN)	This receptive language subtest requires that children listen to a verbally presented instruction and complete the instruction by pointing to the correct images in the correct order. Used to calculate the Receptive Language Index in French and in English, and Global Language Index in French.	X	X
Morphologie (FR) Word Structures (EN)	This expressive language subtest requires that children complete a verbally presented sentence using the correct morphology. Used to calculate the Expressive and Global Language Indices in French and in English.	X	
**Répétition de phrases (FR) **Recalling Sentences (EN)	This expressive subtest requires that children repeat sentences they have just heard. Used to calculate the Expressive and Global Language Indices in French and in English.	X	X
**Formulation de phrases (FR) **Formulated Sentences (EN)	This expressive language subtest requires that children produce a sentence that is related to a picture they are shown using a target word. Used to calculate the Expressive and Global Language Indices in French and in English.	X	X
Structure de phrases (FR) Sentence Comprehension (EN)	This receptive language subtest requires that children listen to a sentence and identify the picture (out of an array of four pictures) that depicts the sentence in question. Used to calculate Receptive Language Indices in French and in English, and the Global Language Index in English.	X	
Famille de mots (FR)	This expressive and receptive language subtest requires that children identify words that go together and then explain why they go together. Used to calculate the Global Language and the Receptive Language Indices in French.		X
Relation sémantique (FR) Semantic Relationship (EN)	This receptive language subtest requires that children identify statements that are semantically related. Used to calculate both the Global and the Receptive Language Indices in English and for the Receptive Language Index in French.		X
Compréhension de	This receptive language subtest requires that children listen to a short story and then answer questions about the story.	X	

paragraphes à l'oral (FR)	Used to calculate the Receptive Language Index in French.	
Word classes (EN)	This receptive language subtest requires that children identify words that are related based on their semantic features Used to calculate Global Language Index and in the Receptive Language Index in English.	X
Sentence Assembly (EN)	This expressive language subtest requires that children create sentences from jumbled words and phrases. Used to calculate Expressive Language Index in English.	X

General Discussion

The objective of this thesis was to examine the influence of bilingualism on language development in both ND school-aged children and in their bilingual peers with ASD who had neither a language disorder nor an intellectual disability. To that end, three manuscripts were developed. For the first manuscript, a literature review of the current research on bilingualism in children with a ND, with a language or developmental disorders, and finally in children with ASD was completed. This review also explored the repercussions for children with ASD and their families when recommendations are made against bilingualism for children from minority language backgrounds. Based on this review, it became clear that there was a dearth of research focusing on ND school-aged simultaneous bilingual children and on their peers with ASD. This led to two studies which were reported in manuscript 2 and manuscript 3. In manuscript 2, the language development in ND school-aged simultaneous bilingual children was examined. Specifically, the relationship between language exposure and language abilities was examined in 19 ND bilingual children. In manuscript 3, a pilot study, the language development of three school-aged simultaneous bilingual children with ASD relative to their 19 ND bilingual peers, as well as to their two monolingual peers with ASD and their 12 ND monolingual peers was examined. These manuscripts are novel contributions to the literature as they provide new insights to the field of bilingualism in ND children and children with ASD.

Manuscript 1 was, to my knowledge, the first literature review to examine bilingualism in children with ASD. Together, the findings from previous studies show that children, including children with ASD, can become bilingual. That is not to say that bilingual and monolingual development is exactly the same. However, studies show that bilingual children, especially simultaneous bilingual children, who receive sufficient amounts of language exposure are able to reach overall levels of proficiency that are similar to those of their monolingual peers with similar cognitive profiles. Additionally, research indicates that bilingualism does not exacerbate or lead to language disorders (Burgoyne et al., 2016; Paradis et al., 2003; Ohashi et al., 2012). Findings also suggest that children who live in a bilingual or minority-language family, but whose direct exposure is limited to a single language, may experience negative repercussions, such as exclusion from conversations (Hampton et al., 2017; Yu, 2013). For children with ASD, who already present deficits in conversational skills, incidental exclusion from conversational opportunities may diminish the opportunities that they will have to practice

conversational skills (Hampton et al., 2017; Yu, 2013). Moreover, when children do not speak their family's minority language, they may not be able to communicate with extended family members such as grandparents, aunts and uncles, and cousins (Filmore, 1991; Kremer-Sadlik, 2005; Yu, 2013). They may also have difficulty interacting with members of their cultural community and acquiring the social rules that are specific to their minority language community (Filmore, 1991; Kremer-Sadlik, 2005; Yu, 2013). These difficulties can lead to infringements of socio-cultural rules and to conflicts (Filmore, 1991). Finally, when children do not speak their parents' minority-language, communication between parents and their children may be challenging, particularly when parents are not proficient in the majority language (Yu, 2013). This, in turn, may have a negative impact on parent-child relationship (Filmore, 1991).

Previous research has shown that bilingualism does not impede language development in ND children (Gathercole, 2007; Bedore et al., 2012; Thordardottir, 2011; Unsworth, 2016) or in children with ASD (Hambly & Fombonne, 2012; Ohashi et al., 2012; Peterson et al., 2012; Valicenti-McDermott et al., 2013). However, in both populations, the majority of the research has examined the language development of preschool-aged children. Thus, numerous questions remain unanswered, specifically when examining language development in school-aged children. Moreover, studies of bilingual language development of ND children have rarely examined these children's performances in both of their languages, and, to my knowledge, no study has examined the bilingual language development of ND school-aged children from additive contexts, in both of their languages. Therefore, before examining the language development of school-aged simultaneous bilinguals with ASD, I first aimed to gain a better understanding of the language development of ND school-aged simultaneous bilinguals who would serve as comparison group in the ASD study.

In manuscript 2, I examined the language abilities of a group of ND school-aged simultaneous bilingual children living in an additive context. Specifically, I investigated the influence of language exposure on these children's language abilities in both of their languages (French and English). It was expected that children's language development would be influenced, to a large extent, by the amount of exposure that they received to each language and that current amounts of language exposure would be linked more strongly with children's language abilities than lifetime amounts of language exposure. Based on previous research (Thordardottir 2011),

I also expected that children would require between 40 and 60% exposure to a language to reach standardized norms and that expressive language measures would be more strongly influenced by language exposure than receptive language measures. Our results only partially supported these hypotheses. They showed that lifetime language exposure, but not current language exposure, was significantly correlated to overall expressive language scores and to the *Recalling Sentences* subtest in English (after controlling for NVIQ). Surprisingly, after controlling for NVIQ, I did not find a correlation between lifetime or current exposure for any of the receptive English-language measures, nor was there a correlation between exposure to French (current or lifetime) and any of the French-language measures. Finally, as expected, expressive language measures were more strongly influenced by exposure than receptive language measures, although, children in the current study required much less exposure than had been predicted to obtain scores in the average range on the different language measures. Thus, the findings in manuscript 2 were somewhat inconsistent with those of previous studies (Bedore et al., 2012; Thordardottir, 2011 and 2019; Unsworth, 2016).

A number of factors could explain the differences between the findings in the current study and those reported in Unsworth (2016), Thordardottir (2011; 2019) and in the Bedore studies (Bedore et al., 2012 and Bedore et al.,2016). First, unlike Unsworth (2016) and Bedore et al. (2012), we found lifetime exposure to be more strongly correlated with performances on language tasks than was current exposure. This difference could be due to differences in how lifetime exposure was calculated in both of these studies. As discussed in the manuscript, the Unsworth study reported lifetime (cumulative) exposure in months and years, whereas in the current work, lifetime exposure was calculated in proportion of exposure. This difference in reporting exposure could account for the difference in our respective findings. It is also important to note that lifetime and current exposure in the current study were strongly correlated, suggesting that, from a clinical perspective, current exposure might be a valid measure of a simultaneous bilingual child's exposure.

A second difference contrasted findings in manuscript 2 with the work of Thordardottir (2011). In the current study, most of the children were able to obtain scores within the average range with as little as approximately 20% exposure to a language, whereas, in the Thordardottir study, children required more exposure to reach similar levels of ability. This result may be due to the smaller sample size in the current study

than that in the Thordardottir study, which may have led to a lack of power. It may also be due to the older age of the children in the present study. Thus, the proportion of lifetime exposure that was needed to attain average norms on expressive tasks may be lower for older children than what is required by younger children. Indeed, it is likely that older simultaneous bilingual children have received more hours of exposure over their lifetimes than have younger children and, therefore, may require a smaller proportion of exposure when compared to younger peers. The differing result may also be due to the way in which exposure was calculated in the two studies. However, since the Thordardottir questionnaire is not available, it is difficult to compare our respective methods. Finally, differences between the two studies could be due to the standard against which children were assessed. In the current study, children were compared to test norms, whereas in the Thordardottir studies (2011; 2019), children were compared against the performances of monolingual children included in their study. Since standardised tests often include some bilingual children in their samples (which are frequently not well defined and that use differing definitions of bilingualism), children in our study were not tested solely against monolingual standards.

A third difference is that, unlike Bedore et al. (2012) who found a correlation between language exposure and performances on language measures in both of their participants' languages, I only found a correlation on some English-language measures, but not on French-language measures. This difference could reflect the differences in the range of exposure to each language in the present study. In particular, the inclusion of trilinguals in the current study meant that the French and English exposure range were not mirror images. Thus, it is unclear whether the discontinuity in the mid-range in English as well as the fact that proportions of exposure in the *low range* in French were relatively high (at approximately 15%) had an influence on our findings. Alternatively, it is possible that children do require different amounts of exposure to different languages, as the findings in Bedore et al. (2012) and Thordardottir (2011) potentially suggest.

In addition to these differences with previous research, manuscript 2 also showed an interesting pattern. When examining the performances of children on the French-language measure, children who received French exposure ranging from 21% to 80% obtained language scores within or above the average range on all of the French-language measures. In contrast, children who received French exposure that was greater than 80%

tended to have scores on French-language measures in the low average or below average range. This finding was unexpected but may be explained by the relationship between performances on language measure and daily exposure to both languages. That is, children who used both of their languages on a daily basis seem to generally obtain higher scores on French-language measures than many of the children who used one of their languages (in this case English) infrequently, regardless of the fact that children in the former group received less exposure to French than did children in the latter group (a similar relationship was reported in English, although given the correlations between exposure to English and some of the language measures, the relationship between daily exposure and language abilities was less clear). In addition, there was a relationship between scores on the various French-language measures and those on analogous English-language measures for most spheres of language, with the exception of receptive vocabulary. This finding might suggest a relationship between language abilities in one language and language abilities in the other language.

Given these findings, it was hypothesised that positive transfer or improved metalinguistic skills more broadly may have contributed to the lack of correlation between many of the language measures (including in English after controlling for NVIQ) and the correlation between daily exposure to both languages and scores on the various language measures. Interestingly, many of the previous studies that have examined metalinguistic abilities in bilingual children included samples of children who attended immersion schools (Bialystok & Barac, 2012; Bialystok et al., 2014). It is likely that these children have been exposed to both of their languages on a daily basis and that this daily dual-language exposure could have led to better metalinguistic abilities, potentially making them better language learners. This improved language-learning ability may in turn have decreased the need for high amounts of language exposure. While the link between language proficiency and daily exposure to one's two languages has not been directly investigated, in their study, Gollan and colleagues (Gollan et al., 2015) found that children who spoke in their minority language with numerous interlocutors were more proficient in that language than children who spoke their minority language with fewer interlocutors, even when controlling for language exposure. Unfortunately, the M-BLUE did not permit for the examination of whether the number of interlocutors that children had in each language influenced their language abilities. However, it is possible that

children who speak a minority language with multiple individuals also use that language more frequently than children who speak their minority language with a smaller number of speakers.

Taken together, the findings in manuscript 2 contribute to the body of research that suggests that multiple factors contribute to language abilities in bilingual children in addition to the amount of language exposure. While language exposure is important, its importance may diminish as children get older. That is, as simultaneous bilinguals age, they may require a smaller proportion of their exposure to a specific language given how much exposure they have received over the course of their lifetime. Additionally, other factors such as daily use of both languages may lead to improved abilities in using positive transfer and metalinguistic strategies. However, more studies will be required to better understand whether this hypothesis is correct.

With a better understanding of the language abilities of ND school-aged simultaneous bilingual children, next I focused on the language abilities of bilingual simultaneous children with ASD through a pilot study. Since the majority of current studies examining bilingual language development in children with ASD have focused on preschool-aged children (Ohashi et al., 2012; Peterson et al., 2012; Valicenti-McDermott et al., 2013), the aim of this study was to examine the language abilities of school-aged simultaneous bilingual children with ASD who come from additive language contexts, and to do so in both of their languages. To that end, in this study, the language abilities of three school-aged simultaneous bilingual children with ASD with neither a language disorder nor an intellectual disability were compared to those of 19 ND simultaneous bilingual peers and also to those of two monolingual peers with ASD and to those of 12 ND monolingual peers on expressive and receptive language measures, and on receptive vocabulary. The rationale for including ND bilingual and monolingual peers was twofold. First, bilingual children with ASD without an intellectual disability are generally schooled with ND children. As such, it was important to examine the language abilities of bilingual children with ASD relative to those of ND children who were similar to their classmates. Second, I was interested in examining whether characteristics of ASD would make it more difficult for these children to acquire two languages as was hypothesized in Hambly & Fombonne (2012). By including children without a language disorder or an intellectual disability, I was able to examine the influence of ASD itself on the bilingual language development of these children. Based on previous findings (Hambly & Fombonne, 2012; Ohashi et a., 2012; Peterson et al., 2012), it

was hypothesized that bilingual children with ASD would have similar performances to those of their monolingual peers with ASD but, that their performances would be weaker than those of their ND peers (based on findings by Gonzalez- Barrero & Nadig, 2018).

For this pilot study, a series of *k-means cluster* analyses were completed using scores on a variety of language measures in French and in English. This method permitted for a comparison of children's performances across the different language measures. Specifically, whether children with ASD clustered with monolingual children with ASD, ND bilingual, and with ND monolingual children, or whether they would form a distinct group. Findings indicated that the performances of school-aged simultaneous bilingual children with ASD were similar to those of their monolingual peers with ASD, and to those of their ND bilingual and monolingual peers. That is, children with ASD clustered with their three peer groups on the various language measures. Additionally, bilingual and monolingual children with ASD did not show the expected language patterns that have been reported in some of the literature to be particular to children with ASD. Specifically, children with ASD in the current study did not have better vocabulary skills when compared to their overall receptive abilities compared to their ND peers, nor did I find evidence of an expressive language advantage. A series of post-hoc analyses were completed to examine the influence of French- and English-language exposure on the performances of these same children on expressive and receptive language, and on receptive vocabulary. In French, there was no correlation between exposure to French and scores on the French-language measures. In English, there were correlations between exposure to English and both receptive vocabulary and expressive language scores, but not to receptive language scores.

Taken together, the results from manuscript 3 suggest that these three school-aged simultaneous bilingual children with ASD who had neither a language disorder nor an intellectual disability were able to develop language abilities similar to those of their monolingual peers with ASD, as well as to their ND bilingual and monolingual peers. These findings are also similar to those of previous studies showing that bilingual children with ASD can become bilingual speakers. It also suggests that symptoms linked to ASD, such as deficits in social skills, do not prevent children with ASD from acquiring two languages. It should be noted that some of these findings may have been influenced by the fact that bilingual children with ASD had higher NVIQ scores,

especially when compared to their ND monolingual peers. However, given our small group sizes, it was not possible to examine whether these differences were statistically significant, nor was it possible to determine whether these differences influenced our findings.

The results regarding exposure obtained in manuscript 3 are similar to those from manuscript 2. In French, there was no correlation between language exposure and French-language measures, even though the analysis in manuscript 3 included French-monolingual children. This suggests that factors other than language exposure influence language development for both ND children and children with ASD. It is also possible that bilingual children, including children with ASD, benefit from improved metalinguistic abilities. Interestingly, the three bilingual children in the ASD study were all daily users of both of their languages as all three attended a French-English immersion school. It is therefore possible that, just like their ND peers, they also potentially benefitted from improved metalinguistic abilities, although further studies will be needed to verify this hypothesis. In English, there was no significant relationship between language exposure and overall receptive language. There was, however, a significant relationship between exposure and expressive language. In manuscript 3, a significant relationship between exposure to English and receptive vocabulary in English was also found, which was not the case in the study in manuscript 2. This difference may be due to a lack of power in the latter study. Alternatively, it may be that children with ASD require slightly more exposure than their ND peers. As noted in manuscript 3, evidence from Gonzalez- Barrero and Nadig (2018) suggested that this may be the case. Further research will be required to better examine this question.

Overall, the results from these three manuscripts are novel. Manuscript 1 was the first literature review to be published on bilingual language development in children with ASD. The second manuscript examined the language abilities of French-English bilingual school-aged simultaneous bilinguals from additive contexts, in both of their languages. This study is novel since, to our knowledge, no other study has examined the language abilities of this population of children, in both of their languages. The findings from this study suggest that ND school-aged simultaneous bilingual children from additive context have the potential of attaining language proficiency levels within the average range with as little as approximately 20% of their exposure to a language. They may, however, require more exposure to reach average range on expressive language measures. Results

also suggest that most children from additive contexts can potentially reach proficiency levels in the average range on norms tests in both of their languages. Also, to our knowledge, no other study has examined whether daily exposure to both languages had a positive influence on bilinguals' language development. Our findings suggest that daily exposure may indeed improve bilingual language acquisition and development, which is likely to be the result of improved metalinguistic abilities.

Manuscript 3 is also novel in three ways: it is the first study, to my knowledge, to compare the language abilities of school-aged simultaneous bilingual children with ASD to those of their monolingual peers with ASD. It also compares bilingual children with ASD to their bilingual and monolingual ND peers, and it makes these comparisons in both of these children's languages. The results from this study suggest that simultaneous bilingual children with ASD without a disorder language or an intellectual disability can potentially attain levels of structural language proficiency that are similar to their monolingual peers with ASD. In contrast with previous studies in the field of ASD (Gonzalez-Barrero & Nadig, 2018), but similar to findings from research in the fields of Down syndrome (Burgoyne et al., 2016; Kay-Raining Bird et al., 2005), the bilingual children with ASD in this study also attained language proficiency levels similar to those of their ND bilingual and monolingual peers of similar cognitive abilities. Thus, it appears that for ND school-aged simultaneous bilingual children, bilingualism does not impede their language development, in at least one, if not both of their languages. It may also be the case for bilingual children with ASD, particularly when examining children without a language disorder or an intellectual disability.

One last novel aspect of this thesis is the development of the M-BLUE. As was discussed in the General Introduction, the M-BLUE was developed because the currently available questionnaires did not meet our needs for these studies. With the M-BLUE, we aimed to create a tool that was language neutral, permitted for the examination of more than two languages, explored language exposure across multiple contexts and interlocutors, and was available to clinicians. We also wanted to create a tool that clinicians could use to help them in interpreting assessment data. Thus, from a clinical perspective, we aimed to develop a tool that could be used with children of any age, and that could easily be adapted for use with adults. As a result, we hope that it will be a useful tool during the assessments of bilingual children.

General Theoretical Implications

From a theoretical perspective, the findings within this thesis serve to increase our understanding of the language development of school-aged simultaneous bilingual children and how they develop in both of their languages when they are raised in additive contexts. Specifically, the findings from manuscript 2 suggest that simultaneous bilingual children are able to develop overall language abilities that are similar to those of their monolingual peers, in at least one of their languages, and often in both languages. While exposure and NVIQ are important factors in the acquisition of children's two languages, the findings in manuscript 2 also suggest that factors beyond exposure and intelligence play a role in simultaneous bilinguals' language acquisition in both of their languages. It appears that along with the amount of language exposure that children receive, daily exposure to both languages may be particularly beneficial in supporting the development of two languages. Children who are exposed to both of their languages on a daily basis may require less exposure to achieve language abilities in the average range on standardized language measures than children who do not use their two languages on a daily basis. It may be that daily exposure to two languages leads to improved metalinguistic awareness, which in turn supports language development, although further studies will be required to confirm this hypothesis.

Additionally, manuscript 3 showed the usefulness of cluster analyses in language research. This statistical analysis permitted a comparison of the different language and diagnostic groups that traditional parametric or non-parametric statistical analyses did not permit given the small number of children in our ASD groups.

General Clinical implications

From a clinical perspective, the findings within this thesis have a number of implications. First, these findings, while on a small sample of children, suggest that children with ASD who have neither a language disorder nor an intellectual impairment have the potential of becoming proficient bilingual speakers. Across the many language measures that children completed, findings show that bilingual children with ASD had performances that were similar to those of their monolingual peers with ASD, and to those of their ND simultaneous bilingual and monolingual peers. Together with previous studies, these findings suggest that

recommendations against bilingualism are not evidenced-based and should be avoided. Consequently, parents can be encouraged to speak the language(s) of their choice with their child. Additionally, given the negative consequences for children when they do not speak their parents' language (Hampton et al., 2017; Yu, 2013) and guidelines from various professional bodies (Crago & Westover, 1997; ASHA, 2013), clinicians have an ethical duty to support parents in whatever choice they make.

The results from manuscript 2 are also clinically interesting as they suggest that while exposure is important, other factors such as daily use of both languages might also be important. These findings also suggest that expressive language, and especially the *Recalling Sentences* subtest from the English version of the CELF are sensitive to language exposure, particularly when children receive less than 20% of their lifetime exposure to the language of testing. Interestingly, Thordardottir & Brandeker (2013) found similar results however, they also found that this subtest could differentiate between children who have language delays because of a lack of language exposure and those bilingual children who have a language disorder, also specificity was poor. Thus, further studies may be required to better understand whether this type of task in truly helpful in reliably discriminating between children with a language disorder and those in the process of acquiring a second language. Furthermore, the findings within this thesis demonstrate the importance of obtaining a broader base of information regarding children's language experiences that goes beyond the amount of language exposure received to each of their languages. These include children's language experiences throughout their lifetime and across various environments and interlocutors. Additionally, information on children's daily exposure to both languages may also be important to gather as it could help to explain performances on language measures relative to the amount of language exposure.

Limitations

The studies included in this thesis have limitations. First, the samples did not include English-monolingual children who were schooled in English, or in English-immersion. Since public English-only schools in Montréal are uncommon, there are few monolingual English-speaking school-aged children in this city. As a result, these studies did not include children who had little to no exposure to French. Since this project was based at Université

de Montréal and had a limited timeline, it was not possible to obtain permission to recruit through school boards in a broader range of communities where there is English-language only education. In future studies, it would be beneficial to include team members from different jurisdictions to support the recruitment of participants across the full range of language exposure. Another limitation is that participants were not recruited based on the amount of language exposure that children had received. Consequently, our sample did not include children from across the full range of language exposure. Thus, I cannot address how children with lower levels of exposure to French would have performed on the French-language tasks, nor was I able to examine how children with 20-50% exposure to English would perform. Additionally, the sample is quite heterogeneous and included bilingual and trilingual children, and some children whose second language was not English. While this sampling reflects the linguistically diverse nature of Montréal, the number of trilingual participants was not sufficiently large to examine the influence of acquiring a third language. Again, future research that specifically compares bilingual versus trilingual language abilities is needed. Finally, manuscript 3 was a pilot study and included only a small number of participants in both the monolingual and bilingual ASD groups. Because we required that children present no comorbid language disorder or intellectual disability, recruitment of participants for this study was quite challenging. Although this small sample allowed us to explore the language potential of bilingual children with ASD, these findings on their own cannot be generalised to the population of children with ASD as a whole. It is possible that the common recommendations against bilingualism for children with ASD may have limited the number of school-ages bilingual speakers, especially those who are simultaneous bilinguals. These limited numbers may have explained the recruitment difficulties faced for the third manuscript. Even in bilingual cities like Ottawa and Montréal, it appears that few children from “bilingual” families were raised as simultaneous bilinguals. This observation highlights the need for future research understanding the longitudinal development of bilingual children with ASD.

Future Directions

While our understanding of bilingualism and bilingual language acquisition has greatly improved in the last decades, numerous questions remain unanswered. At its core, the cognitive mechanisms that underpin bilingual language acquisition and development remain areas of debate. Indeed, we still do not fully understand

how bilinguals acquire their two languages and how they are able to proficiently use them. The impacts of bilingualism on cognition and vice versa are also a matter of debate. More research will be needed to resolve such debates. More studies will also be required to increase our understanding of the relationship between language exposure, language of schooling, daily exposure to both languages and metalinguistic abilities on bilingual language acquisition, both with a neurotypical development and with atypical patterns of development. Furthermore, more research is required to develop appropriate methods of measuring language exposure in bilingual children and ways of assessing them more reliably. Most notably, a better understanding of the relationship between language exposure and language tasks such as sentence repetition tasks, may be required before suggesting that clinicians use this task to differentiate between children with weaker language abilities due to lack of exposure versus a language disorder.

Research in the field of bilingualism in children with ASD is relatively new and the questions left to answer are innumerable. Nevertheless, based on the findings within this thesis and those of other studies, the following themes may be of particular importance. First, a better understanding of the language development of bilingual children with ASD who also present with a comorbid language disorder, or a comorbid intellectual disability, is required. Second, more studies are needed to understand the influence of bilingualism on cognition in children with ASD. Most notably, can children with ASD benefit from increased abilities in executive functioning and theory of mind, as seen in ND peers, and if so, how do those increased abilities influence their everyday lives and their abilities to use social language? Third, it is currently unclear whether children with ASD benefit from the same types of positive transfer and metalinguistic advantages that are found in ND children or whether difficulties related to ASD in early development, such as difficulty attending to others, modulate the impacts of such advantages. Answers to these and other questions can help shape intervention best practices with bilingual children in general and specifically with bilingual children with ASD.

General Conclusion

The findings within these pages further support previous findings suggesting that children can become proficient bilingual speakers and that they can even achieve proficiency levels similar to those of their

monolingual peers in at least one, if not both of their languages. Most importantly, they can do so even in the presence of a diagnosis of ASD. With regards to ND children, the findings within this thesis are novel in that they suggest that, while exposure in school-aged simultaneous bilinguals is important, it is only one of many factors that contribute to children's levels of proficiency in both of their languages. With regards to bilingual children with ASD, findings presented within these pages support previous findings and suggest that children with ASD can potentially become bilingual speakers. These findings show that bilingual children with ASD without intellectual and language disabilities can reach proficiency levels that resemble those of their ND bilingual and monolingual peers on the different spheres of structural language assessed in these manuscripts, and to do so in both of their languages. These findings are also novel in that the focus was solely on school-aged children, and that these children's language development, as well as the influence of language exposure, were examined in both of their languages. Based on these findings, along with findings from previous research, parents can be confident that bilingualism will not be detrimental to their child's language development, regardless of whether their child has a ND development or a diagnosis of ASD. Clinicians can also be confident in supporting parents who want to or have to raise their child in a bilingual context.

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General Appendix

Montreal Bilingual Language Use and Exposure Questionnaire (M-BLUE)

Myriam L. H. Beauchamp and Andrea A. N. MacLeod

Thank you for answering this questionnaire on your child's bilingual language development. Please read each question carefully and answer to the best of your ability. If you have any questions, please do not hesitate to ask.

In the next sections the following terms will be used to define certain concepts:

1. ***Majority Language***: Language spoken by most people in a given community. It is usually the "official" or "governmental" language.

2. ***Minority Language***: A language spoken by a minority of individuals in a given community. Although some governmental services may be available in this language, services in this language are not obligatorily available.

3. ***Native speaker***: A person who identifies a given language as his/her "first" or "maternal" language is a native speaker of that language.

4. ***Fluency (fluent)***: Refers to the ease with which a person can use a particular language. The more *fluent* an individual is in a given language, the more easily he/she can communicate in this language.

0= Not fluent at all: I do not understand or speak in this language.	1= Limited fluency: I understand this language a bit and can say a few phrases in this language.	2= Somewhat fluent: I understand and speak fairly well in this language.	3= Very fluent: I understand and speak this language sufficiently well. I can use this language at work. I am also able to read and write quite well in this language.	4= Fully fluent: A native speaker or someone with abilities similar to those of a native speaker.
Example: I know no/few words in this language. I also don't (really) understand when others speak to me in this language.	Example: I understand a bit of what is said to me in this language if people speak slowly. I can use simple phrases such as "Hello, how are you?". I can also use this language for simple acts such as answering the telephone.	Example: I can meet my wants and needs using this language. I can ask for help shopping, go to the doctor's and explain my issue. I can make a lot of mistakes when I speak.	Example: I can effectively communicate and converse in this language although my vocabulary in this language is more limited than in my maternal language and my knowledge of grammar is also not as good than it is in my maternal language.	Example: I am perfectly comfortable living and working in this language. If this is my second language, I am almost as competent in this language as I am in my maternal language.

SECTION A

1. Name / Participant Code	2. Child's date of birth
3. Date of interview	4. Gender (of child)
5. Name of interpreter (if applicable)	6. Mother's Name and age
7. Mother's highest level of education	8. Mother's occupation
9. Mother's maternal language	10. Language mother generally speaks with the child
11. Father's Name and age	12. Father's highest level of education
13. Father's occupation	14. Father's maternal language
15. Language father generally speaks with the child	16. Language spoken by most people in your city (MAJORITY LANGUAGE)
17. Primary language spoken at home	18. Other language(s) spoken at home
19. Child's maternal language (the first language learnt)	20. Child's second language
21. At what age did your child begin to hear/learn in his/her second language?	22. Where did your child learn his/her second language? If at school or daycare/how often was he/she exposed to this language in an average week?
19. Does your child speak any other language(s) and if YES, which one(s) and since what age?	20. Child's primary language of instruction (at school/daycare)
21. Other language(s) taught at school/daycare and with what frequency (hours/week)	22. What is your child's preferred language?
22. How old was your child when he/she said his/her first word in his/her first language?	23. What was it?
22. How old was your child when he/she said his/her first word in his/her second language?	23. What was it?

24. How old was your child when he/she said his/her first phrase/sentence in his **first** language	25. What was it?
26. How old was your child when he/she said his/her first phrase/sentence in his/her **second** language?	27. What was it?

In the following sections, you will be asked to indicate the number of hours of contact that your child receives in a language during a regular week (over the past year). Please answer these questions as precisely as possible. For example:

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours
		X 7 hours						

SECTION B

1) How fluent is mother in _____ (the **MAJORITY LANGUAGE**)

0= Not fluent at all	1= Limited fluency	2= Somewhat fluent	3= Fairly fluent	4= Very fluent	5= Fully fluent

2) How fluent is mother in _____ (the **MINORITY LANGUAGE**)

0= Not fluent at all	1= Limited fluency	2= Somewhat fluent	3= Fairly fluent	4= Very fluent	5= Fully fluent

3) How fluent is mother in the OTHER LANGUAGE(S) (if applicable, please specify:_____)

0= Not fluent at all	1= Limited fluency	2= Somewhat fluent	3= Fairly fluent	4= Very fluent	5= Fully fluent

4) How many hours of direct contact does your child have to _____ (the **Majority Language**) **with mother** in a regular week (**Monday-Friday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

5) How many hours of direct contact does your child have to _____ (the **Majority Language**) **with mother** in a regular weekend (**Saturday and Sunday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

6) How many hours of direct contact does your child have to _____ (the **Minority Language**) **with mother** in a regular week (**Monday-Friday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

7) How many hours of direct contact does your child have to _____ (the **Minority Language**) **with mother** in a regular weekend (**Saturday and Sunday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

8) How many hours of direct contact does your child have to _____ (the **second Minority Language**) **with mother** in a regular week (**Monday-Friday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

9) How many hours of direct contact does your child have to _____ (the **second Minority Language**) **with mother** in a regular weekend (**Saturday and Sunday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

SECTION C

1) How fluent is **father** in _____ (the **MAJORITY LANGUAGE**)

0= Not fluent at all	1= Limited fluency	2= Somewhat fluent	3= Fairly fluent	4= Very fluent	5= Fully fluent

2) How fluent is **father** in _____ (the **MINORITY LANGUAGE**)

0= Not fluent at all	1= Limited fluency	2= Somewhat fluent	3= Fairly fluent	4= Very fluent	5= Fully fluent

3) How fluent is **father** in the OTHER LANGUAGE(S) (if applicable, please specify:_____)

0= Not fluent at all	1= Limited fluency	2= Somewhat fluent	3= Fairly fluent	4= Very fluent	5= Fully fluent

4) How many hours of direct contact does your child have to _____ (the **Majority Language**) **with father** in a regular week (**Monday-Friday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

5) How many hours of direct contact does your child have to _____ (the **Majority Language**) **with father** in a regular weekend (**Saturday and Sunday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

6) How many hours of direct contact does your child have to _____ (the **Minority Language**) **with father** in a regular week (**Monday-Friday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

7) How many hours of direct contact does your child have to _____ (the **Minority Language**) **with father** in a regular weekend (**Saturday and Sunday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

8) How many hours of direct contact does your child have to _____ (the **second Minority Language**) **with father** in a regular week (**Monday-Friday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

9) How many hours of direct contact does your child have to _____ (the **Second Minority Language**) **with father** in a regular weekend (**Saturday and Sunday: ASSUMING A DAY = 14 waking hours**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

SECTION D

1) How many hours of direct contact does your child have to _____ (the **Majority Language**) at school or daycare in a regular week (**Monday-Friday**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

2) How many hours of direct contact does your child have with _____ (the **Minority Language**) at school or daycare in a regular week (**Monday-Friday**)?

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

3) Does your child receive instruction in a second minority language? If so, please indicate how many hours of instruction your child receives in this language during a regular week (specify the language_____)

Little/no direct contact	< 5 hours	5-10 hours	10.1-15 hours	15.1- 21 hours	22.1-27 hours	28.1-33 hours	34.1-40 hours	> 40 hours

4) Have there been any changes in the amount of input that your child receives in each of his/her languages since the age of 12 months (i.e., changes at home, changes in daycare and/or at school, etc.)? If yes, please specify:

_____

_____

_____

_____

_____

SECTION E

Does your child come in direct contact with anyone else? If so, please indicate with whom, the language this person uses with your child and the number of hours per week this person spends with your child. **If this person speaks more than one language with your child, please indicate the number of contact hours the child receives in EACH language with this individual.**

Person	Person's primary language	Language used with child:	Number of hours spent with the child during a regular week **(ASSUMING A DAY = 14 waking hours)**	Number of hours spent with child during a regular weekend **(ASSUMING A DAY = 14 waking hours)**
1. Siblings				
2. Grandparents				
3. Other family members (specify)				
4. Caregivers/ babysitters (outside of daycare)				
5. Friends				
6. Other people (please indicate who are these individuals)				
7. Religious/ cultural activities (other than those listed in question D3)				
8. Extracurricular activities (other than those listed in question D3)				

SECTION F

What language does your child prefer to use?

1. with mother: _____
2. with father: _____
3. with siblings: _____
4. with maternal grandparents: _____
5. with paternal grandparents: _____
6. with caregiver: _____
7. with friends: _____
8. at recess: _____
9. with others (_____):_____
10. with others (_____):_____
11. with others (_____):_____
12. with others (_____):_____

SECTION G

In what language does your family... and for how many hours per week (ASSUMING A DAY = 14 waking hours)

1. watch TV: English:_____ French: _____ Other (specify): _____
2. watch movies: English:_____ French: _____ Other (specify): _____
3. listen to the radio: English:_____ French: _____ Other (specify): _____
4. other multimedia: English:_____ French: _____ Other (specify): _____

5. Do you read to your child? If so:
   a) in what language(s)?
   b) how many hours per week in each of these languages?

_____

6. Does your child read by himself/herself? If so:
   a) in what language(s)?
   b) how many hours per week in each of these languages?

_____

SECTION H

For the next questions, please compare your child's abilities to those of other children of the same age and who are native speakers of the language in question.

1) When thinking about other children of your child's age, how well does your child speak and understand _____ (the **MAJORITY LANGUAGE**) when compared to other children who are **native speakers** of this language.

a) Speaking	Very delayed	Somewhat delayed	Similar abilities to other children	More advanced	Much more advanced
b) Understanding	Very delayed	Somewhat delayed	Similar abilities to other children	More advanced	Much more advanced

2) When thinking about other children of your child's age, how well does your child speak and understand _____ (the **MINORITY LANGUAGE**) when compared to other children who are **native speakers** of this language.

a) Speaking	Very delayed	Somewhat delayed	Similar abilities to other children	More advanced	Much more advanced
b) Understanding	Very delayed	Somewhat delayed	Similar abilities to other children	More advanced	Much more advanced

3) If your child speaks a third language, how well does your child speak and understand this language compared to other children his/her age who are native speakers of this language?
Specify the language:_____

a) Speaking	Very delayed	Somewhat delayed	Similar abilities to other children	More advanced	Much more advanced
b) Understanding	Very delayed	Somewhat delayed	Similar abilities to other children	More advanced	Much more advanced

THANK YOU!