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Inhibitory Control and Source Monitoring: A Developmental Investigation into Memory for Recently Witnessed Events

By

Dana Maryse Shapero

A Dissertation
Submitted to the Faculty of Graduate Studies
Through the **Department of Psychology**
in Partial Fulfillment of the Requirements for
the **Degree of Doctor of Philosophy**
at the University of Windsor

Windsor, Ontario, Canada

2013

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Inhibitory Control and Source Monitoring: A Developmental Investigation into Memory for Recently Witnessed Events

By

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ABSTRACT

Research has demonstrated that younger children experience difficulty monitoring the source of information and, accordingly, have disproportionately more difficulty accurately recalling details of witnessed events. Within age variability in memory performance, however, suggests that chronological age may not be the only nor the best predictor of source monitoring ability. The present study examined whether inhibitory control (IC) better accounts for variations in the ability to monitor the source of retrieved information than chronological age. Ninety-five children aged 4 to 10 years engaged in a source monitoring task designed to evaluate their ability to accurately identify what information they had witnessed the prior week. Participants further completed measures of IC and other cognitive tasks (receptive vocabulary, memory span, verbal fluency). Exploratory factor analyses revealed three distinct types of IC processes (distractor interference, resistance to PI, prepotent inhibition), indicating that the IC measures administered did not all tap the same unified construct. Participants across ages and IC ability successfully identified witnessed events, and experienced difficulty rejecting the items they previously confabulated. Multiple regression analyses further indicated that IC predicted substantial variance in the ability to reject events that were not witnessed or discussed, while age and the cognitive variables only added a small non-statistically-significant amount of variance above this. IC further predicted variance in the ability to reject events that were not witnessed or discussed once controlling for age and the cognitive variables. The current findings provide evidence suggesting that: 1) measures of IC should not be assumed to assess the same underlying processes; and 2) distractor interference and prepotent inhibition abilities specifically contribute to the ability to

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reject information that was not witnessed or discussed during source monitoring tasks. This provides further evidence that the development of IC is an important aspect of source monitoring ability in children.

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DEDICATION

This dissertation is dedicated to all those who touched my life over the past 6 years, thus playing a role in getting me to where I am at this very moment.

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للاستشارات المنارة

www.manaraa.com

TABLE OF CONTENTS

المنارة للاستشارات

www.manaraa.com

المنارة للاستشارات

www.manaraa.com

www.manaraa.com

المنارة للاستشارات

www.manaraa.com

LIST OF TABLES

المنارة للاستشارات

www.manaraa.com

LIST OF APPENDICES

المنارة للاستشارات

www.manaraa.com

CHAPTER I

INTRODUCTION

Overview

Context of the Problem

Research has consistently shown that both children and adults are vulnerable to the provision of post-event information (Roebers & Schneider, 2005). Individuals may encounter various suggestive influences between the time in which they initially perceive an event and subsequent recall, such as hearing a story about a similar event, being exposed to a comparable incident either on television or in real life, or hearing an erroneous description of the event (Pezdek, Sperry, & Owens, 2007). Individuals may also be asked to generate information about portions of an event that they did not initially see or that they are uncertain of at the time of questioning. These encounters with post-event information and self-generated conjectures may unintentionally become integrated into the original event memory, leading to the later recall of erroneous information.

Children have been shown to be disproportionately affected by post-event information, with younger children being among the most susceptible (Loftus, 1975; Goodman & Reed, 1986; Bruck, Ceci, & Melnyk, 1997; Bruck & Ceci, 1999; Scullin & Bonner, 2006). Although prior research has revealed age trends in levels of suggestibility, demonstrating a negative correlation between suggestibility and age, within age variance suggests that chronological age does not alone serve as a reliable marker of children's levels of suggestibility. Nevertheless, little is known about the individual differences that account for this variance. This research aims to explicate cognitive factors that may result in greater levels of susceptibility to post-event information, beyond developmental age

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trends. Determining a way to better explain suggestibility in terms of ability and skills, rather than age, would provide an increased understanding of the factors underlying suggestibility and a allow for more sensitive assessment of individual vulnerabilities to post-event information. This would provide greater insight into which children can provide accurate accounts of events, and risk factors that may ensue with different levels of functioning.

Determining the underlying factors responsible for susceptibility to post-event information would have many implications. For one, this would provide valuable information to developmental psychologists, elucidating how memory processes unfold, and possible risks in individuals' abilities to provide accurate information as a result of different levels of functioning, irrespective of age. Not only would obtaining a more accurate way to determine whether individuals are susceptible to post event information provide a more sensitive assessment of individual vulnerabilities, but it may provide a marker for determining which individuals should not be exposed to certain techniques (e.g., guided visualization, leading questions) in therapeutic or legal settings.

To better understand individual differences in the ability to accurately recall witnessed information, several possible factors are considered, including the ability to correctly attribute a source to retrieved information (source monitoring), and the ability to inhibit responding to a prepotent response or distracting information (inhibitory control). Further, the way that inhibitory control may contribute to successful source monitoring is explored. The impact of bilingualism on the development of inhibitory control is also considered as a way to disambiguate IC from developmental age trends. The current

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study is then presented, noting how this research aims to explicate whether IC better accounts for the ability to accurately identify witnessed events than chronological age.

Source Monitoring

One theoretical claim that has received support in the literature is that when an individual accesses a memory, there is no "abstract tag or label" that identifies the origin/source of the recalled information (Johnson, Hashtroudi, & Lindsay, 1993, p. 3). Rather, individuals are thought to engage in a decision making process at the time of retrieval, using the activated memory records. Cues as to how the memory was acquired, such as the recalled spatial, temporal, and perceptual cues, in addition to the social context of the event, collectively aid in attributing the perceived source of the retrieved information (Johnson, Hashtroudi, & Lindsay, 1993). This process is presumed to frequently occur nondeliberatively and often without conscious awareness (heuristic processing). However, when individuals fail to automatically attribute a source during the retrieval process, they subsequently engage in a systematic attempt to analyze relevant information in order to infer the source of the retrieved information (systematic processing). This act of attributing the source pertaining to an activated memory is commonly referred to as source-monitoring (e.g., Johnson, Hashtroudi, & Lindsay, 1993; Parker, 1995; Giles, Gopnik, & Heyman, 2002; Mitchell & Johnson, 2009).

Irrespective of whether the decision making process occurs at the conscious or automatic level, individuals employ a set of judgment criteria to aid in attributing sources to the activated memory records. According to Johnson, Hashtroudi, and Lindsay (1993), individuals assign weights to different dimensions, including the level of familiarity, the perceptual information and vividness, spatial and temporal details, and affective

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information, and then assign confidence to this weighted information. The cumulative details from this process are taken together to help provide evidence regarding the source of the information. For example, research has demonstrated that memories of perceived events tend to include more contextual information, more precise spatial and temporal information, and more vivid perceptual details in relation to imagined events (Johnson, Foley, Suengas & Raye, 1988). In assessing whether retrieved information was initially perceived or imagined, then, individuals presumably analyse their memory records along these dimensions in order to assign the appropriate source to the event. Other cues have also been shown to aid in attributing source, including evaluating whether any indicators connect the retrieved information to a particular source ("it was said in a deep voice, so it couldn't have been Susan"), and assessing the perceived levels of plausibility for having encountered the situation ("would I have climbed that mountain?"). Through this, source attributions can be made to varying degrees of specificity and with varying degrees of confidence.

The degree to which individuals establish their judgment criteria, however, is malleable and is contingent on the retrieval context. Individuals, for example, tend to adapt a more stringent set of criteria for situations of greater importance or severity, such as in a legal case where accuracy of recall is emphasized. This judgment criterion is often quite different than when individuals are socializing freely with peers, where source monitoring errors would have little ramification.

Source memory essentially "enables the placement of past events within a contextual framework" (Shimamura & Wickens, 2009, p.1). The ability to successfully monitor the sources of retrieved information is critical to function successfully on a daily

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basis. Determining how to respond to retrieved information (e.g., whether once chooses to endorse the information or assign it personal meaning) is often dependent on where the information was attained and how reliable the individual perceives the source to be. Similarly, it is crucial to distinguish whether recalled events were personally experienced, thought about, or described by another individual in order to determine the relevance of the information. This ability to discriminate between sources is vital to having an accurate representation of one's personal past, to differentiate fact from fantasy, and to monitor one's actions from mere intentions.

Source judgments, however, are not always accurate, and memories can unknowingly be attributed to the wrong source in the decision making process. This has several implications, as the information derived from failures in source monitoring can subsequently colour individuals' memories, thus influencing the "development and expression of [their] knowledge and beliefs" (Johnson, Hashtroudi, & Lindsay, 1993, p. 4). Source monitoring errors, then, may result in erroneous assertions that can have considerable repercussions. For instance, individuals may provide inaccurate accounts of an event during testimony as a result of mistakenly attributing information from a television program to the witnessed event, which could in turn lead to a false conviction. Recollections of past events, accordingly, are not a product of precise memory representations, but, rather, are the result of one's judgment processes (Johnson, Hashtroudi, & Lindsay, 1993).

Errors in source monitoring have been shown to increase when events are similar in regard to their perceptual or semantic attributes. Johnson, Foley and Leach (1988) demonstrated that individuals were more proficient at differentiating words they heard

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from words they imagined when they heard another speaker present the words and imagined themselves saying other words. This is likely due to substantial differences in the features of the two situations. Imagining the words in the speaker's voice and hearing the speaker state other words, however, lead to greater source confusion, presumably because of the increased similarity between the events. Henkel and Franklin (1998) also determined that when individuals were presented with several objects and asked to imagine additional items, they were more likely to confuse imagined objects with those perceived when the objects shared similar physical attributes.

Although imagined and perceived events have been noted to have different mental qualities, research has demonstrated that increasing either the similarity between situations or the vividness of details while imagining an event makes the associated retrieval cues more similar to those of perceived events, and may result in greater confusion in later source discriminations (Hyman & Pentland, 1996; Goff & Roediger, 1998). Encouraging people to vividly imagine events results in a greater likelihood for later source confusions. Further, source confusions may result between imagined and perceived events if individuals utilize more lenient judgment criteria when identifying the source of the retrieved item. In these situations, individuals may not attend to details that would differentiate imagined from perceived events, thus resulting in a greater likelihood that the events may be incorrectly attributed. Implementing lenient judgment criteria could similarly result in incorrect source judgments for similar items or events.

Although there is a noted deficit in source discriminations between highly similar sources in adults, children have demonstrated an even greater difficulty with source attributions. In a study conducted by Foley, Johnson, and Raye (1983), individuals aged

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6, 9, and 17 years were presented with an array of words. In the exposure session, individuals were either asked to say certain words out loud while other words were spoken by the experimenter (internal-external source monitoring), or they were asked to say certain words out loud while they were encouraged to imagine themselves saying other words (internal-internal source monitoring). Following a three minute delay, individuals were presented with a word list and asked to indicate whether the word was heard, spoken, imagined, or if the word was new. The 6 year old participants in the internal-internal source monitoring condition demonstrated a significant impairment in distinguishing whether words were said or imagined in comparison to the 9 and 17 year olds. To determine whether young children's difficulties originated from an inability to distinguish between events generated from the same source (internal or external), a second experiment was conducted in which the participants were asked to discriminate which of two individuals had stated given words (external source monitoring). On this task, the 6 year olds were able to perform as well as the older participants, suggesting that the deficit in children's monitoring was primarily in regard to distinguishing between internal sources.

Foley and Johnson (1985) replicated this finding in a study with 6 year olds, 9 year olds, and undergraduate students using actions instead of words. Here, individuals were asked to discriminate either between actions they performed and actions they saw others perform (internal-external source monitoring), between which of two individuals had completed certain actions (external-external source monitoring), or between actions that they either performed or imagined (internal-internal source monitoring). Although all groups performed comparably on the internal-external and external-external source

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monitoring tasks, as in Foley et al. (1983), the 6 year old and 9 year old children demonstrated significantly greater difficulty than the undergraduate group at distinguishing between the imagined and performed actions (internal source monitoring).

Lindsay, Johnson and Kwon (1991) maintained that this difficulty in internal source monitoring was due to a more general deficit in younger children's ability to discriminate between highly similar sources. To substantiate this, they conducted a study comprising children (mean age = 8.7 years, SD = 1 year) and undergraduate students, in which the participants had to identify the source between real and imagined actions performed by either themselves or another individual. Results demonstrated that the children were more likely than the undergraduate participants to confuse real and imagined actions if the same actor was consistent across tasks than if different actors were involved. This applied when the actor was the child participant (internal source monitoring) or if the actor was another individual and the child imagined that actor performing the other actions (internal-external source monitoring). This finding has been replicated by both Markham (1991) and Parker (1995), who found that 6 year olds had greater difficulty with source discriminations when the same actor was involved than 12 and 10 year olds, respectively. Parker (1995) further noted that individuals demonstrated better source monitoring abilities when having to identify the source for actual/imagined events involving themselves than for actual/imagined events involving another individual. Individuals also provided more incorrect attributions when event inquiries were conducted after a two week delay.

In another experiment, tape recorded word lists were presented to 4 year old children and undergraduate students (Lindsay, Johnson, & Kwon, 1991). For the

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participants' initial exposure to the words, a speaker was placed next to each of their ears; words were then presented, with half of the words coming from each speaker. For individuals in one condition, words were all presented in the same voice, whereas individuals in the second condition had the words presented by a male voice in one speaker and by a female voice in the other. Following the presentation of the words and a brief distracter task, individuals were presented with a list, composed of words presented from each speaker in addition to words that had not been on the recordings. Participants were then asked to specify which speaker location the words came from or if the words had not been heard. Results revealed that children made more source monitoring errors than the undergraduate group in the same voice condition. Although it could be argued that this finding was a result of the greater word recognition abilities possessed by the undergraduate group in comparison to the 4 year old children, similar errors were found in a subsequent experiment by Lindsay, Johnson, and Kwon when controlling for this factor (1991). Here, children aged 4 and 6 years as well as undergraduate students were presented with two videotapes, each comprised of an individual telling a story about the circus (external source monitoring). When storytellers were similar to one another, all individuals were more likely to confuse which storyteller had spoken about a given event, with children making more errors than the undergraduate group. This effect was exacerbated when the stories told were also similar.

Research has further indicated that temporal distinctiveness can also impact one's ability to efficiently distinguish between sources (Nairne et al., 1997; Bright-Paul & Jarrold, 2009). Given the tendency to encounter greater source monitoring errors when sources are similar along any dimension, reducing the time between the initial event and

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the subsequent misinformation makes it more difficult to discriminate between the two sources. The more the temporal cues resemble one another, due to the events occurring closely together, the more similarities in the encoding process, thus resulting in the potential increase in source confusions.

Given the difficulty children have distinguishing between perceptions, thoughts, and actions, especially when they are similar in nature, it is to be expected that younger children would also experience difficulty distinguishing between whether past events were real or fabricated (Foley & Johnson, 1985). Ackil and Zaragoza (1998) examined whether children and adults who were "forced" to confabulate information about an event, by being told they must answer all questions, would later have false memories for the fabricated information. Participants, who were in the first, third, and fourth grade, as well as college students, viewed a brief clip from a movie. After viewing the clip, individuals met independently with an experimenter to answer a series of questions pertaining to the video. Some inquiries addressed events from the clip, whereas other questions asked about information that had not been presented in the video. A week later, a different experimenter met with the participants and told them that the previous individual who questioned them had made some mistakes, and they were asked to help determine which things had really happened in the video. For each item, participants were first asked whether they spoke to the previous experimenter about the event, and then were questioned as to whether the event was present in the video they had watched. Analyses revealed age-related changes in the "tendency to confuse confabulated information for actually perceived events" (Ackil & Zaragoza, 1998, p. 1367). Although the accuracy of responses increased as a function of age, with the first graders being the

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least accurate and most likely to misattribute confabulated items to the video, participants in all age groups revealed false memories for the details that they had generated earlier (Ackil & Zaragoza, 1998). These findings demonstrate that when individuals are forced to provide a response to questions, the answers generated can later become integrated into their memory for the event (Pezdek, Sperry & Owens, 2007). Accordingly, upon subsequent recall, individuals are more apt to make source monitoring errors, confusing the self-generated information with the observed event. This is consistent with research by Koriat and Goldsmith (1996) stating that forcing individuals to respond during post-event questioning often results in a greater quantity of responses, but reduced accuracy.

Research using a similar paradigm with college aged students provided results consistent with these findings (Pezdek, Sperry, & Owens, 2007). However, it was shown that individuals who guessed or confabulated their answers voluntarily, in comparison to those who were forced to provide an answer, were more likely to recall the confabulated response as being a part of the original event. As well, findings suggest that having individuals provide their responses on multiple occasions reliably increased these source errors.

Using a slightly different research design, Schreiber and Parker (2004) investigated the impact of invited speculation, by asking children to voice what they think “maybe happened” or to pretend or imagine what could have happened in different situations. As with forced confabulations, this process requires individuals to provide a fictitious answer using self-generated misinformation. Although the two methods differ, since inviting speculation uses an open-ended prompt to generate a possible answer whereas forced confabulation employs leading questions, results indicate that having

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individuals generate false information that is consistent with the event, despite the methodology, yields similar results. This may partially result from the similarities in the features between the initial event and the subsequent confabulations. Accordingly, having children fabricate possible explanations, or forcing children to answer questions, may have a substantial impact on their later recall.

These aforementioned studies consistently demonstrate that younger children have greater difficulty with source monitoring tasks, especially when the sources are similar, with improved performance positively correlated with age. Nevertheless, research has demonstrated within-age variance, suggesting that age alone is not a reliable marker of these abilities (for a review see Bruck & Melnyk, 2004). Although age trends are often found in this literature, the provision of post-event information has been found to result in different outcomes among same aged peers, as there are some younger individuals who prove to be highly resistant to suggestion, while there are older children who are highly susceptible to post-event information (Bruck, Ceci, & Melnyk, 1997). A better understanding the physical processes involved in source monitoring may provide greater insight into some of this variation in ability.

Neuroscience and Source Monitoring

Brain imaging studies suggest that the medial temporal lobes and the prefrontal cortex are both implicated in source monitoring processes. Appreciating how these regions are involved in the source monitoring process, as well as how one's abilities may change as these regions mature, is essential to understand why susceptibility to source confusions generally decreases as a function of age.

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Research using functional magnetic resonance imaging (fMRI) has demonstrated that the activation of the medial temporal lobes, including the hippocampus, perirhinal cortex, and parahippocampal cortex, is required for successful recall and recognition of contextual information (Holdstock, 2005). The hippocampus has been shown to be responsible for integrating information from different modalities (perceptual, temporal, and emotional), which reside in different neocortical areas, and making associations between these distinct units of information in order to generate and encode a unified event representation. This relational binding later permits the "retrieval of a fully elaborated episode" (Nadel et al., 2003, p. 232), as the information responsible for identifying context would be linked to the event through this initial consolidation process.

Activity in the perirhinal cortex of the medial temporal lobes has further been associated with the binding of episodic features, but primarily for information within the same modality (all perceptual or all temporal). This region has also been implicated with familiarity discrimination (recognition of something as being familiar). Studies have demonstrated that a greater proportion of neurons respond in this region during exposure to familiar items, even on the second presentation, than during the presentation of a novel item (Murray, Graham, & Gaffan, 2005). This sense of familiarity, a feeling of prior exposure to experience with the activated information, is used for recognition and contributes to perceived memory strength, both in the presence and absence of retrieved contextual information.

The parahippocampal region of the medial temporal lobes has been implicated in contributing to both the encoding of spatial context and the representation and reactivation of contextual information (Mitchell & Johnson, 2009; Shrager, Kirwan, &

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Squire, 2008). Activity in this area occurs when context is retrieved, even when done without intent, and has been shown to increase "as a function of the amount of contextual information" being reactivated during retrieval (Tendolkar et al., 2008, p.614; Kirwan, Wixted, & Squire, 2008). Functional magnetic resonance imaging has further demonstrated that the perirhinal cortex is simultaneously activated when this information is retrieved as a result of the associated item familiarity.

Overall, the different parts of the medial temporal lobes (MTL) are all involved in the source recognition processes through the initial binding (consolidation) of essential features from different neocortical areas in new mental representations, though different anatomical regions of this lobe may be responsible for binding different features. The success of this process can optimize the retrieval of the associated contextual details, as source judgments will become less reliable if contextual information is not initially encoded and bound to the other event details. Specific regions of the MTL, as reviewed above, have also been identified as being active during the retrieval of contextual information, and/or are responsible for generating a perceived sense of familiarity. This is essential as item recognition decisions are often based on recollection, familiarity, or a combination of these two processes (Holdstock, 2005). Neuroimaging studies have further demonstrated that both hippocampal and perirhinal activity is predictive of memory strength (Shimamura & Wickens, 2009). Damage to this region has been associated with an inability to identify contextual information (Murray, Graham, & Gaffan, 2005).

The functional maturation of the medial temporal lobe is variable, with the hippocampus, perirhinal cortex and parahippocampal trajectories developing at differing

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rates. Although the majority of the system is functional at birth to support basic functions in early infancy, the connections are incomplete and immature at this time (Rugg & Yonelinas, 2003). Maturation of these areas continues throughout the early years of life. Although it was previously suggested that the hippocampus matures late, to account for infantile amnesia (Diamond, 1990), it is now theorized that the hippocampus is nearly 40% mature at birth and is fully mature by 15 months (Alvarado & Bachevalier, 2000; Diamond et al., 2005). Parirhinal and parahippocampal functional maturation have been proposed to occur around approximately 6 months of age (Diamond, 2005).

The prefrontal cortex (PFC) has also been identified as contributing to effective source monitoring performance. This region has been linked to higher-level cognitive processes, including those of reasoning, attending, problem solving, planning, and decision making (Lezak, Howieson, Bigler, & Tranel, 2012; Waltz et al., 1999). Neuroimaging studies have suggested that the different regions of the prefrontal cortex are involved in several distinctive aspects that are relevant to successful source monitoring. The left and right lateral areas have been shown to support systematic and heuristic processing (discussed above); these areas are involved in identifying whether certain information is more or less differentiated from other information and in evaluating information during the retrieval process (Shimamura & Wickens, 2009). The dorsolateral region has been identified as being active during encoding, as it assists in the evaluation and organization of the multiple features of a given event. The anterior/rostral region has been implicated in pre-retrieval control processes, the retrieval of source details, and the monitoring of self-generated information (Turner et al., 2008). Lastly, the ventrolateral region is involved in selective attention, including the control processes necessary to

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select and encode specific features for consolidation, as well as the mid-retrieval selection of relevant information (Shimamura & Wickens, 2009). Imaging studies consistently demonstrate the activation of these areas during source monitoring tasks.

Accordingly, the prefrontal cortex manages the control processes responsible for successful source monitoring, and may direct the functional processes of the medial temporal lobes. Dorsolateral activity during encoding, ventrolateral control of selective attention, and anterior/rostral activity have all been associated with the successful recollection of source details. Failures in remembering source information could result from specific encoding deficits evident when these regions are not engaged (Mammarella & Fairfield, 2008).

Developmentally, the prefrontal cortex matures later than any other brain region, and does not reach functional maturity until late adolescence (Diamond, 2002). The density of pyramidal cells in this region increases in the first postnatal year, with the establishment of synaptic connections reaching its peak by the age of 15 months. Synaptic pruning begins in late childhood and continues through the adolescent years. This process removes inefficient or weak neurons to produce more efficient synaptic configurations. Myelination, which further increases the efficiency of communication between neurons, has also been shown to increase in this region between the ages of 4 and 13 years. As such, a reduction in gray matter (the unmyelinated portion of the neuron including the cell bodies) has been noted between late childhood and adolescence (Sowell et al., 2001; Diamond, 2002). This thinning of gray matter has been "significantly correlated with source memory [performance], independent of chronological age" (Diamond, 2002, p.491), suggesting that the maturation of the prefrontal cortex and its

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associative functions are largely responsible for successful source monitoring. Development of the prefrontal cortex has been shown to continue into adulthood.

The information presented through these neuroscience investigations provides greater insight into the developmental findings presented in the source monitoring literature. Further, given that frontal lobe development is typically linked to source monitoring abilities (Ruffman et al., 2001; Johnson, Hashroudi, & Lindsay, 1993; Best, Miller, & Jones, 2009), this may account for why children have been found to be substantially more vulnerable to suggestion and post-event misinformation than adults.

Nevertheless, it is important to note that although there are age trends in this developmental progression, studies document variability in scores on measures assessing memory in children matched for chronological age (Roberts & Powell, 2005; Holliday, Reyna, & Hayes, 2002; Alexander et al., 2002; Ruffman et al., 2001; Poole & Lindsay, 2001; Quas, Qin, Schaaf, & Goodman, 1997). Individual variation in the maturation of the frontal lobes and their respective cognitive functions may, potentially, account for the within age differences in the acceptance and endorsement of misinformation (Holliday, Reyna, & Hayes, 2002; Ruffman et al., 2001).

Executive Functioning and Inhibitory Control

The term executive functioning (EF) refers to the "goal-oriented control functions" of the Prefrontal Cortex (Best, Miller, & Jones, 2009, p. 180). These cognitive processes, assumed to underlie the higher order systems of thought and behavior, allow individuals to plan and organize their behaviour and control their attention. Examples of executive processes include selective attention, working memory, resistance to interference, set shifting or mental flexibility, and inhibitory control (Garron, Bryson, &

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Smith, 2008). Consistent with the development of the prefrontal cortex, all of these cognitive functions show improvements in functionality from childhood through adolescence, as reviewed above.

Inhibitory control, the "ability to ignore task-irrelevant information, processes, and automatic or prepotent responses" (Roberts & Powell, 2005, p. 1006), is one aspect of executive functioning that has been associated with source monitoring accuracy (Roebers & Schneider, 2005). The ability to inhibit competing information has been shown to follow a developmental trajectory reflecting the maturation of the prefrontal cortex (Sinopoli & Dennis, 2012). Research documents that performance is poor in young children, consistent with the immature development of the frontrostriatal circuitry, and begins to show rapid improvements in early childhood, between the ages of 3 and 4 years (Romine & Reynold, 2005; Roberts & Powell, 2005; Diamond, 2002; Best, Miller, & Jones, 2009; Diamond, 2002). Significant improvements in performance continue through middle childhood, with adult levels of control frequently achieved between 7 and 12 years of age (Best, Miller, & Jones, 2009). Although some research suggests continued improvement through age 21, the gains observed through adolescence consist primarily of refinements in speed and accuracy (Huizinga et al., 2006; Sinopoli & Dennis, 2012).

It is only after inhibitory processes start to develop "that children typically become less susceptible to suggestibility and more able to monitor the sources of their memories at a level closer to that of adults" (Roberts & Powell, 2005, p. 1006). As previously discussed, deficiencies in source monitoring have been linked to the immature

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development of the prefrontal cortex, and findings from recent studies suggest that this may specifically result from the associated deficits in inhibitory control.

One of the first studies to examine this relationship was conducted by Ruffman et al. (2001). In their study, researchers showed children aged 6, 8, and 10 years a video followed by the presentation of an audiotape. Information on the audiotape was either novel or had previously been presented in the video. To assess source monitoring, children were then questioned about an array of items during which they had to identify whether they had previously been exposed to that item and, if so, whether the item was presented in the video, in the audiotape, or in both. Following each answer, children rated their level of confidence on a 9-point scale. A measure of inhibitory control was then administered to the participants. In this task, participants were presented with rows of digits on a computer screen for the duration of 1 second (e.g., 2 2 2). Individuals had to count the number of digits presented and enter this number on the keypad (e.g. 3) while inhibiting the tendency to press the number presented in the digit string (e.g., 2). A control condition was included where the numerical string was replaced by a string of letters (e.g., F F F) to reduce the amount of conflicting information. This task is considered a version of a Stroop task, as it requires the processing of one visual feature while ignoring others, similar to the original task in which individuals had to read the names of colour words printed in the ink of a different colour (Lezak, Howieson, Bigler, & Tranel, 2012). Analyses indicated that the 6-year-old participants had significantly more difficulty than the older age groups at this source monitoring task. There was also a trend towards significance when comparing the 8 and 10 year old groups on the source monitoring task, with the 8 year old group demonstrating greater impairment. More

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proficient inhibitory abilities were, additionally, associated with avoiding false alarms (incorrectly stating an item was present, when it was not – an occurrence associated with both poor retrieval of context and the inability to inhibit recognition based on familiarity). More advanced inhibitory abilities were also positively correlated with improved source monitoring, specifically on the video only and neither source questions.

Roberts and Powell (2005) used a sample of children between 5 and 7 years to further test the relation between inhibitory control and source monitoring abilities. Participants initially participated in a 30 minute activity, after which they were suggestively interviewed about various details from their experience. Half the questions provided during this interview included the provision of inaccurate information. Participants were later given a recognition test about 16 events. For each event, two questions were administered, one including accurate details and the other including inaccurate details. Children were considered correct for each event if they both endorsed the accurate information and rejected the suggested details. Following the memory test, measures of inhibitory control were administered to the participants. This included a day/night Stroop task, during which individuals had to respond by saying "day" to pictures of cards depicting a dark sky and moon and "night" to cards depicting a blue sky and sun, a tapping conflict task, and two verbal inhibition tasks. Results indicated that children with higher verbal retroactive inhibition skills (the ability to correctly identify the first set of three words after being presented with a second set of three words) were more resistant to suggestions than children with poor inhibitory control on this measure. Although there were no significant relationships between inhibitory control and

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suggestibility on the other tasks of inhibition, the authors proposed that this may have been a result of ceiling effects on these measures.

Alexander et al. (2002) recruited children between 3 and 7 years of age at an inoculation clinic, and videotaped the inoculation to have an accurate representation of what happened for each participant. Approximately two weeks later, the children came to a University laboratory where they engaged in a free recall task regarding their prior inoculation, followed by direct questions and an array of yes/no questions, both of which included specific and misleading questions. Following the interview, children were administered the day/night Stroop task as a measure of cognitive inhibition. Results indicated that as inhibitory control increased, children provided more accurate responses, and were less influenced by the misleading questions (e.g., less likely to indicate what animal walked into the room during the inoculation, when asked). Although age was associated with greater accuracy during free recall and resistance to suggestion, the relationship between inhibitory control and accuracy was maintained after controlling for age.

Despite the growing number of studies reporting the association between inhibitory control and source monitoring ability, not all studies have provided supportive evidence. Roebers and Schneider (2005) had children watch a short video and, after a week delay asked them questions pertaining to what they had watched. Both unbiased and misleading questions were asked, and participants were encouraged to state if they did not know an answer to ensure accuracy. A week later children were provided with a recognition task in which they had to identify which of two provided alternatives were shown in the initial film. A language development subtest was administered at the first

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testing sessions, and tests thought to measure the executive functions of working memory, inhibitory control, and set switching were administered during the second and third testing sessions. These subtests included a version of the go/no-go task (wherein individuals had to inhibit a clicking response when the stimuli was presented in a specific colour), the day/night Stroop task, a nonverbal snow/grass Stroop task (similar to the day/night task, except individuals were asked to respond by pointing), a hand signal conflict task (individuals had to perform the opposite hand action to that presented by the experimenter), and the bear/dragon task (individuals had to follow the actions stated by the bear and ignore/inhibit the actions stated by the dragon). Results indicated that individuals' inhibitory abilities did not relate to their tendency to yield to false suggestions. One reason proposed to account for the lack of significant findings in this study is that the tasks of executive functioning administered had ceiling effects, and were thus not able to capture an accurate representation of the children's abilities. Further, the inclusion of a substantial delay prior to the provision of misinformation may have impacted the perceived distinctiveness of the two events, making them less similar, and thus less likely to be confused with one another.

Several explanations have been proposed to account for how inhibitory control may affect source monitoring abilities. For one, individuals with poorly development inhibitory control may have trouble attending to relevant stimuli during the initial encoding process, due to difficulty inhibiting irrelevant information from entering into working memory (Scullin & Bonner, 2006; Roberts & Powell, 2005; Alexander et al., 2002). This lack of selective attention would impede the binding of essential contextual features. Individuals with more developed inhibitory skills may, thus, be more proficient

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at attending to the target event and relevant cues while ignoring irrelevant information (Best, Miller, & Jones, 2009; Bruck & Melnyk, 2004; Alexander et al., 2002). Less developed inhibitory abilities may also account for difficulties during the retrieval process, due to factors such as a tendency to respond immediately without time for the adequate processing of source cues; an inability to suppress irrelevant information upon retrieval; a failure to inhibit responding based solely on familiarity; or some combination of these factors (Scullin & Bonner, 2006; Roberts & Powell, 2005; Alexander et al., 2002; Ruffman et al., 2001). Further, less developed inhibitory abilities may contribute to individuals' susceptibility to misleading questions or subsequently presented information, as these individuals may have more difficulty inhibiting similar mental representations from adjoining with one another during retrieval, especially if initial encoding was weak. Given these propositions, one's inhibitory abilities may have important implications for predicting an individual's ability to resist post-event suggestions.

Bilingualism and Inhibitory Control

Previous research has shown that individuals who are proficient in two spoken languages and who have used both of these languages daily since their formative years (referred to from here on as unimodal bilinguals) gain control of their inhibitory abilities at an earlier age than their monolingual peers (for a review see Bialystok, 2001). This bilingual advantage has been attributed to the processes necessary for bilingual individuals to effectively control the use of more than one language system (Bialystok, 2007; Bialystok & Martin, 2004). Evidence suggests that for unimodal bilinguals, both of their language systems are constantly active. In order to attend to one of these competing systems, each of which provides alternatives for expressing the same

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concepts, bilinguals “need a mechanism to control attention to the required system and ignore the system not currently in use” (Bialystok, 2007, p.212). To engage in one language fluently, then, individuals must consistently control their attention to attend to the language in which they are conversing while inhibiting the conflicting language system.

Bilingual children, for example, may understand that more than one label can be used to address the same concept, as both the words “dog” and “chien” represent the same four legged creature. In order to converse successfully in a single language, however, individuals must attend to the label from the language they are engaged in and ignore or inhibit the competing label from the alternate language system.

Findings have consistently shown that when children are presented with tasks in which success requires use of inhibitory control, unimodal bilinguals demonstrate superior performance compared to their monolingual peers. Unimodal bilinguals, for one, demonstrate more successful performance on the dimensional change card sort (DCCS), a task where individuals are given cards depicting figures with two dimensions (colour and shape), and are asked to sort them according to each dimension respectively. This requires individuals to switch criteria and inhibit the initial sorting rule in order to successfully complete the task (Zelazo, Reznick, & Pinon, 1995). Studies have demonstrated this advantage across many domains, including the ability to see the alternate image in a reversible figure, a task requiring individuals to inhibit the initial percept (Bialystok & Shapero, 2005); the ability to inhibit misleading visual cues in a flanker task, where individuals are to respond to a central arrow despite adjacent arrows facing a different direction (Emmorey et al., 2008); and the ability to ignore spatial

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information to respond to relevant target features (Bialystok, Craik, & Ryan, 2006). For all these tasks, individuals must inhibit a competing feature, rule, or interpretation in order to attend to the relevant task.

A further specification has been presented by Bunge and colleagues (2002), differentiating between univalent and bivalent representations. According to these authors, univalent displays are those where only one stimulus feature is presented and conflict arises through the provision of two response options to this feature; in these situations, individuals are required to refrain from responding instinctively in favour of an artificial response. Both the day/night task and the go/no-go task are thought to involve this type of processing. Bivalent displays involve the resolution of a conflict between two competing dimensions, where individuals must attend to a relevant stimulus while inhibiting a competing cue. The Simon task, a measure that requires individuals to sort stimuli based on colour while inhibiting competing spatial cues, would be an example of this (see below). The types of inhibition required for these representations have been labelled "response inhibition" and "interference suppression", respectively. It has also been shown that each of these types of inhibition has a different developmental trajectory and engages different regions of the prefrontal cortex (Bunge et al., 2002).

The processes required for bilingual individuals to monitor both language systems, according to this explanation, involve bivalent representations; bilinguals experience conflict due to the presence of two competing language systems and need to attend to the language in use while inhibiting the competing linguistic system (Bialystok & Viswanathan, 2009; Martin-Rhee & Bialystok, 2008; Carlson & Melzoff, 2008). Given that it is proposed that the bilingual advantage results from the constant utilization of

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inhibitory control, it would be assumed, given this new classification, that their advantage would only exist for the types of inhibition resulting from the bivalent displays which are employed routinely. This has been supported in the literature, as bilinguals demonstrate superior performance on tasks requiring interference suppression, while monolingual and bilingual groups perform similarly on tasks requiring response inhibition (Bialystok & Viswanathan, 2009).

In addition, bilingual individuals constantly need to monitor their context to determine which linguistic system is relevant (Bialystok, 2007). This contextual acuity is essential, as each linguistic encounter may require them to shift to an alternate language system, forcing them to inhibit the language that was formerly in use and attend to the previously suppressed representation. This heightened monitoring of context as well as the ability to switch rapidly between language systems, a process which requires proficient inhibitory control, are required for unimodal bilinguals to function efficiently within their two language systems.

The daily use of two language systems, and the associated utilization of inhibitory control required to successfully manage these two representational systems, may "modify the development or operation of the executive function for bilinguals" (Bialystok, 2007, p. 212). Evidence from neuroimaging studies has further revealed that the dorsolateral prefrontal cortex is active during successful monitoring of these language systems (Emmory et al., 2008), supporting the constant employment of this region from a young age in bilingual individuals. Given the implications of this region in the successful utilization of inhibitory control, early proficiency and development of this area would be presumed to impact performance in other areas reliant on the same cognitive

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mechanisms. Accordingly, bilingual children would experience “an enhanced ability to ignore distracting and irrelevant stimuli, not only in language tasks but in general cognitive processing” (Colzato et al., 2008, p. 302). This advantage in their ability to control and attend to relevant properties while ignoring salient misleading cues in comparison to their monolingual peers has been found cross-culturally (Bialystok & Viswanathan, 2009).

This bilingual advantage has been shown to be most prevalent when children are younger and their monolingual peers have not yet sufficiently developed the executive functions of inhibitory control, as bilingual children gain control over this ability earlier than their monolingual peers. This difference in performance becomes less pronounced after the age of 5 years (Bialystok, 2007). Nevertheless, differences have been reported through early adolescence, as the prefrontal cortex continues to mature during this time. In early adulthood, few processing differences have been found on measures of executive control, although a bilingual advantage has been demonstrated on tasks where processing demands become remarkably complex. For example, when several variations of the Simon task were presented to 97 undergraduate students, with each varying in the level of conflict present between the competing dimensions, bilingual participants exhibited better performance only in the most difficult condition (Bialystok, 2006). For this condition, arrows were used instead of coloured squares and many inter-trial switches were present (trials where the correct response was different from that required on the prior trial); the frequent changes in response required in this condition entails higher levels of vigilance and more frequent monitoring (Bialystok, 2007).

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The bilingual advantage has again been shown to emerge to a greater extent during older adulthood when inhibitory control has been shown to undergo a natural decline in functioning. Although both monolinguals and bilinguals demonstrate a significant reduction in performance during this time, bilinguals adults in this older age have exhibited a more gradual decline in the slowing of these functions (Bialystok, 2007).

Accordingly, if source monitoring abilities are attributable to inhibitory control, one would presume that bilingual children would demonstrate more efficient source monitoring abilities in relation to their monolingual peers, and would thus be less susceptible to misleading information. This indicates an inherent flaw in relying on the average developmental progression of susceptibility based on chronological age alone, given that there may be great variability in inhibitory abilities within same age peers, for both children and adults – especially those with cognitive delays. Given previous studies have not investigated this within age variability, little disparity within same age peers would have been evident, as the range of inhibitory abilities would have appeared relatively uniform. This identifies a current gap in the literature. Having a wider range of inhibitory abilities within each age group, may explicate whether the previously noted relationship between age and source monitoring may be better explained inhibitory ability.

Present Study

The present study was designed to investigate whether children's abilities to accurately distinguish between the sources of their memories corresponds with their inhibitory ability. In an attempt to provide further support that inhibitory control uniquely

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contributes to suggestibility, several refinements were made to previous methodologies to obtain a more comprehensive understanding of the association between the two constructs. Specifically, the present study: 1) aimed to elucidate whether inhibitory control predicts source monitoring abilities; and 2) whether inhibitory control predicts source monitoring abilities above that accounted for by chronological age and other cognitive abilities (i.e., short-term memory, crystallized and fluid verbal ability).

This study utilized a diverse set of inhibitory control measures, in an attempt to both provide a comprehensive evaluation of IC ability and to determine whether tests of IC reflect one or more than one set of processes. This is necessary due to limitations in previous research, where researchers have tended to examine the relationship between inhibitory control and source monitoring using only one or two measures of IC (Ruffman et al., 2001; Alexander et al., 2002). Although the inclusion of a single measure may be adequate if it has been shown to reliably assess the construct, the measures administered in these studies have not undergone any substantial analyses to indicate that they primarily measure inhibitory abilities. Further, many measures used in these studies have either been limited by ceiling effects (Roberts & Powell, 2005; Roebers & Schneider, 2005) or have attempted to assess IC using novel measures assumed by the authors to measure inhibitory control (Ruffman et al., 2001). Accordingly, the degree to which prior research has successfully isolated the theoretical construct of inhibitory control remains unknown.

The more recent literature has begun to explore whether different types of inhibitory functions might be subsumed under the term inhibitory control (Sinopoli & Dennis, 2012; Best, Miller & Jones, 2009; Friedman, 2002; Nigg, 2000). Although these

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proposed inhibitory functions have been given different labels across publications, the general processes include the ability to respond while ignoring competing information (Sinopoli & Dennis, 2012; Friedman, 2002; Nigg, 2000), the ability to inhibit a feature of a stimulus to attend to an alternate feature (Sinopoli & Dennis, 2012), the ability to inhibit an action that one has already initiated (Logan, 1994; Sinopoli & Dennis, 2012), and the ability to inhibit or suppress a dominant, automatic, or prepotent cognitive or behavioural response (Sinopoli & Dennis, 2012; Friedman, 2002; Nigg, 2000). These five processes will be referred to as *resistance to distractor interference*, *resistance to previous information*, *cancellation*, *prepotent cognitive response inhibition*, and *behavioural restraint* respectively throughout the remainder of the document. However, these proposed constructs have been largely theoretical, and only one known study in the adult literature (discussed below) has attempted to confirm their presence.

Research with adults has begun to assess whether the different tasks of inhibitory control typically used in the literature evaluate the same processes (Shilling, Chetwynd, & Rabbitt, 2002; Friedman, 2002). The results of these studies typically show low correlations between the tasks of inhibition administered. It has been thought that this may result as measures of inhibitory control tend to have low reliability, and tasks cannot correlate higher with another task than itself (Friedman, 2002). To overcome this obstacle, Friedman and Miyake (2004) used a confirmatory latent variable analysis in attempt to determine whether the measures of inhibitory control administered tap the different inhibitory functions proposed theoretically in the literature, specifically assessing for prepotent cognitive response inhibition, resistance to distractor interference, and resistance to previous information. Results showed that the prepotent cognitive

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response inhibition variable and the resistance to distractor interference variable were significantly correlated, though the variable assessing resistance to previous information was not significantly correlated to either of these variables, confirming that not all tasks thought to evaluate inhibition measure a common ability. However, Friedman's (2002) analysis was constrained by theoretical hypotheses suggested in the literature. It thus remains unknown whether these same factors would emerge based on common variance if entered into an exploratory model.

Despite this proposition that different measures may assess different types of inhibitory functions, most published studies do not take this into consideration in task selection. This is further complicated by the fact that the construct validity of various purported measures of inhibition is not well established (Friedman, 2002). Accordingly, many researchers select measures that they assume involve inhibition without providing any justification for these selections (Friedman, 2002).

The present study utilized a broader range of measures with the goal of assessing a diverse range of inhibitory abilities. A series of exploratory factor analyses were conducted to determine whether the measures used assess similar or distinct abilities. Limited work has been done to evaluate this systematically within the literature, and no known studies have evaluated this with children

The inclusion of a larger age range (preschool through elementary school age) than typical of such studies provided a better understanding of how inhibitory control abilities mature during this critical developmental period. Rather than comparing children at a single age or between stratified age groups, participants ranged from 4 years of age through 10 years of age, a period wherein inhibitory abilities are initially poorly

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developed, but starting to undergo significant developmental changes to the point where children have a greater mastery of these abilities. Monolingual and bilingual children were included with the goal of introducing greater within-age variability in inhibitory control ability, with the goal of making it easier to disentangle the relationship between inhibitory control and source monitoring from the relationship between age and source monitoring. The inclusion of the two language groups across the continuous age span aimed to provide a developmental trajectory for the maturation of IC and source monitoring abilities for each language group across this segment of development.

As inhibitory abilities mature, reaching more adult levels, it becomes more difficult to detect improvements in performance. The utilization of computerized measures in the current research allows for a larger number of trials to be administered and records reaction time in addition to performance scores. This has been thought to be useful in detecting improvements in inhibitory control through late childhood and adolescence (Best, Miller, & Jones, 2009).

This research also attempted to assess children's confidence in their reported answers. It has been proposed that upon recall of an event, individuals evaluate various characteristics to determine the accuracy or validity of the retrieved information (Arbuthnott, Kealy, & Ylioja, 2008). Accordingly, it would be assumed that when identifying the sources of retrieved memories, individuals may endorse their attributions with varying degrees of conviction, based on this evaluation process. For example, it is possible that some children may report lower confidence in their responses for the confabulated items during the source monitoring task, especially when identifying the incorrect source. Asking individuals to identify the sources of events in suggestibility

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paradigms, then, would be insufficient, as this would not discern whether individuals truly believe their responses are accurate, or if they have merely provided their best guess. Incorporating the perceived confidence for each response may provide valuable information regarding which ratings children do and do not strongly endorse (e.g., stating that the event was in the video, even though they are not at all certain that this response is correct).

Within their study, Ruffman et al. (2001) hypothesized that individuals with weaker inhibitory control would confidently endorse false events due to their inability to inhibit familiarity-based retrieval. Accordingly, they attempted to evaluate whether IC performance impacted confidence ratings, predicting that individuals with higher levels of IC would demonstrate greater confidence in their correct source attributions and less confidence when endorsing misleading information. No significant relationships, however, were found between confidence and IC.

Ruffman et al. (2001) hypothesized that this may have been a result of using a relatively complicated measure of confidence. Re-assessing this using a measure of confidence that has been shown to be effective with children will clarify whether IC does impact confidence ratings. Berch and Evans (1973) and Ghetti, Qin, and Goodman (2002) both utilized a 3-point scale anchored by two pictures of either a male or female child, matching the sex of the participant, who looked confident or confused. Both of these scales have demonstrated that children as young as five years are capable of monitoring their own memory states, though children seven and eight year of age and adults have been shown to be more efficient at gauging the accuracy of their responses.

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As well, rather than having individuals engage in interactive situations that would later be queried, the event in the current study was a witnessed incident, in order to better understand witness competencies for observed events. Memory span, receptive language, and verbal fluency were also assessed within the current study. These variables were included to control for other cognitive abilities known to increase across development, to determine whether source monitoring performance is better accounted for by these underlying abilities or whether inhibitory control is uniquely associated with source monitoring performance. These cognitive variables were further used to evaluate whether any between group differences existed between monolingual and bilingual participants.

In summary, the final sample consisted of participants between the ages of 4 and 10 years, with a mix of monolingual and bilingual individuals at each age. Individuals first viewed a 9 minute video, after which they were questioned about the witnessed events to "ensure they did not miss anything". Questions about events that did not occur in the video were embedded within this review, and individuals were encouraged to answer all questions asked. One week later, children were asked to help identify which events were and were not witnessed the prior week. Confidence ratings were provided for each of their responses. Children were then administered a battery of eight IC measures commonly used in the literature to determine their current level of inhibitory functioning. Measures of short-term memory, receptive language, and verbal fluency were also administered to control for other cognitive abilities that might have impacted performance.

Hypotheses

The following predictions were made based upon the previously reviewed

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theoretical perspectives and empirical findings.

Hypothesis 1. Different measures of IC have been used within the literature. Although these measures have good face validity, it remains unknown as to whether they tap a unified construct. Eight measures of IC frequently used in the literature were selected for the purposes of this study, including the flanker task, reverse arrows task, the Simon task, the go-nogo task, retroactive-proactive inhibition task, dimensional change card sort, day night task, and opposite words task (e.g., Roberts & Powell, 2005; Bialystok & Shapero, 2005; Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok & Martin, 2004; Zelazo, 2006; Bunge et al., 2002; Diamond, 2002). It was predicted that these measures of Inhibitory Control would tap into a unified construct. This was tested using exploratory factor analytic techniques. Knowing whether the measures assess similar or different constructs would allow for a better understanding of how to interpret the results of these measures and would allow for more informed task selection in future research.

Hypothesis 2. Previous research maintains that bilingual children are more proficient at inhibiting information from a younger age than their monolingual peers (Bialystok, 2007). Although the bilingual advantage has been shown to be more evident at younger ages, differences have been reported through early adolescence. Accordingly, it was predicted that the bilingual children across ages would obtain higher scores than the monolingual children on measures of Inhibitory Control. Further, given the hypothesized role of IC in the ability to monitor source, it was predicted that the bilingual children across ages would obtain higher scores than the monolingual children on

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measures of source monitoring. This was evaluated through a series of one-way ANOVAs.

Hypothesis 3. Given the normative developmental trajectory, it was predicted that there would be a positive correlation between chronological age and a) measures of inhibitory control, with older children demonstrating a greater proficiency at inhibiting irrelevant stimuli; and b) the source monitoring task, with older children being more efficient at correctly identifying witnessed events and rejecting events not witnessed. These predictions were tested by calculating correlations between age and the outcome variables.

Hypothesis 4. Previous research has begun to elucidate the possible implications of IC on source monitoring ability, suggesting that IC may be responsible for effective encoding of observed events as well as successful retrieval (Best, Miller, & Jones, 2009; Bruck & Melnyk, 2004; Scullin & Bonner, 2006; Roberts & Powell, 2005). Accordingly, it was predicted that the relationship found between both age and source monitoring abilities and bilingualism and source monitoring abilities would be better accounted for by inhibitory control performance. This was tested using regression models to determine: a) whether IC predicted variance in source monitoring ability, and b) whether IC accounted for predictive variance beyond that accounted for by chronological age and other cognitive abilities.

Hypothesis 5. Ruffman et al (2001) proposed that individuals with more developed inhibitory control would have more confidence when correct in their source attributions and would have lower confident ratings when endorsing misleading information. Although Ruffman et al (2001) did not find any significant results, it was

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hypothesized that results would emerge when utilizing a measure of confidence that has been shown to work effectively with younger children. This was tested by examining correlations between IC and both correct and incorrect source attributions.

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CHAPTER II

METHOD

Participants

Ninety-nine children were recruited from the Windsor-Essex area, from a combination of private schools, daycare centres, and the community. Although this sample initially included four 3-year-old children (2 monolingual, 2 bilingual), these individuals demonstrated substantial difficulty understanding and completing the tasks. Accordingly, the data for these four children were considered invalid, and the goal of recruiting 3-year-olds was dropped from the study.

The final sample consisted of 95 children, ranging from 4 to 10 years of age (see Table 1 for demographics); approximately half of the participants from each age group were bilingual speakers. In order to have been considered bilingual, children needed to have been exposed to a minimum of two languages daily since 2 years of age, to have convesed daily in both languages since learning to speak, and they must continue to converse fluently in both languages on a daily basis. This information was obtained from parents using the Language Proficiency Rating Form discussed below. Of the 49 bilingual participants in the final sample, 45 spoke French, 2 German, 2 Chinese, and 1 Punjabi.

Consent was obtained from parents and assent from children prior to participation. Participants were treated in accordance with the Tri-Council Policy Statement, the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 1992), and the "Canadian Code of Ethics for Psychologists – Third Edition"

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Table 1

Participant Demographics

Age (years)	N	M (months)	SD	% bilingual	% male
4	13	54.31	2.93	46.2 (n = 6)	46.2 (n = 6)
5	13	64.92	3.38	46.2 (n = 6)	46.2 (n = 6)
6	14	77.93	3.49	50.0 (n = 7)	35.7 (n = 5)
7	12	88.83	3.66	50.0 (n = 6)	58.3 (n = 6)
8	15	103.27	3.22	53.3 (n = 8)	40.0 (n = 6)
9	14	113.43	4.09	57.1 (n = 8)	35.7 (n = 5)
10	14	125.36	3.39	57.1 (n = 8)	64.3 (n = 9)
Total	95	90.52	24.33	51.6 (n = 49)	46.3 (n = 44)

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(Canadian Psychological Association, 2000). Clearance for the study was obtained from the University of Windsor Research Ethics Board.

Sampling Procedures

Four local school boards were contacted within the Windsor-Essex area. Following the protocol for each board, written applications were submitted to the two English boards, while the French boards were contacted directly by phone. Approval was received to contact the principals within one of the French school boards directly. The other boards declined to participate.

Nine principals from the French school board, seven principals from private schools, and twelve directors of day care centres within the Windsor-Essex area were contacted by phone to notify them of the nature of the study and to inquire as to whether they might be interested in helping with the research process. Twenty principals/directors indicated that they would consider helping with recruitment and were provided with a copy of the parent package (including the notice of study, letter of information, consent form, and questionnaires (see Appendices A through F), after which they had the opportunity to ask any questions pertaining to the research. Seventeen principals/directors expressed continued interest in the research, and a time was arranged for the principal investigator to come into the classrooms to provide the students with a short explanation of what participation would entail (see Appendix G). Children were then given the parent package, enclosed in an envelope, to bring home. Testing dates were later arranged for any students who both returned the completed consent forms to their teachers and who met criteria for the study. Of the 102 packages returned, 69 children met criteria for the study, including 41 children from the French school board, 18 children from private

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schools, and 10 children from private daycare centres. All teachers and organizations that assisted in the recruitment process were entered into a draw; three schools were awarded a $100 gift card to an educational resource store.

Recruitment also occurred through the use of snowball sampling. For this, individuals involved in the research project informed individuals they knew about the study and provided them with a letter containing information about the research being conducted (see Appendix F). If interested, they were given extra copies of this letter to distribute to individuals who they thought might be intrigued by the research. This provided individuals who were not associated with the aforementioned agencies the opportunity to participate in the study. No research assistants assessed individuals with whom they had a current or prior relation. Of the 22 forms received through this sampling method, 21 participants met criteria for the study.

The remaining 5 participants were recruited through advertising. The principal investigator was interviewed on CBC Windsor radio and had an advertisement posted in the University of Windsor Daily News; contact information was provided for anyone who wanted further information. All participants recruited through this method met criteria for the study.

Group Assignment

Participants who met criteria for the study were assigned a yoked partner of the same chronological age from the same language group. The condition each yoked partner was assigned to (A or B) was determined using a randomization table. This assigned condition determined which set of false events the individual was provided, as well as which counterbalanced condition he or she was administered on the Dimensional Change

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Card Sort, Opposite Worlds Task, and Proactive and Retroactive Inhibition Task (described below). For these Dimensional Change Card Sort and Opposite Worlds tasks, participants in each condition started with a different rule (sorting or naming) to control for order effects. For the Retroactive Inhibition Task participants in each condition were assigned different word lists to control for item effects.

Apparatus

Computer Specifications

Both testing sessions utilized a laptop computer with a 15-in monitor, equipped with the Windows 7 operating system. Each computer was assessed to ensure that it met the set specifications and administered the protocol correctly.

Equipment for Computerized RT Measures

For computerized tasks that assessed participants' reaction times via mouse click, a white foam board (0.5 cm thick, 35.5cm long, by 25.5 wide) was placed over the laptop's keyboard. Felt pads (0.5 cm thick, 2.5 cm long, 2.5 cm wide) were affixed to each corner underneath the board to ensure that keys on the keyboard would not accidentally be pressed. Two pieces of Velcro (2 cm by 1 cm) were affixed to the top of the board, one at the top right corner and the other at the left corner, 3.5 cm from each respective side of the board and 1 cm from the screen.

Two mini retractable USB mice (height 3 cm, width 4 cm, depth 7 cm) were used with each computer. Velcro was affixed to the bottom of these mice covering the optical sensor. A thin piece of cardboard was placed under the left button of one mouse and the right button of the other mouse so that these buttons could not be pressed; these mice attached to the left and right sides of the foam board respectively. A sticker was placed

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on the remaining functional button, and participants used this button to respond with their index fingers.

Direct RT v2008 Software

All computerized measures were administered using Direct RT version 2008. This software was created for cognitive and perception tasks requiring millisecond precision. Measures were all developed and programmed by the principal investigator, based on the specifications listed within the literature; all stimuli were created using Adobe Photoshop. No standardized versions of the IC tests currently exist, and researchers are required to recreate these programs for use. None of these measures are subject to copyright. Each test was administered as described below, and the software recorded responses and associated reaction times.

Measures and Materials

Testing Manual and Scoring Package

A 38 page manual was created by the principal investigator that contained administration instructions for all measures. The instructions were based on those provided in previous studies and were to be delivered verbatim to ensure standardized administration across sessions. A scoring package was also created to allow for standardized scoring.

Dunston Checks-In Video

Two clips were selected from 20th Century Fox's 1996 production of *Dunston Checks-In*, totaling 9 min and 30 s. This movie is labeled as a family feature film, and has a rating of PG. A detailed account of the clips can be found in Appendix H. These clips were chosen as they were appropriate for the entire age span, given the events that

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transpire during the segments can be understood at a quite basic level, though have enough humor and sufficient complexity to maintain the interest of the older children. The specific events within the clips were deemed less relevant, as it is assumed that the processes that impact source monitoring would generalize to any events observed. It was further expected that few children would have seen the film, given the 1996 release date. Parents confirmed that their children had not seen the movie prior to testing, and no children reported having previously seen the movie. These clips have not been used in prior research.

Post-event Review and Question List

The post-event review consisted of a list of 12 events pertaining to the video clips, and was modeled after the review of events used by Ackil and Zaragoza (1998). Nine questions were embedded within this review; six that asked about salient events that transpired in the film (true questions) and three that asked about events that did not occur in the film (false-event questions). As in Ackil and Zaragoza (1998), two sets of false event questions were included to ensure that any observed effects would be attributable to the procedure and not the specific questions presented; same-aged yoked partners from the same language group were administered the alternate set of false event questions. All false-event questions pertained to incidents that could have been plausible given the sequence of events shown in the clips. For a list of the post-event questions, see Appendix I.

Source Monitoring Task Questions

This task was composed of fifteen questions pertaining to the video clips. The questions included three events that occurred in the clips and that were discussed during

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the post-event questioning, three events from the video that were not discussed during the post-event questioning, the three false events provided to the child during the post-event questioning, the three false events that their yoked partner was given, and three false events that were not discussed by any individual nor watched in the video clips (see Appendix J). Questions were presented in a fixed order.

A green card with a check mark (for yes responses) and a red card with an "X" (for no responses) were utilized to facilitate responding. Card dimensions were 12 cm by 17 cm. Source monitoring abilities were evaluated based on the ability to correctly endorse or correctly reject the items presented. Participants received four source monitoring ratings: Witnessed Discussed (hits to discussed items; a score ranging from 0 to 3 indicative of their ability to correctly identify information that they witnessed and discussed the prior week), Witnessed Not Discussed (hits to non-discussed items; a score ranging from 0 to 3 indicative of their ability to correctly identify information that were witnessed but not discussed the prior week); Not Witnessed Discussed (correct rejections to previously confabulated items; a score ranging from 0 to 3 indicative of their ability to correctly reject the events that they confabulated the prior week); and Not Witnessed Not Discussed (correct rejections to non-discussed items; a score ranging from 0 to 6 indicative of their ability to correctly reject false events to which they had not previously been exposed). The Not Witnessed Not Discussed events included the false events provided to their yoked partner and three new false events.

This procedure of asking children to identify whether the item queried was present in the observed event has been used to assess source monitoring abilities with

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children in several previous studies (Foley, Johnson, & Raye, 1983; Foley & Johnson, 1985; Lindsay, Johnson & Kwon, 1991; Ackil & Zarigoza, 1998).

Confidence Rating Board – Revised

This rating scale was modeled after the Confidence Rating Board used by Ghetti, Qin, and Goodman (2002). Although different stimuli were used, as neither the images nor the board dimensions were specified in their publication, the general design and administration of the scale remained consistent with that used in their research.

The rating board within the current study consisted of a thin piece of foam board (0.5 cm thick, 72 cm long, 14 cm wide). Two pictures of a girl (17 cm by 14 cm) were located at opposite ends of the board on one side, and two pictures of a boy were located at opposite ends of the reverse side of the board. For both sets of pictures, the image on the right depicted a child with a confident facial expression, while the picture on the left depicted a child with a doubtful expression (see Appendix K). Rights to the images were purchased from iStockphoto®. These images were selected to mirror those used by Birch and Evan (1973), who utilized similar pictoral anchors. Between these pictures, three dots were drawn on the board, each 0.5 cm in diameter and 12 cm apart. The two dots located next to the pictures were each 8 cm from the image, and the third was located in the middle of the board (12 cm from the outer dots). These dots acted as a 3-point scale (*not sure, somewhat sure,* and *very sure*).

Prior research using this style confidence board has demonstrated that children as young as five years were capable of monitoring their own memory states, though children become more efficient at gauging the accuracy of their responses from about the age of seven (Berch & Evans, 1973; Ghetti, Qin, & Goodman, 2002). Research has further

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shown that children (ages 8 and 10 years) demonstrate the ability to accurately report their perceived confidence at a level comparable to adults when questions are unbiased (Roebers, 2002; Roebers & Howie, 2003).

Language Proficiency Questionnaire

This questionnaire was developed by the principal investigator to clarify whether the children who returned the forms met the monolingual or bilingual criteria, as specified within the current study. The questionnaire included 4 questions for the parents to complete. Parents were asked to list the languages that their child could speak fluently; the age at which they were first exposed to these languages and how frequently; and the age at which their child was first able to converse in these languages. A final question asked which of these languages their child currently speaks on a daily basis, and where these languages are spoken. See Appendix G.

All participants who returned this questionnaire, including participants who did not meet criteria to participate in the study, were entered into a draw to win one of three prizes, including 40 dollars for a family restaurant, 40 dollars for a family entertaining centre, or 40 dollars worth of movie gift certificates.

Measures of Inhibitory Control

Proactive and Retroactive Inhibition Task. This verbal inhibition task was modeled after Roberts and Powell (2005); however, given the original task was designed for use with 5 and 6 year old children, the stimuli were adapted to accommodate the age range assessed in the current study.

The task consisted of four practice trials and six testing trials, each consisting of two sets of three words. These words varied by age group and were selected based on

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age-normed material, including the Wechsler Preschool and Primary Scale of Intelligence-Third Edition (Wechsler, 1989), the Wechsler Intelligence Scale for Children (Wechsler, 1991), and the Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981). Two separate word lists were further used to control for item effects. The list for the 5 and 6 year old children included the same words used by Roberts and Powell (2005); the list for the 7 and 8 years olds, and the list for the 9 and 10 year olds were modeled after this original list. See Appendix M.

This task requires participants to either repeat the first set of three words (retroactive inhibition) or the second set of three words (proactive inhibition). Successful responding requires individuals to inhibit the alternate set of three words.

Previous research has indicated that children with higher than average verbal retroactive inhibition are more resistant to suggestion than those demonstrating poor performance on this task (Roberts & Powell, 2005).

Computerized Dimensional Change Card Sort. This task requires children to sort a set of stimuli according to one dimension (e.g., colour or shape), and then to reclassify the same stimuli by sorting them according to a different dimension. Each study that has used this task has utilized different stimuli (e.g., Bialystok & Shapero, 2005; Zelazo & Frye, 1996; Bialystok, 1999; Bialystok & Martin, 2004). The target stimuli in the current task consisted of red and blue circles and squares, and later green and yellow stars and circles. Although previous tasks developed for younger children only had circles of one colour and squares of another colour, making the sorting process easier, shapes were presented in both colours in order to adapt this task to a wider range of participants.

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The task was administered on a laptop computer using Direct RT. Two boxes were presented on the computer screen, one at the bottom of each side of the screen, directly above the affixed mice. For the first portion of the task, a picture of a red square was presented above one box, and a picture of a blue circle was presented above the other box (see Appendix N). The target stimuli (red and blue circles and squares) appeared one at a time in the center of the screen in a fixed order.

The task required target stimuli to be sorted by either shape or colour (dependent on the participant's assigned condition). Four practice trials were presented followed by 20 test trials (pre-switch), with stimuli comprised of 10 squares and 10 circles, half presented in each colour. If a practice trial was answered incorrectly, a red X was presented for 500 ms prior to returning to the first practice trial; if a practice trial was answered correctly, a green checkmark was presented for 500 ms before the next trial was presented. The next block of trials required participants to sort the stimuli according to the opposite sorting rule (post-switch). No practice trials were administered.

A third block required new target stimuli (green and yellow stars and circles) to be sorted according to the same sorting rule previously completed (pre-switch). A green star and yellow circle were now located above the sorting boxes (see Appendix N). Four practice trials were presented followed by 20 trials, with stimuli consisting of 10 stars and 10 circles, half presented in each colour. Again, if a practice trial was answered incorrectly, a red X was presented for 500 ms prior to returning to the first practice trial; if a practice trial was answered correctly, a green checkmark was presented for 500 ms before the next trial was presented. The final block of trials required participants to sort

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the stimuli according to the opposite sorting rule (post-switch). No practice trials were administered.

Correct responses, errors, and reaction times were recorded through the Direct RT program. The scores for the two pre-switch blocks were combined into a single variable and the scores for the two post-switch blocks were combined into a single variable. Average correct RTs and average error rates for each participant were then tabulated manually for these two new variables.

This measure has been used in many studies with children, in which younger children have demonstrated greater difficulty switching between sorting rules (for a review, see Diamond, Carlson, & Beck, 2005). Many of these authors contend that this is due to deficiencies in inhibitory control, which is required to successfully switch to the second sorting rule, as they must inhibit the tendency to continue attending to the previously relevant dimension. Additionally, bilingual children have demonstrated more efficient performance on this task than their monolingual peers, thought to result from the bilingual advantage over inhibitory abilities during childhood (Bialystok & Marin, 2004).

Opposite Worlds Task. This task is an adaptation of Manly, Robertson, Anderson, and Nimmo-Smith's (1999) Opposite Worlds task from the Test of Everyday Attention for Children (TEA-Ch). Using the same general procedure, this task used cows and pigs as stimuli rather than the digits 1 and 2 (Bialystok & Shapero, 2005; Bialystok, Barac, Blaye, & Poulin-Dubois, 2010).

Testing material consisted of a white board (42 cm by 60 cm) on which a winding road is depicted leading to a picture of a red barn (9 cm height), which was affixed to the board with a Velcro strip. Fourteen pigs (height 3 cm) and 14 cows (height 6 cm) were

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presented along the winding road (See Appendix O). Rights to the images were purchased from iStockphoto® or created in Adobe Photoshop. Four conditions were presented, in which participants were required to name the animals as quickly as possible. In 2 trials ("real world" trials), the cows and pigs were to be named by their real names (e.g., "cow" for cow), and in 2 trials ("opposite world" trials) they were to be named by the opposite names (e.g., "pig" for cow). To visually depict being in the "opposite world", the image of the barn was turned upside down. Participants were assigned to start in the real or opposite world based on the condition to which they were assigned in the study. Time to reach the barn and errors were recorded.

As with the original task from the TEA-Ch, this task entailed inhibiting a habitual response to provide a response consistent with a given rule, and required individuals to switch the focus of attention from one task to another (Wiese, 2001; Bialystok, Barac, Blaye, & Poulin-Dubois, 2010). Test-retest reliability on the original task received a coefficient of .87, and the task was found to correlate highly with the Matching Familiar Figures Task, which has been proposed to measure inhibitory control and impulsivity (Wiese, 2001). Analyses using the adapted version has shown effects of both age and language group, with older children being more accurate than younger children and bilinguals performing better than their monolingual peers (Bialystok & Shapero, 2005; Bialystok 2010).

Computerized Day-Night Card Task. This task is an adaptation of Gerstadt et al. (1994)'s Day-Night task, modified for computerized administration.

Card images were modeled after those used in the original task, and included 14 tangible cards and 14 card-shaped digital images, measuring 13.5 cm by 10 cm. Seven of

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these cards depicted a yellow sun with a blue sky (day card), while the other seven cards depicted a yellow moon with a dark sky and stars (night card; See Appendix L).

A training phase, using the tangible cards, required individuals to successfully label the day card as “night” and night card as “day” each twice prior to commencing testing.

Testing was completed using a 15 in computer monitor. Three blocks of trials were presented, each consisting of 14 trials. Trials were presented in a fixed order, with no more than two of the same stimuli presented in succession. In the first and third blocks, individuals were required to label the day card as “night” and night card as “day”, according to standard task instructions. In the second block, participants were asked to refer to the cards by their proper names (e.g., the day card as “day”). A fixation cross (X) was presented in the middle of the screem for 400 ms prior to each trial.

Research assistants entered the participants’ verbal responses by clicking the mouse corresponding with their answer as the response was provided. Correct responses, errors, and reaction times were recorded through the Direct RT program.

This task is a modification of the Stroop Task, designed to assess pre-literate children. Diamond, Kirkham, and Amso (2002) have asserted that this task requires individuals to inhibit the prepotent response of naming the familiar image in order to provide the alternate response; this is further exacerbated as the alternate response and the image presented are semantically related. The day-night version of the Stroop Task, using the 14 day cards, has been widely used in the literature.

Children between 3 and 4.5 years of age have been shown to find the original task, performed with actual cards and using a single presentation of 14 cards, very

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difficult, while children 6-7 years of age often find it trivially easy. Improvement in responding in this original task has been said to be continuous from 3.5 to 7 years of age (Diamond, 2002). The modified version of the task used in the current study was designed to assess reaction times when children were encouraged to perform this task as quickly and accurately as possible, rather than assessing the basic ability to inhibit a prepotent response with no time constraints. This was in attempt to assess variability in performance across a wider age range.

Flanker Task (including Go No-Go and Reverse Arrows). This measure, modeled after the original task by Eriksen and Eriksen (1974), was designed to assess various types of visual inhibition (discussed below). Five blocks of trials were administered on a 15 in computer (see Appendix P for a visual depiction of the stimuli).

In the first block (arrow trials), stimuli consisted of 20 single arrows (4cm in length) presented one at a time in the middle of the screen; arrows were all horizontal to the bottom of the screen, with half pointing right and half pointing left. Correct responding entailed clicking the button on the mouse that the arrow was pointing towards.

In the second block (congruent-incongruent trials), stimulus consisted of 5 arrows (4cm in length) in a horizontal row in the middle of the screen. The center arrow was identical to that of the previous game, though two identical arrows (flanker arrows) now appeared on either side of this central arrow. On 10 trials, these flanker arrows faced the same direction as the central arrow (congruent condition), while on the other 10 they faced the opposite direction (incongruent condition). Correct responding entailed clicking

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the button on the mouse that the central arrow was pointing towards, while ignoring the other arrows.

In the third block (go no-go trials), each stimulus consisted of the same center arrow with either two squares on each side or two Xs. When squares were on the sides of the central arrow (the go condition), correct responding entailed clicking the button on the mouse that the central arrow was pointing towards. If Xs were on the sides of the central arrow (the no-go condition), individuals were required to refrain from responding; after 250 ms the next stimuli would appear. Stimuli consisted of 14 go trials and 6 no-go trials.

In the fourth block (arrow trials), the stimuli and correct response was the same as block one. Trials in this game, however, were presented in a different order.

In the final block (reverse arrows trial), stimuli were the same as block one and three, though correct responding entailed clicking the mouse the arrow was not pointing towards.

Prior to beginning each block, four practice trials were administered. Individuals were required to respond correctly to all questions prior to starting the task. If an incorrect response was provided, a red X was presented for 500 ms prior to returning to the first practice trial. A green checkmark was presented for 500 ms for each correct response, prior to proceeding to the next trial. A fixation point was shown for 250 ms prior to every stimulus presented throughout the task.

Both response time and accuracy rates were measured; reaction times for trials with incorrect responses were excluded from analysis. Accuracy scores were comprised of the total number of correct responses per block. The results from the “arrow trials” and

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the "reverse arrows trials" were evaluated as the Reverse Arrows Task; The "congruent-incongruent trials" were evaluated as the Flanker Task; and the "Go No-go trials" were evaluated as the Go No-go task. These different tasks were included in attempt to assess different types of visual inhibitory control: the reverse arrows task is thought to assess the inhibition of a prepotent response; the flanker task is thought to assess the ability to inhibit conflicting cues (Bialystok, Barac, Blaye, & Poulin-Dubois, 2010); and the go no-go task is thought to assess response inhibition (Simmonds, Pekar, & Mostofsky, 2008).

Research has consistently demonstrated that bilingual children are faster than their monolingual peers on both the congruent and incongruent trials in this task (Bialystok et al., 2004; Bialystok, Craik, & Luk, 2008; Costa et al., 2008; Martin-Rhee & Bialystok, 2008; Emmorey et al., 2008). It has been proposed that this finding may result from both advantages in inhibitory control processing as well as advantages in other areas of executive functioning. Evidence using neurological imaging techniques has provided further support for this assertion, as successful performance in the incongruent condition of this task (within block 2) is accompanied by modulation in the fronto-central area of the brain (Kopp et al., 1996; Heil et al., 2000). This is consistent with idea that incompatible flankers place a greater demand on response and attentional inhibition.

Simon Task. This task was administered on a 15-in laptop monitor. A red line (3.4cm x .3cm) was located at the bottom right side of the screen, and a blue line (3.4cm x .3cm) was located at the bottom left side of the screen. (See Appendix R)

The task consisted of three blocks, each containing 12 trials. For each trial, a red or blue square (3.7cm x 3.7cm) appeared on either the left or right side of the computer

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screen. Correct responding entailed clicking the mouse button under the line that matched the colour of the square. Stimuli remained on the screen until a response was provided.

Prior to testing, 5 practice trials were administered. If a trial was answered incorrectly, a red X was presented for 500 ms prior to being redirected to the first practice trial. A green checkmark was presented for 500 ms for each correct response. Once all practice trials were completed successfully, the first block was presented.

Items were presented in a fixed order, with half the trials in each block consisting of incongruent responses, and no more than three consecutive trials consisting of the same stimuli. The order of stimuli varied across all three blocks. Both reaction time and accuracy rates were calculated for congruent and incongruent trials; response times for incorrect responses were excluded from later analysis.

When the correct response corresponded with the position of the square on the computer monitor (e.g., when the red square appears on the right side of the screen, requiring the participant to press the right mouse), the trial was considered congruent, as the colour and position converge on the same response. When the correct response and the stimulus position conflicted (e.g., when the red square appeared on the left side of the screen but required the participant to press the right mouse), the trial was considered incongruent, as the spatial positioning must be inhibited. It has been proposed that this task is relatively content free and more dependent on the inhibitory “processes proposed to characterize the performance advantage of bilingual individuals” (Bialystok et al., 2004, p. 291). The Simon effect, frequently documented in the literature, demonstrates that response times are impacted by nonrelevant spatial cues (for a review, see Lu & Proctor, 1995). Bialystok et al. (2004) further indicated that both bilingual children and

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older adults demonstrate enhanced performance of this task, signifying less disruption from the incongruent items.

Measures of Additional Cognitive Abilities

Receptive Vocabulary. This subtest was taken from the Wechsler Individual Achievement Test, second edition (2001). Stimuli consisted of 16 cards divided into four quadrants, each containing a different image. Individuals were required to select the image that best matched the specified word. Testing was discontinued if 4 consecutive incorrect responses were provided.

Reliability coefficients have been shown to range from .67 and .88 for children aged 4 through 10 years of age (WIAT-II). This measure of language proficiency was included to 1) ensure that English proficiency was comparable for both language groups, and 2) control for crystallized verbal knowledge when assessing the impact of IC on source monitoring.

Verbal Fluency. This task evaluates the spontaneous production of words according to a specified category within a limited amount of time. Individuals were required to generate the names of as many different types of food as they could within 45 s. One point was given for each unique type of food listed.

A second fluency task was generated for bilingual participants, where individuals needed to generate as many animal names as possible within 45 s. This was to be completed in the other spoken language. Responses were transcribed from the audio recordings and translated to English by a French-speaking research assistant. Other specialists were consulted for words in the other languages. One point was then given for each unique animal listed.

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This task assesses the ability to generate words fluently from overlearned concepts, and performance is expected to increase across development. This measure was included to 1) ensure English proficiency was comparable between both language groups, and 2) to control for fluid verbal ability, the ability to access words belonging to a category, and the ability to organize thinking when assessing the impact of IC on source monitoring.

Forward Digit Span (Memory Span). This task is an adaptation of the Forward Digit Span from the Wechsler Intelligence Scale for Children (2003), and is a rough measure of rote learning, short-term memory, attention, and encoding. The task consists of sixteen trials. The first 4 trials contain strings of 2 digits (e.g., 2-4). Trials then begin to increase by a single digit, with 2 trials presented at each string length (See Appendix S). The numbers used in the strings were modified from those presented in the Wechsler test. Strings were presented orally and required participants to correctly recite the numbers in the correct order. Testing was discontinued when both trials at a given string length were incorrect. One point was awarded for each correctly reproduced string of numbers (See Appendix S).

This task was included to 1) ensure general short term memory was comparable between both language groups, and 2) to control for short term memory and attentional abilities when assessing the impact of IC on source monitoring.

Procedure

Research Assistant Recruitment and Training

The principal investigator provided an announcement about the research position in several undergraduate courses, and the application form was provided to those

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interested (see Appendix T). Out of 147 applications, 80 individuals were selected for interviews; selection criteria included academic history, previous experience with children, and their stated interest in the position. From these interviews, eleven research assistants were selected for the positions based on their interest, enthusiasm, availability, and ability to efficiently deliver an excerpt from the testing manual verbatim.

The selected research assistants were provided with the testing manual and trained to administer the various measures of inhibitory control. To ensure they were able to administer the tasks according to standardized protocol, two practice administrations were completed; these sessions were audio recorded to verify administration.

Three research assistants left the research team before testing commenced, as they were unable to dedicate the time required for the position. The remaining eight research assistants remained with the team until testing was complete. All research assistants were female between the ages of 20 and 30 and had extensive experience working with children in the community.

Participant Testing Session One

All testing occurred in a quiet testing location free of distractions. This was either an empty office or classroom at the participating schools, a room at the University of Windsor, or a quiet area within the participant's home.

The research assistant began each session by introducing herself to the participant, and providing a general agenda for their time together. Assent was reviewed at this time. The research assistant further noted that they would be recording the session so that they could remember everything that the participant said, as long as the participant was

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comfortable with this; all participants provided assent to participate and to being recorded.

Participants were then told that they would be watching two short clips from a movie, after which they would have the opportunity to share their opinion of the video with the research assistant. Participants were seated directly in front of a 15-in computer monitor to view these clips.

Following the presentation of the video clips, the research assistant notified the participant that she would now be turning on the audio recorder. She then asked the participant three warm-up questions, which were intended to facilitate rapport. Each participant was asked what they thought about the video clips, whether they would want to see the rest of the movie, and if they thought that the producers should remake the film for children now.

The participant was then told that they were going to spend a few additional minutes discussing the events that transpired within the video to ensure that they did not miss anything. They were encouraged to do their best to answer all questions. The research assistant then engaged in the post-event review. If a participant indicated that they did not know an answer, they were first told to do their best to explain the event as if it did happen in the video, even if they missed it or were not sure. If they still did not provide an answer following this prompt, they were told to guess and do the best they could. If an answer was still not provided, they were told that this was okay and they proceeded to the next question.

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Following participation, each participant was given the opportunity to select a small prize (e.g., pencil, keychain, small stuffed animal) from a “thank-you box” in appreciation for their time.

Participant Testing Session Two

Part 1. This phase was conducted by a different research assistant to reduce demand characteristics and any possible discomfort for the participants.

The research assistant began by introducing herself to the participant, and renewing assent. The research assistant further noted that she would also be recording the session on an audio recorder to remember everything that the participant said.

The participant was then asked whether he or she remembered having watched a video the week before and whether he or she recalled talking to someone from the university about the video. All participants noted that they recalled this happening.

The participant was then told that the research assistant was not aware of which video clips were shown the prior week, and that she needed to know this information in order to select the games that they were supposed to play. The participant was asked if he or she would help the research assistant determine which events were shown the prior week.

The research assistant indicated that she was going to read a list of several events that the participant might have seen in the video clips. Participants were told that if they saw the event the prior week, that they were to point to a card with a green check mark that also said the word YES, and that if they did not see the event that they were to point to the card with the red X that also said the word NO. Participants were told that they could also say the words “yes” or “no”. These cards were designed to facilitate

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responding, especially for individuals who may be apprehensive about providing an answer.

Two training questions were administered to ensure that the children understood the instructions. The first question asked whether there was a monkey present in the movie (correct response "yes") and the second was if there was an elephant in the hotel (correct response "no"). All participants answered both questions correctly.

Participants were then told that after they answered whether or not they saw the event in the video (using the yes and no cards), that they would indicate how sure they were that their answer was correct. Participants were instructed how to do this using the Confidence Rating Board (see above). It was explained that the pictures on each side of the board were of another participant who took part in this study; the picture on the right was from when they were very sure their answer was correct and that the picture on the left was from when they did not know the answer and were guessing. Participants were told to point to the dot next to the uncertain face if they were quite unsure of their answer and felt like they were almost guessing, and to point to the dot next to the certain picture if they were absolutely sure that they were right. Finally, they were told to point to the middle dot if they had to think a little bit and did not feel as certain as the person in the confident picture, but not as confused as they would be if they were guessing. Accordingly, they were told to select the middle dot at times when they felt "in between."

To ensure the participants understood how to use the board, they were asked to tell the research assistant which dot they would pick if they were very sure their answer was right, which dot they would pick if they did not know and were guessing, and which they would pick if they thought they were right but were not completely sure. If the

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participant had difficulty answering these questions, the research assistant provided further elaboration on how to use the board until the participant was able to answer these three questions correctly.

Participants then played a confidence rating "game" to ensure that they could apply this rating system. Participants were provided with questions designed to evoke different confidence ratings (e.g., how sure are you that this is a shoe?) to ensure that the children's responses made sense (see Appendix H for the list of questions). After three consecutive correct answers were obtained on these practice questions participants were administered the Source Monitoring Task. The fifteen events were read one at a time to the participants. For each event, participants were asked to indicate whether or not they saw the event in the video the prior week and how sure they were that the answer they provided was correct.

Part 2. Following the source monitoring task, participants were administered the tasks of inhibitory control and the other cognitive measures, all of which were posed as "games". engaged in a series of brief "games" designed to assess their cognitive and linguistic abilities.

These measures were presented in a fixed order: Digit Span, Computerized Day-Night Task, Proactive and Retroactive Inhibition Task Trials, Computerized Dimensional Change Card Sort, Proactive and Retroactive Inhibition 1, Listening Comprehension (WIAT), Flanker Task, Verbal Fluency, Opposite World's Task, Proactive and Retroactive Inhibition 2, and the Simon Task. The tasks took approximately 45 minutes to complete. Standardized instructions for all tasks can be found in Appendix U; words in bold text were to be presented verbatim.

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Following participation, each child was given a voucher for a McDonald's Happy Meal in appreciation for his or her time.

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Table 2
List of Inhibitory Control and Cognitive Measures

Task	Trials Administered / Stimuli	Data Scored	Materials
Flanker Task	10 congruent trials (flanker arrows pointing same direction as the central arrow) and 10 incongruent trials (flanker arrows pointing the opposite direction from the central arrow) were administered in a single block. Participants had to click the mouse that the central arrow was pointing towards, while ignoring flanker arrows.	Reaction time (ms) and Accuracy (percent correct) for congruent and incongruent trials	Computer, DirectRT
Reverse Arrows	60 arrows were presented in the centre of the screen across 3 blocks (20 arrows per block). Half of the arrows in each block pointed in the same direction. The first two blocks consisted of congruent trials (click the mouse the arrow is pointing towards). The final block consisted of incongruent trials (click the mouse the arrow is not pointing towards)	Reaction time (ms) and Accuracy (percent correct) for congruent and incongruent trials	Computer, DirectRT
Go No-Go	14 go trials (a central arrow with 2 squares on either side) and 6 no-go trials (a central arrow with 2 Xs on either side) were administered in a single block. Participants were told to click the mouse the arrow was pointing towards when the flanker stimuli were square, and to refrain from responding when the flanker stimuli were Xs.	Reaction time (ms) and Accuracy (percent correct) for congruent and incongruent trials	Computer, DirectRT
Proactive/ Retroactive Inhibition (RI/PI)	6 trials were administered. In each trial participants were read two sets of three words, and they were told to repeat these words after hearing each set. Participants were then asked to recall either the first three words (Retroactive Inhibition) or the last three words (Proactive Inhibition)	A count score out of 9 for RI items and out of 9 for PI items	Word List

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Task	Trials Administered / Stimuli	Data Scored	Materials
Simon Task	3 blocks were administered, each containing 12 trials. For each trial, A red or blue square appeared on either the right or left side of the screen. Participants had to sort the squares by colour, clicking the mouse under the line that matched the corresponding colour.	Reaction time (ms) and Accuracy (percent correct) for congruent and incongruent trials	Computer, DirectRT
Day Night Task	3 blocks, each containing 14 trials, were presented. Each trial consisted of an image of either a day or night card. In the first and third blocks, participants were to label the cards by their opposite names (e.g., "night" for a day card). In the second block the participants were to call the cards by their actual names.	Reaction time (ms) and Accuracy (percent correct) for congruent and incongruent trials	Computer, DirectRT
Opposite Worlds Task (Opp. Worlds)	A board with pigs and cows positioned along a path was shown. In the real world trials, cows and pigs were to be named by their actual names; In opposite world trials, they were to be named by their opposite names (e.g. "pig" for cow). Each condition was completed twice.	Reaction time (ms) and Accuracy (percent correct) for congruent and incongruent trials	Board, Stopwatch
Receptive Vocabulary	16 cards, each with 4 images (one in each quadrant), were presented sequentially. Individuals had to identify the image that best matched the word provided.	A count score out of 16	WIAT cards
Verbal Fluency	Participants were required to generate the names of as many types of foods as possible within 45 seconds. Bilingual participants also had to generate the names of as many animal names as possible (in their other language) in 45 seconds.	A count score based on words provided	Stopwatch, Recorder

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Task	Trials Administered / Stimuli	Data Scored	Materials
Memory Span	Strings of numbers are read orally and children are required to repeat the numbers in the correct order. Trials began with strings of 2 numbers and then increased by a single digit, with 2 trials presented at each string length. The task was discontinued when both trials at a given string length were incorrect.	A count score out of 16	Scoring Sheet

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Table 3

List of Source Monitoring Variables

Question Type	Acronym	Range	Explanation
Witness Discussed	WD	0 to 3	Events present in the video and discussed during post-event questioning
Witnessed Not Discussed	WND	0 to 3	Events present in the video but not discussed during post-event questioning
Not Witnessed Discussed	NWD	0 to 3	Events not in the video; participants encouraged to confabulate answer during post event questioning
Not Witnessed Not Discussed	NWND	0 to 6	Events not in the video; not previously discussed

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CHAPTER III

RESULTS

Preliminary Analyses

The Proactive and Retroactive Inhibition Task (Roberts & Powell, 2005) was dropped from analysis, as all participants performed poorly on the task. No participant answered all three retroactive words correctly within a single trial, and 80% of participants did not correctly recall any retroactive words. This reflects the finding by Roberts and Powell (2005) where 43 percent of their participants failed the retroactive inhibition pre-test, indicating a fundamental issue with the task construction.

The Go No-Go task was also dropped from analysis. The pattern of results observed, including errors on both the go and no-go trials and post error slowing following no-go errors, made it difficult to interpret the results, given the limited number of trials within the task.

Participants' reaction time (RT) data were screened for outliers on the remaining six inhibitory control (IC) tasks. Outliers greater than three standard deviations (SD) from the mean were identified and adjusted to 3 SDs from the mean (see Table 4). Average RTs were then calculated for each participant on the congruent and incongruent trials of each IC task; RTs for incorrect items were omitted from this analysis. The percentage of items answered correctly (PC) was calculated separately for congruent and incongruent trials on each measure. Average mean RTs and accuracy rates by language group are shown in Table 5.

Missing values were evident in the dataset, with missing data ranging from 2% to 8% across measures. All missing data points were due to technological failure, due to a

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Table 4

Outliers Greater than Three Standard Deviations and Missing Data

IC Measure	Trials per Task	Total Trials Adjusted	Missing Data / 95 Participants
Flanker	20	16 (across 12 participants)	4
Reverse Arrows	60	11 (across 8 participants)	4
Simon Task	36	13 (across 10 participants)	8
DCCS[1]	88	56 (across 38 participants)	5
Day Night Task	42	14 (across 8 participants)	4
Opposite Worlds	112	n/a	2

Note: Outliers are greater than three standard deviations from the mean
[1] Dimensional Change Card Sort

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Table 5

Mean Reaction Time (RT), Standard Deviation (SD), and Percent Correct (PC) for Monolingual and Bilingual Participants

	Monolingual			Bilingual		
IC Measure	Mean RT	(SD)	Percent correct	Mean RT	(SD)	Percent correct
Flanker Congruent	789.97	287.77	.94	941.42	497.63	.94
Flanker Incongruent	986.58	650.67	.89	1121.56	759.53	.90
Reverse Congruent	648.25	200.67	.94	655.02	279.31	.94
Reverse Incongruent	867.72	295.38	.94	900.35	501.22	.96
Simon Congruent	972.85	289.71	.93	975.28	446.37	.94
Simon Incongruent	984.54	339.23	.94	1067.55	581.86	.92
OW Congruent[1]	20.57	8.65	.97	20.98	11.28	.96
OW Incongruent[1]	25.99	11.15	.95	25.12	10.80	.95
DN Congruent[2]	1073.29	261.83	.94	1015.10	202.42	.94
DN Incongruent[2]	1369.29	379.46	.88	1208.67	227.90	.89
DCCS Congruent[3]	870.22	357.66	.89	937.57	340.73	.93
DCCS Incongruent[3]	968.29	298.59	.82	1060.94	393.74	.85

[1] Opposite Worlds Task
[2] Day Night Task
[3] Dimensional Change Card Sort

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computer freezing part way through administration, data save failures, or due to stopwatch errors. Analyses indicated that these values were missing at random in relation to the variables collected. (Little's MCAR $c^2(208, 95) = 177.74$, $p > .05$). The expectation-maximization algorithm (EM) in SPSS 19.0 was used to impute missing data, using Student's t to account for both the skewness and kurtosis of variables. EM assumes a distribution for the partially missing data and, using an iterative process, estimates the means, covariance matrix, and correlation of the variables with missing values. Accordingly, the EM algorithm supports parameter estimation to find the maximum likelihood estimates of the missing values. This is a suitable approach in situations where data is missing due to randomness. It should be noted, however, that although imputed values are considered to be "optimal statistical estimates", the statistic does not capture the residual variability that would have been present in the complete dataset (Enders 2001, p. 137). The Multiple Imputation procedure, which is designed to recover residual variability, was also run using SPSS 19.0, and the factor solutions across iterations were similar to that generated by the EM algorithm. Accordingly, the results of the EM were considered a valid estimate of the missing data for the current analysis.

Given variability in error rates, Inverse Efficiency Scores (IE scores) were computed to account for the potential speed-accuracy trade-off present within the data. IE scores combine RT and accuracy data into a single measure of performance by dividing a participant's mean RT by the percentage of responses answered correctly (Townsend & Ashby, 1983). Since analyzing RT and error rates separately complicate the interpretation of the data, researchers in experimental cognitive psychology have increasingly used the IE score to integrate these variables into a single dependent variable (Bruyer & Brysbaert,

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2011). Although Bruyer and Brysbaert (2011) maintained that “blind” use of IE scores can lead to interpretation problems due to the increased variability in scores, they advocated that IE scores can be valuable when there are few errors and when there is a high correlation between RT and the percentage of errors (PE). Pearson correlations were calculated for the current dataset, and the correspondence between RT and error was moderate (.32 to .47) across all measures other than the Simon Task, where the RT and PE were not significantly correlated. Accuracy rates ranged from 88.8 to 96.6 percent on congruent trials (*M* = 93.76, *SD* = 1.90) and from 82.0 to 96.3 percent on incongruent trials (*M* = 90.70, *SD* = 4.33). As a result of the error rates on the incongruent trials, analyzing only correct RT scores resulted in a skewed portrayal of participants' performance; not accounting for response patterns that emphasized speed over accuracy resulted in a score that suggested better performance than that actually attained.

IE scores were, accordingly, considered the best representation of the current data. IE scores were computed for all IC measures administered, for both congruent and incongruent trials (e.g., Flanker congruent RT / Flanker congruent PC). Although the Simon Task did not meet the suggested criteria for the utilization of IE scores, the score was calculated given the noted speed accuracy trade off, and assessed for inclusion in the exploratory factor analysis below. Difference scores were then calculated by subtracting the congruent IE scores from the incongruent IE scores for each measure. These difference scores are thought to reflect the degree to which inhibiting irrelevant information impedes performance. Higher scores indicate greater difficulty inhibiting irrelevant information. Mean IE scores for congruent and incongruent trials as well as IE difference scores are shown in Table 6 by language group.

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Table 6

Mean Inverse Efficiency (IE) Scores by Language Group

	Monolingual			Bilingual		
IC Measure	IE Cong.[1]	IE Incong.[2]	IE Diff.[3]	IE Cong.[1]	IE Incong.[2]	IE Diff.[3]
Flanker	903.51	1286.22	285.28	1086.69	1441.59	33.91
Reverse Arrows	702.07	944.13	240.21	716.76	950.90	232.48
Simon Task	1055.54	1057.79	2.26	1038.12	1169.48	128.62
Opposite Worlds	21.49	27.56	6.07	22.05	26.59	4.75
Day-Night	1156.43	1635.42	434.89	1091.25	1420.41	329.16
DSSC[4]	1063.92	1251.94	212.93	1017.29	1319.44	287.72

[1] Congruent
[2] Incongruent
[3] Difference
[4] Dimensional Change Card Sort

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Each variable was then screened for univariate outliers prior to any additional analyses. Outliers were defined as IE difference scores that fell more than three standard deviations (SDs) from the mean of the sample. Between 1 and 3 outliers were found on each variable. After ensuring that the data were entered correctly, each outlier was adjusted to 3 SDs from the mean, with multiple outliers placed .1 SD apart.

Exploratory Factor Analysis (EFA) – Hypothesis 1

An exploratory principal components analysis was conducted to determine whether the six measures of IC had the same or distinct sources of measurement variance. To assess the whether the data were appropriate for EFA, Pearson correlations were calculated between the six IE difference scores; all variables were correlated with at least one other variable, $r = .31$ or higher. Second, the Kaiser-Meyer-Olkin measure of sampling adequacy for all variables was .53, above the required value of .5 in order for the analysis to proceed, and Bartlett's test of sphericity was significant (χ^2 (94) = 103.79, $p < .001$), indicating that the relationships in the correlation matrix were not random. The communalities were further all above .35, confirming that each item shared common variance with the other items.

Principal components extraction with oblimin factor rotation (Delta = 0) was used to compute the factors underlying the different IC measures, due to expected factor inter-correlations. The principal component analysis was further selected as it transforms the original correlated variables into a smaller subset of uncorrelated variables, while maintaining most of the variance from the original data (Dunteman, 1989; Field, 2005). No a priori theory or model existed prior to analyses. Three factors were extracted with eigenvalues greater than 1, accounting for 72% of the variance prior to rotation. These

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factors additionally made theoretical sense based on the theoretical taxonomies proposed in the literature (refer to pg. 30). Each factor had at least one primary item loading at or above .88, and two factors had a second item loading over .79. No measures cross-loaded above .40.

Factor 1 was primarily influenced by high loadings of the Flanker and Reverse Arrows Tasks, with a moderate loading on the Simon task, and was used to create a variable labeled *resistance to distractor interference (Distractor Interference).* In these tasks, individuals are required to perform an action in response to the stimuli, while ignoring distracting or interfering information. This includes attending to the central arrow while ignoring the directionality of the surrounding arrows in the Flanker Task, ignoring the directionality of the arrow in the Reverse Arrows Task, and attending to the colour of the stimuli while ignoring the spatial location in the Simon Task.

Factor 2 was primarily influenced by a high loading of the Dimensional Change Card Sort, and was used to create a variable labeled *resistance to previous information (Resistance to PI)*. In this task, individuals were required to shift from attending to a specified feature of the stimuli (e.g., shape) in order to attend to an alternate feature (e.g., colour). Accordingly, in order to respond successfully, individuals had to attend to the new feature and resist responding to the feature they previously attended to.

Factor 3 was primarily influenced by high loadings of the Opposite Worlds and Day-Night Tasks, and was used to create a variable called *prepotent cognitive response inhibition (Prepotent Inhibition)*. In both of these tasks, individuals were required to deliberately suppress an automatic or prepotent response (correctly labeling pictures) in order to respond correctly (using the alternative names provided).

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These factors will be referred to by these descriptive labels hereafter. Scores on each factor were calculated using the regression method; all items contributed to each factor per their weight in the EFA. Lower scores on measures of IC indicate better performance, indicative of better performance on tasks requiring inhibition.

The Simon task was evaluated for its inclusion in the factor analysis. The factors remained stable without the inclusion of the task. However, given that the other measures loading on the resistance to distractor interference factor are similar in their presentation (the flanker task and reverse arrows task), having another that loads moderately (r = .40) on this factor, that also fits theoretically, provides additional evidence towards the presence of the factor.

The resistance to previous information factor was clearly unrelated to the other two factors (r = .18 and . 14). *Resistance to distractor interference* and *prepotent cognitive response inhibition* show a statistically significant yet small overlap in variance (~10 percent), indicating that each reflected a distinct source of variance. Factor loadings and factor intercorrelations for the resulting 3 factor model are presented in Tables 7 and 8, respectively.

Bilingualism and Inhibitory Control – Hypothesis 2

To test the primary hypotheses that bilingual children would be more proficient on tasks of inhibitory control (Hypothesis 2), mean scores were analyzed using a series of one way ANOVAs, assessing potential differences between monolingual and bilingual children on each IC factor. No differences were found in performance between language groups on Distractor Interference, Resistance to PI, or Prepotent Inhibition (all $p > .05$).

Verbal fluency was assessed to determine whether the bilingual participants had

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Table 7

Factor Loadings for IE Difference Scores - After Controlling for Outliers

	Distractor Interference		Resistance to PI		Prepotent Inhibition	
IC Measure	Pattern Matrix	Structure Matrix	Pattern Matrix	Structure Matrix	Pattern Matrix	Structure Matrix
Flanker	**.884**	**.854**	-.369	-.191	.116	.354
Reverse Arrows	**.826**	**.830**	.237	.372	-.119	.182
Simon Task	.402	.507	.266	.363	.173	.340
Opposite Worlds	.059	.198	.062	.180	**.789**	**.817**
Day-Night Task	-.074	.327	-.033	.077	**.914**	**.885**
Dimensional Change Card Sort	.009	.217	**.946**	**.954**	.049	.180

Note: Principal Components, oblimin rotation. Loadings > .70 are in bold face.

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Table 8

Factor Intercorrelation Matrix

Component	Distractor Interference	Resistance to PI	Prepotent Inhibition
Distractor Interference	1.000	.183	.326
Resistance to PI	.183	1.000	.135
Prepotent Inhibition	.326	.135	1.000

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similarly developed verbal abilities in both languages. Significant within subject differences were found, with English fluency scores (M = 11.81, SD = 5.39) exceeding the fluency scores in their alternate language (M = 7.67, SD = 4.79); t (42) = 6.20, $p <$ .001.

Further, no differences were found between language groups on any of the cognitive measures: memory span, F (1, 89) = .40, p = .530; verbal fluency, F (1, 88) = .67, p =.416; receptive vocabulary, F (1, 89) = .18, p =.674. Accordingly, subsequent analyses collapsed across language group.

Age, Inhibitory Control, and Source Monitoring – Hypothesis 3

Hypotheses 3 predicted positive correlations between age and both IC and source monitoring abilities, respectively. Age (in months) was significantly correlated with all three IC factors: distractor interference (r = -.46, p < .001); resistance to PI (r = -.23, p = .024); prepotent inhibition (r = -.46, p < .001), with older age corresponding with better performance (negative correlations on IC scores represents better performance). Correlations between age (in months) and source monitoring performance revealed a positive correlation between age and ability to correctly reject not witnessed not discussed events (r = .38, p < .001). Age was not significantly correlated with any of the other measures of source monitoring.

Gender differences were further evaluated to determine whether gender impacted performance on either IC or source monitoring. No significant differences in performance between gender groups were observed (see Table 9).

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Table 9

Correlations between Gender, Inhibitory Control (IC), and Cognitive Tasks

	Gender	Distractor[1]	Resistance	Prepotent[3]	Memory[4]	Receptive[5]	Word[6]
Gender	__						
Distractor[1]	.12	__					
Resistance[2]	.11	.18	__				
Prepotent[3]	-.13	.33*	.14	__			
Memory[4]	.04	-.28*	-.14	-.34**	__		
Receptive[5]	-.08	-.40*	-.09	-.36**	.37**	__	
Word[6]	-.13	-.37*	-.18	-.36**	.52**	.49**	__

[1] Distractor interference
[2] Resistance to PI
[3] Prepotent IC
[4] Memory Span
[5] Receptive Vocabulary
[6] Word Fluency

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Table 10

Frequency Distribution for Dependent Variables

Correct source attributions	WD	WND	NWD	NWND (yoked)	NWND (new)
0	—	—	.73	.31	.11
1	—	.09	.22	.43	.19
2	.06	.46	.05	.22	.31
3	.94	.45	—	.04	.39

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Predicting Source Monitoring with Inhibitory Control – Hypothesis 4

Data Screening

Prior to evaluating hypothesis 4, the source monitoring variables were evaluated to determine their suitability for subsequent analyses. Outcome variables included the number of events participants accurately endorsed as having been in the video clip the prior week (Witnessed Discussed, Witnessed Not Discussed) or correctly rejected as having not been present in the video clip the prior week (Not Witnessed Discussed, Not Witnessed Not Discussed). Tables 10 displays frequencies for each outcome variable.

The distribution of scores for the Witnessed Discussed events was negatively skewed and highly kurtotic, with 93.6% of participants correctly attributing all events to having been in the video, skewness = -3.58 (*SE* = 0.25), kurtosis = 11.06 (*SE* = .50). Given that almost every answer provided was correct, there was insufficient variability to warrant further analysis. Although the Witnessed Not Discussed and Not Witnessed Discussed variables were both highly skewed, there was a small distribution of responses and thus variance to predict; accordingly, these items were subjected to further analysis.

Further, to ensure the results of the Not Witnessed Discussed events were due to the process of discussing not witnessed (confabulated) information and not the questions themselves, paired-samples t-tests were conducted to determine whether the number of correct rejections differed when the same questions were provided to their yoked partner. There was a significant difference in the number of correct rejections between the Not Witnessed events that were discussed ($M = .11$, $SD = .19$) and not discussed ($M = .33$, $SD = .28$); $t(91) = 6.43$, $p < .001$, Cohen's $d = .84$. These results suggest that the effect

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observed when the Not Witnessed items were discussed was due to the process of generating false information and not the specific questions asked.

Given the restricted range of possible values for the Witnessed Not Discussed and Not Witnessed Discussed variables was limited (0 to 3), the ordinal logistic regression model was utilized. This approach is recommended since the outcome variable is made up of discrete categories that can be ranked. Further, logistic regression does not make any assumptions about the distribution of the variables and is thus robust to concerns around normality (Antonogeorgos et al., 2009). The Test of Parallel Lines was assessed for all analyses. No significant differences were found between the models that assumed separate planes and those that assumed parallel lines, confirming that the parallel lines assumption was met for each analysis.

Since the possible values of the correct rejections for Not Witnessed Not Discussed variable ranged over seven points, multiple linear regression was deemed an appropriate analytic approach.

These regression models tested the hypothesis that the relationship between age and source monitoring would be better accounted for by inhibitory control.

Witnessed Not Discussed Items

When examining the responses for items that were in the video that were not discussed during questioning, no predictor variables had a significant bivariate relationship with the outcome variable; age (β = -.01, *SE* = .01, *p* =.285), Distractor Interference (β = .14, *SE* = .20, *p* = .456), Resistance to PI (β = .26, *SE* = .21, *p* = .206), and Prepotent Inhibition (β = .08, *SE* = .22, *p* = .716). Results did not change when including age, IC, and the other cognitive variables in the same model, The pseudo-R^2s

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for all predictor variables were all small (Nagelkerke ranging from .005 to .022 across models).

Not Witnessed Discussed Items

When examining the questions about events that the participants provided confabulations for the prior week, none of the variables had a significant bivariate relationship with the dependent variable. This was the case for age (β = -.01, *SE* = .01, *p* = .600), Distractor Interference (β = -.05, *SE* = .23, *p* = .834), Resistance to PI (β = -.06, *SE* = .23, *p* = .803), and Prepotent Inhibition (β = -.15, *SE* = .26, *p* = .573). All of the pseudo-R^2 estimates for the predictor variables were very small (Nagelkerke ranging from .001 to .012), with all models equally predicting the observed categories. When age and the other cognitive variables were entered in the model simultaneously with each IC variable, the results remained unchanged.

Not Witnessed Not Discussed Items

Prior to conducting the analysis, data were screened to ensure the appropriateness of the statistical approach. Multivariate outliers were evaluated using the Mahalanobis distance statistic. One potentially influential multivariate outlier was identified on the Distractor Interference factor. Analyses were performed with and without this outlier. The inclusion of the outlier did not impact regression scores, and all cases were retained for analyses.

Probability plots for standardized residuals and standardized predictive values indicated that the residual error was distributed normally. Bivariate scatterplots showed that the relationships between the variables were linear and homoscedasticity was observed. Multicolinearity was further assessed, and all residuals in the model were

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adequately independent, as defined by correlation coefficients less than .50 and variance-inflation factors less than 2. Further, all values of the outcome variable were shown to be acceptably independent, with Durbin-Watson values equaling 1.61.

Correlations were run between age, the three IC factors, the three cognitive variables and the Not Witnessed Not Discussed variable (see Table 11). While Resistance to PI correlated with age, it did not correlate with the outcome variable and, accordingly, was not included in subsequent regression models.

Two regression models were run, one with IC first (Distractor Interference and Prepotent Inhibition together) to establish the degree to which IC uniquely predicts source monitoring performance for not witnessed not discussed events, and one with IC last to establish whether IC predicted variance in performance above that accounted for by age and other cognitive abilities. The first regression indicated that IC predicted substantial variance in the ability to correctly reject events that were not witnessed or discussed; $R^2 = .18$, $F\ (2, 85) = 9.02$, $p < .001$. The inclusion of the other cognitive factors and chronological age in the model added a small but non-statistically-significant amount of variance above that accounted for by IC (see Table 12).

To determine whether IC predicted variance in memory above that accounted for by the other variables, chronological age and the cognitive variables were entered into the model first. Chronological age significantly predicted variance in the ability to correctly reject events that were not witnessed or discussed: $R^2 = .14$, $F\ (1, 86) = 13.33$, $p < .001$. The cognitive measures added a small but non-statistically-significant amount of variance to the model on top of age; $R^2 = .19$, $F\ (3, 83) = 1.71$, $p = .171$. Entered last, IC predicted variance in memory above that accounted for by the other variables, supporting the

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Table 11

Correlations between Cognitive Ability, Age, and Correct Rejections to Not Witnessed Not Discussed Events

	NWND[1]	Age	Distractor[2]	Resistance[3]	Prepotent[4]	Memory[5]	Receptive[6]	Word[7]
NWND[1]	___							
Age	.38**	___						
Distractor[2]	-.36**	-.46**	___					
Resistance[3]	-.05	-.23*	.18	___				
Prepotent[4]	-.32**	-.46**	.33**	.14	___			
Memory[5]	.09	.52**	-.28**	-.14	-.34**	___		
Receptive[6]	.35**	.57**	-.40**	-.09	-.36**	.37**	___	
Word[7]	.26*	.71**	-.37**	-.18	-.36**	.52**	.49**	___

Note: Lower scores indicate better performance for Distractor IC, Resistance to PI, and Prepotent IC

**. Correlation is significant at the .01 level (2-tailed).
*. Correlation is significant at the .05 level (2-tailed).

1 Not Witnessed Not Discussed
2 Distractor interference
3 Resistance to PI
4 Prepotent IC
5 Memory Span
6 Receptive Vocabulary
7 Word Fluency

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Table 12

Multiple Linear Regression Model Summary (Inhibitory Control First)

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Distractor Interference	-.44	.16	-.28*	-.34	.17	-.22*	-.29	.17	-.19
Prepotent Inhibition	-.36	.16	-.23*	-.32	.17	-.20	-.26	.17	-.17
Memory Span				-.15	.11	-.17	-.18	.11	-.20
Receptive Vocabulary				.11	.06	.21	.09	.07	.16
Verbal Fluency				.02	.03	.09	-.00	.04	-.01
Age (in months)							.02	.01	.23
ΔR^2		.18			.03			.04	
F change		9.02**			3.10			1.53	
Sig *F* change		.00			.08			.21	

*p < .05. **p < .01.

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Table 13

Multiple Linear Regression Model Summary (Inhibitory Control Last)

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Age (in months)	.02	.01	.38**	.01	.01	.35**	.02	.01	.23
Memory Span				-.16	.11	-.18	-.18	.11	-.20
Receptive Vocabulary				.12	.07	.22	.09	.07	.16
Verbal Fluency				.00	.04	-.00	-.00	.04	-.01
Distractor Interference							-.29	.17	-.19
Prepotent Inhinition							-.26	.17	-.17
ΔR^2		.14			.05			.05	
F change		14.33**			1.71			2.92	
Sig. *F* change		.00			.17			.06	

*p < .05. **p < .01.

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argument that IC is important to this aspect of memory performance: $R^2 = .25$, $F(2, 81) = 2.92$, $p = .060$ (see Table 13). Semipartial correlations were further examined to determine the unique contribution of each independent variable within the model when all other variables were considered. The relationship between both Distractor Interference, Prepotent Inhibition and memory (not witnessed not discussed events) remained notable when all other variables were held constant: $R = -.16$ and -.15 respectively (see Table 14).

Distractor Interference and Prepotent Inhibition both influenced memory for not witnessed not discussed events with approximately the same magnitude.

Confidence Ratings – Hypothesis 5

Confidence ratings were evaluated to determine whether individuals with higher levels of IC have more confidence in their correct source attributions. Higher task switching abilities were correlated with lower average confidence in correct source attributions for witnessed events ($r_s = .21$, $p = .049$). IC ability was not significantly related to confidence ratings on any other source attributions.

It was further proposed that individuals with higher levels of IC would have lower confidence in their source attributions when endorsing misleading information. Higher Resistance to PI was significantly correlated with increased confidence when endorsing previously confabulated false events ($r_s = -.23$, $p = .037$). Higher Prepotent Inhibition, however, was significantly related to less confidence when endorsing previously confabulated false events ($r_s = .24$, $p = .024$). See Tables 15 and 16 for average confidence rating by question type.

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Table 14

Partial and Semi-Partial Correlations

	Model 1			Model 2			Model 3		
Variable	*Zero-order*	*Partial*	*Semi-partial*	*Zero-order*	*Partial*	*Semi-partial*	*Zero-order*	*Partial*	*Semi-partial*
Age (months)	.38	.38	.38	.38	.24	.22	.38	.16	.14
Memory Span				.09	-.16	-.15	.09	-.19	-.16
Receptive[1]				.35	.20	.18	.35	.15	.13
Verbal Fluency				.26	-.00	-.00	.26	-.01	-.01
Distractor[2]							-.36	-.18	-.16
Prepotent[3]							-.32	-.17	-.15

[1] Receptive Vocabulary
[2] Distractor Interference
[3] Prepotent Inhibition

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Table 15

Average Confidence Rating for Correct Source Attributions

Question Type	Mean	SD	n
Correct Hits for Witnessed Events	1.87	.24	89
Correct Rejections for Not Witnessed Not Discussed Events	1.34	.71	80
Correct Rejections for Not Witnessed Discussed Events	1.18	.74	49

Note: n = number of participants with at least one response provided

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Table 16

Average Confidence Rating for Incorrect Source Attributions

Question Type	Mean	SD	n
Rejections for Witnessed Events	1.25	.73	53
Endorsed Not Witnessed Not Discussed Events	1.20	.80	89
Endorsed Not Witnessed Discussed Events	1.76	.39	86

Note: n = number of participants with at least one response provided

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However, given previous research has not demonstrated that children younger than 5 years can successfully monitor how certain they are of their responses, analyses were run excluding the 4 year old participants. Without this age group, no significant relationship was found between IC and confidence.

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CHAPTER IV

DISCUSSION

The present study was designed to assess whether inhibitory control better accounts for source monitoring ability than chronological age. Analyses of the IC measures administered indicated that these measures did not assess a unified construct but rather three distinct abilities (Distractor Interference, Resistance to PI, and Prepotent Inhibition). Although bilingual children were included in the sample to attain a greater range of performance at each chronological age, as bilingual children have been shown to have more advanced inhibitory control abilities from a younger age, no group differences were found and analyses were collapsed across group. While IC abilities improved with age, the source monitoring results indicated that the majority of participants, irrespective of age, were able to correctly identify events they had witnessed (Witnessed Discussed, Witnessed Not Discussed). Conversely, most participants incorrectly attributed the events they confabulated to having been in the video (Not Witnessed Discussed). Distractor Interference and Prepotent Inhibition each significantly predicted the ability to correctly reject Not Witnessed Not Discussed events and, when combined with measures of memory span, receptive vocabulary, and fluid vocabulary, better predicted performance than when entered with age. IC was not correlated with participants' confidence in their source attributions.

Exploratory Factor Analysis

Prior to evaluating the relationship between inhibitory control, age, and source monitoring performance, analyses were completed to determine whether various measures of IC previously used in the literature reflected one construct. Although

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researchers have previously used these measures interchangeably, this study revealed that they do not assess a single unified construct. From the 6 measures included in the EFA analyses, three distinct constructs emerged, capturing different underlying abilities (distractor interference, resistance to PI, prepotent inhibition).

The measures that loaded onto the first component, *distractor interference*, all required participants to resist interference from information in the environment irrelevant to the task (flanker arrows, directionality, and spatial cues). The second component, *resistance to previous information (PI),* primarily consisted of the Dimensional Change Card Sort. This required individuals to resist intrusions from previously relevant information to attend to new features of the task. The flanker task, reverse arrows, and Simon task also had small loadings on this factor, suggesting that an element of resisting previous information is required to successfully complete these measures. The final component generated by the EFA was labeled *prepotent inhibition*, as the measures that loaded onto this component required participants to inhibit a prepotent verbal response and assign a different semantic label to the item.

These three components clearly capture distinct underlying abilities, which are consistent with the theoretical taxonomies proposed in the literature. Further, no distinctions have, to our knowledge, been made around different inhibitory functions in children. This research, using an exploratory model, resulted in latent variables consistent with previous taxonomies based on conceptual distinctions, thus providing support for these models. Additionally, the results provide evidence that suggests that these different functions develop independently from childhood.

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Consistent with Friedman and Miyake (2004), results indicated that distractor interference and prepotent inhibition were related, while neither of these constructs were related to resistance to PI. These constructs further differed in their relationship to source monitoring. This suggests that different types of interference (i.e., environmental and interference from memory), may involve different processes.

Future research should include consideration as to what types of IC makes the most theoretical sense given the research questions being asked. Further, researchers should evaluate both published and unpublished studies in which they failed to attain significant results to determine whether this may have been impacted by the specific type of IC task used. Examining past research would further provide valuable clinical information, as knowing the specific types of IC that are (and are not) related to different abilities would allow for a more comprehensive understanding of the constructs being assessed.

It would be of great value to continue to explore which measures of inhibitory control assess these different inhibitory factors. However, given the Flanker and Dimensional Change Card Sort have recently been standardized in the NIH toolbox (Weintraub et al., 2013), it would be more valuable to utilize these tools in the future rather than relying on independent tasks constructed based on face validity.

As well, no studies have yet been published with children that explore whether the IC measures commonly used in the literature were assessing the same construct. Confirmatory research is needed to verify the factor solution found in the current study. It is further possible that examining a larger or more diverse sample (e.g., individuals with ADHD, individuals with mild intellectual disabilities), or including additional measures

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of IC, may impact the factor solution. As well, the current research attended to a specific cross-section of development (ages 4-10 years), and the inclusion of individuals outside of this age range may also impact the results.

Bilingual Advantage

Bilingual participants were included in this study in attempt to increase the variability of IC performance at each age group. Nevertheless, no difference was found in performance between monolingual and bilingual children on the various IC measures assessed. Several factors may account for these findings. For one, the bilingual advantage has been shown to be more prevalent at younger ages, when monolingual children's inhibitory abilities are still poorly developed. Although differences in ability have been noted through adolescence, these differences in performance become less pronounced after 5 years of age (Bialystok, 2007). Dropping the 3 year olds from the sampling strategy may have influenced the ability to show significant differences between language groups. Further, even when evaluating the 4 and 5 year olds together, there are only 13 monolingual and 13 bilingual participants. Accordingly, an effect size greater than 1 would have been needed to detect the bilingual advantage reported in the literature. Given the small number of monolingual and bilingual participants at each chronological age group, the current study could not adequately assess whether a bilingual advantage was present. Future research assessing these variables with a large number of 4 and 5 year olds would be of benefit in answering this research question.

Although bilingual children have consistently been shown to perform worse than their monolingual peers on tasks of English verbal fluency and receptive vocabulary (Bialystok, et al., 2009), no group differences were found with the current sample.

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Further, bilingual children performed significantly better on the verbal fluency task when completed in English than when completed in their other language. Although this finding must be interpreted with caution, as comparing raw scores does not account for differences in the ease of the semantic categories provided, this raises question as to whether the bilingual sample was equally proficient in both languages, despite parental report.

It is possible that differences in resources to invest in education between the groups may have had an impact on the results. Whereas only 10 percent of bilingual participants were recruited from private schools or daycares, 48 percent of the monolingual participants were recruited from private institutions.

Relation Between Age and Outcome Variables

As expected, performance on the measures of IC improved with age. This was in line with prior research and converges with the developmental trajectory of the prefrontal cortex, as previously discussed (Diamond, 2002).

Results further demonstrated that age was associated with fewer false alarms for questions assessing novel false events (events not previously witnessed or discussed). Ackil and Zaragoza (1998) suggest that the tendency for younger children to incorrectly endorse events that have not been witnessed or discussed results from perceived familiarity due to the contextual similarity of the witnessed events. Accordingly, participants may confuse the novel false events with those they witnessed. It is also possible that this finding is associated with younger individuals answering more questions, whether or not the information was in the video. Although it is less clear what is impacting response style for these questions, it is evident that presenting questions

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about events that did not happen can lead to incorrect source attributions at the time of questioning.

Age did not, however, correlate as expected with the other source-monitoring abilities, due to ceiling and floor effects. All participants performed extremely well at correctly identifying events that they had witnessed, indicating that children as young as 4 years are relatively proficient at this ability. When the witnessed events were discussed following the presentation of the video, participants' accuracy rates further increased. Given this ceiling effect, no correlations were found between age and performance. This replicated previous findings showing that preschool children, school age children, and college participants were able to respond with almost perfect accuracy rates to true-event questions (Ackil & Zaragoza, 1998). It is further possible that these results may indicate that the items participants were asked about in the current study were too easy, as they focused on very salient central features of the video clips. It would be of value to assess children's ability to correctly identify more peripheral events or difficult items in future investigations.

Conversely, nearly all participants had significant difficulty rejecting the events that they confabulated the prior week. Although prior research has demonstrated that preschoolers perform disproportionately worse than older children and adults, with the older groups still demonstrating deficits (Ackil & Zaragoza, 1998), the majority of participants at all age groups endorsed that all of the confabulated events had occurred in the video; accordingly, no age differences were found. This finding provides further evidence for the assertion that individuals tend to integrate the answers that they generate during questioning into their memory for the event (Pezdek, Sperry, & Owens, 2007).

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This finding was not impacted when the participants initially hesitated or asserted that they did not recall the event that they were being asked to discuss. Accordingly, asking children to voice what might have happened or to guess what could have happened, a process that still requires participants to answer with self-generated misinformation, yielded similar results.

This absence of age-related differences in the participants' tendency to misattribute their confabulated items to the video may have been impacted by several different factors. For one, the interval between the initial event and subsequent misinformation was brief (5-10 minutes), which may have made it more difficult for individuals to discriminate between events given the temporal similarity during retrieval (Nairne et al., 1997; Bright-Paul & Jarrold, 2009). Further, participants received the suggestion that the events did happen. This, combined with children's general deficit in their ability to discriminate between similar sources, may have resulted in further difficulty with source discriminations. Johnson, Hashtroudi, and Lindsay (1993) have additionally maintained that individuals use different judgment criteria when evaluating the source of retrieved information, depending on the perceived importance of the accuracy in their responses. Given the rationale for correct identifications was to determine which games to play with the participants, it is possible that lenient judgment criterion was utilized when retrieving information about the witnessed event, as incorrect answers may have been perceived as having few ramifications. Further research is needed to evaluate the impact that these different factors have on children's tendency to endorse previously confabulated information.

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Evaluating Inhibitory Control and Age as Predictors of Source Monitoring

To determine whether IC better predicted source monitoring than age (hypothesis 4), analyses were conducted to determine whether IC uniquely contributed to the ability to correctly reject events that had not been witnessed or discussed when controlling for chronological age. Results indicated that distractor interference and prepotent inhibition predicted additional variance that was not accounted for by age, suggesting that these two processes significantly contribute to this aspect of source monitoring.

Nevertheless, given that both IC and memory performance are expected to increase with age, the previous analyses may have been limiting in that age may have acted as a suppressor variable. Analyses were subsequently conducted to assess the unique contribution of IC when controlling for other cognitive abilities, which also showed substantial increase with age (receptive vocabulary, verbal fluency, and memory). Results indicated that distractor interference and prepotent inhibition each added significant predictive variance above the other cognitive factors. This provided further support for the unique contribution of these inhibitory abilities in the ability to correctly reject events that had not been witnessed or discussed.

This supports the assertion in the literature that less developed inhibitory abilities may contribute to individuals' susceptibility to novel information, as they may have greater difficulty inhibiting similar mental representations from adjoining with one another during retrieval, especially if initial encoding is weak. This, together with difficulty inhibiting information based on familiarity, may result in individuals being unable to refrain from providing the response suggested by the interviewer. The present study provides evidence that distractor interference and prepotent inhibitory abilities

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contribute to the ability to reject misleading information. The importance of these two types of inhibitory control specifically may be due to the importance of inhibiting unrelated stimuli in the environment (i.e., the events during the source monitoring test) from becoming integrated with the initial representation of the event.

These results further support and clarify previous research that has assessed the implications of inhibitory control on source monitoring abilities. Ruffman et al. (2001) and Alexander et al. (2002) both maintained that more developed inhibitory abilities were associated with avoiding false alarms. Although the measures of IC used within their studies differed from those used in the current study, one involved a task in which individuals were required to inhibit misleading visual information, while the other task (a different version of the day-night task) required inhibition of verbal inhibition. While Roebers and Schneider (2005) failed to find evidence supporting the influence of inhibitory ability on source monitoring, it is possible that this could be attributable to the tasks of IC utilized, as they primarily assessed inhibition of a prepotent behavioural response (e.g., tapping). Although behavioural inhibition was not assessed within the current study, future research is needed to better determine how this type of inhibitory process relates to the factors generated within this study and source monitoring abilities.

Confidence Ratings

Results of the current study demonstrated that inhibitory abilities did not significantly correlate with participants' confidence in their correct source attributions (hypothesis 5). These results were consistent with those reported by Ruffman et al. (2001). Although significant correlations were noted when the 4 year old participants were included in the analysis, research has not demonstrated that children this young can

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successfully monitor confidence in their responses, and these results were, accordingly, deemed invalid.

Qualitatively, most children provided high confidence ratings when endorsing confabulated events, demonstrating that they were not aware of their incorrect source attributions. Participants were slightly less confident when endorsing or rejecting events that had not been witnessed or discussed, indicating that there was a greater awareness that they may be incorrect in their source attributions. Nevertheless, despite these patterns of responding, the confidence ratings were not significantly related to inhibitory abilities.

Although distractor interference and prepotent inhibition accounted for some of the predictive variance in source monitoring abilities for items that had not been witnessed or discussed, the process by which individuals inhibit irrelevant information from being integrated into their memories likely occurs nondeliberatively. Even when children's recollections are influenced by inhibitory processes, children within the age ranges assessed may base their reported confidence more on feelings of familiarity. Further research, however, is required to elucidate these findings.

Implications

The current study provides further evidence that children who generate information during post-event questioning tend to integrate this information into their subsequent memory of the event; this was true regardless of age or inhibitory ability. Although previous research suggests that adults are also prone to this source monitoring error (Pezdek, Sperry, &Owens, 2007; Zaragoza et al., 2001; Ackil & Zaragoza, 1998), children have consistently been shown to experience greater difficulty, with the current results suggesting that children 10 years and under experience significant impairment.

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This has several implications for individuals working with children. Encouraging children to answer questions they are not sure of, or asking direct questions about an event, can impair the ability to accurately recall the witnessed event. Accordingly, different approaches to eliciting information from children should be explored. The current research suggests that it is more advantageous to have children engage in free recall directly after witnessing the event to avoid introducing new information or prompting individuals to generate information not witnessed; this recommendation is consistent with best practice models for interviewing children (Poole & Lamb, 1998; Lamb et al., 2008). This approach may further be beneficial as results of the current study showed that discussing witnessed events directly after being exposed to them lead to an increase in later recognition when compared to witnessed events that were not discussed. If questioning is required, it may be advantageous to wait until a later time to increase the temporal distinctiveness of the two events, however further research would be needed to elucidate these findings.

As well, the current study suggests that individuals with poorer inhibitory abilities have greater difficulty discriminating between witnessed and novel events during questioning after a week delay. Within the context of the current study, this may have been a result of the perceived plausibility of the novel events, as all presented events were things that could have happened given the context of the clips shown. It is likely that individuals with less developed inhibitory abilities rely to a greater extent on a sense of familiarity, thus making it more difficult to distinguish between witnessed and plausible events. Accordingly, assessing specific inhibitory functions, specifically distractor interference and prepotent inhibition processes, may provide a more sensitive method of

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determining which children are able to answer questions about a witnessed event with greater accuracy, than relying on chronological age. Additional research is needed, however, to support this assertion.

Deficits in inhibitory control have further been implicated with several psychiatric disorders, including Attention Deficit Hyperactivity Disorder (ADHD) and Obsessive Compulsive Disorder (OCD). Research on ADHD has documented that inhibitory deficits are a central feature of this disorder, and likely impact several of the other cognitive features observed within the disorder (Friedman & Miyake, 2004; Durston, 2003; Barkley, 1997). Individuals diagnosed with ADHD have been shown to experience difficulty inhibiting extraneous information, movement, as well as prepotent behaviours (Schachar et al., 2000; Nigg, 2001; Gaulney et al., 1999). Notwithstanding, few studies have examined different types of cognitive inhibition within this population (Friedman & Miyake, 2004).

Poor inhibitory abilities have also been implicated in Obsessive Compulsive Disorder (OCD), which is characterized by obsessions and compulsions that are intrusive and result in heightened levels of distress (APA, 2000). It has been hypothesized that this may be in part related to impairments in inhibitory abilities, which manifest in an inability to suppress both the intrusive thoughts and compulsive behaviours (Chamberlain et al., 2005; Friedman & Miyake, 2004). Patients with OCD have been shown to have difficulties on tasks requiring response inhibition (Penades et al., 2007; Bannon et al., 2002) as well as the Stroop task (Penades et al., 2005). Mataix-Cols et al. (2004) further propose that different types of IC may underlie different symptoms in this population.

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Studies assessing different types of anxiety have shown mixed results, which may have been impacted by the IC measures utilized within the study.

It is important to determine what types of inhibitory abilities are impaired within these populations in order to better understand the types of inhibitory deficits present, as this would have implications regarding both diagnosis and treatment. One key feature of ADHD is inattention, defined as an inability to pay close attention to details, difficulty sustaining attention, and being easily distracted by extraneous stimuli (APA, 2000). This feature may be specifically related to a deficit in the ability to inhibit distracting information (distractor interference). The hyperactive and impulsive features of the disorder, including talking excessively, blurting out responses, and difficulty awaiting turns, may be more related to a deficit in prepotent inhibition, as individuals are unable to inhibit their instinctive responding. It could further be hypothesized that the symptomology within OCD may be more related to deficits in prepotent inhibition given the intrusive nature of the obsessions and compulsions. Understanding the specific type of inhibitory deficits associated with different disorders would allow for a more specific assessment protocol and a more thorough way of understanding the associated deficits of the disorder. Further, this would allow treatment approaches to be more targeted and ensure that they are attending to the actual deficits present within the population.

Limitations and Future Directions

The results of the current study provide compelling evidence that distractor interference and prepotent inhibition contribute to the ability to monitor source for events that have not been witnessed or discussed (novel events). Although previous studies have begun to establish the association between IC and source monitoring, the current

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literature is sparse and few studies have evaluated the relationship between these factors (El Haj & Allain, 2012). The current results begin to elucidate the specific types of inhibition that may underlie this relationship. These results, however, demand replication. Further, there were some limitations inherent in the present study that should be addressed in future studies.

For one, the current study utilized non-clinical sample. Given this, it is possible that the components that emerged within the principal components analysis were skewed by this sampling. Accordingly, a confirmatory factor analyses is necessary to determine whether these three factors continue to emerge when including children with a wider range of abilities.

It would further be valuable to assess the convergent and divergent validity of the measures, relative to other established psychometric measures, to determine whether the tasks are assessing the processes hypothesized within the current study. Accordingly, it would be beneficial to administer additional tasks that have been reported to assess the same underlying processes, as well as those assessing different processes that might alternatively explain the variance in performance.

Although several inhibitory tasks have been developed and used for individual studies, these measures have not been validated and it remains unknown what they are actually assessing. The use of established measures would allow for a more clear understanding of the constructs being assessed. Three tasks thought to assess different inhibitory processes include: the stop signal paradigm (Logan and Cowan, 1984), which has been reported to assess prepotent inhibition, as individuals are required to withhold a prepotent response when a tone is presented; the cancellation task on the Wechsler

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Intelligence Scale for Children – 4th edition (WISC-IV), which requires individuals to identify target images as quickly as possible while resisting interference from distractors; and the Children's Auditory Verbal Learning Test -2 (CAVLT-2; Talley, 1993), which requires individuals to inhibit an initial set of words (previous information) to recall the new world list. By evaluating whether these tasks correlate with the current measures, it would elucidate whether they are theoretically similar or unrelated, thus providing additional evidence as to what the different latent variables are measuring.

It would further be necessary to administer measures of memory and attention to ensure that other areas of executive function do not overlap excessively with the IC factors observed in the current study. For example, differences in controlled attention may result in the ability to maintain information amidst distraction. Tasks including the dot locations and stories subtests on the Children's Memory Scale (CMS-IV) would help discern whether visual or verbal memory are responsible for the different latent constructs. The dot location subtest requires individuals to recall the location of several dots after a short and long delay, while the stories subtest requires individuals to recall a short story after a short and long delay. Including the backwards digit span and symbol search from the WISC-IV would further assess working memory and visual processing, respectively.

Given the methodological challenges often encountered within developmental research, whereby age masks individual differences, the use of a clinical sample (e.g., ADHD, mild intellectual disabilities, gifted designation) could help disentangle the effect of inhibitory control from normative age trends. This would further explicate whether IC acts as a better predictor of source monitoring performance than chronological age.

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Given that the current study had a limited number of participants at each chronological age, it was not feasible to explore within age differences. Including a larger number of participants at each chronological age would allow these additional analyses. Expanding the age range to test slightly older children would also be of value, as it would clarify the points at which children become less susceptible to source confusion.

Additionally, the ceiling and floor effects observed within the current source monitoring task suggest that the true events were too easy, given they asked about salient information, while all participants performed poorly when required to confabulate information. Providing questions that attend to less salient information may allow for greater variability in responses and, subsequently provide a more thorough understanding of the processes required to successfully monitor source for these questions. Controlling for plausibility of the events presented may further provide valuable information in this process.

Additionally, participants within the current study were told that the events that they had to confabulate responses for did transpire within the film. It would be valuable to assess the impact that this suggestion may have on responding and subsequent source confusion.

Despite these limitations, the results of the current study contribute to better understanding the cognitive factors that contribute to source monitoring abilities within children. Further, the results provide evidence that these cognitive factors, including visual and verbal inhibitory control, may provide a more sensitive assessment of children’s ability to provide accurate accounts of witnessed events than chronological age. These results require replication.

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Appendix A

Notice of Research Opportunity

University of Windsor

NOTICE: RESEARCH OPPORTUNITY

We would like to let you know about a research study being conducted at the University of Windsor by Dana Shapero, a graduate student from the Psychology Department. Included in this package you will find a letter of information outlining the study (for you to keep), a consent form (which contains the same information as the "letter of information" but must be signed and returned), and a language proficiency questionnaire (to help us determine whether your child is eligible for the study).

In short, the research would consist of meeting with your child at their school or daycare on two occasions. First, they would **watch a brief video** (from a 1995 family feature film) and discuss what they watched with a research assistant. On the second occasion they would, again, **discuss the video**, and then engage in **several games** meant to assess their cognitive abilities. In appreciation for their time, they will receive a **toy from a "thank you box"** following the first session, and a coupon for a **free McDonald's Happy Meal** following the second session. As well, for simply returning the forms, you will be entered into a draw for one of three **Family Fun Prizes**! We are only working with 12 children at each age group, so please return your form as soon as possible if you are interested in having your child take part in the study.

In order to participate, you must return the consent form (with both pages signed) and the language proficiency questionnaire. Once we work with 12 children at a given age, no more testing will occur for children at that age – even if you have provided consent. You will, however, still be entered into the draw for the family fun prizes.

Prior to signing the consent forms, please ensure that you read all information pertaining to the study, including the stated **criteria for participation**. If your child does not meet the listed criteria, we will not be able to work with them. If you have any questions, you can contact Dana Shapero directly by email at shapero@uwindsor.ca or by phone at either (---) --------- or (---) ---------. If you have any additional questions or concerns, you may also contact Dr. Alan Scoboria, the faculty supervisor for this study, at (---) --------- (extension ----), or by email at scoboria@uwindsor.ca. Please note that you do not need to provide consent, and participation in the study is completely optional.

Thank you for your time, and please know that any assistance would help greatly in better understanding children`s abilities.

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Appendix B

Notice of Research Opportunity – French

AVIS: DEMANDE DE PARTICIPANTS POUR UN PROJET DE RECHERCHE

Nous désirons vous informer d'une étude qui se déroule à l'Université de Windsor, et qui est entreprit par Dana Shapero, une étudiante au niveau doctorat dans le département de Psychologie. Dans ce paquet vous trouverez une lettre d'information décrivant l'étude, un formulaire de consentement qu'on vous demande de signer et de nous retourner, et un questionnaire pour déterminer la maîtrise du langage de votre enfant (qui nous aidera à déterminer si votre enfant se qualifie pour participer dans notre étude).

L'étude consistera de deux rencontres avec votre enfant à leur école ou à leur garderie. Premièrement, il/elle **écoutera un court vidéo** (d'un film de 1995, approprié au niveau familial) et il/elle discutera ce qu'il/elle avait vu avec l'assistante de recherche. Pour la deuxième rencontre, il/elle va encore une fois **discuter le vidéo,** et par après, participera dans **plusieurs jeux** qui ont comme intention d'évaluer leurs habilités cognitifs. Pour le/la récompenser pour son temps, votre enfant recevra un **jouet de la "boîte merci"** pour la première rencontre et un coupon pour un **Repas Joyeux Festin de McDonald gratuit** pour la deuxième. En plus, simplement pour avoir retourné le formulaire, vous serez inscrits dans un tirage pour un de trois **Prix d'amusement de famille**! Nous avons de la place pour seulement 12 enfants par groupe, donc s'il vous plaît retournez votre formulaire aussitôt que possible si vous êtes intéressés d'avoir votre enfant comme participant dans l'étude.

Pour pouvoir y participer, vous devez retourner le formulaire de consentement (avec les deux pages signées) et le questionnaire de la maîtrise du langage. Malheureusement, une fois que nous avons rempli les places pour un groupe d'enfant d'un certain âge, il n'y aura plus de places disponibles pour les prochains tests avec des enfants de cet âge – même si vous avez donné votre consentement. Par contre, vous serez quand même inscrit dans le tirage pour les prix d'amusement de famille.

Avant de signer le formulaire de consentement, s'il vous plaît assurez-vous d'avoir lu toutes les informations concernant l'étude, incluant les **critères énoncés pour participation**. Si votre enfant ne rencontre pas les critères listés, l'enfant ne sera pas éligible pour cette étude. Si vous avez des questions, vous pouvez contacter Dana Shapero directement par courriel à shapero@uwindsor.ca ou par téléphone au (---) --------- or (---) ---------.. Si vous avez d'autres questions ou préoccupations, vous pouvez aussi contacter Dr. Alan Scoboria, le superviseur de l'étude ainsi que membre de la faculté universitaire au (---) --------- (poste ----), ou par courriel à scoboria@uwindsor.ca . S'il vous plaît notez que vous n'êtes pas obligés de donner votre consentement et votre participation dans cette étude est complètement volontaire.

Merci pour votre temps, et s'il vous plaît sachez que votre assistance aidera grandement à mieux comprendre les habiletés d'enfants.

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Appendix C

Consent Forms for Participation and Audio Taping

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: **Children and Memories**

We would like to ask for your permission to allow your child to participate in a research study conducted by Dana Shapero, a graduate student from the Psychology Department at the University of Windsor. Results from this study will contribute to Ms. Shapero's dissertation research. Several qualified undergraduate research assistants, all of whom have extensive work experience with children and whom have obtained police clearance for the purpose of this study, will be assisting in the administration of the procedures.

You can contact Dana Shapero directly at shapero@uwindsor.ca or by phone at (---) ---------- If you have any additional questions or concerns about the research, please feel to contact Dr. Alan Scoboria, the faculty supervisor for this study, at (---) --------- (extension ----), or by email at scoboria@uwindsor.ca.

PURPOSE OF THE STUDY

This study is being conducted to better understand the relationship between children's cognitive abilities, language, and memory.

PROCEDURES

If you agree to allow your child to participate in this study, we would ask them to do the following things: (Please do not share this information ahead of time with your child, as it may impact how they respond during the study)

Meeting one (totalling approximately 20 minutes):

1. Your child will watch two short movie clips, totalling 9 minutes, from a 1995 family feature film produced by 20th Century Fox.
2. Your child will answer some questions for a research assistant about the clips that they just watched.

Meetings two – one week later (totalling approximately 30-40 minutes):

3. Your child will meet with another research assistant to answer a few additional

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questions about the film.

4. Your child will engage in activities and games that are commonly used to assess children's cognitive and language abilities. These activities will include some computer games, as well as other activities and games that present pictures on a Bristol Board or that will require children to engage in a spoken word game.

POTENTIAL RISKS AND DISCOMFORTS

There are no foreseeable risks, discomforts, or inconveniences, be they physical, psychological, emotional, financial, or social, associated with this research. However, depending on when we work with your child, if it is during a work period at school, they may have to complete some of their school work for homework. No instruction time will be missed during participation in this study.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

This research will aid us in better understanding the processes impacting children's abilities to accurately recount previously experienced events. Although participants may not benefit directly from the sessions, the knowledge gained as a result of this research may impact researchers and teacher's understanding of these developmental abilities, which may in turn affect various institutions (e.g., legal, educational) and their practices.

PAYMENT FOR PARTICIPATION

1. Children will receive a small token in appreciation for their assistance in the first session. They will be able to select this from the "thank you box", which will include items such as pencils and stickers. Individuals will receive this compensation even if they decide to withdraw their participation during this session.
2. Following participation in the second session, children will receive a gift certificate redeemable for a Happy Meal at McDonalds. Upon completion of the study, your family will be entered into a draw to win 1 of 3 Family Fun Prizes, which can include either a $40 gift card for XS Family Fun Centre (choice of mini golf, laser tag, go carts, batting cages, or an arcade), a $40 Cineplex Odeon gift certificate, or a $40 Swiss Chalet gift card.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with your child will remain confidential and will be disclosed only with your permission. Once your child has completed both of their sessions, all identifying information will be removed and their sessions will be labelled with a random number. Your child's responses will therefore be anonymous once they are done the study.

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With your permission, we will also be audio recording the sessions with your child to ensure that the answers that your child provides will be recorded accurately. All identifying information will be removed from these files, and the recording will be assigned the same random number as the rest of your child's responses. Once your child's answers are transcribed and verified, these audio files will be destroyed.

Once the data is collected, there is no method by which we can link the data to your child. Informed consent forms and assent forms will be stored separately from the data in a locked filing cabinet; these forms will be retained for six years and then will be destroyed. Any reports or publications produced from this research will be general in nature, and will not specifically refer to any individual participant's responses. Paper records of data will be destroyed after the dissertation is defended. No information

regarding your child's participation in this study will be released. The only exception is if your child indicates that someone has been hurting them. If a research assistant suspects that your child is being hurt or abused, we will need to contact you and/or other authorities to ensure that your child is safe.

This data will only be accessible to individuals directly involved in this research project, including research assistants, the primary researcher, and the researcher's faculty advisors.

PARTICIPATION AND WITHDRAWAL

You can choose whether you want your child to be a part of this study or not. If you do choose to give permission to your child, you may withdraw this permission at any time without consequences of any kind. Your child will also be asked whether they want to participate the study if you provide your consent. If your child does not agree to participate, they will not engage in the sessions. If your child agrees to participate, they will be able to withdraw from the study at any time without consequences. Your child may also refuse to answer any questions they do not want to answer and still remain in the study. You or your child may also choose to withdraw their information at to 48 following the completion of their last session by calling or emailing Dana Shapero. After this point, their information will become anonymous, and withdrawal of the information will not be possible.

There is the possibility that, based on the information that you provide us, that your child may not qualify for the study, as we are looking to work with a specific population. If this is the case, we will not be able to work with your child as a part of this study. However, to thank you for your interest, your child will still be entered into the draw to win one of the Family Fun Prizes, if you desire.

As well, we need to ensure that none of the children we are working with have previously seen the movie Dunston Checks In. If your child has seen this movie, they are not eligible for participation in this study. Please ensure that if you do return this consent form, you are indicating that your child has not seen this movie and will not see it prior to their

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participation in our study as this would jeopardize the validity of our results. As well, please do not share the name of this movie with your child prior to the time in which they participate in the study.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE SUBJECTS

Research findings will be made available to all interested parties upon completion of the study, on the Research Ethics Board web site (www.uwindsor.ca/REB). These results will be available as of December 01, 2011.

SUBSEQUENT USE OF DATA

This data may be used in subsequent studies.

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. If you have questions regarding the rights of your child as a research subject, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF RESEARCH SUBJECT/LEGAL REPRESENTATIVE

I understand the information provided for the study **Children and Memories** as described herein. My questions have been answered to my satisfaction, and I agree to allow my child to participate in this study. I have been given a copy of this form.

______________________________ ______________________________

Name of Subject (child) Child's birth month/year

______________________________ ______________________________

Signature of Parent or Legal Guardian Date

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

______________________________ ______________________________

Signature of Investigator Date

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University of Windsor

CONSENT FOR AUDIO TAPING

Child's/Research Participant's Name: ___________________________

Title of the Project: Children and Memories .

I consent to the audio-taping of my child during the procedures involved in this study, as outlined in the letter of information provided to me. I understand that you would like to audio record these sessions to ensure that the answers that my child provides will be recorded accurately.

I understand these are voluntary procedures and that my child will be told that they are free to withdraw at any time by requesting that the taping be stopped. I also understand that my child's name will not be revealed to anyone and that taping will be kept confidential. All tapes will be filed by number only and will be stored in a locked cabinet. I also am aware that once my child's answers are transcribed and verified by a research assistant, these files will be destroyed.

I understand that confidentiality will be respected and that the audio tape will be for professional use only. Tapes will only be accessible to individuals directly involved in this research project, including research assistants and the researcher's faculty advisors.

_______________________________ _____________________

Signature of Parent or Guardian Date

_______________________________ _____________________

Research Participant Date

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Appendix D

Child Assent Form

Assent for Children Aged 3 to 10 Years

I am a student who is helping a researcher at the University of Windsor with one of their projects. If you are interested, I would like to have you help us out with this project. As a part of it, you will be asked to watch some clips from a movie and then answer some questions for me. You will also have a chance to do some activities next week, like playing games on a computer.

I also have a voice recorder here with me that we would have on whenever you are with me or one of the other university students. This is just so we can remember everything you say during our time together. I definitely do not want to forget any of your answers.

Once we have finished working with all the kids who agree to be in this study, the researcher I am working for will write a report on what they have learned. This information could be really helpful in better understanding what kids are able to do. Their teachers will read this report, and the information might even be put in a book, but no one will know who the kids were that were a part of these activities.

I also want you to know that I will not be telling your teachers or parents or any other kids the answers you give me or how you do on any of the activities. Only the researcher that made this project will hear about our time together. The only exception is if you tell me that someone has been hurting you or that someone else has a chance of getting hurt. If I think that you are being hurt or that someone else is at risk for being hurt, I will need to tell your parents or someone else who can help. Otherwise, I promise to keep everything else that we do together private and, as I said, I will only share this information with the researcher that I am working for.

Your mom or dad has said that it is okay for you to do these things with me, but it is entirely up to you - you can say yes or no. You won't get into any trouble if you say no. If you decide to help out by doing these activities with us, you can stop at any time, and you don't have to answer any questions that you do not want to answer. If you help us out, even if you don't answer all of the questions, I will give you a small prize when you leave today, and if you also help out with the activities next week, you will get a gift certificate for a McDonald`s Happy Meal and you`ll be entered into a draw to win one of here Family Fun Prizes. Would you like to be a part of these activities?

I understand what I am being asked to do to be in this study, and I agree to be in this study.

______________________________ ________________________

Name Date

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Appendix E

Letter of Information

LETTER OF INFORMATION

Title of Study: **Children and Memories**

We would like to let you know about a research study being conducted at the University of Windsor by Dana Shapero, a graduate student from the Psychology Department. Results from this study will contribute to Ms. Shapero's dissertation research. Several qualified undergraduate research assistants, all of whom have extensive work experience with children and whom have obtained police clearance for the purpose of this study, will be assisting in the administration of the procedures.

Information pertaining to the study is detailed below. If you have any questions or are interested in participating in the study, you can contact Dana Shapero directly by email at shapero@uwindsor.ca or by phone at (---) ---------. If you have any additional questions or concerns, you may also contact Dr. Alan Scoboria, the faculty supervisor for this study, at (---) --------- (extension ----), or by email at scoboria@uwindsor.ca.

PURPOSE OF THE STUDY

This study is being conducted to better understand the relationship between children's cognitive abilities, language, and memory.

PROCEDURES

If you agree to allow your child to participate in this study, we would ask them to do the following things: (Please do not share this information ahead of time with your child, as it may impact how they respond during the study)

Meeting one (totalling approximately 20 minutes):

5. Your child will watch two short movie clips, totalling 9 minutes, from a 1995 family feature film produced by 20th Century Fox.
6. Your child will answer some questions for a research assistant about the clips that they just watched.

Meetings two – one week later (totalling approximately 30-40 minutes):

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7. Your child will meet with another research assistant to answer a few additional questions about the film.
8. Your child will engage in activities and games that are commonly used to assess children's cognitive and language abilities. These activities will include some computer games, as well as other activities and games that present pictures on a Bristol Board or that will require children to engage in a spoken word game.

POTENTIAL RISKS AND DISCOMFORTS

There are no foreseeable risks, discomforts, or inconveniences, be they physical, psychological, emotional, financial, or social, associated with this research. However, depending on when we work with your child, if it is during a work period at school, they may have to complete some of their school work for homework. No instruction time will be missed during participation in this study.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

This research will aid us in better understanding the processes impacting children's abilities to accurately recount previously experienced events. Although participants may not benefit directly from the sessions, the knowledge gained as a result of this research may impact researchers and teacher's understanding of these developmental abilities, which may in turn affect various institutions (e.g., legal, educational) and their practices.

PAYMENT FOR PARTICIPATION

3. Children will receive a small token in appreciation for their assistance in the first session. They will be able to select this from the "thank you box", which will include items such as pencils and stickers. Individuals will receive this compensation even if they decide to withdraw their participation during this session.
4. Following participation in the second session, children will receive a gift certificate redeemable for a Happy Meal at McDonalds. Upon completion of the study, your family will be entered into a draw to win 1 of 3 Family Fun Prizes, which can include either a $40 gift card for XS Family Fun Centre (choice of mini golf, laser tag, go carts, batting cages, or an arcade), a $40 Cineplex Odeon gift certificate, or a $40 Swiss Chalet gift card.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with your child will remain confidential and will be disclosed only with your permission. Once your child has completed both of their sessions, all identifying information will be

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removed and their sessions will be labelled with a random number. Your child's responses will therefore be anonymous once they are done the study.

With your permission, we will also be audio recording the sessions with your child to ensure that the answers that your child provides will be recorded accurately. All identifying information will be removed from these files, and the recording will be assigned the same random number as the rest of your child's responses. Once your child's answers are transcribed and verified, these audio files will be destroyed.

Once the data is collected, there is no method by which we can link the data to your child. Informed consent forms and assent forms will be stored separately from the data in a locked filing cabinet; these forms will be retained for six years and then will be destroyed. Any reports or publications produced from this research will be general in nature, and will not specifically refer to any individual participant's responses. Paper records of data will be destroyed after the dissertation is defended. No information

regarding your child's participation in this study will be released. The only exception is if your child indicates that someone has been hurting them. If a research assistant suspects that your child is being hurt or abused, we will need to contact you and/or other authorities to ensure that your child is safe.

This data will only be accessible to individuals directly involved in this research project, including research assistants, the primary researcher, and the researcher's faculty advisors.

PARTICIPATION AND WITHDRAWAL

You can choose whether you want your child to be a part of this study or not. If you do choose to give permission to your child, you may withdraw this permission at any time without consequences of any kind. Your child will also be asked whether they want to participate the study if you provide your consent. If your child does not agree to participate, they will not engage in the sessions. If your child agrees to participate, they will be able to withdraw from the study at any time without consequences. Your child may also refuse to answer any questions they do not want to answer and still remain in the study. You or your child may also choose to withdraw their information at to 48 following the completion of their last session by calling or emailing Dana Shapero. After this point, their information will become anonymous, and withdrawal of the information will not be possible.

There is the possibility that, based on the information that you provide us, that your child may not qualify for the study, as we are looking to work with a specific population. If this is the case, we will not be able to work with your child as a part of this study. However, to thank you for your interest, your child will still be entered into the draw to win one of the Family Fun Prizes, if you desire.

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As well, we need to ensure that none of the children we are working with have previously seen the movie Dunston Checks In. If your child has seen this movie, they are not eligible for participation in this study. Please ensure that if you do return this consent form, you are indicating that your child has not seen this movie and will not see it prior to their participation in our study as this would jeopardize the validity of our results. As well, please do not share the name of this movie with your child prior to the time in which they participate in the study.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE SUBJECTS

Research findings will be made available to all interested parties upon completion of the study, on the Research Ethics Board web site (www.uwindsor.ca/REB). These results will be available as of December 01, 2011.

SUBSEQUENT USE OF DATA

This data may be used in subsequent studies.

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. If you have questions regarding the rights of your child as a research subject, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

______________________________ __________________

Signature of Investigator Date

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Appendix F

Language Proficiency Questionnaire

LANGUAGE PROFICIENCY RATING FORM

Please answer the following questions as accurately as possible. Responses on this form will help determine whether your child is a viable candidate for participation in this study. Please note that children who do not meet criteria for this study will not be able to participate, even if you have provided your consent. If this is the case, your child will still have the option to be entered into the draw to win the Family Fun Prizes, if desired.

1. On the lines below, please list the language(s) that your child is able to speak fluently.

   [*note:* to be considered fluent in a given language, your child should be able to fully understand when an adult is speaking to them in that language. As well, they should be able to speak comfortably in this language. It is acceptable if some incorrect grammar is used on occasion during these interactions.]

a) ____________________________ b) ______________________________

c) ____________________________ d) ______________________________

2. For each language listed above, please indicate how your child was first exposed to this language (e.g., by parents from birth; by teachers in an immersion school program; etc.), and at what age they were first able to converse fluently in the language.

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a) ______________________________ (at age:)

b) ______________________________ (at age:)

c) ______________________________ (at age:)

d) ______________________________ (at age:)

3. Out of the languages listed above, please indicate which one(s) your child speaks on a daily basis. Languages that you list below should only be those that your child engages in every day. For example, if you child speaks English at School and Arabic at home every day, both of these languages should be listed. Further, please indicate where your child engages in each of these languages daily.

____

____

____

✂ ---

If you would like to be entered into the draw to win one of the Family Fun Prizes (either a $40 gift card for XS Family Fun Centre (choice of mini golf, laser tag, go carts, batting cages, or an arcade), a $40 Cineplex Odeon gift certificate, or a $40 Swiss Chalet gift card), please complete the form below. All ballots will be removed from this questionnaire once submitted and will remain in a locked cabinet in the research lab at the University of Windsor. Following the draw, all ballots will be destroyed.

First name of person to be contacted (parent's name): ______________________________

Best way to contact you, should your family win the draw (e-mail, phone): ___________

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Appendix G

Information for Students

“Hi everyone,

“I am so excited to be coming in to tell you about a study that we are conducting at the University of Windsor. Because your principal and teacher (daycare/camp director) have (has) let us come in, you can have the chance to help us out with this.

“If you are interested and your parents say it is okay, we would come back in another time to do some activities with you. One thing that you’ll get to do is watch some clips from a movie and then chat with us for a few minutes about the movie. Whoever is working with you at this time – it could be me, or it could be someone else on my research team – they will audio-record what you tell them so that they don’t forget anything that you said… but after they write out the things you said on the tape, they’ll get rid of the tape so no one else could hear it. We also won’t share what you have said to us with anyone – not your teachers (counselors/instructors), or your parents, or your friends… unless you tell us that someone is hurting you, because we want to make sure you’re safe. For helping us out with this, and telling us your thoughts about the movie, you’ll get to choose a small prize from the thank you box as our thank you for helping us out. Then, another time, we’ll come in to play some games with you – most games will be on a laptop computer, but there will also be some other games that use game boards and some memory games. It should be fun. If you help us out with this part, to thank you for your time, we’ll give you a pass to the movies.

“Later, we’ll be taking everything that we’ve learned from working with you and lots of other kids, and a researcher at the university will be writing a paper that might even get put in a book at the library. No names of who helped us out will be in the book, but it will be based on the activities that you did with us.

“Does anyone have any questions? [answer questions]

“I am going to be giving all of you a form to take home to your parents. If you want to be a part of this - to watch the movie clips, chat with us, and play the games - you need to get your parents to sign this for you. If your parents agree and think it would be good for you to help out, and they sign the form for you… bring it back to your teacher as soon as possible, and then we’ll come in to work with you!

“How does that sound? [pause] I hope that some of you are interested in helping us out with this. Thanks for listening – and I hope that I’ll have the chance to work with some of you guys over the next few weeks.”

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Appendix H

Events from Selected Clips (Duston Checks In)

Clip 1 (running from 2:30 through 5:38)

This clip depicts two wealthy guests who are checking into a fancy hotel. However, due to a prank that two boys are attempting to pull, these guests are accidentally sprayed with water from the lobby's fountain. After chaos erupts in the lobby, the clip ends with the guests falling into the fountain.

Clip 2 (running from 21:29 through 27:51)

This clip depicts an orangutan, Dunston, dressing in undercover clothing, exiting his hotel room, and climbing up the side of the hotel into another guest's room. Once there, he explores her room in a comical fashion and steals her jewelry. He then leaves the room and climbs up the side of the hotel to where he hears the boy from the prior clip walking a dog. The dog, however, senses the orangutan and runs off the platform that the he is being walked on, falling past the orangutan and landing in a dumpster below. In looking over the edge of the building to make sure the dog is alright, the boy comes into contact with the orangutan (Dunston) for the first time. Dunston then kisses the boy and the boy screams. The clip ends with the boy returning the dog, all dirty from the dumpster, to his owner.

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Appendix I

Post-Event Questioning

Half of the participants in each age group were asked False- Event Questions 3, 5, and 11, whereas their yoked partners were asked questions 4, 8, and 10. As done in the study by Ackil and Zaragoza (1998), in the cases where participants were not asked a false event question (marked in italics), it alone was deleted, while the context preceding the question continued to be included in the review of the movie's events. Participants were told to provide an answer to every question and to guess if they did not know the answer.

"Now we're going to chat about a few things that happened in the movie just to make sure that you didn't miss anything. I want you to do your best to answer all the questions that I ask you."

★ check your participant's assigned number to determine whether they have been assigned the letter a or b (e.g., 29b). Make sure to avoid the questions specified to be for the other group only

[If a child at any point says that they did not see an event or that they do not know the answer, state: "Do your best to explain the event as if it did happen in the video, even if you missed it or aren't sure". If the child continues to show scepticism after this first prompt, tell them it's okay – just guess and do the best you can. If the child continues to resist at this point, just say that's okay – let's move on and try the next question. Try to stay as light hearted as this so the child doesn't feel like they have let you down.]

i. **Remember at the beginning when the man walked in to the hotel, *what kind of pet was he holding?***

ii. **Then remember when the young boy hiding upstairs told his brother that they were "on target" and to "go go go!" and his brother spun a wheel in the basement. *What did that do?***

iii. **So as the water started spraying all of the guests at the front desk, everyone was screaming.** [group a only:] ***What did instructions did the manager behind the desk yell to his employees?***

iv. [group b only:] ***What did the employees by the desk do to stop the water from hitting the guests?***

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v. **Then remember how the woman ended up falling backwards into the fountain along with many others?** [group a only:] ***Remind me of how the luggage got knocked into the water.***

vi **While all this happening, the boys were downstairs trying to escape so that they wouldn't get into trouble. The younger brother wasn't able to stop because he was going so fast on his rollerblades and he bumped into some shelves.** ***What fell on him when this happened?***

vii. **Then remember the beginning of the second clip? The monkey was all dressed up and climbed out the window.** ***Where was he going?***

viii. **The monkey then started climbing up the pipes on the side of the building.** [group b only:] ***What happened that almost made him fall?***

ix. **Then in the next part when the monkey got into the lady's room, he was messing around with a bunch of things. One thing he did was drink her perfume.** ***When he didn't like it, what did he do to the bottle?***

x. **He also saw a pair of fake teeth in a cup.** [group b only:] ***What silly thing did he do when he put them in his mouth?***

xi. **After that, the monkey tried on a lot of the lady's things before looking for her jewels – he tried on lots of hats and he put a pair of underwear on his head.** [group a only:] ***What silly thing did he do when he tried on the wig that was on the counter?***

xii. **When the monkey was leaving and heard the boy, he climbed up to see what they were doing, remember? After the dog ran off the edge of the building and fell, the boy was looking over the edge for him and saw the monkey.** ***What did the monkey do?***

"That was great. Thank you – that's all the questions that I have about the movie!"

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Appendix J

Source Monitoring Task

2. "**So last week you watched the clips from the movie Dunston Checks In, and then you discussed what you watched with** [insert name] **and answered some questions, right?** [wait for them to agree]. **Well I am not completely sure which clips** [insert name] **showed you, and it is really important for me to know which clips you saw so that I know what games to play with you today. Sooo... I need your help. I need you to let me know which things you *actually* saw happen in the clips that you watched.... do you think you might be able to help me out?"** [wait for an answer]

    ★ If the child says that they do not want to help out, tell them how it is really important for us to make sure which clips they were actually shown and it would really mean a lot to have them help us figure this out. If they still refuse to help, skip to step 6.

    ★ If the child asks why we don't know, just say that the person didn't write down which clips they showed on that day. If you need to say this, record this on their scoring sheet.

3. **"Excellent!... so I am going to list a bunch of different things that you might have seen in the clip you were shown. If the event that I say is something you saw in the clips, I want you to point to this card with the green check mark that also says the word YES.** [put the yes card down on the table in front of them]. **If the event I say was not something you saw, I want you to point to the card with the red X that also has the word NO.** [put the no card down on the table in front of them, to the left of the no card. Both cards should be centred in front of the child]. **You can also say "yes" or "no" out loud as you're responding. Let's practice first just to make sure you know what to do.... Was there a monkey in the movie?"**

    ★ Make sure to use record sheet to record responses.

    If child points to <u>yes</u>, state: **"Good job. There was a monkey in the movie, so you are to point to the yes card – yes there was a monkey."** [go to step 4]

    If child points to **<u>no</u>,** state: **"Well, there was a monkey in the movie, so you would point to this** [point to the yes card] **because the answer is yes – yes there was a monkey in the movie. Let's try another one. Was there a dog in the movie?"**

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- ✯ If the child points to **yes**, state: **"Good job. There was a dog in the movie, so you are to point to the yes card – yes there was a dog."** [go to step 4]

- ✯ If the child points to **no**, state: "**There was a dog in the movie – maybe it was not in the clips you were shown. So if there was not a dog in the clips you were shown, yes, you would point to the no card. That is correct."** [skip to step 6 to go through the source monitoring questions – and ignore the confidence rating questions, then continue with the remainder of the testing session (steps 7 through the end)]

4. **"Let's try one more. Was there an elephant in the hotel?"**

If the child points to **no**, state: **"Right again. There was definitely no elephant in the movie, so you are to point to the no card – no there was no elephant. You get the idea of how these cards work. Excellent."** [go to step 5]

If the child points to **yes**, state: **"Well there was not an elephant in the movie, so you would point to the no card** [point] **because the answer is no – no there was no elephant. Let's try another one. Was there an airplane in the movie?"**

- ✯ If the child points to **no**, state: **Well done. There was no airplane in the movie, so you are to point to the no card – no there was no airplane. You get the idea of how these cards work. Excellent."** [go to step 5]

- ✯ If the child points to **yes**, state: **There wasn't an airplane in the movie, so you would actually point to the no card – no there was no airplane in the movie. Does that make sense?** [wait for the child to say yes. If the child indicates that they are confused. You can try to explain it in your own words... then skip to step 6 to go through the source monitoring questions – and ignore the confidence rating questions, then continue with the remainder of the testing session (steps 7 through the end)]

List of events.

"Alright – I think we're ready to go over the list of events? Do you have any questions?" [answer any questions]

"So remember, I am going to read you an event and ask you if you saw that event in the movie that we showed you last week. First you're going to respond by telling me yes – you did see it - by pointing to the green card, or no – you did not see it – by pointing to the red card"

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[Read each event to the child and record their response on the response form. Remember to first get them to point to the yes/no card and then ask them how certain they are that their response is correct. Make sure to give them the prompt for questions 1 and 2. The prompts are only needed for the remaining questions if the child does not automatically respond on their own.]

1. **A man walked into the hotel holding a dog and went to check in.**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

2. **When the prank went wrong and the water started spraying the guests, the manager behind the desk yelled instructions to his employees.**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

3. **The employees by the desk tried to help stop the water from hitting the guests**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

4. **When the water hit the man, the dog went flying out of his hands and landed on the lady**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

5. **The luggage was knocked into the water.**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

6. **When crawling through the air vent, the young boy's pants got caught on a screw, and he had to rip them to get away**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

7. **When the boys were running downstairs, the security guard saw them and called their names**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

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8. **The younger boy ran into a shelf and had lots of toilet paper fall on him.**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

9. **The boys got sent to their rooms by their father for having caused the fountain to soak the guests**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

10. **The monkey almost fell when he was climbing up the pipes on the side of the building.**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

11. **The monkey's owner called him on the phone when he was in the lady's room to tell him to only steal nice things**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

12. **The monkey drank perfume and threw a perfume bottle on the floor (**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

13. **The monkey put the lady's fake teeth in his mouth.**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

14. **The monkey put a blonde wig on while messing around with all her stuff.**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

15. **The boy told his dad that he saw a monster on the side of the building**
    a. **Did this happen in the part of the movie you watched?**
    b. **How sure are you that your answer is correct?**

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Appendix K

Confidence Rating Board Stimuli and Questions

Uncertain Anchors

Certain Anchors

Confidence Board Training

	Trial 1	Trial 2	Trial 3
Trial 4			
... very sure that your answer is the right answer?	✔ x		
... uncertain of your answer/guessing?	✔ x		
...not completely sure?	✔ x		

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Need 3 correct answers in a row to move on:

1. [point to the floor] **Is this the floor?** (answer should be yes, certainty should be high)
   ✔ x

2. [point to a table] **Is this a chair?** (answer should be no, certainty should be high)
   ✔ x

3. [point to a shoe] **Is this called a "blunofold" in the Hebrew language?** (regardless of
   ✔ x answer, certainty should be medium or low)

4. [point to own nose] **Is this my nose?** (answer should be yes, certainty should be high)
   ✔ x

5. [point to own ear] **Is this my foot?** (answer should be no, certainty should be high)
   ✔ x

6. [point to a book] **Do you think I've read this book in the last week?** (regardless of
   ✔ x answer, certainty should be medium or low)

7. **Does my friend Michael have a cut on his leg?** (regardless of answer, certainty should
   ✔ x be medium or low)

8. **Do you think my middle name is Jessica/Jason?** (regardless of answer, certainty should
   ✔ x be medium or low)

9. [point to own eye] **Do I have two eyes?** (answer should be yes, certainty should be high)
   ✔ x

10. [show both hands] **Do I have four hands**? (answer should be no, certainty should be high)
✔ x

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Appendix L

Computerized Day-Night Card Sort Stimuli

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Appendix M

Verbal Inhibition Word Lists

3 and 4 Year old:

GROUP A:

	Word List 1	Word List 2	PI/RI
Trial 1	bed – sun – eye	dog – hand – ring	Pro
Trial 2	cut – water – leaf	girl – box – eat	Pro
Trial 3	toy – moon – face	room – man – baby	Retro
Trial 4	ear – glass – sock	bread – leg – mom	Retro
1	bus – duck – chair	ball – fire – bug	Retro
2	foot – drink – clock	hair – tree – castle	Pro
3	cat – knife – flower	hero – train – bucket	Pro
4	house – drum – shoe	cow – reading – lamp	Retro
5	jump – cup – bedroom	doctor – hill – finger	Pro
6	fly – leaf – closet	table – hand – key	Retro

GROUP B:

	Word List 1	Word List 2	PI/RI
Trial 1	bed – sun – eye	dog – hand – ring	Pro
Trial 2	cut – water – leaf	girl – box – eat	Pro
Trial 3	toy – moon – face	room – man – baby	Retro
Trial 4	ear – glass – sock	bread – leg – mom	Retro
1	foot – drink – clock	hair – tree – castle	Retro
2	bus – duck – chair	ball – fire – bug	Pro
3	house – drum – shoe	cow – reading – lamp	Pro
4	cat – knife – flower	hero – train – bucket	Retro
5	fly – leaf – closet	table – hand – key	Pro
6	jump – cup – bedroom	doctor – hill – finger	Retro

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5 and 6 Year old:

GROUP A:

	Word List 1	Word List 2	PI/RI
Trial 1	cake – sun - door	book – sock - eye	Pro
Trial 2	truck – spoon – chair	shirt – lips - couch	Pro
Trial 3	watch – sandwich -leg	stove – sweater - leg	Retro
Trial 4	pot – comb – doorknob	belt – envelope - hair	Retro
1	cat – table – clock	turtle – climbing - sail	Retro
2	holiday – dog – finger	tree – sitting – umbrella	Pro
3	castle – nail – shoe	donkey – glow – thief	Pro
4	alphabet – leave – ring	bicycle – lamp – brave	Retro
5	hero – children – kite	rat - leaf – key	Pro
6	moth – pulling – tire	peeking – trunk - snap	Retro

GROUP B:

	Word List 1	Word List 2	PI/RI
Trial 1	cake – sun - door	book – sock - eye	Pro
Trial 2	truck – spoon – chair	shirt – lips - couch	Pro
Trial 3	watch – sandwich -leg	stove – sweater - leg	Retro
Trial 4	pot – comb – doorknob	belt – envelope - hair	Retro
1	holiday – dog – finger	tree – sitting – umbrella	Retro
2	cat – table – clock	turtle – climbing - sail	Pro
3	alphabet – leave – ring	bicycle – lamp – brave	Pro
4	castle – nail – shoe	donkey – glow – thief	Retro
5	moth – pulling – tire	peeking – trunk - snap	Pro
6	hero – children – kite	rat - leaf – key	Retro

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7 and 8 Year old:

GROUP A:

	Word List 1	Word List 2	PI/RI
Trial 1	candle – book – phone	fan –backpack – snake	Pro
Trial 2	write – holiday – penny	nail - table – river	Pro
Trial 3	iron – giraffe – hanger	trunk – award – sugar	Retro
Trial 4	shampoo -picture - shorts	children – fork - sweater	Retro
1	kitten – tape - blanket	drink – carpet – dishes	Retro
2	window – sandwich - lamp	ear – toothbrush - climb	Pro
3	clean – waffle - elephant	island – pen - turtle	Pro
4	envelope – boat - time	umbrella – watch - pants	Retro
5	sleep –castle - glow	monkey – car - bathtub	Pro
6	fox – ladder – clock	computer – star – jacket	Retro

GROUP B:

	Word List 1	Word List 2	PI/RI
Trial 1	candle – book – phone	fan –backpack – snake	Pro
Trial 2	write – holiday – penny	nail - table – river	Pro
Trial 3	iron – giraffe – hanger	trunk – award – sugar	Retro
Trial 4	shampoo -picture - shorts	children – fork - sweater	Retro
1	window – sandwich - lamp	ear – toothbrush - climb	Retro
2	kitten – tape - blanket	drink – carpet – dishes	Pro
3	envelope – boat - time	umbrella – watch - pants	Pro
4	clean – waffle - elephant	island – pen - turtle	Retro
5	fox – ladder – clock	computer – star – jacket	Pro
6	sleep –castle - glow	monkey – car - bathtub	Retro

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9 and 10 Year old:

GROUP A:

	Word List 1	Word List 2	PI/RI
Trial 1	mirror – hospital –number	library – finger - shower	Pro
Trial 2	parachute - drilling -frame	canoe – envelope – award	Pro
Trial 3	writing –parrot -eyelash	night – vegetable - swamp	Retro
Trial 4	shoulder – nest -porcupine	flamingo – nostril - wrench	Retro
1	city – turtle – blanket	trunk – island - calculator	Retro
2	heart – raccoon - accident	fountain -shampoo- holiday	Pro
3	juggle- shoulder -universe	camera – potato - bridge	Pro
4	vacation -president -river	square-elephant-bathtub	Retro
5	window-sandwich-fever	alphabet-clock-umbrella	Pro
6	bicycle-monkey-fish	picture-waffle-history	Retro

GROUP B:

	Word List 1	Word List 2	PI/RI
Trial 1	mirror – hospital –number	library – finger - shower	Pro
Trial 2	parachute - drilling -frame	canoe – envelope – award	Pro
Trial 3	writing –parrot -eyelash	night – vegetable - swamp	Retro
Trial 4	shoulder – nest -porcupine	flamingo – nostril - wrench	Retro
1	heart – raccoon - accident	fountain -shampoo- holiday	Retro
2	city – turtle – blanket	trunk – island - calculator	Pro
3	vacation -president -river	square-elephant-bathtub	Pro
4	juggle- shoulder -universe	camera – potato - bridge	Retro
5	bicycle-monkey-fish	picture-waffle-history	Pro
6	window-sandwich-fever	alphabet-clock-umbrella	Retro

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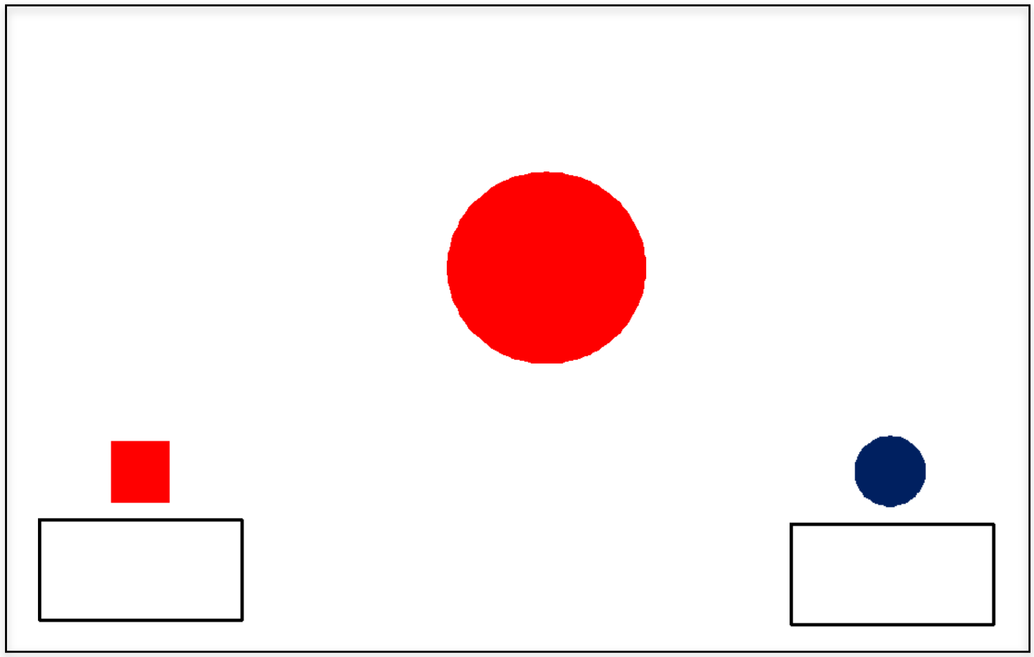
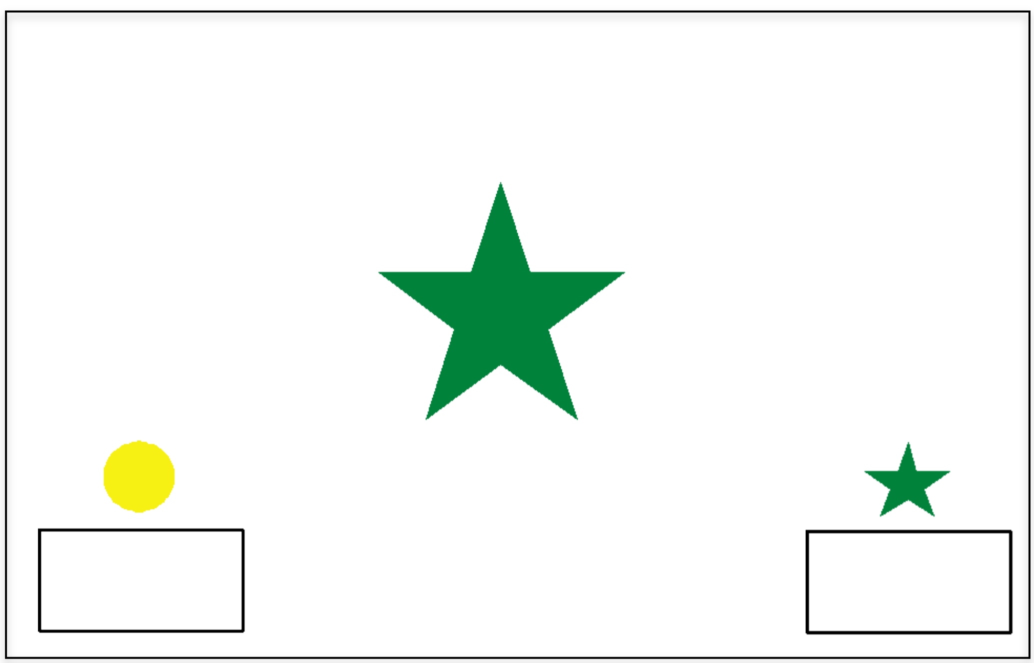
Appendix N

Computerized Dimensional Change Card Sort Stimuli (DCCS)





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Appendix O

Opposite Worlds Task

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Appendix P

Flanker Task Stimuli

Congruent Trial Right

Congruent Trial Left

Incongruent Trial Right

Incongruent Trial Left

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Appendix Q

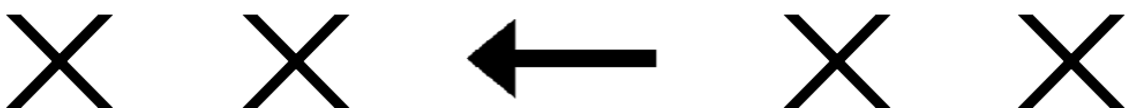
Go No-Go and Reverse Arrows Stimuli

Go Trial Right

Go Trial Left

No-Go Trial Right

No-Go Trial Left



Reverse Arrow Right

Reverse Arrow Left

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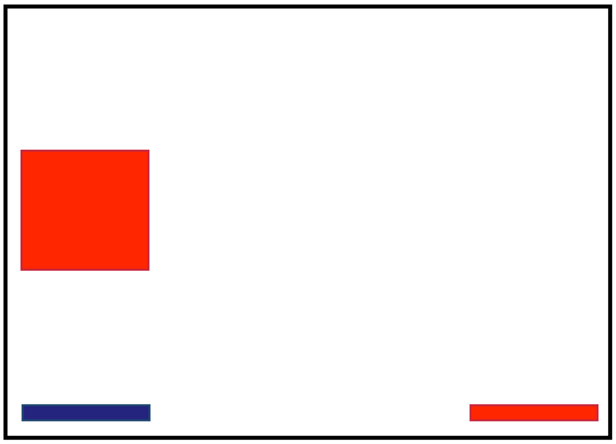
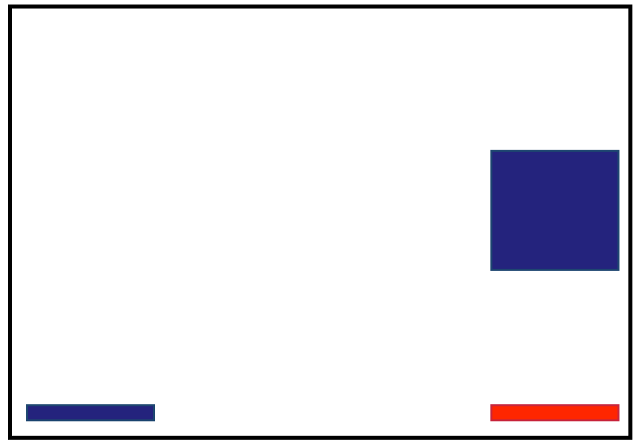
Appendix R

Simon Task

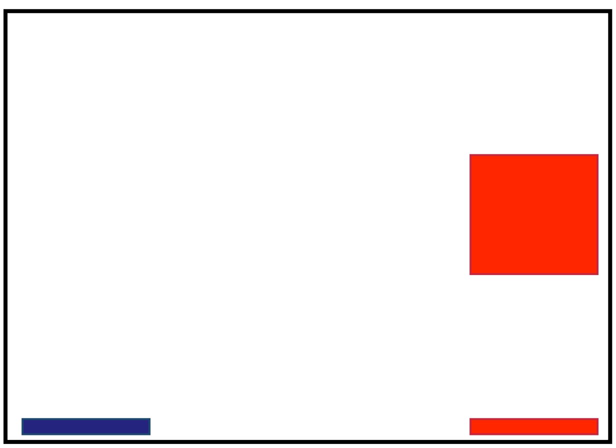
Incongruent Trial Red



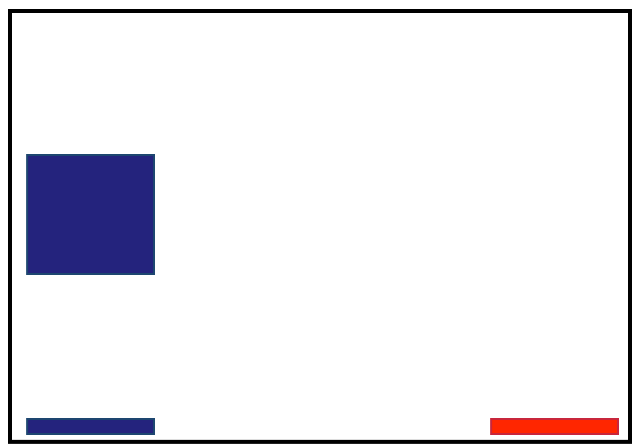
Incongruent Trial Blue



Congruent Trial Red



Congruent Trail Blue



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Appendix S

Forward Digit Span (Memory Span)

Digits	Digits Repeated	Incorrect/Correct	
2-1		0	1
4-7		0	1
8-3		0	1
6-9		0	1
5-1-7		0	1
6-2-9		0	1
3-8-7-2		0	1
9-4-6-1		0	1
4-1-6-9-3		0	1
5-2-8-4-7		0	1
2-8-3-9-1-6		0	1
7-4-9-5-2-3		0	1
1-8-5-4-9-3-7		0	1
5-3-9-2-8-6-4		0	1
9-4-1-7-2-8-5-3		0	1
3-7-2-9-5-8-6-1		0	1

Total Score _______

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Appendix T

Research Assistant Application Form

RESEARCH ASSISTANT APPLICATION – Children and Memory Project

Please complete the following information in the word document below. Once completed, return this form electronically to shapero@uwindsor.ca . You will be notified within a week as to whether or not you will progress to the interview stage of this process.

1. Personal Information:
    a. Today's date:
    b. Name:
    c. Gender:
    d. Phone # :
    e. E-mail :

2. Educational Information
    a. Major:
    b. Grade point average:
    c. Year in school:
    d. Expected date of graduation:
    e. Are you planning on doing an honours thesis in the future?:

- Please include an unofficial transcript as a separate attachment. You can copy and paste this from the SIS into a word document.

3. Previous work with children.
   Please list your previous experience with children. This may include student teaching, babysitting, swim instructor, camp counselor, etc. Include the name of at least one reference who could speak to your abilities with children 10 years or younger.

4. Please put an X next to the semesters/summers you would be willing to work on the project:

- Summer 2010

- Fall 2010

- Winter 2011

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5. Why are you interested in being a research assistant on this project?:

6. Prior research experience (not required) and/or special skills:

7. Approximate amount of hours willing to dedicate as a research assistant in this study per week (minimum 3):

8. Research assistants will have to travel to off-site locations to do the study. Do you have a car or would you have access to a means of transportation to get to these locations (if you don't have a car, but you do have other means of transportation, please explain.):

9. In order to enter schools, individuals working on this study would be required to obtain a police check. Would you be willing to have this completed?

Additional comments:

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Appendix U

Instructions for Measures (Excerpt from Manual)

8. Turn to the Digit Span scoring sheet.

   "So the first game that we are going to play is going to be a memory game. I am going to say some numbers to you, and I want you to repeat them to me – just say exactly what I say.

   So if I were to say 5-8 what would you say?

   - [if child says 5-8]: **"That's right. 5-8. So you say exactly what I say."**
     - Continue with next trial.
   - [if the child is incorrect]: "**Actually, you would say 5-8. I said 5-8, so you would say 5-8 back to me. You just repeat what I say."**

   "Let's try another one for practice: 1-6."

     - [if child says 1-6]: **"That's right. 1-6. So you say exact what I say. Are you ready?"**
     - [if child is incorrect]: **"Actually, you would say 1-6. I said 1-6, so you would say 1-6 back to me, just like I said it. You say what I say."**
     - Turn to scoring sheet and read each number string at the time interval of 1 number per second. Record what the child's response was on the sheet for each answer, and indicate by circling the 0 or 1 whether their response was correct. If the child gets both trials of a given span length incorrect, discontinue the task and move to number 9.

   ★ Score their total digit score after, recording their total at the bottom of the page.

9. **"Good job! For our next game, I have these two cards.** [take out day card and night card]. **This card here is a picture showing the Day and this card is a picture showing the Night. However, there's a twist to this game. When I show you the Day card, I want you to say the word *Night*, and when I show you the Night card, I want you to say the word *Day*. So if I were to show you this card** [show day card] **what would you say?**

   - [if child says Night]: **"Great."** [go to 9a]

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- [if child says Day]: **"Remember – we're saying the opposite here. So if I should you the Day card, you would say Night."** [go to 9a]

9a. **"And what would you say if I showed you this card?"** [show night card]

- [if child says Day]: **"Great."** [go to 9b]
- [if child says Night]: **"Remember – we're saying the opposite here. So if I should you the Night card, you would say Day."** [go to 9b]

[if the child gets either wrong, repeat the two trials – otherwise, continue]
Indicate on child's package if they got 1 or more of these practice cards wrong, specifying how many.

★ For yourself – you will have pieces of paper with the word day and night on it. Place these pieces of paper on the appropriate mice at this time – with the day word going on the right mouse clicker. This will help reduce error.

9d. [go to the computer screen and open the Day-Night Task]

"So now the pictures are on the computer. [click from the title screen to the next slide] **They are the exact same pictures as the real cards, only they are on the computer. Just like before, when you see this card, I want you to say *Night"*** [click to next screen] **"and when you see this card, I want you to say *Day*".** [click to the next screen] **I want to see how quickly you can respond to each picture without making any mistakes. I'm going to record how fast you are by clicking these mice – but remember, even though I want you to go quickly, I don't want you to make any mistakes. Are you ready?"**

[when the child says yes, click to the next screen. The pictures will come up, and your job it so press the day or night button as soon as the child responds. Errors and reaction time will be recorded based on your responses - Once you hit the "Good Job" screen, it will automatically progress to the next screen]

9e. **"Let's change the rules. This time, when you see the Day card, I want you to say the word *Day,* and when you see the Night card, I want you to say the word *Night.*"** [click to the next screen]

"So what would you say if you saw this card in this game?"

- [if child says Day]: **"Great."** [click to the next screen and go to the next question]
- [if child says Night]: **"Remember – we're calling the cards by their proper names this time, so you would say Day."** [repeat the question above until answers correctly, then click to the next screen]

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"So what would you say if you saw this card in this game?"

- [if child says Night]: **"Great."** [click]
- [if child says Day]: **"Remember – we're calling the cards by their proper names this time, so you would say Night."** [repeat the question above until answers correctly, then click to the next screen]

"Are you ready?"

[when the child says yes, say:]

"Remember, I want to see how quickly you can respond to each picture without making any mistakes. Are you ready?"

[once the child says yes, click to the next screen. The pictures will come up, and your job it so press the day or night button as soon as the child responds. Errors and reaction time will be recorded based on your responses - Once you hit the "Good Job" screen, it will automatically progress to the next screen]

9f. **"Let's change the rules one more time. This time, it will be like the first time we played the game. When you see the Day card, I want you to say the word *Night,* and when you see the Night card, I want you to say the word *Day.*"** [click to the next screen]

"So remember – when you see this card, you are to say the word *Night* [click to the next screen] **and when you see this card, you are to say the word *Day.*** [click to the next screen] **Are you ready?** [allow time for the child to respond] **"Remember to go as fast as you can without making any mistakes... and go!"**

[when the child says yes, click to the next screen. The pictures will come up, and your job it so press the day or night button as soon as the child responds. Errors and reaction time will be recorded based on your responses - Once you hit the "Well Done" screen, click to exit and the data will be saved"

10. **"Excellent! Next we're going to play a word game together. I am going to read you 3 words and then want you to say them back to me. Then I'm going to read you 3 more words, and I want you to repeat those ones back to me. Let's practice."** [go to RI/PI word list and go through trial 1 for the appropriate age].

10a. after both sets of words are repeated, state one of the following, and record the responses:
For Retroactive: **"What were the first three words again?"**
For Proactive: **"What were the last three words again?"**

Administer ONLY practice trials here. (trials 1-4)

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Note: if the child does not get the first three words right in the first Retro trial and, instead, lists the second three words again, state:

"You have a great memory and that was sooo close – but those were actually the last three words I read to you. First I said [insert words here] and then I said [insert words here]. So which words came first [read first three] or [read second three]?

If correct, say – perfect those were the first three! Let's try another one...

If wrong, say – actually, the first three words were [repeat]. Let's try another one...

11. *Card Sort A Only*: **"Alright – now let's go back to the computer for another game.**

Colour Game 1: **"This is the colour game – In the colour game, I need you to help me sort the colours that come up in the middle of the screen into the correct boxes by colour.** [click to the next screen]. **In this game, red shapes go in this box over here** [point]**. So when you see a red shape, you put it in the red box by pressing this button right underneath the red box like this.** [press mouse under the red box]. **There will also be blue shapes. Blue shapes go in this box over here. So when you see a blue shape, you put it in the blue box by pressing the button underneath the blue box like this.** [press mouse under the blue box].

[click to the 'let's practice screen'] **Alright – let's practice a few together. Put your hands on both mice.** [help them position their hands]. **I want you to sort the red and blue colours as quickly as you can without making any mistakes – I'll be timing you.** [pause] **Click any button when you are ready and your first colour will come up.**

If the child gets a red X, say: "r**emember – we are sorting by colour, so blue shapes go in the blue box and red shapes go in the red box**

[when practice trials are done]**: "Alright – now you know how to play the game! Remember – sort the colours as quickly as you can without making any mistakes. I'll be timing you. Are you ready?** [pause] **Click any button to start!"**

- if the child gets the first trial incorrect (as indicated by a red X) say **"remember we are sorting by colour"**

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Shape Game 1: **"Good job! So now we are going to play the shape game – In the shape game, I need you to help me sort the shapes in the middle of the screen into the correct boxes by shape.** [click to the next screen]. **In this game, squares go in this box over here** [point]**. So when you see a square, you put it in the square box by pressing this button right underneath the square box like this.** [press mouse under the square box]. **There will also be circles. Circles go in this box over here. So when you see a circle, you put it in the circle box by pressing the button underneath the circle box like this."** [press mouse under the circle box].

[click to the 'let's play] **"Alright – it's time to play the Shape Game! Remember – all circles go in this box here** [point]**, and all squares go in this box here** [point] **– and I'm going to time you to see just how quickly you can sort the shapes without making any mistakes! Are you ready?** [pause] **Click any button to start."**

- if the child gets the first trial incorrect (as indicated by a red X) say **"remember we are sorting by shape "**

Stretch – **"Good Stuff. Alright, so before we continue, I need you to get up and stretch as high as you get up to the ceiling. I want to see how much taller you can get when you stretch all your muscles. Seriously – see how close you can come to touching the ceiling! Now stretch to both sides... and sit back down."**

Shape Game 2: **"Alright – so now we are going to play the Shape Game again. Just like last time, for the shape game, I need you to help me sort the shapes in the middle of the screen into the correct boxes by shape.** [click] **In this game, stars go in this box over here** [point]**. So when you see a star, you put it in the star box by pressing this button right underneath the star box like this.** [press mouse under the star box]. **There will also be circles. Circles go in this box over here. So when you see a circle, you put it in the circle box by pressing the button underneath the circle box like this."** [press mouse under the circle box].

[click to the 'let's practice screen'] "**Alright – let's practice a few together. Put your hands on both mice.** [help them position their hands]. **I want you to sort the shapes as quickly as you can without making any mistakes.** [pause] **Click any button when you are ready and your first shape will come up."**

If the child gets a red X, say: "r**emember – stars go in the star box and circles go in the circle box"**

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[when practice trials are done]**: "Alright – now you know how to play the game! Remember – sort the shapes as quickly as you can without making any mistakes. Last time you were really quick, and I was impressed... but I want to see if you can go even quicker this time without making any mistakes. Are you ready?** [pause] **Click any button to start!"**

<u>Colour Game 2:</u> **"Nice job!** [optional high 5] **So now we are going to play the colour game again. Just like last time, for the colour game, I need you to help me sort the colours that come up in the middle of the screen into the correct boxes by colour.** [click to the next screen]. **In this game, green ones go over here** [point]**. So when you see a green shape, you put it in the green box by pressing this button right underneath the green box like this.** [press mouse under the green box]. **There will also be yellow shapes. Yellow shapes go in the yellow box over here. So when you see a yellow shape, you put it in the yellow box by pressing the button underneath the yellow box like this."** [press mouse under the yellow box].

[click to the 'let's play screen'] **"Remember – all green shapes go in this box here** [point]**, and all yellow shapes go in this box here** [point]**..You've been doing great so far – and I want you to show me one more time just how incredibly fast you can sort these colours without making any mistakes. Do you think you can do it?** [wait for response] **Alright! We're ready to sort the colours!** [wait for a response] **Click any button to start."**

- if the child gets the first trial incorrect (as indicated by a red X) say **"remember we are sorting by colour so the green shapes go in the green box"**

"Excellent Work! I knew you could do it." [skip to step 13]

12. *<u>Card Sort B Only</u>*: **"Alright – now let's go back to the computer for another game.**

<u>Shape Game 1:</u> **"This is the shape game – In the shape game, I need you to help me sort the shapes in the middle of the screen into the correct boxes by shape.** [click to the next screen]. **In this game, squares go in this box over here** [point]**. So when you see a square, you put it in the square box by pressing this button right underneath the square box like this.** [press mouse under the square box]. **There will also be circles. Circles go in this box over here. So when you see a circle, you put it in the circle box by pressing the button underneath the circle like this."** [press mouse under the circle box].

[click to the 'let's practice screen'] **Alright – let's practice a few together. Put your hands on both mice.** [help them position their hands]. **I want you to sort the circles and squares as quickly as you can without making any mistakes – I'll be timing you.** [pause] **Click any button when you are ready and your first shape will come up.**

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If the child gets a red X, say: "r**emember – we are sorting by shape, so squares go in the square boxes and circles go in the circle boxes."**

[when practice trials are done]**: "Alright – now you know how to play the game!**
Remember – sort the shapes as quickly as you can without making any mistakes. I'll be timing you. Are you ready? [pause] **Click any button to start!"**

- if the child gets the first trial incorrect (as indicated by a red X) say **"remember we are sorting by shape"**

Colour Game 1: **"Good job! So now we are going to play the colour game – In the colour game, I need you to help me sort the colours in the middle of the screen into the correct boxes by colour.** [click to the next screen]. **In this game, red shapes go in this box over here** [point]**. So when you see a red shape, you put it in the red box by pressing this button right underneath the red box like this.** [press mouse under the red box]. **There will also be blue shapes. Blue shapes go in this box over here. So when you see a blue shape, you put it in the blue box by pressing the button underneath the blue box like this.** [press mouse under the blue box].

[click to the 'let's play] **"Alright – it's time to play the Colour Game! Remember – all red shapes go in this box here** [point]**, and all blue shapes go in this box here** [point] **– and I'm going to time you to see job how quickly you can sort the colours without making any mistakes! Are you ready?** [pause] **Click any button to start."**

- if the child gets the first trial incorrect (as indicated by a red X) say **"remember we are sorting by colour"**

Stretch – **"Good Stuff. Alright, so before we continue, I need you to get up and stretch as high as you get up to the ceiling. I want to see how much taller you can get when you stretch all your muscles. Seriously – see how close you can come to touching the ceiling! Now stretch to both sides... and sit back down."**

Colour Game 2: **"Alright – so now we are going to play the Colour Game again. Just like last time, for the colour game, I need you to help me sort the colours in the middle of the screen into the correct boxes by colour.** [click] **In this game, green shapes go in this box over here** [point]**. So when you see a green shape, you put it in the green box by pressing this button right underneath the green box like this.** [press mouse under the green box]. **There will also be yellow shapes. Yellow Shapes go in this box over here. So when**

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you see a yellow shape, you put it in the yellow box by pressing the button underneath the yellow box like this." [press mouse under the circle box].

[click to the 'let's practice screen'] "**Alright – let's practice a few together. Put your hands on both mice.** [help them position their hands]. **I want you to sort the colours as quickly as you can without making any mistakes.** [pause] **Click any button when you are ready and your first colour will come up."**

If the child gets a red X, say: "r**emember – green shapes go in the green box and yellow shapes go in the yellow box"**

[when practice trials are done]**: "Alright – now you know how to play the game! Remember – sort the colours as quickly as you can without making any mistakes. Last time you were really quick, and I was impressed... but I want to see if you can go even quicker this time without making any mistakes. Are you ready?** [pause] **Click any button to start!"**

<u>Shape Game 2:</u> **"Nice job!** [optional high 5] **So now we are going to play the shape game again. Just like last time, for the shape game, I need you to help me sort the shapes that come up in the middle of the screen into the correct boxes by shape.** [click to the next screen]. **In this game, stars go over here** [point]**. So when you see a star, you put it in the star box by pressing this button right underneath the star box like this.** [press mouse under the star box]. **There will also be circles. Circles go in this box over here. So when you see a circle, you put it in the circle box by pressing the button underneath the circle box like this."** [press mouse under the circle box].

[click to the 'let's play screen'] **"Remember – all stars go in this box here** [point]**, and all circles go in this box here** [point]**. You've been doing great so far – and I want you to show me one more time just how incredibly fast you can sort these shapes without making any mistakes. Do you think you can do it?** [wait for response] **Alright! We're ready to sort the shapes!** [wait for a response] **– click any button to start."**

if the child gets the first trial incorrect (as indicated by a red X) say **"remember we are sorting by shape"**

"Excellent Work! I knew you could do it." [skip to step 13]

13. **"Alright, let's go back to the word game for a minute."** [return to the RI/PI word lists]

"Just like last time, I am going to read you 3 words and then I want you to say them back to me. Then I'm going to read you 3 more words, and I want you to repeat those ones back to me as well – just like before. Then I'll ask you to repeat either the first word list or the second word list"

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[make sure to use appropriate list based on assigned condition]

After both sets of words are repeated, state one of the following (as indicated on the scoring sheet), and record the responses:

For Retroactive: **"What were the first three words again?"**
For Proactive: **"What were the last three words again?"**

- Administer ONLY test items 1-3 here (RI PI PI)

14. Receptive Vocabulary. Use instructions provided verbatim on scoring sheet

15. Flanker

<u>**ARROW**</u>**: "Let's go back to the computer. Now I'm going to see how fast you can move! An arrow is going to come up in the middle of the screen. It can be pointing towards either mouse. Your job is to push the mouse that the arrow is pointing to as quickly as you can.** [click to the next screen] **The arrow could be pointing this way** [click] **or this way** [click]. **When the arrow is pointing towards this mouse** [point]**, you click this mouse as quickly as you can** [click]. **When the arrow is pointing towards this mouse** [point]**, you click this mouse as quickly as you can** [click]**. Let's practice – put your hands on the mice** [position their hands]. **Remember, you want to click the mouse that the arrow is pointing towards as quickly as you can. You can press any button to start."**

[if during the trial they get an X, say: **"Remember to press the mouse the arrow is pointing towards"**

[after trial rounds, the "Good Job" screen will come up, say:] **"Good job! Alright... now we're going to play for real. Remember to click the mouse that the arrow is pointing to as quickly as you can without making any mistakes. Press any button to start."**

<u>**MIXED**</u>**: "Well done! Now we are going to play the Mixed Arrows game. In this game, there will be other arrows around the center arrow. Your job is to push the mouse that the center arrow is pointing to as quickly as you can just like last time. The other arrows are not important.** [click] **So the arrows could be facing the same direction as the center arrow, like this. So here you would click this mouse because the center arrow is pointing to it** [point and click]. **They could also look like this – so you would click this mouse because the center arrow is pointing to it** [point and click]**. Or the arrows can be facing the opposite direction from the center arrow, like this. So if they look like this, you would**

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click this mouse because the center arrow is pointing to it [point and click]. **Or it could look like this – so you would click this mouse because the center arrow is pointing to it** [point and click]. **Let's practice – put your hands on the mice** [position their hands] ...**and you can press any button to start."**

[if during the trial they get an X, say: **"Remember to press the mouse the center arrow is pointing towards"**

[after trial rounds, the "Good Job" screen will come up, say:] **"Good job! Alright... now we're going to play for real. Remember to click the mouse that the center arrow is pointing to as quickly as you can. I'm measuring how fast you can go... so I want you to use all the power you have to go as quickly as you can without making any mistakes. Press any button to start."**

<u>GO NOGO:</u> **"Excellent! Now we are going to play the Go or No-Go game. In this game there will be other shapes around the center arrow. Sometimes these shapes will be squares. If there are squares around the arrow, you are to push the mouse that the center arrow is pointing to as quickly as you can.** [click] **So if it looks like this, with squares, you would click here, because the center arrow is pointing to this mouse.** [point and click] **or if it looks like this, you would click here because there are squares and the center arrow is pointing to this mouse.** [point and click]. **Sometimes, though, these shapes around the center arrow will be a bunch of Xs. If you see an X you are not to press any button. X means stop. It doesn't matter which way the center arrow is pointing, your job is to not press a thing and wait for the screen to change on its own. So if it looks like this with the Xs, you do not press anything and the screen will change on its own.** [click] **Or if it looks like this, there are Xs, so you also just wait and do not press a thing, and the screen will change just like this. Let's practice – put your hands on the mice** [position their hands] **and you can press any button to start."**

[if during the trial they get an X, say either: **"Remember to press the mouse the center arrow is pointing towards when there are squares"** or **"If you see an X, don't press any buttons"**

[after trial rounds, the "Good Job" screen will come up, say:] **"Good job! Alright... now we're going to play for real. Remember to click the mouse that the center arrow is pointing to as quickly as you can if there are squares, and to stop and not press a thing if you see the Xs. Are you ready?** [pause] **Press any button to start."**

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<u>ARROWS 2:</u> **"Now we're going to go back to the first game that we played together. Only a single arrow will show up on the screen. Your job is to click the mouse that the arrow is pointing to as quickly as you can. So if it is facing this way you press the mouse that it is pointing to as quickly as you can like this** [point and click] **or if it is pointing this way you press the mouse that it is pointing to as quickly as you can like this** [point and click]. **Alright – put your hands on the mice... we're ready to play. I think you can definitely beat your score from last time for this one – but we'll seeeee. Just remember to click the mouse that the arrow is pointing to as quickly as you can. Are you ready?** [pause] **Press any button to start."**

<u>BONUS:</u> **"You've done so well we now get to play the bonus round! This time we are going to mix things up.** [click] **Instead of clicking the mouse that the arrow is pointing towards, this time your job is to press the mouse that the arrow is not pointing towards.** [click] **So if the arrow is pointing this way towards this mouse, this time you would press the other mouse on this side, like this.** [click] **and if the arrow is pointing this way towards this mouse, this time you would press the mouse over here because this is the mouse the arrow is not pointing to.** [click] **Remember – you are always going to press the button that the mouse is NOT pointing to. Let's practice – put your hands on the mice** [position their hands] **and you can press any button to start. "**

[if during the trial they get an X, say: **"Remember to press the mouse that the arrow is not pointing towards"**

[after trial rounds, the "Good Job" screen will come up, say:] **"Good job! Alright... now we're going to play for real. Remember to click the mouse that the arrow is not pointing towards as quickly as you can. Press any button to start."**

16. **"Now, I want you to think of as many types of food as you can. Like an apple or a hamburger. It can be anything that you eat. When I say go, I want you to list as many types of food as you can as fast as you can until I say stop. Are you ready... set... go!"** [start stopwatch. At 45 seconds, say **"stop!"**]

★ The list of words the child is saying will be recorded, but do your best to record on the record sheet the words that the child is saying... use shorthand if needed.

For bilingual children ONLY: "**Now, I want you to think of as many types of food as you can. Like an apple or a hamburger. It can be anything that you eat. When I say go, I want you to list as many types of food IN ENGLISH as**

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you can as fast as you can until I say stop. Are you ready... set... go!" [start stopwatch. At 45 seconds, say **"stop!"**]

- ★ The list of words the child is saying will be recorded, but do your best to record on the record sheet the words that the child is saying... use shorthand if needed.

"Now you also speak ________, don't you? Now what I want you to do is think of as many types of animals as you can, like a dog or a tiger. When I say go, I want you to list as many types of animals in [state other language's name] **as you can as fast as you can until I say stop. Are you ready... set... go!"** [start stopwatch. At 45 seconds, say **"stop!"**]

- ★ Although you will not know the language, try to record a tally mark for each response the child gives.

17. Opposite Worlds A: real world – opposite world – real world 2 – opposite world 2

Opposite Worlds B: opposite world – real world – opposite world 2 – real world 2

"So here we have a path with a bunch of pigs and cows walking to a barn. The barn at the top can be right-side up like this and if it is, these cows and pigs are in the real world. If the barn is flipped upside-down like this [turn barn upside down] **the cows and pigs are in the opposite world."**

<u>REAL WORLD</u>: "So now let's go into the real world [turn the barn the right way]. **In the real world, what is this animal called?** [point to a pig – make sure the child answers with the name of the pig] **and what is this animal called?** [point to a cow – make sure the child answers by saying cow]**. Now you know everything you need to know to play this game! What I want you to do is name the animals as fast as you can heading up the path to the barn. Follow my finger as I lead you up the path. If you make a mistake, by accidentally calling the animal by the wrong name, I will stay on that animal until you get it right. Your job is to name these animals as fast as you can without making any mistakes. I will be timing you. Do you have any questions?** [answer any questions] **"Alright... on your marks, get set.... go!"**

- ★ Start the stopwatch as soon as you say go. Hold this stop watch in the hand that you are not using to point to the animals and press stop immediately after the name the last animal. Also keep count of how many errors the child got going up the path and record this as well as the time as soon as the child completes the round.

<u>OPPOSITE WORLD</u>: "Now we are going to enter into a crazy, mixed up, opposite world. [turn the barn at the top upside down]. **In this world,**

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cows are called pigs, and pigs are called cows. So in the opposite world, what is this animal called [point to a pig]

- If the child says cow: **"good job"** [continue]

- If the child says pig: **"Remember, in the opposite world, pigs are called cows.** [ask the child this again after asking them about the cow below. Continue to ask what the animals are called in the opposite world until the child gets both right.

"and what is this animal called in the opposite world? [point to a cow]

- If the child says pig: **"good job"** [repeat both animals if the child got the first question wrong, otherwise continue]

- If the child says cow: **"Remember, in the opposite world, cows are called pigs.** [go back and ask the child about the pig and the cow again until the child answers both correctly, then continue.]

Good! Now you know everything you need to know to play this game! What I want you to do is name the animals as fast as you can heading up the path to the barn – using their opposite world names. If you make a mistake, by accidentally calling the animal by the wrong name, I will stay on that animal until you get it right. Your job is to name these animals – using their opposite world names – as fast as you can without making any mistakes. I will be timing you. Do you have any questions? [answer any]

Do you have any questions?[answer any questions] **"Alright... on your marks, get set.... go!"**

★ Start the stopwatch as soon as you say go. Hold this stop watch in the hand that you are not using to point to the animals and press stop immediately after the name the last animal. Also keep count of how many errors the child got going up the path and record this as well as the time as soon as the child completes the round.

<u>**REAL WORLD 2**</u>**: "Alright let's go into the real world again** [turn the barn the right way]. **Remember, in the real world, animals are called by their proper names – so cows are called cows and pigs are called pigs. So in the real world, what is this animal called?** [point to a pig – make sure the child answers with the name of the pig] **and what is this animal called?** [point to a cow – make sure the child answers by saying cow]**. Great! So, just like before, I want you to name the animals using their real names as fast as you can–and if you make a mistake I will stay on that animal until you call it by the correct name. Go as**

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quickly as you can without making any mistakes and we'll see if you can beat your last real world score. Are you ready? [wait until they say yes]

"Alright... on your marks, get set.... go!"

<u>**OPPOSITE WORLD 2**</u>**: "Alright let's go into the opposite world again** [turn the barn upside down]. **Remember, in the opposite world, animals are called by their crazy mixed up names – so cows are called pigs and pigs are called cows. So in the opposite world, what is this animal called?** [point to a pig – make sure the child answers with the name of the cow, otherwise repeat steps above] **and what is this animal called?** [point to a cow – make sure the child answers by saying pig – repeat this until the child gets both names right]**. Great! So, just like before, I want you to name the animals using their opposite world names as fast as you can– and if you make a mistake I will stay on that animal until you call it by the correct name. Go as quickly as you can without making any mistakes and we'll see if you can beat your last opposite world score. Are you ready?** [wait until they say yes]

"Alright... on your marks, get set.... go!"

18. **"Alright, let's go back to the word game one last time!"** [return to the RI/PI word lists]

"Just like last time, I am going to read you 3 words and then I want you to say them back to me. Then I'm going to read you 3 more words, and I want you to repeat those ones back to me as well – just like before. Then I'll ask you to repeat either the first word list or the second word list"

[make sure to use appropriate list based on assigned condition]

After both sets of words are repeated, state one of the following (as indicated on the scoring sheet), and record the responses:
For Retroactive: **"What were the first three words again?"**
For Proactive: **"What were the last three words again?"**

- Administer ONLY test items 4-6 here (RI PI RI)

19. Go to the Simon Task

"This game is called Sort the Squares. Your job in this game is to place the squares that come up into the proper slots according to their colour. [click] **If you see a red square, you are going to put it in this red slot over here by pressing the mouse under the red slot** [point and click] **and if you see a blue square, you are going to put it in this blue slot over here by pressing the**

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mouse under the blue slot [point and click]. **So the squares that will come up will either be red or blue like this, and either one can show up at either side of the screen.** [click]

So if the red square is here, you would put it into the red slot by clicking here [point and click] **or if the red square is here, you would put it into the red slot by clicking here** [point and click]. All red squares go in the red slot. Same thing if you see a blue square – blue squares always go into the blue slot – so if the blue square is here [click] or here, you always put it **into the blue slot by clicking here** [point and click]. **Do you have any questions?"** [answer any questions]

"Let's practice. Are you ready? [pause] **Alright – put your hands back on the mice, and you can click to start when you are ready."**

- If the child gets any of the practice trials wrong, simply state either **"That was a blue square, so you have to put it in the blue slot by clicking the mouse under the blue slot"** or **"That was a red square, so you have to put it in the red slot by clicking the mouse under the red slot"**

[when you arrive on the let's play screen:] **Alright – just like the other games, I want to see how quickly you can sort these squares without making any mistakes. Are you ready? Put your hands on the mice and click when you're ready to go!"**

[when you hit the Round 2 screen:] **"Excellent – we've made it to round 2! Again sort the squares as quickly as you can– without making any mistakes. Let's see if you can beat your round 1 score. Are you ready?** [pause] **Alright – put your hands on the mice and click when you're ready to go!"**

[when you hit the Round 3 screen:] **"You've made it to round 3! This is your last chance to try to beat your score! Sort the red and blue squares into their slots as quickly as you can without making any mistakes... are you ready** [pause] **Put your hands back on the mice and click when you're ready to go!"**

[when you hit the Well done screen:] **Well done! You played that game really well – I am impressed.**

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