SENTENCE COMPREHENSION IN MONOLINGUAL AND BILINGUAL CHILDREN

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Abstract

Bilingual children outperform monolingual children on non-linguistic tasks that tap executive function. It still unknown whether the enhancement of executive functioning found for bilingual children improves complex linguistic comprehension. The present study examined possible differences between monolingual and bilingual children's sentence comprehension in the presence of different sources of information that conflicted with a correct interpretation.100 children (33monolinguals and 67 bilinguals) between the ages of 4- and 5-years old were examined on two complex linguistic tasks. The findings showed that bilingual children were more accurate than monolingual children in understanding the meaning of the spoken sentences in the presence of distraction. Bilingual children's advanced attentional control skill has been proposed as a possible cause that led them to effectively focus their attention on the relevant information while ignoring other sources of information that interfered with the correct interpretation.

Keyword: Bilingual children, Monolingual children, Executive function, Attentional Control, Sentence comprehension

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Sentence Comprehension in Monolingual and Bilingual Children

The effect of bilingualism in early childhood has been a topic of much discussion and debate among parents, educators, and researchers. Peal and Lambert (1962) challenged the argument that bilingualism had negative effects on a child's development by showing positive outcomes for bilingual children. Peal and Lambert (1962) compared monolingual and bilingual children's performance on linguistic and non-linguistic measures. The researchers hypothesized that bilingual children would perform more poorly on linguistic tasks and two groups would be equivalent on non-linguistic tasks. To their surprise, bilingual children exhibited superior performance on all of the tasks. Thus, Peal and Lambert (1962) argued that bilingual children have more advanced cognitive flexibility as a result of being exposed to two jointly activated languages that compete for selection requiring them to constantly switch between languages.

Following that, researchers have initiated a new line of research demonstrating cognitive advantages in bilingual children (Bialystok, 1986; Carlson &Meltzoff, 2008; Crivello et al., 2016; Kovacs & Mehler, 2009; Kuipers, & Thierry, 2015; Martin-Rhee & Bialystok, 2008). Bilingual children experience conflicting incoming messages on a constant basis as a result of their exposure to two languages that compete for selection (Kroll, Dussias, Bogulski, & Valdes-Kroff, 2012; Timmer, Ganushchak, Ceusters, & Schiller, 2014; Wu, & Thierry, 2012). The domain-general processes that are a part of the executive functions (EF) control language selection and overall adaptation to the two competing languages for bilingual individuals (Bialystok, Craik, Green, & Gollan,2009; Colzato, Bajo, van den Wildenberg, Paolieri, Nieuwenhuis, Laheij, 2008). The continuous use of these domain-general EF process to select the target language makes them more effective for other non-linguistic tasks. Consistent with this view research has shown that bilingual children exhibit superior performance than monolingual

children on nonlinguistic tasks requiring executive function (meta-analysis in Adesope, Lavin, Thompson, Ungerleider, 2010; review in Barac, Bialystok, Castro, Sanchez, 2014).

However, with regards to vocabulary knowledge, bilingual children generally perform more poorly than monolingual children on a measure of receptive vocabulary such as the Peabody Picture Vocabulary Test (PPVT, Dunn & Dunn, 1997) (Bialystok, Luk, Peets & Yang, 2010). In PPVT task children are required to point to the picture that best matches the word spoken by the experimenter. Bilingual children show a lower level of vocabulary knowledge in each language than monolinguals because bilingual children must spread their language-learning time across two languages; thus, they learn fewer vocabulary in each language than monolinguals. But what happens if the linguistic task is challenging and in addition to linguistic proficiency, executive function is required to complete the task as in the case of complex linguistic comprehension? Do the cognitive benefits of bilingualism compensate for the deficits of linguistic processing and produce a high level of performance for bilingual children on complex linguistic comprehension?

During linguistic comprehension, our concentration is considerably affected by linguistic and non-linguistic environmental distraction (Foster & Lavie, 2008).To perceive a speaker's speech in the presence of different sources of information that interfered with the correct interpretation listeners are required to selectively focus their attention on the target communicative cues and control the interference from the non -target cue, a task that goes beyond formal linguistic knowledge and require executive function. Adults typically use numerous relevant cues that vary depending on the given context to gain a greater understanding of the meaning behind an utterance, particularly when it is ambiguous. Young children can use simple verbal and nonverbal cues to comprehend a speaker's referential intent (Diesendruck,

Hall & Graham, 2006). However, young children have difficulty when they must track several verbal and non-verbal cues that may conflict with one another or when cues have different meanings, depending on the situation or environment (Nurmsoo & Bloom, 2008).

However, it still unknown whether the enhancement of executive functioning found for bilingual children improves complex linguistic comprehension that depends on both linguistic processing and executive functioning. The current study investigated this question by comparing monolingual and bilingual children's ability to attend to the meaning of a speaker's speech in the presence of challenging communicative cues that conflicted or interfered with the correct inference. The hypothesis was that the executive function ability of bilingual children would compensate for their language processing deficits and produce high levels of performance for bilingual children.

Bilingualism and Cognitive abilities

There is significant evidence that children's language environment has a significant effect on the quality of the cognitive systems they develop, so it is not surprising that bilingualism influences children's cognitive ability (Goldin-Meadow et al., 2014). A substantial body of research has revealed a high level of performance by bilingual children on a variety of non-verbal tasks that tap executive function (Adesope et al., 2010; Barac, et al., 2014). Executive Function (EF) refers to the processes that underline inhibitory control, cognitive monitoring, working memory and attentional control (Zelazo, Müller, Frye, & Marcovitch,2003). The usual explanation for bilinguals' advantages in non-verbal tasks that tap executive function is that in bilingual children's mind two languages being constantly active and they compete for selection. In the presence of two different languages, bilingual children are required to attend to the target language and control the interference from the non-target one. This language management needs

a higher-order cognitive process specifically, executive function (EF) (Bialystok, Craik, Green, & Gollan, 2009; Schwartz and Kroll, 2006; Spivey & Marian, 1999). Therefore, bilingualism is assumed to improve executive function through its constant use for language selection.

Consistent with this view, in a study by Martin-Rhee and Bialystok (2008), bilingual children outperformed monolinguals on a Simon task. Bilingual and monolingual children (between the ages of 4- and 5-years old) were presented with a Simon task in which they were asked to respond to the color of a stimulus while ignoring its location on the screen. In some cases, the button indicating the color and the location were on the same side of the display and in other cases on opposite sides, resulting in conflict. The results revealed that bilingual children completed the task faster than their monolingual counterparts.

Similarly, a number of studies showed the differences between monolingual and bilingual children's performance on a Fish Flanker Task. This task requires children to view a row of five fish, with the fish in the center being chosen as the target, and the other four fish are directed in either the same (i.e., *congruent trials*) or opposite (i.e., *incongruent trials*) directions. The children must "feed" the target fish by selecting a key that indicates the direction that the fish is facing. Bilingual children generally demonstrated faster or more accurate responding than monolingual children (Bialystok, Barac, Blaye, & Poulin-Dubois, 2010; Carlson & Meltzoff, 2008). Similar results between monolingual and bilingual children were reported when the flanker interference effect was embedded in an attentional network task (Blom et al.,2017; Kapa &Colombo, 2013).

In addition, bilingual toddlers exhibited better performance than monolinguals on a children's version of the Stroop Task (Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011). In this task, children were presented with a small picture of a fruit that was located in a larger picture of

a different fruit (e.g., a picture of a small banana in a picture of a big orange). Children were asked to point to a target picture (e.g., "Point to the small orange"). The result showed that bilingual children were more accurate in detecting the target fruit than monolinguals. The findings indicate that bilingual children showed better cognitive flexibility and inhibitory control skills than their monolingual counterparts after controlling for age and intelligence.

The possible source of bilingual children's advantages in non-verbal tasks such as the Simon Task, the Stroop Task, and the Fish Flanker Task was enhanced inhibition in that inhibition is required to focus on relevant stimuli in the presence of irrelevant stimuli (Bialystok et al., 2010; Carlson, & Meltzoff, 2008; Kuipers, & Thierry, 2015; Yoshida, Tran, Benitez, & Kuwabara, 2011). Nevertheless, the main predictions of the inhibition hypothesis have not been supported (e.g., Hilchey & Klein, 2011), and so inhibition has recently been rejected as an explanation for these effects (Bialystok, 2015). For instance, some studies have shown that bilingual children outperform monolingual children not only on incongruent trials where inhibition might be necessary but also on congruent trials where no explicit inhibition is needed as misleading information was not presented (Kapa & Colombo,2013; Yang, Yang, & Lust, 2011). Hence, some scholars have claimed that monitoring rather than inhibition is the source of the bilingual advantage. To a certain extent, inhibition is included in monitoring. The dimension change card sort task (DCCS, Zelazo, Frye, & Rapus, 1996) includes both monitoring and inhibition. In this task, a set of cards with bivalent stimuli such as colored shapes should first be categorized by one dimension (shape) and then the other (color). For young children, this task is challenging, and they typically fail to do the second classification correctly. To perform successfully, children must ignore the first dimension (inhibition) and shift attention completely to the second dimension (monitoring). After controlling for IQ between participants, bilingual

children outperform monolingual peers on this task. Hence, bilingual children show superior performance than monolinguals, in particular for tasks requiring resolution of conflict (Bialystok, 1999; Carlson, & Meltzoff, 2008; Kalashnikova, & Mattock, 2014; Okanda, Moriguchi, & Itakura, 2010)**.**

However, more powerful evidence was that differences in performance as a function of bilingualism can be found in the first year of life. Kovacs and Mahler (2009) recorded eye gazes of 7-month-old infants who have been exposed to monolingual versus bilingual home environment. In the first half of the test, infants were presented with a speech cue followed by a visual reward that always presented on the same side of the screen. Infants were required to learn that the cue predicted the presence of the visual reward in a specific location. In the second half of the test, infants were presented to different words and the position of the reward changed and it was appeared on the opposite side of the screen. Thus, infants were required to redirect their attention to the opposite side of the screen. Results showed that only bilingual infants could switch their attention to the new place; monolingual infants continued to anticipate reward as it was first learned. But what could be the possible source for bilingual infants' enhanced ability to override a learned response with a new one? Evidence from preverbal infants shows that managing conflict from two activated languages is inadequate to explain the bilingual's advantages in a nonverbal task requiring executive function.

In a bilingual environment, two languages introduce two different sets of facial configurations, speakers, structures, cadences, and sounds. These contrasts produce novelty which requires more attention than similarity. Thus, bilingual infants attend more carefully to subtle environmental differences, which improves their attentional control processing. To be more precise, infants do not need to resolve the conflict between lexical features; rather, they

identify different organized systems and need attentional control to discriminate between them (Bialystok, 2015). Consequently, attentional control mechanism must be recruited into language processing in order to avoid interference.

Empirical support for this assumption comes from studies of infants processing a salient stimulus. In two studies, infant's ability to distinguish between languages was examined when infants were watching a mute video clip of a person reading sentences in one language then switching to another language (Sebastian-Galles, Albareda-Castellot, Weikum, & Werker, 2012; Weikum, et al., 2007). The research question was to determine if infants could identify the language change based on visual cues only and therefore show interest again in the video. In both studies, only bilingually -exposed infants notice the language shift by using visual cues alone. Moreover, the bilingual infants noticed the change whether the languages were familiar to them or not (Sebastian-Galles, et al., 2012; Weikum, et al., 2007). Thus, the infants' ability to make the discrimination was more general than the facial expressions related to known languages. The possibility raised by these studies is that bilingual experience might change how attention is directed to the environment.

Older bilingual children just as infants focus their attention on the contrasting features of the two jointly-activated languages. Therefore, bilingual children constantly attend to two jointly activated languages that creates the need for using a general selection mechanism such as attentional control into language processing to avoid interference from the non-target language. The experience of constantly direct attention to the target language and disengaging attention from the non-target one improves this attentional processing broadly (Biaystok,2015).

Previous research showed that bilingual children were faster and they were more accurate than monolinguals in performing tasks requiring high level of attentional control despite their

lower level of the vocabulary knowledge (Antoniou et al., 2016; Bialystok, Craik, Green & Gollan, 2009; Bialystok & Luk, 2012; Blom et al., 2017; Bosma et al., 2017; Costa et al., 2008 ; Garraffa et al., 2015; Hernández et al., 2013; Kappa & Colombo, 2013; Lauchlan et al., 2013; Yang & Yang, 2016). For example, Blom and et al., (2017) Compared monolingual and bilingual groups of 6-7-year-old children on two attention measures: 1)Interference suppression that was assessed with a Flanker Task(Engel de Abreu et al. (2012), that was adopted from the child Attention Network Task from Rueda et al. (2004a,b), and 2)Selective attention that was measured with the visual Sky Search task from the *Test of Everyday Attention for Children* (Manly, Robertson, Anderson,& Nimmo-Smith, 1999). In this study children were matched for the IQ and children with a non-verbal intelligence below 70 were excluded. In the Sky Search task, children were asked to look for identical pairs of spaceships on a paper. The test sheet contained 20 identical pairs and 108 non-identical pairs. The children were asked to encircle the identical pairs as fast as they could while ignoring the non-identical pairs. Results revealed that bilingual children outperformed monolinguals on both tasks. In the Flanker task, consistent with previous studies(Bialystok et al., 2010; Carlson & Meltzoff, 2008; kappa & Colombo, 2013), bilingual children responded faster and more accurate than monolingual children. Similarly, in the Sky Search task that measured selective attention, bilingual children were more efficient to focus their attention on the similar stimuli while ignoring non-identical ones. These outcomes support the hypothesis that bilingualism influences the development of attentional control (Bialystok, 2015).

Sentence Comprehension in Children

Sentence comprehension includes the integration of different communicative cues and the disposition of mental models (Gernsbacher, 1990; Johnson-Laird, 1983). Understanding a

speaker's referential intent is best achieved by coordinating the various linguistic and non-linguistic cues as the linguistic information included in an expression are not sufficient to correctly understand a speaker's referential intent (Kreuz, 2000). To perceive the speaker's communicative intent, adults must consider several types of communicative information, including paralinguistic cues, semantics and the linguistic context of what was said (e.g., De Groot, Kaplan, Rosenblatt, Dews & Winner, 1995; Kreuz,1996; for a review, see Pexman, 2005). For example, the tone of voice and facial expression are paralinguistic cues that are critical in adult communication, as these are some of the means by which thoughts, emotions, and attitudes are relayed between individuals (Fussell & Moss, 1998; Goldie, 2002; Ortony, 1975; Roberts & Kreuz, 1994). Paralinguistic cues provide an indication of expressed emotion by, for instance, revealing the thoughts and feelings of the speaker that might be more profound than verbalizations. The use of basic paralinguistic cues is evidenced as young as infancy when babies utilize line-of-regard and particular intonations to understand the feelings and emotions (i.e., referential intent) of the speaker (e.g., Baldwin & Moses, 1994).

There are circumstances when the listening adult holds the expectation that the speaker will provide cues to clarify any vagueness, such as irony, sarcasm, deception, or false pretenses (Yow, & Markman, 2015). These cues typically are relayed in the form of changes in vocal tone and facial expression; signs that indicate to a listener that they should interpret the information from a different perspective (Bryant & Fox Tree, 2002; Sperber & Wilson, 1986). In adult communication, nonverbal cues are used in situations of vague communication to decipher the speaker's feeling (Argyle, Alkema & Gilmour, 1971; Morton & Trehub, 2001) and intentions accurately (Kreuz & Roberts, 1995; Rockwell, 2000).

Studies on children's understanding of vocal affect have indicated that children's

communication is different from that of adults, depending upon the developmental level of the child and the situation (Morton, Trehub, & Zelazo, 2003; Waxer & Morton, 2011). Friend (2001) found that 15-month old infants regulated their behavior based on the vocal affect when it was delivered in a manner incongruent to the lexical content of the request. This study has shown that there was a confusion in the infant's accepting and rejecting verbal messages and accepting and rejecting paralinguistic messages to produce communication. The finding of this study revealed that infants were better able to interpret a speaker's communication intent by applying paralinguistic cues such as facial expressions more so than linguistic cues. As children grow older and enter preschool, they tend to focus more on linguistic cues than on nonlinguistic cues in different circumstances. Friend (2001) proposed that the children's level of receptive vocabulary was a significant predictor of the child's inclination to apply linguistic information. Children with a high level of receptive vocabulary are likely to use linguistic cues to understand a speaker's communicative intent.

Morton and Trehub (2001) conducted a study where children aged 4 through 7-years old were exposed to linguistic information that did not correspond with the expected vocal affect information (e.g., "I lost my cat" stated with positive vocal affect). Children from the 4 through 7 age range focused more on the linguistic information in the sentence to assess the emotional message from the speaker. Adults, however, made the determination based on the vocal affect of the speaker. These findings indicate that children may have difficulty attending to competing cues in the communication process, especially when the message can change depending on opposing information relayed by the speaker (Freire, Eskritt & Lee, 2002; Jaswal & Hansen, 2006; Nurmsoo & Bloom, 2008). Young children may become confused by the conflicting nature of such a task; however, as they develop and achieve more life experience and possess

more advanced cognitive resources, they will be better able to decipher this type of communication more effectively (e.g., Friend, 2000; Morton et al., 2003; Morton & Munakata, 2002; Morton & Trehub, 2001; Waxer & Morton, 2011). For example, although newborn infants can differentiate between various facial expressions (Field, Woodson, Greenberg, & Cohen, 1982), children are not able to relate the descriptor "happy" with a facial expression that expresses happiness and the descriptor "sad" with a facial expression that demonstrates sadness until just prior to age 4 (Widen, 2013).

Berman, Chambers, and Graham (2016) investigated how children between the ages of 3 and 5-years old match vocal affect with the corresponding facial emotion. The time elapsed to process this information and gauge emotion was measured along with the children's ability to identify and point to the corresponding face, as well as eye movement towards the correct facial expression even prior to pointing. This study demonstrated that young children are able to relate visual and auditory cues to a speaker's expressed emotion.

In another study, Berman, Chambers, and Graham (2010) examined preschoolers' ability to use vocal affect to understand a speaker's referential intent involving an ambiguity. The child was presented with three images. Two of the images belonged to the same category but differed regarding the likelihood to be associated with negative or positive affect (broken doll vs. intact doll). The third image was from a different category. The speaker used positive, negative, and neutral emotional expression while asking the children to point to an object by using a vague phrase (e.g., "Point to the ball."). The child's eye fixation pattern was recorded when the ambiguous noun was delivered in the first sentence to investigate whether the child would select the "broken" object (e.g., the deflated ball) when the speaker's verbal expression was negative more often and least often when the speaker's verbal expression was positive. Interestingly, the

eye fixation patterns of the 4-year-old children demonstrated an acknowledgment of vocal affect, while the child's pointing did not demonstrate this distinction. In addition, the 3-year-old children tended to not acknowledge vocal affect despite the employment of eye gaze measure. Results demonstrated that the 4-year old group showed an implicit sensitivity to the speaker's vocal affect to understand a speaker's referential intent when ambiguity is involved, however, they did not have an explicit sensitivity (Berman et al., 2010).

The Berman et al. (2010) findings are similar to those of Morton and Trehub (2001) who reported that children demonstrated longer response times when opposing information was presented between linguistic information and vocal affect cues than when linguistic and paralinguistic information matched. These findings suggest that there is a developmental progression in children's capacity to accurately infer spoken sentences by integrating linguistic information with non-linguistic cues. Therefore, the lack of 3-year-old children's explicit and implicit ability to interpret a speaker's referential intent is followed by 4-year old's implicit ability to understand a speaker affect, which predicts later development of coordinating different communicative cues later in childhood and adulthood.

In a study with young adults, Shi (2010) found that monolinguals outperformed bilinguals in sentence comprehension task where background noise was presented. Participants were presented with incomplete sentences (e.g., "*The doctor prescribed the …*") and they were asked to complete those sentences with the proper word while background consisted of verbal environmental noises. The results showed that monolingual adults were more accurate than bilinguals in this speech perception task where sentences were presented in a noisy environment. These results were in line with the previous study demonstrating a bilingual poor performance in sentence comprehension in the context of distraction (Rogers, Lister, Febo, Besing & Abrams

2006). For example, Tabri, Chacra & Pring (2011) compared the performance of monolinguals, bilinguals, and trilinguals on an English speech Perception Task in a quiet and noisy environment using the Speech Perception in Noise (SPIN) Test. All the participants had normal hearing. Bilingual and trilingual adults exhibited poorer performance in speech perception than monolinguals in a noisy environment, in spite of their similar performance to monolinguals in a quiet condition. The results show that this deficit is higher in participants who learned the second language later in life.

However, Filippi, Leech, Thomas, Green, Dick (2012) showed that bilingual adults were better able to comprehend sentences in the presence of linguistic interference than monolinguals. Participants were presented with two images of animals on two sides of a computer screen while they were hearing one male and one female speaking together. Participants were asked to recognize the target sentence that was cued by the speaker's gender and at the same time ignore the non-target sentence that was presented with the opposite gender voice. The target and non-target sentences were concurrently given in both ears. The target sentence described one animal doing a bad action to another one, and participants had to identify the "bad animal" through the target voice that was specified by the gender of the speaker and ignore the interference produced by non-target voice. Thus, the participants were required to identify the animal doing the "bad action" by choosing the right or left image shown on the screen. The results showed that bilingual adults were better than monolinguals at comprehending sentences where they were required to exclusively direct attention to the target sentence while controlling the interference from the non-target sentence.

Similar to the observed advantages in sentence comprehension in the presence of linguistic interference in bilingual adults (Filippi et al., 2012), bilingual children also exhibited

superior performance in sentence interpretation in the context of auditory linguistic interference (Filippi et al., 2015). The task that measured children's ability to comprehend a speaker's speech in the context of linguistic interference was similar to the adults' version (Filippi et al., 2012). The results showed that bilingual children 's advantage was observed when they were presented with a difficult sentence such as passive grammatical construction that was more cognitively demanding than active grammatical construction. The results also demonstrated that bilingual children's ability to comprehend the spoken sentences in the context of verbal interference seems to be enhanced with age. The findings of this study demonstrated that the degree of bilingualism was the most reliable predictor of good performance. Therefore, in a sentence comprehension task where children were required to control attention over the interference, especially in the grammatically passive sentences that depended upon advanced cognitive skills, bilingual children were more efficient than monolinguals.

Soveri, Laine, Hamalainen, Hugdahl (2011) examined the differences between bilinguals and monolinguals' attentional control in a phonological task, forced-attention dichotic listening task. Participants were presented with a series of syllables in three condition: non-forced condition in which participants did not have to focus their attention on the specific ear stimulus; Forced-Right (FR) condition in which participants needed to control their attention to the right ear stimulus while inhibiting the stimulus presented in the left ear; Forced Left (FL) condition in which participants needed to focus their attention on their left ear stimulus while ignoring the right ear's stimulus. The findings demonstrated that bilinguals outperformed monolinguals in both Forced Left (FL) and Forced Right (FR) conditions demanding higher controlled attention to the relevant stimuli while ignoring the distracting stimuli from the opposite ear. Thus, the findings of this study demonstrated a bilingual advantage in speech comprehension in the context

of distracting information where participants were required to suppress distraction interfering with relevant communicative information.

In a study with young adults, Moreno, Bialystok, Wodniecka, Alain (2010) also found that bilinguals were more accurate than monolingual participants in a linguistic task in which they had to focus their attention exclusively on the grammatical value while ignoring the meaning of the sentence. In that study, bilingual adults deployed their enhanced attentional control for difficult linguistic processing where there was a conflict between grammatical and semantic information despite no apparent advantage in sentence processing under the simpler context in which there was no conflict. Bialystok (1986, 1988) found similar results with children when bilingual children outperformed monolinguals on the syntactic judgment task. Children were asked to make syntactic judgments of sentences that were either semantically or grammatically meaningful. Children were required to focus only on the grammar while ignoring the meaning of sentences. Results showed that bilingual children outperformed monolinguals when they were presented with the sentences that were grammatically correct but not semantically meaningful (e.g., Apples grow on hands). It has been suggested that bilingual children's advanced executive control can account for their superior performance on this type of sentences. Thus, bilingual children exhibited better performance than monolinguals in complex linguistic processing when superior attentional control is required in spite of no advantages for their linguistic knowledge.

Present Study

Bilingual children outperform monolingual children on non-linguistic tasks that tap executive function (Adesope et al., 2010; Barac, et al., 2014). The possible source of bilingual children's executive performance is advanced attentional control (Bialystok,2015). Researchers

have found significant evidence of the advanced attentional control skills in bilingual children during non-linguistic tasks (Bialystok, Craik, Green & Gollan, 2009; Bialystok & Luk, 2012). However, with regards to linguistic processing, bilingual children performed more poorly on linguistic tasks because of their smaller vocabulary size (Bialystok, Luk, Peets & Yang, 2010).

In addition, as demonstrated by previous studies, children can use simple verbal and nonverbal cues to comprehend a speaker's referential intent (Diesendruck, Hall & Graham, 2006). However, children have difficulty when they have to keep track of several verbal and non-verbal cues that may conflict with one another or when cues have different meanings, depending on the situation or environment (Nurmsoo & Bloom, 2008).

However, it is still unknown if there are any differences between monolingual and bilingual children's ability to keep track of the information in a sentence to arrive at a correct interpretation in the presence of distraction. We know from previous research that bilinguals perform poorer on linguistic tasks because of their smaller vocabulary size. But, if the linguistic task required executive function, would the same bilingual advantage observed on non-verbal tasks also extend to linguistic tasks, where we typically find a bilingual disadvantage? Do the advanced executive function ability found for bilingual children compensate their language processing deficits and produce high levels of performance for bilingual children?

This study addressed these questions by comparing monolingual and bilingual children's ability to attend to the meaning of a speaker's speech in the presence of challenging communicative cues that conflicted or interfered with the correct inference. It was hypothesized that bilingual children are better able than monolinguals to comprehend sentences in the presence of misleading perceptual information because they could rely on advanced attentional control skills. It was assumed that bilingual children have this processing advantage because they

continually need to monitor the challenging communicative circumstances requiring greater

attentional control.

Method

Participants

100 children (33monolinguals and 67 bilinguals) between the ages of 4- and 5-years old were recruited for this study from community daycare centers within the Greater Toronto Area. Children were categorized as monolingual or bilingual based on their parents' responses on the Language and Social Background Questionnaire (LSBQ; Anderson, Mak, Keyvani Chahi, Bialystok, 2018)

Materials

Language and Social Background Questionnaire (LSBQ)

The LSBQ (Anderson et al., 2018) provides the child's demographic information (e.g., age, sex, handedness, SES), other relevant background information (e.g., parent's education), and the child's language experience. Parents were asked to fill in the questionnaire and return it to school (Appendix A).

Sentence-to Picture Matching Task

Sentence-to-picture Matching Task is a task we developed to examine children's ability to keep track of the information in a sentence to arrive at a correct interpretation in the context of distraction. The Sentence-to-picture Matching Task consisted of 4 type of sentences: 1. Relational action, 2. Relational spatial, 3. Perceptual, and 4. Two-actions (Appendix B). In Perceptual and Two-action sentences, children had to match the details of the sentence to the pictures. However, for the more difficult relational sentences, Relational action, and Relational Spatial, the correct response could be chosen by the relation between the picture elements as stated in a relative clause. 40 sentences were recorded (10 trials for each type of sentences) (Appendix C). Each sentence was read twice by a female native English speaker. Each child was

seated on a small chair facing a computer monitor. An array of four images was presented on a large display screen accompanied by a recorded complex sentence. The four images were confusing as they all contained the same elements but differed in terms of the relationship between them and this confusion can only be resolved by attending to the linguistic structure. The material of this task is novel and the population in which this was given to very young children is completely novel. Each child was asked to choose one of the four pictures that matched the sentence they are heard. The time was not limited, meaning that the images stayed on the screen until children click on the response image. In this task, mouse movements were recorded and Accuracy, Reaction time and Initiation time data were calculated, but mouse trajectory data were not analyzed in this study. Reaction time is the total time in ms the child needed to move the mouse from the start button to click on the response image. Initiation time refers to the time in ms between image presentation and onset of the mouse movement.

Referential Interpretation Task

Berman, Chambers, and Graham (2010) developed a Referential Interpretation Task to examine preschooler's sensitivity to the emotional cues in a speaker's speech to understand a speaker's referential intent. We are grateful to Susan Graham for sharing this task with us. All the materials were the same as those used in their study. We used this task to examine four to five-year-old monolingual and bilingual children's ability to integrate relevant communicative cues to infer a speaker's referential intent. Each child sat on a small chair and faced a computer screen. Three images appeared on the screen, along with recorded directions that relate to one of the objects on the screen (e.g., "Point to the doll"). Each sentence was recorded by a female native English speaker with the only variations being in the emotional expression in the speaker's voice (i.e., happy, sad or neutral). The voice recording was the original material by

Berman, Chambers, Graham (2010). The speaker conveyed emotion through emotional expressions, such as using different pitch levels, pitch contours, and speed of speech (see Banse & Scherer, 1996; Frick, 1985). Hence, the information provided relevant cues for the linguistic content in speakers' utterances about objects. The task consisted of 3 conditions: 1. Positive vocal affect condition, 2. Negative vocal affect condition, and 3. Control condition. In Positive vocal affect and Negative vocal affect conditions, 12 sentences were recorded using positive or negative vocal affect (6 sentences for each vocal affect condition). Children were presented with three images, two of them belonged to the same category but differed in their likelihood of being associated with positive vocal affect or negative vocal affect (broken doll vs. intact doll). The third image was from a different category and served as the control (Appendix D). In the control condition, 10 sentences were recorded using neutral vocal affect. In some control trials, three distinct object types (e.g., a shoe, a boat, and a turtle) were displayed and in other control trials two-same category objects that differed in terms of one dimension such as color (e.g., a blue cup and a red cup) and another object that referred to different category were displayed. Each sentence was read by a female native English speaker with the only variations being in the emotional expression in the speaker's voice (i.e., happy, sad or neutral) (Appendix E). The pairing of a vocal affect type and object array was counterbalanced across participants. Each array appeared just once in each affect condition. The time was not limited, meaning that the images stayed on the screen until the participant pointed to the target image.

Peabody Picture Vocabulary Test (PPVT– IV)

To measure receptive vocabulary in English, a computerized version of the PPVT- IV (Dunn & Dunn, 2007) was used (*Form-A*). This task was used to measure the participants' English receptive vocabulary. The PPVT-IV is an individually administered, un-timed, norm-

referenced test of hearing vocabulary. The task contains four practice items and 204 test items. The assessment includes 17 sets of 12 trials each with a gradual increase in difficulty. For each trial, there are four images shown to the child, accompanied by an auditory word, and the child was asked to choose the image that best matches the word. The testing continues until eight or more errors are committed within a set. The obtained raw scores were subsequently converted into standard scores by an age-based norming table. The task has been standardized on an American sample ranging in age from 3 to 89 years old and has a reported population mean of 100 and a standard deviation of 15(Appendix F).

Procedure

Participating Daycare centers were asked to send home packages to parents of children in the daycare. The packages included the Language Social Background Questionnaire (LSBQ) and the informed consent (Appendix G). Those children who returned their informed consents and filled out LSBQ were eligible to participate in the study. Once informed consent was received from the child's parent, the child was greeted by the researcher and taken to a quiet space provided by the daycare. The researcher read the verbal assent to the child. If the child agreed to participate, testing began with the assignment of a unique ID. The assessment was conducted in a quiet room.

Children were administered the tasks in the following order: Sentence-to picture Matching Task, Referential Interpretation Task, and "Peabody Picture Vocabulary Test (PPVT-IV). Each session took approximately 30 minutes to complete. We gave stickers to all children throughout the activity as well as at the end to increase their motivation and interest, but receiving stickers were non-contingent on their performance.

Results

Bilingualism was assessed in two ways. The first was to classify the children manually into two groups based on their parent's responses on the Language and Social Background Questionnaire (LSBQ). The second was to use a continuous measure of bilingualism obtained from the LSBQ. The composite factor score that represents the degree of bilingualism was a weighted mean of three component scores: 1. Family, based on the extent of non-English language proficiency and use at home(Language spoken to the child by Maternal Grandparents, language spoken to the child by Paternal Grandparents, Language spoken to the child by other relatives , Language spoken between parents, Language spoken between Maternal Grandparents, Language spoken between Paternal Grandparents, and Language spoken between other relatives) ; 2. Media, based on the non-English language use for media(Language used in the home for searching internet, Language used in the home for reading, Language child uses listening to radio/music, Language child uses watching T.V); and 3. Sibling, representing the extent of non-English Language spoken with siblings (Language child speaks to siblings, Language spoken in the home to the child by siblings, and Language spoke in the home between siblings). Each of the three-factor scores was calculated by standardizing raw scores and multiplying these by the factor weights. Then weighted standardized scores were summed to produce a factor score for each child on each factor. A composite factor score was computed by summing the factor scores weighted by each factor's variance. The factor scores function from the psych r package with the Thurstone method of estimation was used. The factor analysis was then applied to a correlation matrix. Thus, the factor score was based on a linear combination of the correlation matrix and the factor weights.

To examine the differences between monolingual and bilingual children's performance,

first, the categorical division was used to examine the language effect on children's performance in two groups, monolingual and bilingual children, and then we tested whether a continuous measure of bilingualism has contributed to children's performance on the tasks.

Background Measures

Mean scores for the background variables are presented in Table 1. Bilingual children and monolingual children were similar on age and parent's education, $Fs < 1$. English receptive vocabulary indicated by PPVT differed between language groups, with monolingual children obtaining higher scores than bilinguals, $F(1, 98) = 29.35$, $p < .001$, $d = 1.12$, consistent with previous research (Bialystok et al., 2010). Composite factor score that represents the degree of bilingualism differed between language groups, with bilingual children receiving higher scores than monolinguals, $F(1,98) = 89.17$, $p < .001$, $d = -2.28$.

A regression analysis that was used to determine the contribution of bilingualism to performance on PPVT task once other factors had been controlled is shown in Table 2. The results showed that there was a significant effect of Composite factor score on PPVT scores after controlling age, and parent's education, $F(1,98) = 8.78$ $p = 0.004$, $R^2 = 0.13$. A child with a lower degree of bilingualism had a higher score in English Receptive Vocabulary Task than a child with a higher degree of bilingualism.

Sentence-To-Picture Matching Task

Mean accuracy scores for the Sentence-to picture Matching task scores are shown in Table 3. A 2 x 4 repeated measure ANOVA was conducted with language (monolingual versus bilingual) as the between-subject variable and type of sentences (Relational sentences and Descriptive sentences) as the within-subject variable. There was a significant main effect of language status on sentence comprehension ability, $F(1,98) = 8.66$, $p < .004$, $d = -0.61$, with

better performance by bilingual children than monolinguals. Additionally, there was a significant effect of the type of sentences, $F(3, 294) = 7.14$, $p<.0001$. The interaction of language and type of sentences was not significant, $F(3, 294) = 1.58$, $p = 0.19$.

Analysis of variance of contrasts showed that the significant effect of sentence type came from the difference between the scores for Perceptual sentences and two other sentences, Relational action sentences, $F(1,98) = 10.33$, $p=0.001$, and Relational Spatial sentences, $F(1,98) = 5.29$, $p=0.02$. Perceptual sentences were better performed by children than Relational action and Relational Spatial sentences. Also, there was a significant difference between Two actions sentences and two other sentences, Relational action, $F(1,98) =16.25$, $p= 0.001$ and Relational spatial sentences, $F(1,98) =12.07$, $p =0.008$. Two action sentences were better performed by children than Relational action and Relational spatial sentences.

Mean Reaction times scores for the Sentence-to-Picture Matching task are shown in Figure 1. A 2 x3 repeated measure ANOVA was conducted with language (monolingual versus bilingual) as the between-subject variable and type of sentences (Relational action, Relational spatial, Perceptual, and Two actions) as the within-subject variable. There was no significant main effect of language status on reaction times scores, Fs<1. The difference between reaction time within the type of sentences was significant, $F(3, 294) =4.14$, $p< 0.006$. The interaction of language and type of sentences was not significant, Fs<1.

Mean Initiation times scores for Sentence-to-Picture Matching task are shown in Figure 2. There was no significant main effect of language status on initiation times scores, Fs<1.

Analysis of variance of contrasts showed that the significant difference between the reaction times within type of sentences came from the difference between reaction time for Relational action sentences and two other sentences: Relational Spatial sentences, $F(1,97)$

=4.17, p=0.04, and Perceptual sentences, F (1,97) =5.72, p=0.01. Relational action sentences from difficult category were performed by children slower than Relational Spatial sentences and Perceptual sentences. Also, there was a significant difference between the reaction time of Perceptual sentences and Two action sentences, F (1,97) =6.63, p =0.01. Children performed Perceptual sentences faster than Two action sentences.

A regression analysis that was used to determine the contribution of bilingualism to performance on this task once other factors had been controlled is shown in Table 4. The results showed that there was a significant effect of Composite factor indicating the degree of bilingualism on Sentence- To- Picture Matching Task after controlling age, and PPVT, F (1,98) =4.04, p=0.04, R^2=0. 045. Therefore, a child with a higher degree of bilingualism was better able to perceive a speaker's speech in the context of a distraction than a child with a lower degree of bilingualism.

Referential Interpretation Task (RIT)

Mean proportion accuracy for the Referential Interpretation task scores is shown in Table 5. The scores reflect the proportion of correct responses for each child for each condition. As the scores were out of different totals, Positive vocal affect condition (out of 6), Negative vocal affect condition (out of 6), and Control condition (out of 10), they were reported as proportion correct so they could be easily compared across conditions. These data were analyzed by a 2 x 3 repeated-measures ANOVA with language (monolingual versus bilingual) as the between-subject variable and type of vocal affect (Negative, Positive and Control condition) as the within-subject variable. The analysis revealed a significant main effect of language status, F (1,98) = 53.94, p <.001, d= -1.58, indicating better performance by bilingual children than monolinguals. The main effect of type of vocal affect, F (2, 196) = 106.97, $p < .001$, was also significant.

Analysis of variance of contrast variables showed that three type of vocal affect were significantly different from each other: control trials were performed better than positive affect, F (1,98) = 23.58, $p < .001$, and negative affect, F (1,98) = 186.10, $p <. 001$. In addition, positive affect was performed better than negative affect, F (1,98) =75.09, $p <.001$.

There was also an interaction effect of language group and type of vocal affect, F (2, 196) = 19.54, $p <. 001$. That means that the effect of language group depends on the level of the type of vocal affect was significant. The language group difference is significant for positive and negative trials but not for control trails. Bilinguals obtained higher scores than monolinguals on both positive trials, F (1, 98) =4.41, $p =.038$, d = -0.43, and negative trials, F (1, 98) =40.53, $p<.001$, $d = -1.32$. There was no language group difference for control trials, $Fs < 1$,

A regression analysis that was used to determine the contribution of bilingualism to performance on this task once other factors had been controlled is shown in Table 6. The results showed that the Composite factor score that was a weighted mean of three component scores: Family, Media, and Sibling, had a significant effect on Referential Interpretation Task scores, that was the average score of the three levels of vocal affect, after controlling age, and PPVT, F (1,98) =8.77, $p=0.003$, $R^2=0. 18$. Therefore, it has been suggested that children with a higher degree of bilingualism were more efficient in integrating all relevant communicative cues to understand a speaker's referential intent than a child with a lower degree of bilingualism.

Discussion

The present study examined possible differences between monolingual and bilingual children's sentence comprehension in the presence of different sources of information that conflicted with or interfered with a correct interpretation. There were two linguistic tasks that introduced conflict in different ways. In the first task, Referential Interpretation Task, children had to interpret the speaker's referential intent by integrating all relevant linguistic and non-linguistic cues while controlling the interference that came from another picture belonging to the same category but did not correspond with the speaker's vocal affect and therefore interfered with the correct interpretation.

In the Sentence-to-Picture matching Task, children were presented with four images that were confusing as they all contained the same elements but differed in terms of the relationship among them and this confusion could only be resolved by the linguistic structure. In both tasks, children were required to attend to the relevant communicative information while resolving the conflict that came from other picture (s) that interfered with the correct language comprehension. Therefore, both tasks required attentional resources to guide linguistic processing in order to properly comprehend the complex sentences.

Monolingual and bilingual children were similar on age and parent's education; thus, these background measures cannot account for the differences in children's performance in the linguistic tasks.

For Sentence-To-Picture Matching Task, bilingual children's performance surpassed that of monolinguals. In the easier descriptive sentences (perceptual and two actions), the correct image could be chosen directly by matching the details of the sentence on to the pictures. However, for the more difficult relational sentences, the correct image is determined by the

relation between the picture elements as stated in a relative clause. Since all the pictures contained the same elements but differed in terms of the relationship between them and this confusion could only be resolved by the linguistic structure. Bilingual children demonstrated an advanced ability to keep track of relevant information while controlling the interference from the other three images to resolve the confusion and eventually attend to the correct interpretation. We suggest that bilinguals' advanced attentional control might account for their better performance in Sentence-To-Picture Matching Task.

Past research has shown that preschool children can successfully attend to simple communicative cues to interpret a speaker's referential intent, however, complications have arisen when multiple sources of information incongruent with each other are involved requiring children to integrate linguistic and paralinguistic information to arrive at the correct interpretation (Freire, Eskritt & Lee, 2002; Nurmsoo & Bloom, 2008; Yow & Markamn, 2015).In Sentence-To-Picture Matching task bilingual children's advanced ability to coordinate non-linguistic information with the linguistic structure to resolve the confusion and attend to the correct comprehension might be due to their enhanced attentional control skills.

The results from the Referential Interpretation task also revealed the differences between monolingual and bilingual children's ability to interpret a speaker's referential intent when challenging communicative cues were involved, requiring children to coordinate linguistic and non-linguistic cues to properly infer a speaker's referential intent.

The findings also demonstrated that there was a significant difference between integrating linguistic information with negative vocal affect versus positive vocal affect. Monolingual children have more difficulties in inferring negative vocal affect. Vaish, Grossman, and Woodward (2008) provided evidence that children attend to negative versus positive information

differently. Peeters and Czapinski (1990) suggest that negative stimuli carry a greater amount of information which needs a greater amount of processing and therefore may benefit from more attentional resources. Consistent with this assumption, neurological studies point to the greater effort required to process negative information, in which participants showed greater event-related brain potential (ERP). ERP measured participant's electrical brain activity at the surface of the scalp when participants were processing negative information by reading or looking at the images of people doing the negative act. The amplitude and latency of each ERP component provide information regarding the strength and timing of negative image processing. There was a larger amplitude late positive brain potentials during evaluating the negative images(Ito, Larsen, Smith, Cacioppo, 1998). In this study, bilingual children performed much better than monolingual children in processing sentences with the negative vocal affect that demands a greater amount of attentional processing.

The findings of the present study demonstrate that bilingual children who grow up in an environment with challenging communicative context are becoming adept at focusing attention where needed in response to a goal, a process that becomes more effortful in the context of different communicative cues. In this sense, bilingualism operates as a form of attentional control training, leading to benefits in attentional control and conflict monitoring -the skills to control unpredictable distractors and flexibly attend to relevant resources in the context.

In addition, not only did the group analyses show that bilinguals on the whole performed better but also the regression analyses showed that performance was calibrated to the degree of bilingualism. The more bilingual they were across the entire spectrum, the better their performance on both linguistic tasks. Thus, children who were more bilingual were more efficient in attending to relevant communicative cues to interpret the speaker's speech in the

presence of challenging communicative cues interfered with the correct interpretation.

The result suggests that monolingual children might be overwhelmed by the cognitive demands of these two sentence comprehension tasks, however, bilingual children were better able to overcome the difficulties of the task in spite of no apparent advantage in their English vocabulary size. It has been proposed that these results are consistent with better attentional control skills by bilingual children because bilingual children are regularly exposed to various challenging communicative circumstances requiring greater attentional control. The constant need to pay attention to the target language and disengage attention from the non-target one strengthens attentional control abilities in this group. Thus, bilingual children have developed more advanced attentional resources which have been proposed as a possible cause of bilingual children's superior performance in interpreting the meaning of spoken sentences in the condition where different sources of information that interfered with a correct response were presented. Thus, bilingual children were less vulnerable to the interference produced by competing cues which is possibly due to their attentional benefits as a result of their constant use of two languages. It has been assumed that bilingual children who regularly monitor difficult communication situations requiring more flexibility, attention, and inhibitory control, are more efficient in attending to different communicative cues to interpret the spoken sentences compared to monolingual children.

Conclusion

These findings from the present study showed that bilingual children were more accurate than monolingual children in understanding the meaning of the spoken sentences in the presence of challenging cues that interfered with the correct response. Bilingual children's superior attentional resources capacity has been proposed as a possible cause that led them to effectively

focus their attention on the relevant information while ignoring other sources of information that interfered with the correct interpretation.

Previous researchers argued that in bilingual children's mind two different languages are constantly active and they compete for selection. Bilingual children are required to attend to the target language and control the interference for the non-target one. This language management needs a higher-order cognitive process specifically, executive function (EF) (Bialystok et al.,2009; Schwartz and Kroll, 2006; Spivey & Marian, 1999). It has been suggested that selective attention is the responsible mechanism for bilingual executive function performance (Bialystok, 2015). The constant use of attentional control skills for language management makes them more effective for performing non-linguistic tasks (Barac, Bialystok, Castro, & Sanchez, 2014). It is possible that advanced attentional control found in bilingual children on non-linguistic task extends to linguistic processing as in the case of sentence comprehension tasks.

These results help to clarify language and cognitive processing in monolingual and bilingual children by showing the possible role of attentional control in complex linguistic comprehension. The findings of this study are important because they highlight ways in which bilingual children's information-integration abilities might differ from those of monolingual children. These results show how previous research demonstrating the differences between monolingual and bilingual in attentional control can be extended to explain the differences between these two groups in certain aspects of linguistic processing. These findings clearly support the role of bilingualism in developing children's progress in achieving attentional control skills which might lead bilingual children to be more effective in complex linguistic comprehension. Thus, it has been proposed that bilingualism improves attentional skills for both linguistic and non-linguistic processing. This finding is very important as attentional control

plays a significant role in learning and cognition.

Limitations/Future directions

Our sample did not have a large socioeconomic status (SES) diversity, as the data were only collected from private schools in Toronto. This limits the generalizability of the results in this group of children to a whole population. In addition, intelligence was not controlled across groups, including an intelligence measure should be considered in future research. Furthermore, we were hoping that the mouse-tracking data from Sentence-to-Picture Matching Task would be helpful in understanding the underlying processes but at this point that has not been the case, although we will continue to consider other ways of examining the data. The results also provide an important avenue for future neuroimaging research to examine the differences between monolingual and bilingual children's functional characteristics of brain activation in the attention system during sentence comprehension.

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Table 1

Mean scores (and standard deviation) for Background Measures for Monolingual and Bilingual Children

Background Measures	Monolingual(*n*=33)	Bilingual(*n*=67)
Family	-1.15(0.38)	0.56(0.96)
Media	-0.82(0.17)	0.40(1.05)
Sibling	-0.67(0.25)	0.33(1.36)
Language Composite Score	-0.72(0.17)	0.35(0.64)
PPVT	118.21(14.70)	102.58(12.98)
Age in months	57.97(7.83)	58.33(7.68)
Parent's education	4.25(0.82)	4.21(0.82)

Note: Family, Media, Sibling and Language Composite Score were calculated from the Language and Social Background Questionnaire (LSBQ)

Table 2

Regression Analysis for Variables Predicting PPVT- IV Scores

Variable	B	SE B	β	t
PPVT -IV task R^2 = 13%				
Age	-0.35	0.18	-0.19	-1.87
Parent's education	2.8	1.77	0.16	1.58
Composite Factor	-5.74	1.93	-0.30	-2.96*

Note. *$p < .001$

Table 3

Mean accuracy (out of 10) (and Standard Deviation) in Sentence-To-Picture Matching Task

Conditions	Monolingual	Bilingual
Relational Action	6.27 (1.92)	7.09*(1.86)
Relational Spatial	6.52 (1.64)	7.24*(1.34)
Perceptual	7.12(1.67)	7.49 (1.53)
Two actions	6.82(1.61)	7.97** * (1.41)

*Note. *p < .05, ***p < .001*

Table 4

Regression Analysis for the Variables Predicting Sentence-to-Picture Matching Task Scores

Variable	B	SE B	β	t
Sentence-to-Picture Matching Task R^2= 4%				
Age	0.06	0.06	0.09	0.95
PPVT	0.03	0.03	0.10	0.99
Composite Factor	1.47	0.73	0.21	2.01*

Note. *p < .05

Table 5

Mean Proportion accuracy (and Standard Deviation) in Referential Interpretation Task

Conditions	Monolingual	Bilingual
Negative Vocal Affect	0.32 (0.32)	0.70 (0.25) ***
Positive Vocal Affect	0.81 (0.20)	0.89(0.16) *
Control	0.94 (0.07)	0.94 (0.07)

*Note. *p* < .05, ***p* < .001

Table 6

Regression Analysis for Variables Predicting Referential Interpretation Task Scores

Variable	B	SE B	β	*t*
Referential Interpretation task $R^2 = 18\%$				
Age	0.001	0.001	0.010	0.11
PPVT	-0.001	0.007	-0.23	-2.40*
Composite Factor	0.048	0.016	0.28	2.96**

*Note. *p* < .05, **p* < .01*
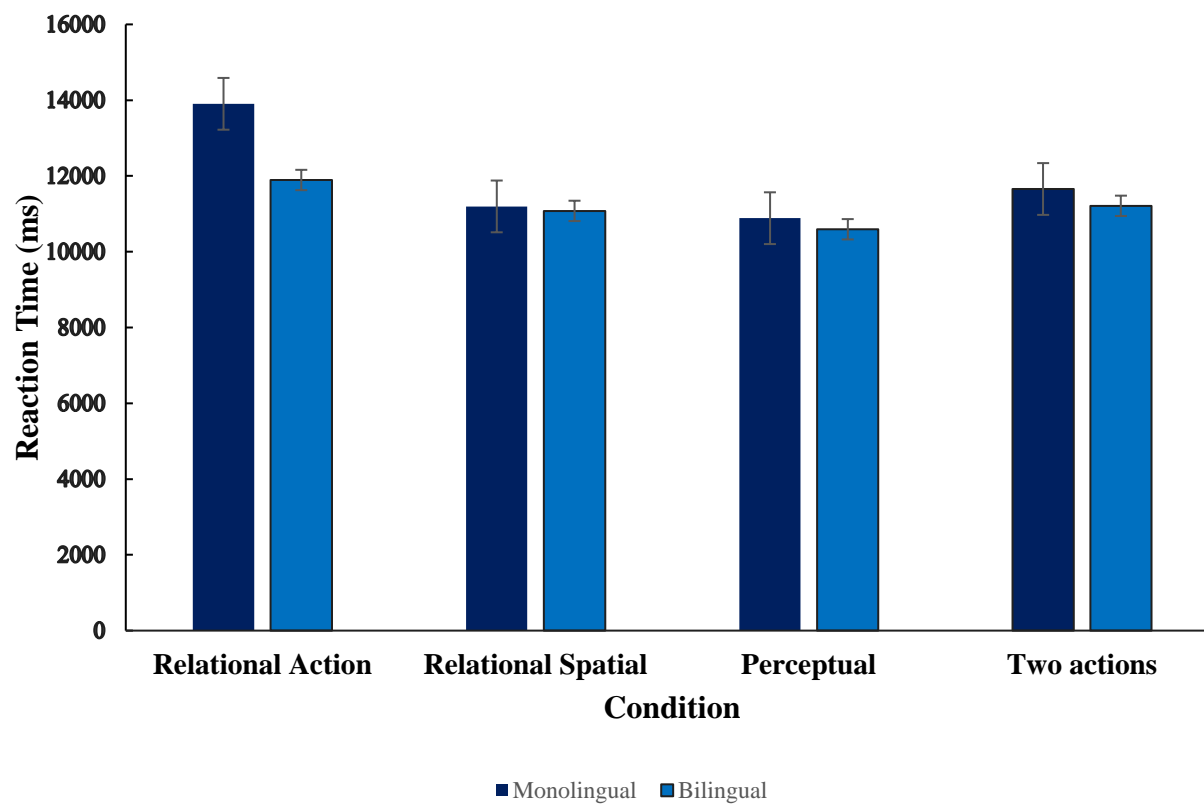
Figure1. Mean Reaction times and standard error bars in Sentence-To-Picture Matching Task
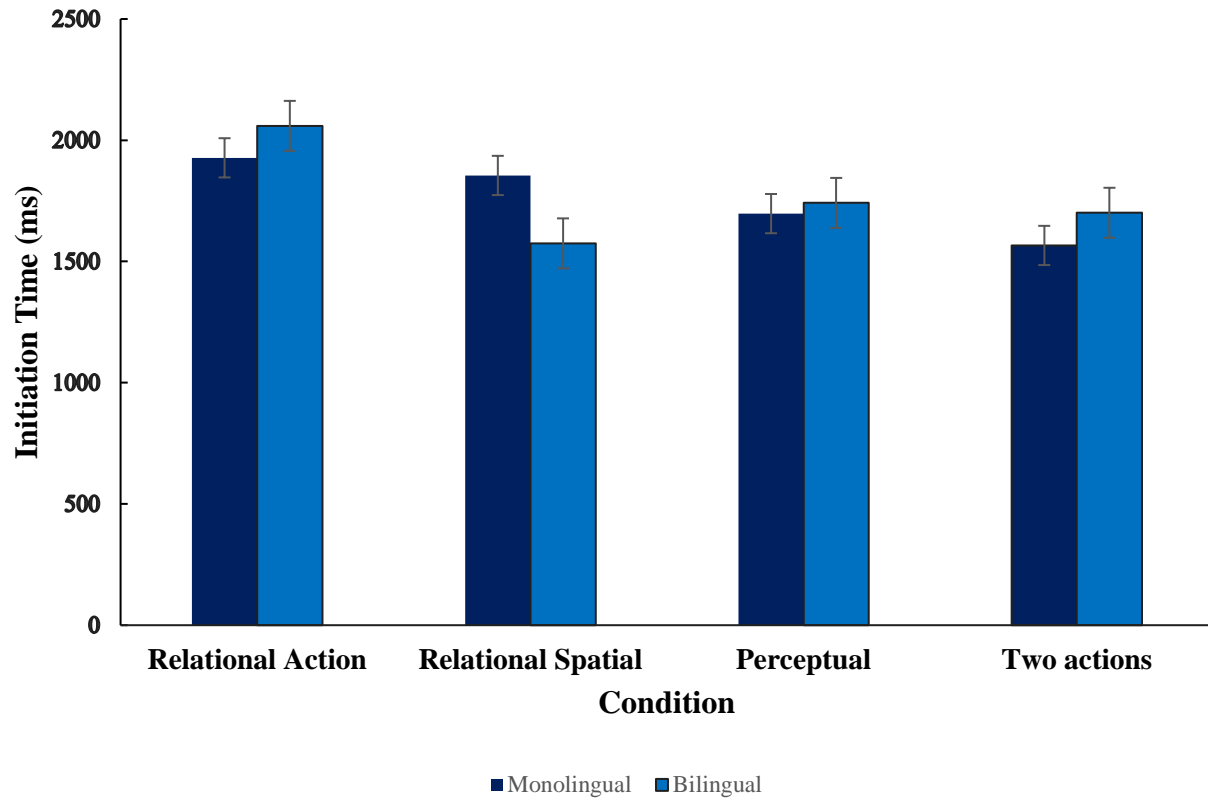
Figure2. Mean Initiation times and standard error bars in Sentence-To-Picture Matching Task

Appendix A: Language and Social Background Questionnaire (LSBQ)

Language and Social Background Questionnaire (LSBQ

YORK U
UNIVERSITE
UNIVERSITY

Cognition and Development Lab
Ellen Bialystok Ph.D., Principal Investigator
Department of Psychology, York University

Language and Social Background Questionnaire (to be completed by parents)

1. Today's date: _____
day   month   year

2. Completed by: Mother ☐   Father ☐   Other ☐ (please specify) _____

Part A – Background

The following information refers to your **CHILD**:

3. First name: _____   Last name: _____

4. Date of birth _____   **5. Sex:** _____   **6. Grade:** _____
day   month   year

7. Country of birth: _____   **8. Handedness:**   left ☐   right ☐

The following information refers to the **PARENTS**:

10. Country of birth of MOTHER: _____

   If not born in Canada, when did the mother come to Canada? (Month/Year) _____

   What language(s) did the mother grow up speaking? _____

   List the languages known by the mother, *in order of fluency (most fluent to least fluent)*:

   _____

11. Country of birth of FATHER: _____

   If not born in Canada, when did the father come to Canada? (Month/Year) _____

   What language(s) did the father grow up speaking? _____

   List the languages known by the father, *in order of fluency (most fluent to least fluent)*:

   _____

Reference Code _____

Please indicate the highest level of education and occupation for each parent:

12. MOTHER	13. FATHER
1._____No high school diploma	1._____No high school diploma
2._____High school graduate	2._____High school graduate
3._____Some college or college diploma	3._____Some college or college diploma
4._____Bachelor's degree	4._____Bachelor's degree
5._____Graduate or professional degree	5._____Graduate or professional degree
Occupation: _____	Occupation: _____

Part B – Child's Language Experience

14. Does your child *understand* any language other than English? yes ☐ no ☐

If **yes**, how would you rate your child's understanding of the other language(s)?

Name other language(s)	Poor	Fair	Moderate	Good	Excellent
_____	☐	☐	☐	☐	☐
_____	☐	☐	☐	☐	☐
_____	☐	☐	☐	☐	☐

15. Does your child *speak* any language other than English? yes ☐ no ☐

If **yes**, how would you rate your child's speaking of the other language(s)?

Name other language(s)	Poor	Fair	Moderate	Good	Excellent
_____	☐	☐	☐	☐	☐
_____	☐	☐	☐	☐	☐
_____	☐	☐	☐	☐	☐

16. Does your child attend any language or school program other than regular school? yes ☐ no ☐

If **yes**, which program? _____

How often? Every day ☐ Once a week ☐ Other: _____

17. Which language did your child first speak?

English ☐ Other language(s) ☐ Both/All at the same time ☐

18. Is there another relative (e.g., grandparent) who lives in the home? yes ☐ no ☐

If **yes**, what are the languages spoken by that relative? _____

Reference Code _____

<table>
<tr><td colspan="8" style="background:red;color:white;text-align:center">Part C – Language in the home</td></tr>
</table>

For each of the following, please indicate with a check mark (√) the use of language in your home for that activity. If a question does not apply to your family, please indicate by writing N/A.

Questions about the CHILD	All English			Half English/ half other language(s)			Only in the other language(s)
Language CHILD speaks to:	1	2	3	4	5	6	7
1. Mother	☐	☐	☐	☐	☐	☐	☐
2. Father	☐	☐	☐	☐	☐	☐	☐
3. Siblings	☐	☐	☐	☐	☐	☐	☐
4. Maternal grandparents	☐	☐	☐	☐	☐	☐	☐
5. Paternal grandparents	☐	☐	☐	☐	☐	☐	☐
6. Other relatives (aunts, uncles etc.)	☐	☐	☐	☐	☐	☐	☐
7. Friends	☐	☐	☐	☐	☐	☐	☐
Language CHILD uses for:							
8. Reading	☐	☐	☐	☐	☐	☐	☐
9. Listening to the radio/music	☐	☐	☐	☐	☐	☐	☐
10. Watching TV/video	☐	☐	☐	☐	☐	☐	☐
11. Searching the internet (e.g., Google, Facebook)	☐	☐	☐	☐	☐	☐	☐
Overall, language your CHILD uses to speak:							
12. At home	☐	☐	☐	☐	☐	☐	☐
13. Within your community/local environment	☐	☐	☐	☐	☐	☐	☐

Questions about the FAMILY

Language spoken IN THE HOME to the child by:	1	2	3	4	5	6	7
14. Mother	☐	☐	☐	☐	☐	☐	☐
15. Father	☐	☐	☐	☐	☐	☐	☐
16. Siblings	☐	☐	☐	☐	☐	☐	☐
17. Maternal grandparents	☐	☐	☐	☐	☐	☐	☐
18. Paternal grandparents	☐	☐	☐	☐	☐	☐	☐
19. Other relatives (aunts, uncles etc.)	☐	☐	☐	☐	☐	☐	☐
20. Neighbours/friends/ other caregivers	☐	☐	☐	☐	☐	☐	☐
Language spoken IN THE HOME between:							
21. Parents/Spouses	☐	☐	☐	☐	☐	☐	☐
22. Siblings	☐	☐	☐	☐	☐	☐	☐
23. Maternal grandparents	☐	☐	☐	☐	☐	☐	☐
24. Paternal grandparents	☐	☐	☐	☐	☐	☐	☐
25. Other relatives (aunts, uncles etc.)	☐	☐	☐	☐	☐	☐	☐
26. Neighbours/friends	☐	☐	☐	☐	☐	☐	☐
Language used IN THE HOME for:							
27. Reading	☐	☐	☐	☐	☐	☐	☐
28. Listening to the radio/music	☐	☐	☐	☐	☐	☐	☐
29. Watching TV/video	☐	☐	☐	☐	☐	☐	☐
30. Searching the internet (e.g., Google, Facebook)	☐	☐	☐	☐	☐	☐	☐
31. Reading stories to the child	☐	☐	☐	☐	☐	☐	☐

Appendix B: Sentence –Picture Matching Task

An array of four images was presented on a large display screen accompanied by a recorded complex sentence. Each child was asked to choose one of the four pictures that match the sentence they are heard ("Wolf is chasing the sheep who is chasing the man")

Appendix C: List of Sentences Used in the Sentence-to-Picture Matching Task

Practice Trials

1. The girl wearing the blue dress is reading the blue book.

2. The girl jumping off the stool is behind the boy.

3. The book is on top of the cup that is underneath the table.

4. The boy wearing the red shorts is bouncing on the red trampoline.

5. The girl is swinging the bat and the boy is kicking the ball.

6. The boy jumping on the stool is behind the girl.

7. The book is underneath the cup that is on the table.

8. The boy wearing the blue shorts is bounding on the blue trampoline.

9. The girl is kicking the ball and the boy is holding the bat.

Task Trials

1. The girl is running away from the boy who is running away from the dog.

2. The wolf is chasing the sheep who is running toward the boy.

3. The girl and the boy are running after the kite that is flying away.

4. The man is holding back the squirrel that is running after the dog

5. The man with the little girl in front of him is riding his bike toward the three.

6. The ball is under the mouse that is under the elephant.

7. The plate is on top of the apple that is on the box.

8. The mouse is beside the dog that is under the cat.

9. The screen is on top of the desk and the speakers are under the desk.

10. The clothes are beside the basket that is on top of the washing machine.

11. The boy wearing the black hat is riding the black horse.

12. The boy wearing the orange shirt is playing with the green ball.

13. The blue fish is eating the green fish that is behind the red fish.

14. The girl reading the red book is sitting next to the boy reading the red book.

15. The frog is on the red napkin that is on the grey box.

16. The girl is facing the boy who is holding the ice cream.

17. The man hiding the dog is facing the woman hiding the cat.

18. The boy and girl are listening to music and reading.

19. The boy is giving flowers to a woman who is receiving flowers from the girl.

20. The girl holding the apple is standing next to the boy holding the backpack.

21. The girl is running away from the boy who is running away from the dog.

22. The wolf is chasing the sheep who is chasing the boy.

23. The girl is running after the boy who is holding the kite.

24. The man is holding back the dog that is chasing the squirrel.

25. The man with the little girl behind him is riding his bike away from the three.

26. The ball is under the mouse that is under the elephant.

27. The apple is on the plate that is on the box.

28. The dog is under the cat that is under the mouse.

29. The screen is in between the speakers that are on top of the desk.

30. The clothes are in the basket that is beside the washing machine.

31. The boy wearing the brown hat is riding the black horse.

32. The boy wearing the green shirt is playing with the orange ball.

33. The blue fish is eating the red fish who is eating the green fish.

34. The boy reading a red book sitting next to the girl reading a green book.

35. The frog is on the white napkin that is on the grey box.

36. The boy is walking away from the girl who is holding ice cream.

37. The woman hiding a cat is facing the man hiding a cat.

38. The pile of books is next to the boy who is listening to music and reading a book.

39. The boy is giving flowers to a woman who is receiving a gift from the girl.

40. The boy holding the apple is standing next to the girl holding the backpack.

Appendix D: Referential Interpretation Task

 An array of three images were presented on a large display screen, accompanied by a recorded

instruction relating to one of the objects (e.g., "Point to the doll"). The sentences were recorded

by a female native English speaker, varying only in the emotional affect expressed by the

speaker's voice (happy , sad or neutral). Two of the images belong to the same category with

similar dimension but differing in terms of their likelihood to be associated with positive or

negative affect (e.g., the intact doll vs. the broken doll). The third image belongs to a different

category.

Appendix E: List of Sentences Used in the Referential Interpretation Task

Practice Trials

- Look at the apple
- Pont to the apple

- Look at the dog
- Point to the dog

Negative Vocal affect Trials

- Look at the Car.
- Point to the Car.

- Look at the Doll.
- Point to the Doll.

- Look at the Flower.
- Point to the Flower.

- Look at the Fork.
- Point to the Fork.

- Look at the Toy.
- Point to the Toy.

- Look at the Plate.
- Point to the Plate.

Positive Vocal affect Trials

- Look at the Ball.
- Point to the Ball.

- Look at the Bird.
- Point to the Bird.

- Look at the Duck.
- Point to the Duck.

- Look at the Egg.
- Point to the Egg.

- Look at the Glass.
- Point to the Glass.

- Look at the Pencil.
- Point to the Pencil.

Control Trials

- Look at the Hammer.
- Point to the Hammer.

- Look at the Dinosaur.
- Point to the Dinosaur.

- Look at the Corn.
- Point to the Corn.

- Look at the Elephant.
- Point to the Elephant.

- Look at the Fish.
- Point to the Fish.

- Look at the Ice cream.
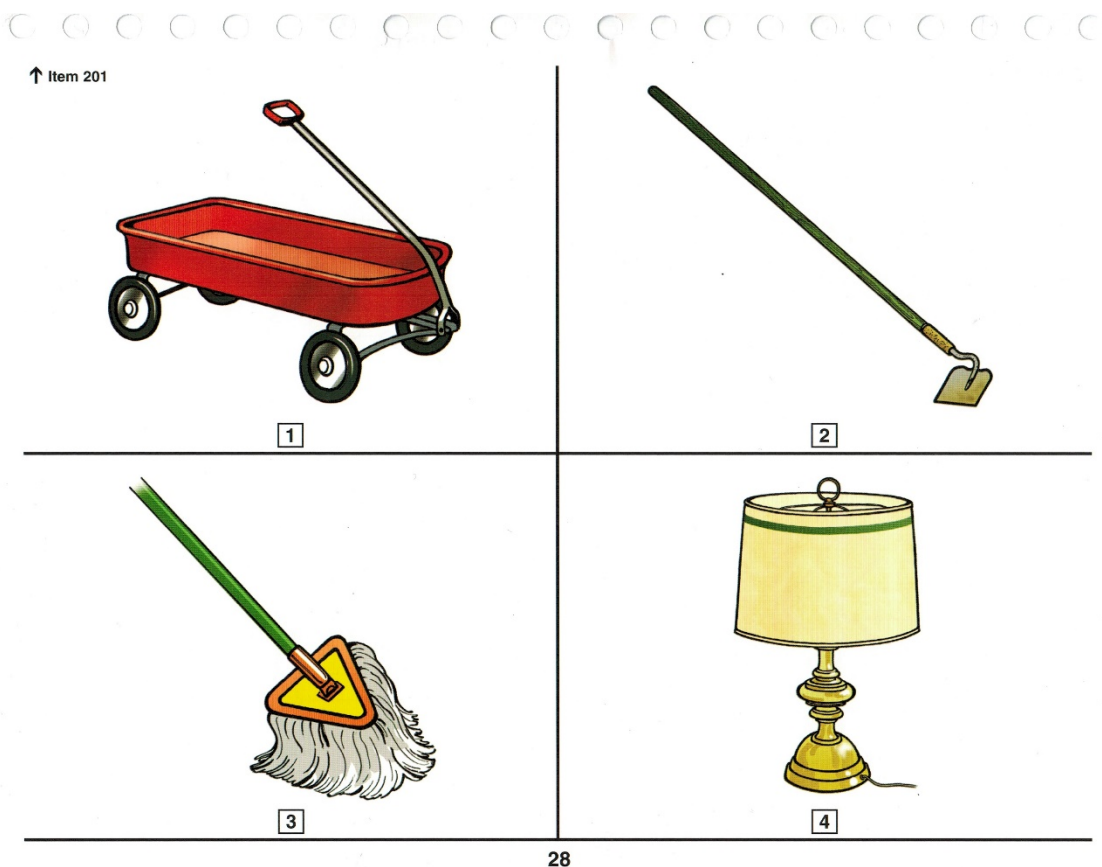- Point to the Ice cream.

- Look at the Monkey.
- Point to the Monkey.

- Look at the Rattle.
- Point to the Rattle.

- Look at the Shoe.
- Point to the Shoe.

- Look at the Tree.
- Point to the Tree.

Appendix F: Peabody Picture Vocabulary Test (PPVT– IV)

For each trial, there are four images shown to the child, accompanied by an auditory word (e.g., lamp) and the child was asked to choose the image that best matches the word.

Appendix G: Informed Consent
Sentence Comprehension in Monolingual and Bilingual Children
Researcher:

- Dr. Ellen Bialystok
Distinguished Research Professor
York University

Other members of the research team:

- Sarvenaz Ostadghafour
Master student in Psychology (Developmental Science area)
York University

- TBA
Undergraduate student in Psychology
York University

Sponsor: York University
This research has been approved by the Human Participants Review Subcommittee (HPRC) of York University for compliance with York University Senate Ethics policy.

Purpose of the study:
The purpose of the study is to better understand the effect of bilingualism on cognitive and linguistic Processing in children. In this study we will compare monolingual and bilingual children' sentence comprehension in the presence of distraction. Canadian cities are models of cultural diversity and understanding the effect of learning two languages on cognitive function in children will provide developmental models of cognitive and linguistic development in early childhood. Such information will also inform applied issues of educational programming and theoretical issues of the impact of bilingualism on children's development.

Collecting Data:
We will contact selected community day care centers within the Greater Toronto Area. Community day care centers will be randomly selected. Participating Daycare centers will be asked to send home packages to parents of children in the daycare. The packages will include the Language Social Background Questionnaire (LSBQ), and the informed consent. Those children who return their informed consents and filled out LSBQ will be eligible to participate in the study.

What your child will be asked to do in the study:

Once informed consent is received from the child's parent, your child will be greeted by the researcher and taken to a quiet space provided by the daycare. The researcher will read the verbal assent to the child. If the child agrees to participate, testing will begin with the assignment of a unique subject ID. The child will be asked to complete 3 computer-based activities. They will be

provided with clear instructions and examples at the beginning of each activity. In all tasks, the child will be asked to select the corresponding picture upon hearing a word or a sentence. Breaks will be provided throughout the activities, and we will answer any questions that come up. The study will be completed in one session, approximately 25 minutes long. During the testing, children will receive stickers as an incentive to keep going.

Voluntary Participation
Participation in this study is completely voluntary. Decision to participate is entirely up to you and your child. You can change your mind at any time.

Risks and Discomforts
We do not expect the study to cause any risks or discomforts for your child. However, if your child feels uncomfortable or becomes tired, he/she can take a break whenever he/she desires.

Withdrawal from study
Your child can stop participating in the study any time he/she wants. If you or your child decides to withdraw, you or your child does not need to give a reason, and it will not impact your future relationships with your teacher, your school, the researchers, or any part of York University. Should your child withdraw from the study all of the data generated during their participation will be destroyed.

Confidentiality
The information (data) we get from your child during the study will be kept confidential. Their name will never be used in connection with any of the information we collect. Your signature below indicates that you are willing for the *information* we collect from you to be used in an article or lecture as long as your child's name is not revealed. Data will be safely stored in a locked file cabinet and only my supervisor and I will have access to this information. The data will be stored for seven years, after which it will be destroyed (e.g. paper copies shredded, and electronic files deleted). Your confidentiality will be maintained to the extent allowed by law.

Benefits
Children will not benefit directly from being in study; however, participation will inform applied issues of educational programming and theoretical issues of the impact of bilingualism on children's development.

Data Security
Electronic data will be stored separately from their respective data files and will be stored on a secure server in a Microsoft Excel file locked with a password known only to the PI and affiliate researchers on the project. The secure server is hosted York University and can only be accessed with a university user ID and password, and the folder for data storage that will be hosting digital files pertaining to this project is one that only affiliated researchers can access. Behavioral data will be stored in two places: on a secure external hard drive that has been purchased for the explicit purpose of storing the files for the study, and on the secure server hosted by University.

Legal Rights and Signatures: You will receive a copy of this informed consent. You are not waiving any of your legal rights by signing this form. Your signature below indicates that you agree to your child participating in this study.

Name of Parent or Legal Guardian (Print):

Signature of Parent or Legal Guardian: _____

Name of Participant (Print): _____ Birthdate: _____

Signature of Participant: _____ Today's Date: _____

Signature of Experimenter/Principle Investigator: _____ Date: