THE EFFECTS OF BILINGUALISM ON THE COGNITIVE AND PHONOLOGICAL AWARENESS SKILLS OF CHILDREN WITH AUTISM SPECTRUM DISORDER

by

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Abstract

To date, the literature on the effects of bilingualism on the language development of children with Autism Spectrum Disorder (ASD) is limited. The few studies which do exist have indicated that bilingualism does not negatively impact the linguistic development of children on the Autism spectrum. The current study explored whether the cognitive and linguistic advantages that have been observed in typically developing bilingual children also exist in school-age, English-Chinese bilingual children with ASD.

Two groups of children were recruited for this study: a monolingual group and a bilingual group. The monolingual group consisted of English-speaking children with an average age of 6.58 years (n = 8). The bilingual group consisted of English-Chinese bilingual children with an average age of 7.20 years (n = 6). This study used the Simon task in order to evaluate attentional control and a series of three phonological awareness (PA) tasks in order to evaluate metalinguistic skills. Results indicated no differences between the groups' accuracy and RTs on the Simon task. Additionally, no differences were observed between the groups' performance on the PA tasks. Correlational analyses between the two groups indicated that the bilingual participants' performance on the Simon task was consistently related to their non-verbal scores and language skills (both English and Chinese). Although the findings from this study do not provide evidence for the existence of a bilingual advantage in children with ASD, they do highlight the need for continued research in the area of bilingualism and its effect on the linguistic and cognitive skills of children with ASD.

Preface

The following research was approved by the UBC Behavioural Research Ethics Board. The Certificate Number of the Ethics Certificate obtained was H12-00064.

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Dedication

This study is dedicated to my amazing grandma, Bessie Quirk (1921-2012), who was not able to see this thesis to completion, but whose love, support, and generosity made it all the more possible.

1. Introduction

This thesis will investigate whether the cognitive and metalinguistic advantages found for typically developing bilingual children also exist in bilingual children with Autism Spectrum Disorder (ASD). It is anticipated that this study will add to the small body of literature that currently exists regarding the effect that bilingualism has on the language and cognitive development of children with ASD. There has been a dearth of research on this population and as a result many families of children with Autism are still being advised by language specialists and other professionals to stop speaking their home language in order to avoid further potential language difficulties (Paradis, Genesee, & Crago, 2011). For many families, particularly those who have emigrated from their country of origin, becoming bilingual is a necessity instead of a choice. It is especially important to uncover the effects of bilingualism on children with ASD so as to better serve and advise families who are raising their children within dual language environments. As of 2012, it was estimated that the prevalence rate of ASD was one in every 88 people in the United States (Centers for Disease Control and Prevention, 2012) and one in every 200-300 people in Canada (Canadian Institutes of Health Research, 2012). With the general consensus across both countries being that diagnoses of Autism Spectrum Disorders are on the rise, there is an increasing need for more information regarding the language development of bilingual children with ASD. Current research has indicated that linguistic development is not hindered in children who are exposed to two languages, even in the cases of children with developmental disabilities, such as Down syndrome (Feltmate & Kay Raining Bird, 2008; Kay-Raining Bird, Trudeau, Thordardottir, Sutton, & Thorpe, 2005) and Specific Language Impairment (Gutierrez-Clellen , Simon-Cereijido, & Wagner, 2008; Gutierrez-Clellen, Simon-Cereijido, & Erickson Leone, 2009; Paradis, Crago, Genesee, & Rice, 2003; Westman, Korkman, Mickos, & Byring, 2008). Results from the few studies investigating the effects of bilingualism on the development of children with Autism have paralleled these findings (Hambly & Fombonne, 2011; Ohashi et al, 2012; Petersen, Marinova-Todd, & Mirenda, 2011; Seung, Siddiqi, & Elder, 2006; Yang, 2011). Despite these outcomes, many clinicians and parents remain wary of maintaining a bilingual lifestyle in children with Autism.

The following sections will provide an overview of what is currently known about cognitive development in bilingual children, metalinguistic awareness in bilingual children, and the language abilities of bilingual children with atypical language development.

1.1 Cognitive Development in Bilingual Children

Many studies have reported a "cognitive advantage" that exists in typically developing bilingual children. It is only within the last fifty years that researchers have begun identifying and exploring the apparent verbal and non-verbal advantages that bilingual children have. Prior to Peal and Lambert's 1962 seminal paper, many researchers believed bilingualism to be detrimental to the education and development of children. These hypotheses were often the result of poorly regulated experiments that did not control for confounding factors, such as age, socioeconomic status, and degree of bilingualism. Peal and Lambert (1962) defied many of these beliefs by demonstrating through a well-controlled study that bilingual children were capable of performing better than their monolingual peers on both verbal and non-verbal measures of intelligence. The authors speculated that, while this superior intelligence may have been the reason why these children were able to successfully become bilingual, there is also the possibility that the bilingualism itself spurred the development of increased cognitive function.

From this point onward, much of the research performed on bilingual children has focused on exploring the possibility that bilingualism has the potential to hone specific mental faculties and create distinct cognitive advantages in dual language speakers. Much of this research has come from the lab of Ellen Bialystok, where a significant amount of evidence has been found in favour of a bilingual advantage in the area of attentional control. The term 'attentional control' refers to "the ability to selectively attend to specific aspects of a representation, particularly in misleading situations" (p. 636, Bialystok, 1999). Bialystok's research has demonstrated that bilingual children have the ability to perform better than monolinguals on various cognitive measures that require attentional control. It has been hypothesized that this bilingual advantage in attentional control exists because bilinguals are constantly required to inhibit attention to representations in one language when operating in the other (Bialystok, 2001; Green, 1998). That is, bilinguals' need to focus on one group of labels while also simultaneously inhibiting attention to labels that represent the same concept in their other language requires constant attentional control (Bialystok & Martin, 2004). The same cortical mechanisms which are responsible for inhibiting representations from the competing language are also utilized during the completion of activities that involve inhibition of misleading stimuli (Bialystok, 2001; Bialystok & Martin, 2004). Thus it is reasonable to theorize that individuals who frequently exercise attentional control during daily communication would also exhibit an advantage on tasks that capitalize on the ability to inhibit irrelevant stimuli. It would be particularly justified to suggest that individuals who receive early experience inhibiting representations in one language – such as children who are raised speaking two languages – would be especially practiced at tasks requiring high levels of attentional control. The bilingual advantage in attentional control has been shown in children as young as three years old (Bialystok & Codd, 1997) and continues to appear later in adulthood (Bialystok, Craik, Klein, & Viswanathan, 2004).

1.1.1. The Bilingual Cognitive Advantage

Further explorations of monolingual and bilingual children's cognitive abilities have prompted researchers to theorize that the bilingual cognitive advantage only reliably holds when bilinguals are required to inhibit a competing perceptual attribute, such as shape or colour, instead of a conceptual one, such as a lexical-semantic dimension (Bialystok & Martin, 2004). This hypothesis is derived from comparisons of monolingual and bilingual children's results on perceptual tasks, such as the Simon task and the colour-shape Dimensional Change Card Sort task (DCCS) and conceptual tasks, such as the function-location task. In the Simon task, participants watch a computer screen and are instructed to hit either a red button or a blue button on a response box placed in front of them. The response box is positioned in such a way that the red button is in line with the left side of the computer and the blue button is in line with the right side of the computer. Children then watch the screen and see a series of squares appear in front of them, some of which are red and some of which are blue. They are instructed to hit the button every time that they see a square and that the button must correspond to the colour of the shape on the screen. Some of the trials show a square appearing on the same side on the screen as its corresponding button (congruent trials) while others show the square on the opposite side of the screen as its corresponding button (incongruent trials). During incongruent trials, children must suppress the urge the hit the button that corresponds with the side on which the square appears and instead focus only on the colour of the square. This is an example of a perceptual task in which bilingual children have generally shown a smaller 'Simon effect' when compared to their monolingual peers (Bialystok, 2001; Bialystok, Craik, Klein, & Viswanathan, 2004; Martin-Rhee & Bialystok, 2008). The Simon effect refers to the need for increased time on trials that are incongruent (Simon, 1969). While most individuals demonstrate a Simon effect, in that their

RTs on the Simon task are longer for incongruent trials, bilinguals tend to exhibit faster RTs for incongruent trials than do monolinguals. Although the Simon effect specifically refers to the increased time required to complete incongruent trials, there is also evidence that bilinguals perform faster overall on the Simon task, regardless of trial congruency (Bialystok et al, 2004; Martin-Rhee & Bialystok, 2008).

In the colour-shape DCCS, children are required to sort cards based on one perceptual attribute, usually either colour (e.g. red and blue) or shape (e.g. circles and squares). Once the cards have been sorted, children are asked to re-sort the cards based on the opposite dimension (e.g. if the first round was sorted by colour, the second round is to be sorted by shape). This post-switch trial means that children must now suppress perceptual information which was previously relevant and instead focus their attention on a different perceptual attribute. The function-location task is a variation of the DCCS in which children are asked to sort cards based on conceptual attributes, such as lexical-semantic information. For this task, children are given cards with pictures that contain both a functional property (e.g. things to play with versus things to wear) and a location property (e.g. things that belong outside the house versus things that belong inside the house). In the pre-switch round, children are asked to sort the cards according to their function. In the post-switch round, children are asked to re-sort the cards, this time according to their location. While monolingual-bilingual comparisons on perceptually-based tasks (such as the Simon task or DCCS) have shown a clear bilingual advantage (Bialystok, 2001; Bialystok & Codd, 1997; Bialystok & Martin, 2004; Bialystok et al, 2005; Martin-Rhee & Bialystok, 2008), those involving similar comparisons for conceptually-based tasks (such as the function-location task) have not shown such distinct results (Bialystok & Martin, 2004). Therefore, it is still unclear whether the bilingual advantage holds true for tasks that require the participant to inhibit information that activates semantic levels of cognitive representation. Although both the Simon task and the DCCS are frequently cited as tasks which elicit the bilingual cognitive advantage, they are generally used with children of different age groups. The DCCS is generally considered a task which is more appropriate for children younger than the age of five years since older children may reach ceiling levels on this task (Bialystok & Martin, 2004). The Simon task is considered more appropriate for use with school-age children as well as with adult populations.

In addition, other researchers have inquired into the specific set of executive function skills, such as response suppression and self-regulation, that are affected by bilingualism. Evidence from such research has indicated that bilingualism does not appear to affect all domains of executive function and that the bilingual advantage appears to influence performance on ‘conflict’ tasks (Carlson & Meltzoff, 2008). Conflict tasks are those which require individuals to make a novel response while inhibiting a conflicting, yet potentially more salient, response (Carlson & Moses, 2001). This finding is in keeping with Bialystok and Martin's (2004) observation that the bilingual advantage is prominent in tasks where the optimal response is embedded within a deceptive context. Tasks such as the DCCS and the Simon task are examples of conflict tasks as they require individuals to provide a response which may be in competition with other, perhaps more prominent, stimuli. Other executive function tasks – such as the delay of gratification task, which requires response suppression – have not been shown to elicit a bilingual advantage (Carlson & Meltzoff, 2008). Similarly, tasks which require activation of lexical-semantic information have not reliably shown an advantage for bilinguals (Bialystok & Martin, 2004). Thus it can be presumed that tasks which necessitate retrieval of conceptual information and/or those which rely on areas of executive function other than attentional control make use of cognitive processes which are not involved in the bilingual advantage. Given the specific nature of the bilingual cognitive advantage, the DCCS and Simon task are generally utilized in research examining specific facets of the effects of bilingualism on the development of executive function skills. While the DCCS is used in order to learn more about the bilingual cognitive advantage in younger populations, the Simon task is used to further knowledge regarding the bilingual advantage in school-aged children and adults.

1.1.2. Factors Contributing to the Cognitive Advantage

While the distinct cognitive processes that make up the bilingual advantage have been closely studied and continue to be unveiled, the contributing causes of this advantage have also been heavily scrutinized. Several factors have been highlighted as possible contributors to the bilingual advantage observed in children. The degree of bilingualism that must be attained in order to demonstrate a cognitive advantage is one factor which has received particular attention. A recent study by Bialystok and Barac (2012_a) indicated that performance on an executive function task was related to the extent of children's bilingualism. This study featured two experiments, both of which targeted children attending second language immersion programs. The first experiment examined the attentional control skills of 100 English-speaking children enrolled in Grades 2 and 3 at a Hebrew immersion school. Performance on an attentional control task (similar to the Simon task) was positively correlated with children's degree of bilingualism as determined by parent questionnaire and both English and Hebrew versions of the Peabody Picture Vocabulary Test (PPVT-III, Dunn & Dunn, 1997, Version A, B). The second experiment of this study was conducted in order to test the generalizability of the previous experiment's results. In this experiment, 80 English-speaking children enrolled in Grades 2 and 5 at a French immersion school were asked to participate in a task-switching exercise similar to the DCCS. The results from this experiment paralleled those from the first study in that degree of bilingualism correlated with success on the task-switching activity. Within this study, degree of bilingualism was measured by a Language Background Questionnaire which resembled that from the first experiment as well as through English and French versions of the Peabody Picture Vocabulary Test (PPVT-III, Dunn & Dunn, 1997; EVIP, Dunn, Theriault-Whalen, & Dunn, 1993).

Similarly, the developmental level of the individual being tested appears to affect the sensitivity of certain tasks' ability to elicit a cognitive advantage. Tasks which are too developmentally simple do not tend to reliably elicit a bilingual advantage (Bialystok & Martin, 2004; Bialystok & Shapero, 2005). As individuals age, certain tasks – such as the DCCS – become easier to solve (Bialystok & Martin, 2004) and presumably no longer require such high levels of attentional control. As such, it is reasonable to theorize that a bilingual advantage would no longer be detectable in these tasks since the attentional control demands are low. Martin-Rhee and Bialystok (2008) investigated this notion and found that bilinguals only reliably showed an advantage on the Simon task when demands for inhibitory control were high, such as in conditions where incongruent trials are presented 50% of the time as opposed to only 25% of the time. Since attentional control abilities, like any cognitive skill, generally mature as individuals develop, it is natural to expect that tasks which require high levels of attentional control during the preschool years would likely not necessitate such high demands during later stages of development. Thus tasks which are aimed at elicitation of the bilingual cognitive advantage must be tailored appropriately based on the age of the individual(s) being tested in order to ensure that the attentional control demands are high.

Age of exposure to two languages has also been discussed in the context of the development of the bilingual advantage. The increased development of attentional control, and its consequential effects on executive function skills, appears to be particularly prevalent in children who received early exposure to their two languages as opposed to children who received second language input proceeding mastery of the first language (Carlson & Meltzoff, 2008). Evidence from a study of infant neurodevelopment has indicated that, due to the plasticity levels in the early developing brain, input from two languages has the potential to affect further development in areas such as cognitive abilities (Neville, 1993). Thus research in the area of the bilingual cognitive advantage has often focused specifically on children whose exposure to their two languages occurred prior to the age of three, as these children tend to exhibit an advantage in executive function more reliably than children whose second language input occurred after age three. Given that constant practice in the area of attentional control has been posited as the cause for the bilingual cognitive advantage, it is reasonable to theorize that children with increased practice time (e.g. those children with early exposure to two languages) would have more experience in the area of inhibition than children with decreased practice time (e.g. children with later exposure to their second language). Since many studies concerning the bilingual advantage have examined early school-age children, it is reasonable to hypothesize that in this population, a difference of three years' experience in practicing attentional control would affect performance on an inhibition task differently for simultaneous versus sequential bilinguals.

1.1.3. Alternate Explanations of the Cognitive Advantage

The question of confounding variables is one that is particularly relevant given that the bilingual population is made up of many individuals from a wide variety of cultural, socioeconomic, and language backgrounds. Several researchers have questioned whether the bilingual advantage does in fact occur as a result of superior executive function skills, or whether it is the result of extraneous factors, such as cultural influence and the educational and academic experiences that comprise the upbringing of children in different cultures. In fact, Sabbagh, Xu, Carlson, Moses, and Lee (2006) reported higher scores on executive function tasks for monolingual Chinese-speaking preschoolers living in China when compared to their English-speaking counterparts living in the United States, suggesting that the values, educational experiences, and teaching practices of some cultures may play more of a role in increased executive function than does bilingualism. Indeed, other sources have also claimed that Chinese and Korean monolingual children demonstrate more advanced executive function when compared to their North American peers (Oh & Lewis, 2008). In order to uncover whether culture does indeed play a role in the performance of bilingual children, Bialystok and Barac (2012_b) recruited 78 bilingual children from either Spanish, French, or Chinese backgrounds. In addition, 26 English-speaking children served as the monolingual group. The children were between the ages of 5 and 7 years old and all, except for the French-English bilinguals, attended English-speaking primary schools. All of the children completed a task-switching activity, much like the DCCS, as a measure of executive function. The researchers found that all of the bilingual children, regardless of language background, performed better than their monolingual peers on the task-switching activity, suggesting that the executive control advantage observed in bilingual children exists independently of factors such as culture, educational experience, and native language.

Socioeconomic status has also been considered as a potential confounding factor in studies comparing monolingual and bilingual participants. Many children who are brought up in bilingual environments are being raised by, or are themselves, immigrants. In general, individuals who immigrate to Canada tend to live in poverty more often than their Canadian-born cohort (Kazemipur & Halli, 2000) and this potentially increases the likelihood that many bilingual children will grow up in lower socioeconomic circumstances than their monolingual peers. Given the well-established, positive relationship between socioeconomic status and executive function (Ardila, Roselli, Matute, & Guajardo, 2005; Hughes & Ensor, 2005; Mezzacappa, 2004; Noble, Norman, & Farah, 2005) it would be expected that children from lower SES backgrounds would perform worse than their peers of higher SES backgrounds on measures of executive function. Carlson and Meltzoff (2008) investigated this hypothesis with respect to its effect on the bilingual community by comparing the executive function scores of English-speaking monolingual children, English-speaking children enrolled in either Japanese or Spanish immersion programs, and Spanish-English bilingual children. Executive function scores for this study were compiled from a battery of nine executive function tasks, including the advanced DCCS, Simon Says, the Comprehensive Test of Nonverbal Intelligence (C-TONI; Hammill, Pearson, & Wiederholt, 1997), and delay of gratification task. All of the children selected lived in a large, multicultural American city and attended Kindergarten. The Spanish-English bilingual group was considered to be at a significant economic disadvantage (as measured by parental education level and household income) in comparison to the monolingual and immersion groups. On average, the Spanish-English bilingual families earned a mean household income of $20-30,000 annually with parental education levels not generally exceeding high school education. These figures were significantly lower than those of the English-speaking children enrolled in second language immersion programs and of the English-monolingual children, whose data displayed a mean annual income of $70-80,000 and $60-70,000, respectively, as well as parental education levels which generally included college education.

Despite the considerable demographic differences between the groups, the raw scores on the advanced DCCS were equivalent for the bilinguals, monolinguals, and immersion children, suggesting that native bilingualism may have contributed to the Spanish-English speakers' executive function skills to the point where they were able to perform comparably to their economically advantaged peers. The authors speculate that early exposure to two languages may have nurtured the cognitive skills necessary for solving a variety of complex problems requiring strong executive function skills. Additionally, the authors propose that this advantage may be sufficient enough to compensate for the weaker executive function skills typically associated with low SES. Since the English-speaking children who were enrolled in second language immersion programs did not demonstrate stronger executive function scores than their monolingual peers, the authors suggest that early and/or intensive exposure to a second language may be necessary to the development of the bilingual advantage in executive function.

In summary, the cognitive bilingual advantage appears to exist independently of cultural influences and despite possible socioeconomic disadvantages. Although research into the bilingual cognitive advantage has mainly focused on children from middle-class socioeconomic backgrounds, there is some preliminary evidence which suggests that the lower executive function scores typically associated with low SES may be partially ameliorated in children with early, intensive exposure to two languages (Carlson & Meltzoff, 2008). Although the bilingual advantage can be observed in children from various age groups and linguistic backgrounds, it is sensitive to the nature of the task by which it is measured as well as to the degree of bilingual proficiency attained by the children. Individuals who are considered to be more balanced bilinguals, that is, those who are close to or are equally skilled in both languages, are more likely to demonstrate a cognitive advantage on particular tasks. Tasks that require individuals to suppress interference from competing, perceptually salient stimuli seem to reveal the bilingual advantage more reliably than tasks which focus on conceptually salient stimuli or rely on response inhibition. Thus, tasks such as the DCCS and the Simon task are consistently utilized in order to further our knowledge of the cognitive processes that underlie the bilingual advantage along the continuum of development.

1.2 Phonological Awareness in Bilingual Children

In addition to performing better than their monolingual peers on certain non-verbal tasks, bilingual children have also been shown to score higher on measures of metalinguistic awareness; a subset of cognitive skills that allows individuals to identify and manipulate language structures, such as individual sounds, words, and morphosyntactic rules (Tunmer, Herriman, & Nesdale, 1988). Metalinguistic awareness includes, but is not limited to phonological awareness (PA), which is the ability to manipulate individual phonemes and syllabic structure (Nagy, 2007). Bialystok (2001) has suggested that bilingual children become more aware of language – that is, they have stronger metalinguistic skills, such as PA – due to differences that exist between their two languages. This is an area that has been widely studied and one which repeatedly shows favourable results for bilingual children.

One particular population that continually demonstrates a bilingual advantage in the area of metalinguistic awareness is early school-age children, namely those between the ages of five and six years. Several studies have investigated the phonological awareness skills of young school-age children and found that during the early school years, such as Kindergarten, bilingual children are capable of performing better than their monolingual peers (Rubin & Turner, 1989; Campbell & Sais, 1995; Bruck & Genesee, 1994; Loizou & Stuart, 2003; Marinova-Todd, Zhao, & Bernhardt, 2010). Rubin and Turner (1989) and Bruck and Genesee (1994) both examined groups of English-speaking children attending Kindergarten and/or Grade 1 classes within a French Immersion program. In Rubin and Turner's study (1989), 32 children made up of a monolingual English group and an English-French group, were asked to verbally parse spoken words in order to delete specific phonemic and syllabic segments. Bruck and Genesee (1994) tested groups of English monolinguals and English-French bilinguals over the course of Kindergarten and Grade 1 in order to determine whether the bilingual group showed a longitudinal advantage in PA tasks, such as onset deletion and rime matching. Both studies indicated that English-French bilingual children demonstrated an advantage in the PA tasks; however, the age at which the advantage was observed was different for the two studies. While Rubin and Turner (1989) still found the advantage to be present in Grade 1 students, Bruck and Genesee (1994) found that the advantage that was apparent in Kindergarten children had disappeared by the time the students reached Grade 1. One potential explanation for this disparity relates to the level of literacy attained by the two groups. It is possible that the group of students examined in Bruck and Genesee's study (1994) had attained higher levels of literacy skills by Grade 1 than their peers from Rubin and Turner's study (1989). Since the bilingual advantage in phonological awareness skills seems to be more evident during the early stages of literacy, this difference between groups could account for such a discrepancy. It also remains possible that the children from Bruck and Genesee's research (1994) experienced practice effects, a factor that would not have been an issue in Rubin and Turner's study (1989), and as such displayed stronger PA skills by the end of the longitudinal study which led to equivalent performance between the two groups.

Others have also shown that between the ages of five and six years old, bilingual children demonstrate stronger phonological awareness skills than their monolingual counterparts. In one such study, English-Italian bilingual children were shown to score higher than their English monolingual peers on a variety of metalinguistic tasks, including PA measures such as syllable and letter deletion (Campbell & Sais, 1995). In Marinova-Todd et al's study (2010), three groups of children between the ages of five and six years old were examined: one English-monolingual group from Vancouver, Canada, one Mandarin-monolingual group from Shanghai, China, and one Mandarin-English bilingual group from Vancouver, Canada. All three groups participated in a variety of phonological awareness tasks, many of which were adapted from the Comprehensive Test of Phonological Processing (CTOPP, Wagner, Torgeson, & Rashotte, 1999). A clear advantage in PA skills was observed for the bilingual group on both English and Mandarin PA tasks, with bilingual children outperforming their English monolingual peers on tasks of elision and blending and their Mandarin-monolingual peers on tasks of onset-rime combination, initial sound identification, and rhyme detection.

Studies within this area have also examined the PA skills of older school-age children who are bilingual. Although these investigations have still provided evidence in favour of a bilingual PA advantage (Chen et al, 2004; Bialystok, Majumder, & Martin, 2003), the results have indicated that this advantage is likely limited to a younger cohort. In their 2004 paper, Chen et al examined the effects that bilingualism had on the PA skills of Cantonese-Mandarin bilingual children compared to Mandarin-monolingual children. The bilingual and monolingual groups were composed of second- and fourth-grade children living in Guangzhou and Beijing, China. Results indicated that in Grade 2, the Cantonese-Mandarin bilingual children had superior PA skills compared to their Mandarin-monolingual peers, particularly in the areas of onset and rime awareness. While bilingualism did seem to temporarily accelerate the progression of phonological awareness skills for the Cantonese-Mandarin speakers, this difference in PA skills was no longer noticeable by the time the children had reached Grade 4, indicating that the observed PA advantage in bilingual children may be age sensitive and more easily detected when children are not yet fully literate.

Based on the reviewed literature, it would appear that the bilingual advantage in PA is strongest when children are between the ages of five and six years, yet fades as higher grade levels are reached. Given the strong link between phonological awareness and literacy (National Reading Panel, 2000), it is entirely plausible to theorize that the heightened phonological awareness exhibited by young bilingual children is no longer detectable as a result of the increased proficiency in literacy that generally accompanies advancement in school. It is justifiable to posit that by the time that children reach Grade 1 and/or higher grades, they are more evenly matched with respect to their phonological awareness skills as a result of increased literacy instruction and thus any advanced phonological awareness skills that bilingual children would have displayed previously are no longer as easily detected, if detectable at all.

As with the cognitive advantage in bilingualism, the issue of language background also arises as a possible confound in the study of the bilingual advantage in PA skills. In their 2003 study, Bialystok and colleagues brought forth unanswered questions regarding the interaction between language background and its effect on the PA advantage. The authors recruited groups of children in Grade 1 and 2 consisting of English-monolinguals, Spanish-English bilinguals, and Chinese-English bilinguals, to whom they administered a variety of PA tasks. While the Spanish-English bilinguals performed better than their monolingual peers on a phoneme segmentation task, the Chinese-English monolinguals scored the lowest of all three groups. The main difference between the two bilingual groups was the orthographic system associated with each language (alphabetic for Spanish speakers and logographic for Cantonese and Mandarin speakers). The authors suggested that previous knowledge of an alphabetic language may have facilitated English phonological awareness tasks for the Spanish-English bilinguals. Additionally, Bialystok et al (2003) argued that any advantages observed in previous dual-language studies might have been due to the specific conditions of bilingualism, such as exposure to a second language which emphasizes phonological structure and skill, instead of to bilingualism in general.

Despite Bialystok et al's (2003) findings, other studies have indicated that different language backgrounds do not appear to hamper the development of advanced PA skills (Rubin & Turner, 1989; Bruck & Genesee, 1994; Campbell & Sais, 1995), even in the cases of logographic orthography systems, such as Mandarin (Marinova-Todd et al, 2010). There is however, other evidence which suggests that certain language profiles – particularly those from alphabetic languages, such as French, Spanish, and Italian – may be more conducive to the development of advanced PA skills than others. While the nature of a child's second language may play a role in the emergence of heightened PA skills, there is also the possibility that it is in fact the interaction between a child's first and second languages that affects the development of the PA advantage. Based on findings from their 2003 study, Loizou and Stuart posited that exposure to a second language that is phonologically simpler (for example, one with simpler syllabic structure and fewer consonant clusters) than the first language may facilitate PA development more so than in cases where individuals are exposed to a second language that is more phonologically complex than their first language. That is, exposure to a second language with a less complex phonological system may accelerate as well as facilitate the development of PA skills in young children. This theory arose as a result of the authors' explorations into the PA skills of 68 five-year-old children who were English-Greek bilinguals, English-speaking monolinguals, or Greek-speaking monolinguals. This study assessed the bilingual children's PA skills in each of their two languages in order to more closely examine the interaction between the bilingual children's two languages. The authors also differentiated between bilinguals who were living and being educated within an English-speaking country, but often spoke Greek at home and in the community (English-Greek bilinguals) and bilinguals living in a Greek-speaking country who had attended a bilingual preschool, and were currently enrolled in a private school that provided simultaneous English and Greek instruction (Greek-English bilinguals). Results from scores on various PA tasks, such as rhyme identification and initial phoneme identification, revealed a significant difference between the English-Greek bilinguals and the English monolinguals, with the bilingual group receiving superior scores overall. Interestingly, this finding was not present in comparisons between the Greek-English bilinguals and Greek monolinguals. In fact, in areas where a significant difference did exist between these groups, it was the monolinguals that scored higher. Besides performing better than their English monolingual peers, the English-Greek bilinguals also demonstrated enhanced PA skills over the Greek-English bilinguals; however, this finding was almost certainly influenced by the fact that the English-Greek children had already begun literacy instruction whereas the Greek-English children had not.

Based on the above studies, it would appear that the PA advantages caused by bilingualism are more detectable in children whose two languages are phonologically and orthographically similar. Despite the consistency of this finding, there has been evidence which suggests that children from Chinese language backgrounds are also capable of developing temporarily stronger PA skills than their monolingual peers (Chen et al, 2004; Marinova-Todd, 2010). Given these findings, it is reasonable to presume that knowledge of a non-alphabetic language, such as Mandarin or Cantonese, would not preclude the development of increased PA skills. Although there has been one study indicating that the bilingual advantage in PA skills may not be present in children from Chinese language backgrounds (Bialystok et al, 2003), there is still insufficient evidence to claim that this population does not experience the same accelerated PA development as other bilingual children.

In summary, while factors such as the type of languages involved and the age at time of testing appear to influence bilingual children's performance on PA tasks, it would appear that such an advantage may exist within certain constraints, such as during the early stages of literacy and when the two languages examined are phonologically similar. Young bilingual children, particularly those who are still in the process of becoming literate, tend to demonstrate a more salient advantage in metalinguistic skills when compared to their monolingual peers than do their older cohorts who have already reached more proficient levels of literacy (Rubin & Turner, 1989; Bruck & Genesee, 1994; Campbell & Sais, 1995; Chen et al, 2004; Loizou & Stuart, 2003; Marinova-Todd et al, 2010). Studies of five and six-year-old children have demonstrated that, during this developmental period, bilinguals are capable of performing better than their monolingual peers on early developing PA tasks, such as rime detection and initial phoneme matching (Bruck & Genesee, 1994; Campbell & Sais, 1995; Marinova-Todd, 2010), as well as on later developing PA tasks, such as syllable/phoneme elision and/or segmentation (Bruck & Genesee, 1994; Campbell & Sais, 1995; Marinova-Todd, 2010; Rubin & Turner, 1989). Although bilingualism has also been shown to affect the development of other metalinguistic skills, phonological awareness is a metalinguistic domain in which the positive effects of bilingualism have been consistently demonstrated within a variety of language backgrounds.

1.3 Phonological Awareness in Children with ASD

According to the National Institute of Mental Health (2011), the term 'Autism Spectrum Disorder' refers to a group of neurological disorders that manifest themselves in a distinct pattern across individuals. Autism Spectrum Disorder is considered a developmental disorder since symptoms appear during childhood, often in the earliest stages of development. There are various disorders which fall under the category of ASD, including Autism, Asperger syndrome, Rett syndrome, and Childhood Disintegrative Disorder. Although individuals on the Autism spectrum can vary significantly with respect to their level of impairment, they all tend to exhibit the following three characteristics: stereotyped and/or repetitive behaviours, social difficulties, and communication impairment. Many individuals with ASD present with IQs below 70; however, there are also those who display average, or even above average, intelligence scores. Co-morbidities, such as Attention Deficit Disorder, seizure disorders, mental illness, and sensory issues, are not uncommon in children and adults with ASD.

Although research examining the physiological and cognitive deficits in children with ASD is plentiful, areas such as PA skills have yet to be examined in such detail. While studies focusing on PA development in children with ASD are limited, those that have been published indicate that this population is generally at a disadvantage in the development of PA skills. Gabig (2010) directly studied the PA skills of 14 school-aged children (five to seven years old) with Autism using elision and sound blending tasks. The children's performance on the PA tasks was compared to the performance of 10 typically developing (TD), age-matched children. Despite having adequate single word reading ability, the children with Autism displayed PA skills that were weaker than those of the TD children. This finding was not noted for the TD children, who demonstrated a strong, positive relationship between their single word reading ability and PA skills.

Other studies within this area have explored the PA skills of children with ASD as part of a larger battery of language and literacy-related measures. In one such study, the PA skills of children with ASD were measured pre- and post-training as a means of exploring the effectiveness of a computer-based literacy teaching program (Heimann, Nelson, Tjus, & Gillberg, 1995). Pre-training PA assessments demonstrated that the ASD and mixed handicap groups both had PA skills that were significantly lower than the TD children. However, the children with ASD were among the only participants whose mean PA scores actually decreased following the computer training. Unfortunately, no speculations were made regarding possible explanations for this finding as PA skills were not a focus of the study. Another study that investigated the PA skills of children with ASD as part of an assessment battery differentiated between children with ASD who did or did not have a history of hyperlexia (Newman, Macomber, Naples, Babitz, Volkmar, Grigorenko, 2007). Hyperlexia refers to a precocious ability to read single words, often in the presence of cognitive or behavioural deficits (Silberberg & Silberberg, 1967). Children with hyperlexia also generally exhibit reading skills that exceed their comprehension abilities (Silberberg & Silberberg, 1967). The results revealed that between the two groups with ASD, children with hyperlexia displayed stronger PA skills which were not significantly different from those of the TD group. In addition, the children without hyperlexia scored significantly lower on the PA tasks when compared to the TD group.

Taking into account the limited findings from these three studies, it would appear that children with ASD generally exhibit lower scores than their TD peers on measures of PA skills. There are exceptions to this pattern in that children on the Autism spectrum who have a history of hyperlexia tend to demonstrate PA skills that are more equal to those of children without developmental disabilities.

1.4 Bilingualism in Children with Atypical Language Development

The effects of bilingualism on the language development of children with atypical language abilities have been examined, particularly in the areas of Down syndrome (Kay-Raining Bird et al, 2005; Feltmate & Kay-Raining Bird, 2008), Specific Language Impairment (Gutierrez-Clellen et al, 2008; Gutierrez-Clellen et al, 2009; Paradis et al, 2003; Westman et al, 2008), and Autism (Fernandez & Garcia, 2012; Hambly & Fombonne, 2011; Kay-Raining Bird et al, 2012; Kremer-Sadlik, 2005; Ohashi et al, 2012; Petersen et al, 2011; Seung et al, 2006). Although children with developmental disabilities and delays very often experience slower progress in language development, research findings have suggested that children with atypical language are in fact capable of becoming bilingual without experiencing further drawbacks to their linguistic development.

Multiple studies have consistently demonstrated that bilingual children with developmental disabilities, such as Down syndrome, have the ability to function as successfully as their monolingual peers with developmental disabilities as long as bilingual exposure has been early, intensive and consistent (Kay-Raining Bird et al, 2005; Feltmate & Kay-Raining Bird, 2008). Despite this growing body of evidence, it is not unusual for clinicians and language specialists to dissuade families of children with developmental disabilities from speaking two languages (Paradis et al, 2011). The two studies which have investigated the effects of bilingualism on the development of children with DS have demonstrated that while bilingual children with DS tend to score lower on language and cognitive measures than their TD peers, they perform comparably to their monolingual peers with DS (Kay-Raining Bird et al, 2005; Feltmate & Kay-Raining Bird, 2008). Results from both studies support the notion that children with developmental disabilities, specifically DS, can be raised bilingually. The similar patterns of language deficits displayed by both monolingual and bilingual children with DS give further credence to the belief that individuals with developmental disabilities are capable of becoming bilingual without negatively impacting their existing language skills.

Studies of bilingual children with Specific Language Impairment (SLI) have paralleled the results from studies on bilingualism and DS in that bilingualism does not appear to be detrimental to the linguistic growth of children with atypical language development (Paradis et al, 2003; Westman et al, 2008; Gutierrez-Clellen et al, 2008; Gutierrez-Clellen et al, 2009). Unlike Down syndrome, SLI is a disorder that generally exists in the absence of other delays, such as motor or physical impairments (Paradis, Genesee, & Crago, 2011). Children with SLI are usually classified as such in the presence of typical non-verbal intelligence and cognitive function, although recent research has revealed that the deficits of children with SLI may extend beyond being purely language-based (Gillam & Hoffman, 2004). Despite this profile, research has indicated that children with SLI are capable of becoming bilingual without suffering from further challenges in the development of their language.

Studies examining general language development in bilingual children with language-based impairments have been unable to prove that bilingualism negatively impacts language development in this population. Both Paradis et al (2003) and Westman et al (2008) have studied the overall language profiles exhibited by bilinguals with language delays. Results from both studies suggested that bilingualism does not add to the burden of disordered language already existent in children with SLI. These results have also been paralleled in studies addressing more specific aspects of language development, such as code-switching within narratives (Gutierrez-Clellen, 2009), verb finiteness marking (Gutierrez-Clellen, 2008), and nominative subject use (Gutierrez-Clellen, 2008). Within these domains, bilingual children with

SLI have been shown to perform as well as their monolingual peers, suggesting that bilingual children with language impairment do not appear to encounter increased challenges as compared to their monolingual peers. In fact, in Gutierrez-Clellen et al's 2009 study on code-switching – a rule-governed process that requires a certain degree of grammatical proficiency and that is considered typical for bilingual children and adults – bilingual children with SLI were able to combine their two languages and demonstrate code-switching behaviour typical of children without language delays.

Taken together, the results from studies of bilingual children with DS and SLI suggest that individuals with language impairments can indeed function bilingually without experiencing a detrimental effect on their language development. It is important to note that those studies which have examined the impact of bilingualism on children with developmental disabilities have focused mainly on children who use a non-majority language within the home and use the majority language within educational and/or community settings. Given that children may become bilingual for numerous different reasons and within a variety of situations, it is important to specify the context in which bilingualism is taking place in order to extend research findings only to children from similar bilingual circumstances. In the case of research within the area of bilingualism and children with Down syndrome and SLI, the majority of children were exposed to one of their languages within the home via parents and family members and to the other language in school and often within the community. Many of these children lived in areas where other individuals within the community were also bilingual (e.g. certain areas of Canada where French-English bilingualism is common and often necessary) and where opportunities to utilize both languages was possible within an array of different settings.

The body of research on the effects of bilingualism on children with ASD is quite limited and to date there are only a handful of published studies that have compared bilingual children with ASD to monolingual children with ASD (Hambly & Fombonne, 2011; Kay-Raining Bird et al, 2012; Ohashi et al, 2012; Petersen et al, 2011)Two studies have conducted broad examinations of overall language development in young bilingual children with Autism Spectrum Disorder (Ohashi et al, 2012; Hambly & Fombonne, 2011). The most recent of these studies (Ohashi et al, 2012) utilized data collected for the Pathways in ASD Project, an organization funded by the Ontario Ministry of Children and Youth Service. All children whose data was drawn from this project met the following criteria: a clinical diagnosis of ASD, a chronological age between two to five years at the time of diagnosis, a reported vocabulary of 30 or more words, and no concurrent disorders such as cerebral palsy or sensory impairment. Of the 60 selected children, 20 met the stringent criteria for sufficient ongoing bilingual exposure, meaning that they had received ongoing exposure to two languages (English and French) within the home at some point between the time of birth and 24 months of age as well as a minimum of 20% exposure to each language. The researchers examined various aspects of the children's development, including age(s) of first words and phrases, receptive language scores, and expressive language scores. Results did not demonstrate any significant differences between the group with bilingual exposure and the group with monolingual exposure, lending further support to the notion that bilingual exposure does not impede the acquisition of language in children on the Autism spectrum.

Similarly Hambly and Fombonne’s (2011) study on early language development in bilingual children with ASD demonstrated that bilingual environments do not have a negative effect on the language skills of children from various linguistic backgrounds. In their Quebecbased study, Hambly and Fombonne (2011) recruited both monolingual and bilingual (mainly English-French) preschool-aged children diagnosed with ASD. Those children who were exposed to bilingual environments were divided into two groups and labeled as ‘simultaneous’ or ‘sequential’, based on age of exposure to the second language (before or after 12 months of age, respectively). Regardless of group (simultaneous or sequential), no significant differences were found between the language skills of the monolingual and bilingual participants. When considered in conjunction with the results from Ohashi et al (2012), the Hambly and Fombonne (2011) study suggests that the language development of bilingual children with ASD is not unlike that of their monolingual peers. The theoretical implications of these findings indicate that children with ASD who are exposed to specific bilingual input and environments do not experience harmful effects to their language development as a result of their bilingualism. As such, children with ASD could potentially be exposed to their home language without experiencing further negative consequences to their linguistic development.

Petersen et al (2011) specifically explored the lexical comprehension and production skills of English-Chinese bilingual and English-monolingual children with ASD. The participants included in this study were recruited from Vancouver, Canada and ranged in chronological age from three to six years old. All participants were tested using the Peabody Picture Vocabulary Test-III (PPVT-III; Dunn & Dunn, 1981), the Preschool Language Scale (PLS-3, Zimmerman et al, 1992), the Mullen Scales of Early Learning (MSEL; Mullen, 1995), and the Communicative Development Inventories (CDI; Fenson et al, 1993). Children in the bilingual group were also tested using the Chinese version of the PPVT (PPVT-R; Lu & Liu, 1994) as well as a Chinese CDI. Using the CDI results, a conceptual vocabulary score was computed for each of the bilingual children. This score consisted of an inventory of all concepts lexicalized in either language. Children were matched on PLS-3 scores and non-verbal IQ based on scores from the MSEL. Results of this study demonstrated that the English-Chinese bilingual children with Autism had larger total production vocabularies than their monolingual counterparts, as well as equivalent conceptual vocabularies and English vocabulary sizes.

The results of these exploratory studies have demonstrated that general language development is not impeded in bilingual children with ASD any more than it is in their monolingual peers provided that children receive a sufficient amount of early exposure to both of their languages. A 2011 study by Yang has also indicated that more specific facets of language, such as narrative abilities, are equally strong in monolingual and bilingual children with ASD. In this study, the narrative abilities of 10 English-Mandarin bilingual children were compared with 13 of their English monolingual peers as well as with 9 typically-developing English-Mandarin bilingual children. Participants were asked to tell a story from a wordless picture book, with the bilingual children providing both a Mandarin and an English version of the story. Although the bilingual children with ASD experienced more difficulties with their narratives than did the typically-developing bilinguals, they performed comparably to their monolingual peers with ASD. Results from Yang's study (2011) parallel those found in other research in that they support the possibility that children on the Autism spectrum can manage two languages without experiencing further language regression.

Although to date there are no further studies that directly assess and compare the language skills of monolingual and bilingual children with ASD, the following qualitative studies have explored the effects of bilingualism on the lives of children with ASD and their families. In recent studies, Fernandez y Garcia, Breslau, Hansen and Miller (2012) and Kay-Raining Bird et al (2012) both collected information from multilingual parents of children with

ASD diagnoses. In the case of Fernandez y Garcia at al. (2012), all five of the interviewed families had adopted an “English-only” approach to communicating with their child and ceased speaking their home language following explicit recommendations from health care professionals and/or teachers. These families then shared their experiences of trying to maintain an English-only home as well as the repercussions that proceeded this decision. Among the most frequent comment made by parents was the feeling of sadness and personal loss that resulted from having to communicate with their child in a language that was not as familiar or fluent to them as their home language. Parents also reported speaking less with their child due to feelings of inadequacy regarding their English skills. The unintended, yet negative, consequences that arose as a result of choosing to implement an English-only environment have the potential to significantly alter both the linguistic and social development in children with ASD, two areas which are often already affected in this population. Indeed, Kremer-Sadlik (2005) has actually shown that limiting the non-English home language input could have negative effects on the social skills and language development of children with ASD. Kremer-Sadlik (2005) states that the home environment is “the primary site in which a child learns to be an empathetic, social, and communicatively competent member of society” (p.1227) and that as such, it is crucial that children (regardless of typicality) be able to understand and speak the language that is used predominantly in the home. Kay-Raining Bird et al’s study (2012) surveyed 49 bilingual families of children with ASD, 75% of whom were raising their child in a bilingual household, despite inconsistent or nonexistent support for this choice. Through these surveys, the authors collected information from the families regarding the factors that influenced the decision to raise their child in a monolingual or bilingual environment, how successfully the bilingual children with ASD were able to become bilingual, the advice that professionals had provided with respect to bilingualism and ASD, and the level of support/services available to families considering raising their child with ASD bilingually. Unsurprisingly, parents who rated bilingualism as being very important to them were more likely to be raising bilingual children. The need to communicate with other family members or individuals within the community was frequently cited as a reason for maintaining two languages within the home. Generally, those children who were raised bilingually appeared capable of attaining some level of language proficiency in both languages, although the language and cognitive profiles displayed by the children differed significantly, with not all children functioning at the same developmental level. Although further research is needed to confirm that bilingualism is in fact an attainable goal for children with ASD, this survey indicates that exposure to two languages may not negatively impact the linguistic development of children on the Autism spectrum.

Finally, one study to date has examined the effect of a bilingual speech-language intervention program on a child with ASD (Seung et al, 2006). While the results from this study do not provide us with information regarding the language development of bilingual children with ASD in comparison to their monolingual peers, they do support the concept that children with ASD can be raised in a bilingual environment provided that a linguistic foundation in the home language has been established before a non-native language is introduced. Within this bilingual speech-language therapy program, the speech-language pathologist provided Korean-only therapy for the first year of intervention, followed by a gradual introduction of English speech-language therapy. In the last six months of treatment, the child was exposed to English-only intervention in preparation for English-only instruction at school. Following this 24-month intervention program, the child demonstrated significant gains in both languages, at receptive and expressive levels, as well as a notable decrease in problematic behaviour.

To conclude, although the existing research on the effects of bilingualism on the language development of children with ASD is scant, the few studies that have been published have begun to shed light on the possibility that bilingualism is not in fact harmful to the acquisition and progression of language development in children with Autism. Despite these positive findings, more research is still needed in order to form concrete statements regarding the effects of bilingualism on developmentally disabled populations. There are still areas of research within the field of bilingualism and atypical language development that have not been explored thoroughly, such as the impact of simultaneous versus sequential bilingualism on the children with developmental disabilities. The bulk of research within this field has examined children who are being raised in environments where opportunities to receive input in the non-majority language exist within the community as well as in the home (for example, Chinese-English bilingual children living within predominantly Chinese neighbourhoods in Vancouver, Canada). Similarly, most of this research has focused on children whose at-home language differs from their language of instruction. Given the rising number of Autism diagnoses in the last ten years, as well as the cultural diversity that exists within many Canadian cities, this is an area that certainly warrants further investigation in order to best understand the conditions that are required in order for bilingual children to operate as successfully as their monolingual peers.

1.5 Current Study

While only a handful of studies have actually examined the effects that bilingualism has on children with ASD, none have yet explored the potential advantages that may or may not exist within this population as a result of bilingual exposure. The current study will investigate whether the cognitive and linguistic advantages that have been observed in typically developing bilingual children under some circumstances also exist in English-Chinese bilingual children with ASD. Two domains, attentional control and PA skills, were selected since they have been widely researched in typically developing bilingual children and are generally found to be an area of strength within this population. The following main hypothesis were tested:

1) On the Simon task:
    a. Based on the cognitive advantages that typically developing bilingual children have demonstrated, it was hypothesized that bilingual children with ASD will exhibit faster RTs, most noticeably on incongruent trials, though on congruent trials as well.
    b. It was also hypothesized, that the bilingual children will be more successful at inhibiting irrelevant stimuli and therefore perform more accurately on the Simon task than the monolingual children.
2) On the PA tasks:
    a. Based on the PA advantages that typically developing bilingual children have demonstrated, it was hypothesized that the bilingual children in this study will demonstrate higher scores on all three PA measures, in particular the Word Segmentation task. Given that some or all of the children in this study may already have received some early literacy instruction, it is possible that the two groups will not differ on earlier-developing tasks, such as Rime Matching and Sound Matching. As such, later-developing tasks, such as Word Segmentation (particularly at the phonemic level), would be most likely to elicit a bilingual advantage should one exist within this population. Although stronger PA skills are expected for the bilingual group, it was also anticipated, given previous research on the PA skills of children with ASD, that all of the

children within this study will experience challenges during the assessment of their PA skills.

3) Since previous research (Bialystok 1988; Hakuta & Diaz, 1985) has revealed links between degree of bilingualism and development of the cognitive advantage, it was hypothesized that the bilingual children will demonstrate positive associations between their language proficiency in each language and performance on the Simon task.

2. Method

2.1 Participants

This study was included 14 participants, two females and 12 males, all of whom were children with a diagnosis of an Autism Spectrum Disorder between five and nine years old. All participants were recruited from and tested within the Greater Vancouver Regional District. The chronological ages of these participants ranged from 60 months to 117 months, with an average age of 80.93 months. The children were divided into two groups based on their language history: monolingual or bilingual.

The participants in both groups had been diagnosed with an Autism Spectrum Disorder by skilled and qualified clinicians, according to *DSM-IV* standards and provincial guidelines. All but two of the children had received a diagnosis of Autism. Of the other two children, one had received a diagnosis of Asperger's syndrome and the other had received a diagnosis of Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS). Of the 14 children tested, six had received diagnoses from Sunny Hill Health Centre for Children, a Vancouver-based facility funded by the Provincial Health Services Authority of British Columbia. The remaining children had received diagnoses through private organizations, the Alberta Children's Hospital, or child development centres within the Lower Mainland. The child development centres contracted their services through Provincial Health Services Authority and complied with British Columbia guidelines for Autism assessment. The private organizations used similar diagnostic procedures as those recommended by the provincial government of British Columbia for the diagnosis of Autism Spectrum Disorder.

Only children who met the operational definition of High-Functioning Autism (HFA) were selected because it was felt that individuals with lower levels of functioning may not have been able to understand and partake in all of the research tasks. This study required all children to meet two specific criteria in order to qualify as being sufficiently high-functioning: (1) the child was able to meaningfully participate in most activities within a mainstream classroom environment, with or without extra assistance; and (2) the child regularly communicated using non-echolalic sentences or phrases. These requirements were confirmed through parent and/or speech-language pathologist report, as well as through researcher observation.

2.1.1. Bilingual Children with Autism

This group consisted of six English-Chinese bilingual children, two girls and four boys. The chronological ages in this group ranged from 5.42 years to 9.75 years, with an average age of 7.20 years. These children were recruited primarily through private speech-language pathologists, online parent groups, and Autism centres within the Lower Mainland. Only children who were exposed to both English and Chinese (either Cantonese or Mandarin) on a daily basis and who were able to understand sufficient Mandarin or Cantonese to participate in an assessment of receptive vocabulary in either language were accepted into this group. It was mandatory that at least one of the parents of the bilingual children speak either Cantonese or Mandarin daily within the home and as their native language. Seven bilingual children were originally recruited and tested; however, one child was removed from the final data pool as her English language skills were deemed too low to be comparable to the other bilingual children. During data analysis, this child was consistently noted to be an outlier on various linguistic measures, including several subtests from the TOLD and the PA tasks. Of the seven total bilingual children tested for this study, this participant was the only one whose Chinese skills were stronger than her English skills. In addition to this finding, it was also noted though examiner observation that this child often required several repetitions of English instructions. As such, this child’s language skills in English were judged to be substantially different from those of the rest of the children in the sample. Since the majority of testing was administered in English, this child was seen to be at a significant disadvantage and removed from the data set.

The participants’ parents were asked to complete a questionnaire prior to testing that included information regarding the child’s language use, the parent's language use, exposure to other languages, previous therapy/intervention, and highest level of parental education. All of the children had been exposed to either Mandarin (n = 5) or Cantonese (n = 1) since birth. First age of exposure to English ranged from 7 months to 4.67 years, with the average age of exposure being 30.5 months (2.5 years). All parents reported having either Mandarin or Cantonese as their native language. As for language use within the home, all of the parents reported and were observed speaking either Mandarin or Cantonese to their child. All of the participants had exposure to Mandarin or Cantonese from individuals besides their parents, including other family members such as grandparents or siblings, neighbours, speech-language pathologists, friends, or other individuals within the community. Three of the participants had parents who reported also speaking to their child in English. All of the bilingual participants attended English-speaking schools and were spoken to in English by peers and teachers.

Aside from language background, both parents were also asked to report on their levels of education. The majority of parents had received at least one post-secondary degree/certification and all parents reported completing high school. Parents were also asked to comment on their child’s history of therapy, including behavioural interventions, speech-language therapy, occupational therapy, physiotherapy, and alternate therapies. Five of the children had received or were receiving behavioural intervention services, either in the form of Applied Behaviour Analysis (ABA) or Reference and Regulate (R&R), with an average of

555.33 hours of behavioural intervention per child. All of the children had received or were receiving speech-language therapy although two of the participants had only received assessment and consultation services. The four participants who had received or were receiving treatment services provided by a speech-language pathologist had an average of approximately 92 hours of speech-language therapy per child. In addition, two children had received or were receiving weekly services from an occupational therapist, and one child was receiving weekly physiotherapy. Overall, the children in the bilingual group each received an average of 616.66 hours of combined therapies.

2.1.2. Monolingual Children with Autism

This group was composed of eight English monolingual children, all of whom were males. The chronological ages in this group ranged from 5.0 years to 8.92 years, with an average age of 6.58 years. These children were recruited mainly from private speech-language pathologists, but also through online parent groups and private Autism centres within the Lower Mainland. As with the bilingual group, the parents of the monolingual participants were asked to answer a questionnaire pertaining to their child's language and history, services received, and parental education. All of the parents of the monolingual participants reported speaking to their child exclusively in English. The monolingual children's exposure to other languages was minimal to nil.

As with the bilingual participants, the majority of parents had received at least one post-secondary degree/certification and all parents reported completing high school. Based on this information, the monolingual and bilingual families were deemed to have roughly equivalent levels of education. Six out of the eight children had received behavioural intervention services, all of which included ABA therapy. Three children had also received other forms of behavioural intervention, such as R&R, Sensory Integration Therapy, Floortime/DIR, and/or biomedical treatment. The six children who had received behavioural intervention services had an average of 150.33 hours of therapy per child. Six of the children had also received speech-language therapy, including the two children who had not received any behavioural intervention. These six children each had an average of 92 hours of speech-language services. Overall, the children in the monolingual group received an average of 181.75 hours of combined behavioural intervention and speech-language therapies. In addition, four children had or were receiving weekly services from an occupational therapist for an approximate average of 97 hours per child.

The children in this study were matched across groups according to receptive and expressive language skills (as measured by scores on the TOLD-P:4), non-verbal IQ (as measured by scores on the KBIT-2), and age. No significant differences were found between the two groups on any of the above measures.

2.2. Materials

For comparative purposes, all participants were assessed using four subtests from the Test of Language Development (TOLD-P:4; Hammil & Newcomer, 2008) as well as the 'Matrices' section from the Kaufman Brief Intelligence Test (KBIT-2; Kaufman & Kaufman , 2004). In addition, to these measures, the bilingual participants were also assessed using the Chinese version of the Peabody Picture Vocabulary Test (PPVT-R; Lu & Liu, 1994). The two groups of participants were compared based on their calculated standard scores from the TOLD-P:4, the KBIT-2, and, for the bilingual participants, from the PPVT-R. These scores were used in order to ensure that the children did not differ significantly from one another in their general English language skills and non-verbal intelligence.

2.2.1. Simon Task

Although both the DCCS and the Simon task are frequently used in research involving the bilingual cognitive advantage, the current study opted to assess children's attentional control skills using only the Simon task. Since previous research has indicated that the DCCS is not sufficiently challenging for school-age children (Bialystok, 2001; Bialystok & Martin, 2004), the Simon task was felt to be a more appropriate choice for assessing the current study's participants. Although some studies have utilized more challenging versions of the DCCS (such as computerized varieties or the advanced DCCS) in order to test older children, the availability of the Simon task equipment and software made it a more logical choice for the current study.

During the Simon task (ST), the participants watched a computer screen and were instructed to hit either a red button or a blue button on a response box placed in front of them. The response box was positioned in such a way that the red button was in line with the left side of the computer and the blue button was in line with the right side of the computer. Each child was told to push the button that matched the colour of the square presented on the computer screen. Some of the trials showed a square appearing on the same side on the screen as its corresponding button (congruent trials) while others showed the square on the opposite side of the screen as its corresponding button (incongruent trials). The children were instructed to hit the button that corresponded to the square's colour, not to the side of the screen where the square appeared. Before the experimental trials began, children were able to complete one practice round on the computer, which consisted of 6 total trials. During this practice round, children received feedback when necessary. After the practice round, the children completed the experimental task, which consisted of 30 randomly presented trials, 16 of which were congruent. Both reaction times (RT) and accuracy measures were recorded.

2.2.2. Phonological Awareness Tasks

During the phonological awareness (PA) tasks, each child participated in activities that tested three areas of PA: Rime Matching, Word Segmentation, and Sound Matching. Two of these tasks were presented through PowerPoint slides (Rime Matching and Sound Matching) and the Word Segmentation task was presented verbally and without visual support. These tasks are modified versions of questions from the Pre-Reading Inventory of Phonological Awareness (PIPA; Dodd, Crosbie, McIntosh, Teitzel, and Ozanne, 2003) and the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgeson and Rashotte, 1999). Modifications of these tests' original questions were used to ensure that the words utilized in the current study were high-frequency and likely to be familiar to all of the participants. Additionally, some of the original questions were modified so as to eliminate any semantic links between the words on the Rime Matching and Sound Matching tasks. Each PA activity included one demonstration of the activity, two teaching trials and 10 - 12 test items. A description of the PA test items is detailed in the Appendix.

During the Rime Matching task, the participants viewed a series of PowerPoint slides, each with three pictures: two side by side at the bottom of the screen and one at the top of the screen. The children were asked to select the bottom picture that rhymed with the picture at the top of the screen (e.g. "Here is a snake, which picture rhymes with 'snake': 'cake' or 'corn'?"). The children then pointed to the picture that they believed to be an appropriate response. Children who did not understand the word 'rhyme' were asked to look for the picture which "sounded the same". Before beginning the activity, the researcher provided a demonstration of rime matching and then presented the child with two teaching trials. If the child failed to correctly identify the rhyming word during these trials, the demonstration and teaching trials were repeated.

The Word Segmentation task required the participants to delete a syllable from a word and indicate what was “left over”. For example, each child was orally presented with the word “cowboy” and asked “what is left over if we take away ‘cow’ from ‘boy’?”. The Word Segmentation task also included four items that required segmentation at the phonemic level. For example, the child heard the word ‘cup’ and was asked “what is leftover if we take /k/ away from ‘cup’? The Word Segmentation task was presented verbally and did not require use of a computer. Much like in the Rime Matching activity, the children were presented with a demonstration as well as two teaching trials before beginning the formal task.

The Sound Matching task consisted of one target picture and three additional pictures (presented via PowerPoint slides). The target picture began with a target sound and each child had to select which of the additional three pictures also began with the target sound. For example, each child was told “This is a fox. ‘Fox’ starts with the /f/-sound. What other picture starts with the /f/-sound: ‘cat’, ‘man’, or ‘fish’?”. This task also provided children with the chance to observe a demonstration and complete teaching trials before participating in the exercise.

2.2.3. The Test of Language Development

The Test of Language Development - Primary Fourth Edition (TOLD-P:4) is a standardized measure of language proficiency that evaluates various facets of linguistic development (Hammil & Newcomer, 2008). The subtests that were administered from this test are as follows: Picture Vocabulary, Oral Vocabulary, Syntactic Understanding, and

Morphological Completion. The authors report test-retest reliability coefficients for subgroups of children between the ages of 4 and 8 years to be over 0.80.

The Picture Vocabulary (PV) subtest of the TOLD-P:4 evaluates language comprehension, specifically vocabulary at the single word level, by instructing the child to point to a target picture based on a spoken word (e.g. “Point to ‘truck’”). The Oral Vocabulary (OV) subtest evaluates expressive language by instructing the child to provide verbal descriptions of orally-presented words (e.g. “Tell me what you know about a bird”). The Syntactic Understanding (SU) subtest evaluates comprehension of grammatical structures by instructing the child to point to a picture that corresponds to a spoken grammatical form (e.g. “Point to ‘They had all left’”). The Morphological Completion (MC) subtest evaluates understanding and use of various morphological forms by having the child complete sentences in a cloze-like task (e.g. “Carla has a dress and Denise has a dress, together they have two ____”). Taken together, these four subtests provided sufficient information regarding the child’s comprehension and production of English to allow for group-matching purposes.

In addition to the scaled scores calculated for each individual TOLD subtest, the participants also received a Composite Listening score and a Composite Speaking score, based on their combined scores from the PV and SU subtests, and the OV and MC subtests, respectively. The mean for scaled scores is 10, with a standard deviation of 2. The mean for composite scores is 100, with a standard deviation of 15. These composites provided further information regarding each child’s general receptive and expressive language skills in English

2.2.4. The Kaufman Brief Intelligence Test

The Kaufman Brief Intelligence test - Second Edition (KBIT-2) is a norm-referenced standardized assessment tool that is designed to measure both verbal and non-verbal intelligence in individuals aged 4 to 90 years old. For the purposes of this study, only the 'Matrices' subtest was used. This subtest does not require the participant to speak, read, or write in any language (Kaufman & Kaufman, 2004). The test subject must only understand the instructions provided by the administrator as all other components of the 'Matrices' subtest are non-verbal. Participants are directed to select a picture which corresponds to and completes a pattern that has been provided yet remains unfinished. For example, children may see two pictures, one of a rabbit and one of a carrot. Underneath these pictures, the children will see a picture of a dog as well as an empty square next to it. In order to score a full point, children must then select the picture (from an array of five drawings) that belongs in the empty square. In this case, the correct picture would be of a dog bone since the pattern is clearly meant to depict pairings of animals and the foods that they eat. As the test progresses, the patterns become more abstract and complex. The reported test-retest reliability coefficient for the test composite is above 0.90.

2.2.5. The Peabody Picture Vocabulary Test

The Peabody Picture Vocabulary Test – Third Edition (PPVT-3) is a commonly used standardized measure of receptive vocabulary at the single word level (Dunn & Dunn, 1981). This test simply requires children to listen to a verbally presented word and select one of four possible pictures which matches the spoken word. For this study, the Chinese version of the Peabody Picture Vocabulary Test, the PPVT-R (Lu & Lu, 1994), was used for the purpose of ensuring that the bilingual participants had sufficient understanding of Chinese. The PPVT-R is advantageous in that in can be used to test children in either Mandarin or Cantonese. The test-retest coefficient for this test is above 0.90.

2.3 Procedure

Each participant took part in two to three one-hour assessment sessions, which generally occurred within two weeks of one another. With the exception of one participant, all assessments were completed in the child's home within a quiet room. The remaining participant was tested in a quiet room within the bilingualism lab at the University of British Columbia. During the first session the participants completed the ‘Matrices’ section of the KBIT-2 as well as the four subtests from the TOLD-P:4. During this first session, the bilingual participants were also tested using the PPVT-R. During the second meeting, each child participated in a set of phonological awareness activities, one verbal and two computerized, as well as the Simon task.

3. Results

3.1 Comparisons of Monolinguals and Bilinguals

In order to investigate any possible differences between the monolingual and bilingual children with Autism, independent *t*-tests were run on the Simon task data and PA task scores. Table 3.1 displays the group means and standard deviations for the matching variables, background measures, including chronological age and standardized assessment measures. Although the two groups did not differ significantly with respect to one another on the background measures, the monolingual group generally exhibited higher scores on the standardized language assessments as well as on the non-verbal intelligence measure. Both groups of participants demonstrated mean scores within the normal range for all of the standardized assessments, with the exception of the Oral Vocabulary subtest from the TOLD-P:4. Both groups scored below the normal distribution on this subtest, which was also informally judged by the examiner to be the most challenging subtest of the TOLD-P:4 for many of the participants. Table 3.2 displays the group means and standard deviations for the PA tasks and Simon task data.

Table 3.1 Comparison of monolingual and bilingual participants' means and standard deviations for all background measures

Measure	Monolingual	Bilingual		
	Mean (SD)	Mean (SD)	*t*-value	*p*-value
TOLD – PV Scaled Score	11.25 (3.61)	9.50 (3.27)	.932	.370
TOLD – OV Scaled Score	7.75 (1.49)	6.50 (1.38)	1.604	.135
TOLD – SU Scaled Score	11.12 (3.27)	9.67 (4.18)	.734	.477
TOLD – MC Scaled Score	10.75 (2.76)	9.50 (2.88)	.823	.427
TOLD – Listening Composite	106.50 (14.76)	97.17 (16.57)	.641	.288
TOLD – Speaking Composite	95.50 (11.45)	88.50 (10.71)	.609	.268
KBIT – Matrices Standard Score	111.0 (9.67)	102.67 (17.28)	1.153	.271
PPVT-R – Standard Score	-	86.50 (15.42)	-	-
Age (years)	6.58 (1.51)	7.20 (1.70)	-.713	.490

PV = Picture Vocabulary, OV = Oral Vocabulary, SU = Syntactic Understanding, MC = Morphological Completion

Table 3.2 Comparison of monolingual and bilingual participants' means and standard deviations for PA tasks and Simon task data

Measure	Monolingual	Bilingual		
	Mean (SD)	Mean (SD)	*t*-value	*p*-value
PA Task – RM (% correct)	97.50 (7.07)	96.67 (8.16)	.204	.841
PA Task – WS (% correct)	85.42 (23.88)	83.28 (25.41)	.161	.874
PA Task – SM (% correct)	95.83 (6.30)	98.61 (3.40)	-.973	.350
PA Composite Score (% correct)	90.63 (12.74)	90.97 (12.75)	-.050	.961
ST – Total Score (% correct)	90.0 (9.43)	92.78 (5.74)	-.635	.538
ST – Average RT (ms)	759.9 (237.1)	804.9 (198.1)	-.376	.713
ST – Congruent Score (% correct)	96.87 (4.72)	94.79 (4.70)	.818	.429
ST – Incongruent Score (% correct)	82.14 (17.50)	90.48 (7.38)	-1.088	.298
ST – Congruent Average RT (ms)	740.6 (233.9)	762.8 (182.1)	-.192	.851
ST – Incongruent Average RT (ms)	782.0 (254.2)	853.2 (223.0)	-.545	.596

RM = Rime Matching, WS = Word Segmentation, SM = Sound Matching, PA Composite = average score from WS and SM, ST = Simon Task

3.1.1. Simon Task Data

The participants' accuracy and speed (RT, measured in milliseconds) on the Simon task were both recorded for each trial. From the accuracy measures, the total number of times that the button was correctly pushed was recorded. As well, the number of correct responses for congruent and incongruent trials were also calculated and used in the comparison of the two groups. This provided a total of three accuracy measures per child from the Simon task: one total score, one overall score for congruent trials, and one overall score for incongruent trials. From the speed measures, the average RT for each trial was calculated and used to determine the average RT time for congruent trials as well as for incongruent trials. This provided a total of three speed measures per child from the Simon task: one RT average for all trials, one average RT for congruent trials, and one average RT for incongruent trials. Independent groups *t*-tests were run on these measures. Statistical analyses demonstrated no significant differences between the groups on all of the Simon tasks measures. Despite generally having lower – albeit not significantly different – language and non-verbal scores, the bilingual participants tended to have higher total accuracy scores as well as a higher overall scores for incongruent trials (the differences were not significant). Longer RTs were noted for the bilingual participants, both on congruent and incongruent trials.

3.1.2. PA Task Data

Statistical analyses demonstrated no significant differences between the groups on the Rime Matching, Word Segmentation, and Sound Matching PA tasks. Examinations of the participants' data from the PA tasks revealed that the majority of the children tested (both monolingual and bilingual) scored 100% on the Rime Matching PA task. As a result, there was a ceiling effect and further analyses (beyond the initial t-tests) of the PA task data did not include the Rime Matching task. Instead, a post-hoc composite score was derived based on the average of the Word Segmentation and Sound Matching scores. While some children also scored 100% on the Word Segmentation and Sound Matching tasks, there were fewer ceiling scores on these tasks compared to the Rime Matching task.

3.1.3. Correlational Measures

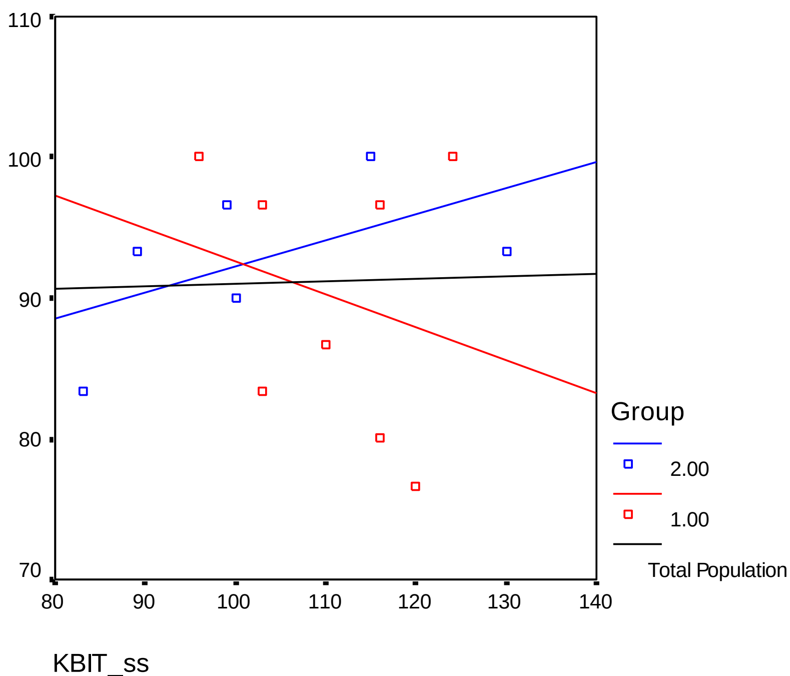
Generally, this study found very few significant correlations between background measures, such as language skills and non-verbal IQ, and performance on the Simon task and PA tasks. Given the small sample size on which this study's correlations were based, all findings should be interpreted cautiously. Despite this lack of power, some interesting trends were noted.

The following section will first outline the correlations found for the Simon task accuracy and RT. Only those variables which are conceptually and theoretically linked to Simon task performance will be presented.

Correlational analyses from the Simon task data revealed a number of differences between the two groups. See Table 3.3 for a complete summary of all correlations found for the bilingual and monolingual participants for the Simon task. In regards to total accuracy on the Simon task, there was a moderate positive correlation between ST total accuracy and KBIT scores (r = .56) in the bilingual group, while in the monolingual group there was only a weak negative correlation (r = -.24). The relationships between ST total accuracy scores and English language scores (as measured by the Listening and Speaking composite scores from the TOLD) were strong only in the bilingual and weak or non-existent in the monolingual group. There was also a strong correlation between Chinese language scores (measured with the Chinese PPVT-R) and ST total accuracy scores (r = .74). The two groups displayed markedly different patterns between their total accuracy scores and age, with the bilingual participants demonstrating moderately strong, negative correlations (r = -.66) and the monolingual participants demonstrating moderately strong, positive correlations (r = .67). An examination of the scatterplots revealed that the two oldest children in the bilingual group performed the poorest on the Simon task and that. The two groups also displayed converse correlations between their total accuracy scores and average RTs, with the bilinguals displaying moderate, positive correlations (r = .44) and the monolinguals displaying moderate, negative correlations (r = -.48). See Figures 3.1 – 3.2 for scatterplot depictions of Simon task accuracy correlations.

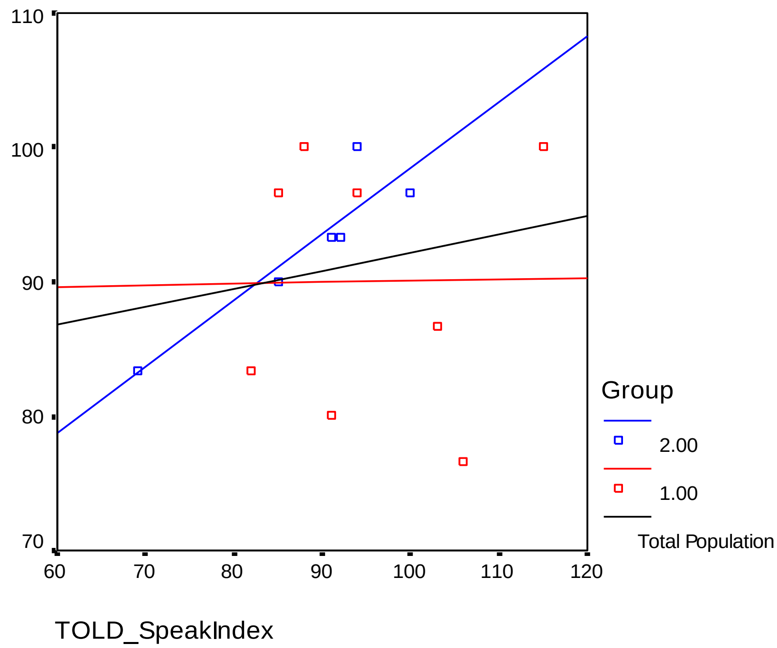
Correlations between the participants' average RTs and their English language scores revealed similar patterns as the ones described above, namely that language scores were more strongly associated with the RT on the Simon task for the bilingual group only. Correlations for the PA tasks were not performed due to large ceiling effects on all three tasks, in particular on the Rime Matching task.

Figure 3.1 Scatterplot data for correlations between Simon task total accuracy and KBIT scores



Blue = bilingual group, red = monolingual group, black = all participants

Figure 3.2 Scatterplot data for correlations between Simon task total accuracy and TOLD Speaking Composite scores



Blue = bilingual group, red = monolingual group, black = all participants

Table 3.3 Correlations of monolingual and bilingual participants' performance on Simon task (top half of table denotes bilingual correlations)

	1	2	3	4	5	6	7
1. ST – Total Accuracy		.44	.56	.74	.88*	.92*	-.66
2. ST – Average RT	-.48		.05	.06	.48	.61	-.78~
3. KBIT Scores	-.24	.23		.41	.54	.47	-.35
4. PPVT-R Scores	-	-	-		.88*	.43	-.22
5. TOLD – Comp. Listening	.39	.07	.52	-		.70	-.56
6. TOLD – Comp. Speaking	.01	-.23	.64	-	.76*		-.84*
7. Age	.67	-.36	-.18	-	-.15	-.31	

ST = Simon Task, asterisk (*) indicates significance at the .05 level ($p < .05$)

4. Discussion

This study compared the cognitive and metalinguistic skills of both monolingual and bilingual children with ASD. The main purpose of this investigation was to determine whether the well-established advantages that exist for typically-developing bilingual children were also present in the bilingual population with ASD. This study was also intended to provide more general information about the effects of bilingualism on clinical populations as this is an area that to date has received little attention in research. Given the findings from previous research with typically-developing bilingual children, it was hypothesized that the bilingual participants in this study would perform more rapidly as well as more accurately than their monolingual peers on the Simon task. It was also hypothesized that while the children in this study would experience challenges with the PA tasks, the bilingual participants would receive higher overall PA scores than the monolingual participants. These hypotheses were not confirmed as results revealed that the bilingual and monolingual participants did not perform significantly different from one another on any of the administered tasks. The following discussion will highlight the main findings from this study as well as discuss the implications from these findings, limitations of the current study, and future directions.

4.1 Lack of Bilingual Advantage for Populations with ASD

Results revealed that while the bilingual participants did not perform better than their monolingual peers on the Simon task or PA tasks, their scores did not differ significantly from those of their monolingual peers. While these findings revealed lack of a bilingual advantage in the ASD population, they are in line with the small body of literature that currently exists regarding ASD and bilingualism in that the bilingual children with ASD did not appear to experience any additional challenges to their cognitive and linguistic development as a result of being bilingual (Hambly & Fombonne, 2011; Kay-Raining Bird, Lamond, &Holden, 2012; Ohashi et al, 2012; Petersen, Marinova-Todd, & Mirenda, 2011; Seung, Siddiqi, & Elder, 2006; Yang, 2011). Given the small number of participants on which this study was based, further research in the area of bilingualism and its effects on children with ASD are required in order to truly ascertain whether the results from this study are indicative of the effects of bilingualism in the larger population.

Although previous research has demonstrated that typically-developing bilingual children generally complete the Simon task more efficiently, particularly for incongruent trials, than monolingual children do (Bialystok, 2001; Martin-Rhee & Bialystok, 2008), this trend was not observed in the current study. While the bilingual participants did receive higher overall accuracy scores, the difference between the performance of the two groups was not large enough to be considered significant. Similarly, the bilinguals also received higher, yet not significantly different, overall scores for incongruent trials. It is possible that with a larger sample these differences between the groups would become significant; however, the current study did not find the two groups to be statistically different in their performance on the Simon task. Previous research has also demonstrated that bilingual children often complete the Simon task faster than their monolingual peers (Bialystok, 2001; Martin-Rhee & Bialystok, 2008), though this pattern was not observed in the current study. The bilingual participants in fact had longer RTs for both trials, especially incongruent ones, though these RTs were not significantly different from those of the monolingual participants. It is possible that the bilingual children placed greater importance on accuracy than on speed, thus resulting in higher RTs, particularly for the trials where the bilinguals' accuracy exceeded that of the monolingual group. The fact that both groups were able to perform comparably on the Simon task suggests that bilingualism may not be detrimental to the cognitive functioning of children with ASD; however, future studies would be needed in order to confirm this hypothesis.

Correlational analyses between the two groups indicated that the bilingual participants' performance on the Simon task was consistently related to their non-verbal scores and language skills (both English and Chinese). This pattern was not seen in the monolingual participants' Simon task performance. Despite the fact that the bilinguals in this study performed comparably to their monolingual peers, the factors contributing to each group's performance on this task may have been different for the monolinguals and the bilinguals. Since previous research has not indicated any links between accuracy on the Simon task and general language abilities, it is possible that the bilingual participants' strong ties between language skills and Simon task accuracy are more related to the degree of bilingualism attained by each child. That is, children who performed better on the language tests (both in English and Chinese) can potentially be considered to be more balanced bilinguals and, based on previous research findings, could therefore be expected to perform better on the attentional control tasks than children with weaker skills in one of their languages (Bialystok, 1988; Bialystok & Martin, 2004; Hakuta & Diaz, 1985). The literature concerning the bilingual advantage has been done with children with early, consistent exposure to both languages in order to ensure that children are relatively balanced between their two languages. Thus it is reasonable to posit that the more balanced bilingual participants, particularly those with strong skills in both languages, would be expected to perform more accurately on the Simon task. Additionally, both PPVT-R scores and TOLD composite scores were found to positively correlate with KBIT scores, suggesting that perhaps those children with more balanced English and Chinese skills experienced a cognitive advantage compared to those children with decreased language proficiency.

Past studies have generally found that bilingual children perform better on PA tasks, such as elision and alliteration, than monolingual children do (Rubin & Turner, 1989; Campbell & Sais, 1995; Bruck & Genesee, 1994; Loizou & Stuart, 2003; Marinova-Todd et al, 2010). In the current study, no significant differences were found between the monolingual and bilingual groups on any of the three PA tasks. While previous research has shown that children with high-functioning Autism tend to have below average PA skills (Heimann et al, 1995; Gabig, 2010) in spite of often having average single word reading ability, one study demonstrated that children with ASD who have hyperlexia are capable of performing comparably on PA tasks when compared to their typically developing peers (Newman et al, 2007). Given the high rate of hyperlexia in children with ASD (Grigorenko, Klin, Pauls, Senft, Hooper, Volkmar, 2002; Newman et al, 2007), it is possible that the results from the PA tasks may have been affected by the presence of hyperlexia in some of the participants, but not in others. Since information on each participant's literacy skills was not collected for this study it would be important for future studies of this nature to include measures of reading ability.

A less likely, yet possible, explanation for this finding is the fact that the bilingual participants came from a language background with a logographic orthographic system. Although previous studies have indicated that children from Chinese language backgrounds demonstrated a bilingual advantage in a language with alphabetic orthographic system, English (Marinova-Todd et al, 2010), there has been evidence which points to the possibility that the PA advantage may be more noticeable in children whose first and second languages resemble one another phonologically and share an alphabetic orthography (Bialystok et al, 2003). Information regarding literacy abilities was not collected for this study, therefore, it is unknown whether the bilingual participants had received exposure to written Chinese.

4.2 Ceiling Effect on PA Tasks

Although it was expected that the bilingual children would have performed better than their monolingual peers on the PA tasks, previous literature on the PA skills of children with ASD have indicated that this population generally performs worse than their typically-developing peers on measures of PA (Heimann et al, 1995; Gabig, 2010). As such, it would not be unprecedented for the children in this study to experience difficulty on the PA tasks. The Rime Matching and Sound Matching tasks used in this study were chosen because these are two areas of PA that are generally considered to be early developing (Cisero & Royer, 1995) and which are commonly used in assessment of children's PA skills. Some studies have indicated that it is not uncommon for young school-age children to reach ceiling levels on rhyming tasks (Fox & Routh, 1974; Stanovich, Cunningham, & Cramer, 1984) yet still experience difficulty on tasks that require segmentation of syllables or phonemes. The current study used tasks that are generally mastered in the early school years, such as Rime Matching and Sound Matching, as well as tasks that tend to develop later, such as Word Segmentation at both syllabic and phonemic boundaries. Despite previous findings, the majority of the participants in this study (both monolingual and bilingual) performed well on all of the PA tasks, particularly the Rime and Sound Matching tasks. It is clear from the results on the Rime Matching task that a more challenging PA task would have been required in order to detect whether PA skill differences truly do exist between monolingual and bilingual children with ASD.

4.3 Limitations and Future Directions

The findings from this study must be interpreted with caution given the small number of participants on which the results are based as well as the heterogeneous nature of the participants. In order to truly generalize the findings of this study, greater numbers of participants would be needed in both groups. Additionally, this study was unable to restrict participation to those children who were simultaneous bilinguals due to the already specific nature of participant criteria. Since only half of the bilinguals in this study were simultaneous bilinguals, it is possible that no significant differences arose between the two groups due to the heterogeneous nature of the bilingual group. Given that previous research has not found evidence for a cognitive advantage in some successive bilingual children – such as those learning their second language within academic immersion program (Carlson & Meltzoff, 2008) – it is entirely plausible that exposure to two languages during the early years of childhood is key to the development of the cognitive bilingual advantage. In order to isolate the effects that age of exposure has on the development of the cognitive bilingual advantage in the ASD population, bilingual participants would have to be divided into two groups based on whether their second language was acquired in conjunction with or in succession to their first language.

This study is also limited in that it can only provide implications for those children who are considered to have 'High-Functioning Autism'. The nature of the Simon task and the PA tasks require children to have relatively typical levels of intelligence and language skills and as such, this study cannot provide information regarding the effects of bilingualism on children with ASD who are functioning below this level.

There were some variables in this study that could have affected the detection of a possible bilingual PA advantage. Firstly, although the average ages for the monolingual and bilingual groups were certainly within the age range during which the bilingual PA advantage is often observed, there were two children within both groups that exceeded the age of eight. As noted from past literature, the PA advantage is often no longer as detectable when children mature and achieve higher levels of literacy (Chen et al, 2004; Bialystok, Majumder, & Martin, 2003). Although it is possible that several of the children in this study may have reached higher literacy levels, it is especially likely that this would have been the case for the older children. Future research within this area should strive to include literacy measures as part of the group-matching assessment battery.

Future research that involves larger numbers of participants is needed in order to determine whether the results of this study can be extended to the larger population of bilingual children on the Autism spectrum. Additionally, research with bilingual children of non-Chinese language backgrounds should also be completed in order to ensure that the results of this study were not specific to children with Mandarin/Cantonese language profiles. Furthermore, as suggested by the current study as well as previous studies, both degree of bilingualism and age of exposure to two languages have the potential to affect the bilingual advantage, particularly on cognitive measures such as the Simon task. As such, any proceeding research within this area could benefit from greater control over the nature of bilingualism exhibited by the participants.

Given that the majority of the participants scored at or above 90% on the Simon task, it is possible that this task is easier for children with ASD than typically-developing individuals. Individuals with ASD generally exhibit rigid behavioural and/or thought patterns (Kjelgaard & Tager-Flusberg, 2001), a characteristic which could be considered advantageous in the completion of activities such as the Simon task, which do not capitalize on flexible thinking. Similarly, since the Simon task does not require the individual to interact socially (another area which is underdeveloped in children with ASD), children with ASD may consider it to be an appealing activity. Anecdotal evidence also suggests that children on the Autism spectrum may be more drawn to systematic, machine-based activities, such as those presented on a computer, and as such, may focus better on these types of activities than on activities that do not utilize these delivery methods. In order to truly isolate whether the children in this study performed equivalently because of similar cognitive profiles or because of the nature of the task, future research using a non-computerized, cognitive task is warranted.

Future studies that examine the possible PA advantages in bilingual children with Autism should also aim to only include children who are in the early school years (e.g. Kindergarten and Grade One), or to control for literacy abilities. It would also be interesting to utilize more PA tasks, such as blending or word-final sound matching, to evaluate how bilingual children with ASD perform across a greater range of PA tasks, including those which are considered to be more developmentally advanced.

4.4 Summary and Implications

In conclusion, this study found no significant cognitive or linguistic differences between monolingual and bilingual children with ASD, as measured by performance on the Simon task and a series of PA tasks. The findings from this study do provide justification for future research in the area of bilingualism and ASD. Results from this study suggest that, even though bilingual children on the Autism spectrum do not appear to demonstrate an advantage, they may be capable of performing similarly to their monolingual peers on cognitive and linguistic measures. Given the rising prevalence of ASD as well as the multi-ethnic, linguistically diverse populations that exist across many Canadian cities, continued research into the effects of bilingualism on children with Autism is critical if health care professionals are to continue to provide evidence-based service and advice to their patients.

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Appendix A: Phonological Awareness Tasks

A) Rime Matching Task

Teaching Trial: **snake**, cake, corn
Training Trial 1: **clock**, cat, rock
Training Trial 2: **fox**, bed, box
1. dig: **pig**, stove
2. mat: bear, **rat**
3. tail: sock, **mail**
4. sun: **run**, shoe
5. lick: **stick**, kite
6. coat: **goat**, head
7. bag: glove, **flag**
8. cook: **book**, brush
9. sand: bird, **hand**
10. car: hat, **jar**

B) Word Segmentation Task

Teaching Trial: playground (answer: ground)
Teaching Trial 1: popcorn (answer: pop)
Training Trial 2: baseball (answer: base)
1. hotdog (answer: dog)
2. blackboard (answer: black)
3. cowboy (answer: boy)
4. toothbrush (answer: brush)
5. pancake (answer: pan)
6. ice cream (answer: ice)

Teaching Trial: cat (answer: 'at')
Teaching Trial 1: top (answer: /t/)
Training Trial 2: hall (answer: 'all')

7. meat (answer: /m/)
8. hair (answer: air)
9. cup (answer: up)
10. bean (answer: /b/)
11. kick (answer: ick)
12. hose (answer: /h/)

C) Word-Initial Sound Identification Task

Teaching Trial: **sock**, sun, bear, cup
Training Trail 1: **neck**, nut, bed cake
Training Trial 2: **foot**, bat, hook, fish
1. /p/ pan: **pig**, hat, cone

2. /d/ duck: run, kick, **dice**
3. /f/ fan: **fire**, can, bag
4. /m/ man: cat, fin, **mouse**
5. /l/ love: dive, **light**, tub
6. /n/ nap: tape, **net**, man
7. /k/ cake: bike, **coat**, game
8. /b/ bag: **bone**, dad, pig
9. /r/ rain: tape, line, **rope**
10. /h/ house: mice, **ham**, couch
11. /s/ seal: **saw**, bus, fork
12. /p/ pie: king, leaf, **pen**