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Cognitive Influences On Preschoolers’ And Adults’ Eyewitness Memory In Response To Misleading Questions

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COGNITIVE INFLUENCES ON PRESCHOOLERS' AND ADULTS' EYEWITNESS MEMORY IN RESPONSE TO MISLEADING QUESTIONS

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ABSTRACT

The present study investigated cognitive influences on the malleability of memory for an eyewitness event, specifically focusing on age, executive function, and divided attention. Preschoolers (3- to 5-year-olds) and adults completed an executive function (EF) battery, witnessed an event either under divided attention (DA) or full attention (FA), following this, participants were asked a series of questions, the majority of which were misleading from the Video Suggestibility Scale for Children. This study supports previous findings that children are more suggestible than adults to misleading questions. However, there was no influence of EF on suggestibility in either children or adults. Lastly, level of attention was related to suggestibility in yield 1 scores, where those in the DA condition had higher suggestibility scores than those in the FA condition, supporting previous findings in adult literature and extending these findings to the preschool age.

DEDICATION

This dissertation is dedicated to my husband Josh and son Arjen whose unyielding love, support, and encouragement have enriched my soul and inspired me to pursue and complete this research.

LIST OF ABBREVIATIONS AND SYMBOLS

EF Executive Function

WM Working Memory

DA Divided Attention

FA Full Attention

ToM Theory of Mind

DCCS Dimensional Change Card Sort

SOPT Self Ordered Pointing Task

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I INTRODUCTION

Cognitive Influences on Preschoolers' and Adults' Eyewitness Memory in Response to Misleading Questions

It was estimated that over 13,000 children testify each year in sexual abuse cases (Ceci & Bruck, 1993), with 40.65% of these children being seven years of age and under (Scullin & Ceci, 2001). Often, individuals (and especially children) interviewed during these cases encounter suggestive techniques that can lead to the creation of false memories (Neuschatz, Lampinen, Toglia, Payne, & Cisneros, 2007). These false memories can lead to drastic consequences, such as innocent persons being convicted. In fact, there are several hundred documented cases of innocent people being convicted of various crimes, with the Innocence Project exonerating by DNA at least 22 people convicted based on false testimonies of others (The Innocence Project, 2017; Davis & Leo, 2012). In light of this information, research focused on better understanding the malleability of memory across the lifespan for witnessed events is necessary to assist in avoiding false convictions via false testimonies. The purpose of this study was to investigate individuals' suggestibility to a particular technique that is common across interrogations (i.e., misleading questions), with an emphasis on how developing abilities in cognitive control and the management of attention impact suggestibility in young children and adults.

Suggestibility in Response to Misleading Questions

Suggestibility is the degree to which a person is accepting of and incorporates another person's suggestion into their memory for an event (Ceci & Bruck, 1993), and could be due to a variety of situations (e.g., repeated questioning, social incentives, memory visualization, see Ceci, Loftus, Leichtman, & Bruck, 1994; Garven, Wood, Malpass, & Shaw, 1998). Suggestibility in response to misinformation (i.e., introduction of false information and details) is among the most commonly studied instances of suggestibility dating back to the early 1900s (Ceci & Bruck, 1993). Susceptibility to misinformation is typically studied in a three-phase structure; 1) participants witness an event, 2) participants are provided with false information, 3) participants are asked questions about the event to determine if they incorporated the false information provided to them into their memory (Lampinen & Smith, 1995; Leding, 2012). For example, in a study conducted by Loftus, Miller, and Burns (1978), participants saw a car accident take place and false information about the event was given to the participants while questioned about the event "Did another car pass the red Datsun while it was stopped at the stop sign?" (in the actual event it was a yield sign not a stop sign). Following this, participants were asked to recall details about the event, "Did you see a stop sign?" or asked to recognize a scene from the event. The "misinformation effect" occurs when subjects exposed to misleading information for that event are more likely than a control group to choose a misleading option later during recall (e.g., say "yes" to seeing a stop sign, see Ackil & Zaragoza, 1995; Huff, Weinsheimer, & Bodner, 2016; Loftus, 2005). It is assumed that participants who incorporate misinformation into memory for the event (Roebers & Schneider, 2000) may create a false memory (i.e., memory they believe to be true but did not actually occur or contains inaccuracies, Bruck, Ceci, & Hembrooke, 1998; Loftus, 1979; Meade & Roediger, 2002; Leding, 2012).

Although misinformation can come from a variety of sources (e.g., talking to others about the event, viewing media coverage, suggestive interrogations, Bruck & Ceci, 1999), the most common source of misinformation in interrogations is misinformation presented through questioning or misleading questions (Ceci, Ross, & Toglia, 1987; Lampinen & Smith, 1995). In a misleading question paradigm, the false information is introduced during the second phase of the three-phase structure, in the form of a question (see the Loftus et al., 1978 example above). In addition to prevalence, another reason why the misinformation during a questioning paradigm is so well-studied is because misinformation is often introduced without the interrogators' awareness (i.e., they believe the information they present to be true) or understanding of the effect it can have on the subsequent testimony (Bruck & Ceci, 1999). Further, the use of misleading questions is especially common with younger populations, because their free recall often lacks details (Ceci & Bruck, 1993; Price & Goodman, 1990; Roeber & Schneider, 2000) and interrogators supplement questioning with additional information to assist in drawing out detailed testimony. Unfortunately, the information provided to children during questioning is often inaccurate leading to unreliable and potentially false testimony by children (Ceci & Bruck, 1993, Garven et al., 1998; Price & Goodman, 1990; Roeber & Schneider, 2000). Although misinformation in questioning may be present to a lesser extent when interviewing older children and adults, misleading questions still occur because of interviewer bias or to encourage more detailed accounts (e.g., to extract the truth when the eyewitness appears to be lying or to reveal details that were forgotten due to the traumatic experience of the crime, Ofshe & Leo, 1997).

In addition to misleading questions being more prevalent in younger samples, the introduction of misinformation during questioning has more detrimental effects for younger children (Bruck & Ceci, 1999; Cohen & Harnick, 1980). For example, when exposed to misleading questions after having witnessed or engaged in an event, preschoolers (3- and 4-year-olds) more often incorrectly recognize the misinformation presented during questioning as information obtained from the witnessed event and are more likely to give fewer correct accounts of the event when compared to school age children (6- to 12-year-olds) and adults (Bruck & Ceci, 1999; Ceci & Bruck, 1993; Ceci et al., 1987; Ornstein, Gordon, & Larus, 1992). Further, 6-year-olds are more likely to incorporate misinformation from suggestive questions into their memory for an event compared to 9- to 16-year-olds (Cohen & Harnick, 1980). Thus, preschool seems to be a period during which episodic memory for events is fragile and easily affected by misleading questions, though older children and adults are not immune to misleading questions' effects.

Frameworks Explaining Preschoolers' Susceptibility to Misleading Questions

Social Frameworks. There are several reasons why preschool aged children may be more suggestible to the misinformation effect when presented with misleading questions. Socially, young children may fall vulnerable to suggestive information by social pressure (i.e., trying to please the interviewer, appealing to an authority figure, Ceci & Bruck, 1993). Research has shown that children are more vulnerable to misleading questions when produced by an adult, authority figure, a credible adult or child, or a person perceived as truthful, competent, believable, and not deceptive (Ackil & Zaragoza, 1995; Ceci et al., 1987; Lampinen & Smith, 1995; Lippman, 1911; Loftus & Loftus, 1980). Lippman (1911) suggests a child's thought process through an interrogation from a person of authority is as follows: "If the respected person who is questioning me expects such an answer, then it must be the right one." Thus, children rely heavily on authority figures and may expect them to be right leading them to override their memory or be less confident in it than adults.

Source Monitoring Frameworks. Theories of cognitive explanations for susceptibility to misleading questions primarily draw on source monitoring frameworks (Zaragoza & Lane, 1994, 1998; Lane, 2006). Source monitoring involves cognitive processes that allow for representations and retention of the origins of memories to ensure that information is linked to the correct source (Hala, Rasmussen, & Henderson, 2005; Johnson, Hashtroudi, & Lindsay, 1993; Zaragoza & Lane, 1994). While source-monitoring can be a controlled conscious effort that is deliberate and involves the use of representations, most often source-monitoring is automatic and conducted quickly without conscious awareness leaving room for errors (Johnson et al., 1993). The source-monitoring hypothesis suggests that when witnesses are introduced to misleading information they may confuse the source of the information with the witnessed event itself (Johnson et al., 1993). When responding to misleading questions an automatic response may be based on familiarity rather than reflecting on the representation of that memory (Zaragoza & Lane, 1994).

There are individual differences in source monitoring, with better source monitoring being associated with resisting suggestibility (Melinder, Endestand, & Magnussen, 2006). Source monitoring has also been proposed as a potential reason why young children show more susceptibility to misinformation compared to older children. A number of studies show preschoolers have difficulty distinguishing between two or more separate sources of events in memory when asked to consciously recall the source (Ackil & Zaragoza 1995; Ceci, Crotteau Huffman, Smith, & Loftus, 1994; Poole & Lindsay, 1995; Powell, Roberts, Ceci, & Hembrooke, 1999). Further, major improvements in the ability to monitor external sources dramatically increasing between 4- to 6-years of age (Lindsay, Johnson, & Kwon, 1991; Melinder et al., 2006), likely linked to the substantial achievements in the ability to control and manage behavior and attention during this time period (i.e., in order to monitor sources, one must selectively attend to and form a conscious representation for the source of the event).

One explanation for why children struggle with source monitoring may be due to the underdeveloped cognitive processes that assist in source monitoring. The fact that a large body of research shows that deficits in source monitoring relate to higher levels of suggestibility across the lifespan (Ceci et al., 1994) and preschoolers show substantial deficits in source monitoring compared to older samples (Ceci & Bruck, 1993), have led a number of theorists to suggest source monitoring deficits as a primary cause for suggestibility to misleading questions (Ceci et al., 1994). However, this source-monitoring framework likely only accounts for a portion of the developmental progression seen in preschool. Individual contributions of the conscious representational systems that allow for conscious reflection (Marcovitch & Zelazo, 2009) likely underlie and subsume issues with source monitoring. Thus, further work examining how the foundational higher order cognitive processes developing during this period (Garon, Bryson, & Smith, 2008, Posner & Rothbart, 1998) relate to suggestibility is necessary.

Cognitive Influences on Preschoolers' Susceptibility to Misleading Questions

Executive Function. Broadly, executive function (EF) is defined as higher order cognitive processes that underlie goal directed behavior (Epstien, 1973; Jacques & Marcovitch, 2010; Miyake & Friedman. 2012). Exercising EF is often required when automatic behavior is insufficient (e.g., consciously reflecting and recalling a new parking location is necessary to avoid automatically walking to your typical but incorrect spot; Diamond, 2006; Wheeler, Stuss, & Tulving, 1997). EF plays a role in children's and adults' memory with the higher order cognitive processes involved in EF thought to assist in encoding and retrieving information from long-term memory (Alexander et al., 2002; Miller, Chatley, Marcovitch, & McConnell Rogers, 2014; Schacter, Kagan, & Leichtman, 1995). For instance, EF is needed to form a strong event representation that can be maintained in long-term memory and is also needed during recall to resist the urge to automatically draw on familiarity in memory (Kelley & Jacoby, 2000) and consciously reflect on the appropriate memory trace (Marcovitch & Zelazo, 2009). Although there are links between EF and suggestibility to misleading questions, there are several important considerations that impact EF's influence on suggestibility.

First, the structure of EF has been suggested to consist of three core components (i.e., inhibition, working memory, and cognitive flexibility, Diamond, 2006; Miyake & Friedman, 2012), which can relate differentially to social and cognitive abilities (e.g., Miller, Avila, & Reavis, 2018; Miller et al., 2014). Inhibition is commonly measured through tasks that require individuals to override the tendency to produce an automatic response (e.g., following a rule to say a printed color word while inhibiting the tendency to read the words' ink color, Stroop, 1935). Working memory (WM) is a process in which information is temporarily maintained and manipulated (e.g., completing an ongoing task while maintaining other information in mind and using new information to update task completion, Miyake & Friedman, 2012). Cognitive flexibility, or set shifting, is the mental process of flexibly shifting between tasks or considering multiple mental sets (e.g., switching the sorting of two-dimensional cards from one dimension to a different conflicting dimension, Zelazo, 2006). These components are linked to suggestibility in adults. For example, to resist suggestibility one must maintain current information about the witnessed event in mind, update memory to reflect the sources of information and misinformation, inhibit the tendency to rely on more automatic processing (e.g., recalling anything familiar about the event, Kelley & Jacoby, 2000; Yonelinas, 2002), and rely on more conscious reflection to separate true information from misinformation when asked to recall the event (Kapinski & Scullin, 2009; Scullin & Bronner, 2006).

Children's abilities to execute these EF components show dramatic development during the preschool years (Garon et al., 2008; Jacques & Marcovitch, 2010), thus, a second important consideration in understanding EF's relation to suggestibility is EF's development across the lifespan. According to Garon et al.'s (2008) integrated framework of EF in development, the emergence of simple EF skills and executive attention networks (i.e., regulation of cognitive processes to monitor and solve conflicts, Posner & Fan, 2008) together result in complex EF skills. Links between EF and suggestibility to misleading questions align with this integrative EF development. For instance, the ability to engage in inhibition increases from infancy to 5-years of age, with the first instances of inhibition emerging in infancy and children under three evidenced in Delay of Gratification inhibition tasks (e.g., inhibiting playing with an attractive toy when asked not to, Garon et al., 2008). Inhibition in 3- to 5-year-olds is often measured with complex inhibition tasks, requiring holding a rule in mind that is contrary to a dominant response and responding according to the rule, such as the Day/Night Stroop (Garon et al., 2008). Higher performance on complex inhibitory control tasks are related to less suggestibility when exposed to misleading questions in children from 3- to 7-years-old, (Alexander et al., 2002; Clarke-Stewart, Malloy, & Allhusen, 2004; Kapinski & Scullin, 2009; Roberts & Powell, 2005). Initially, WM develops in infancy as holding information in mind over a delayed period of time (Garon et al., 2008). More complex skills of WM develop throughout preschool allowing for children to hold more information in mind while actively manipulating and updating that information, (Carlson, 2005; Cragg & Nation, 2007; Garon et al., 2008). For example, preschoolers' WM is often measured with more complex WM tasks like the Self-Ordered

Pointing task (SOPT; Petrides & Milner, 1982), which requires not only remembering a stimulus but also choosing new stimuli while avoiding previously chosen stimuli. There is a negative relationship between WM and suggestibility in children 3- to 5-years old when exposed to misleading questions (Clarke-Steward et al., 2004; Kapinski & Scullin, 2009). Cognitive flexibility is often thought of to be the last of the three core components of EF to develop due to its prerequisite of both inhibition and WM (Garon et al., 2008). For instance, researchers have consistently found that 4-year-olds and most 5-year-olds show major developments in cognitive flexibility (i.e., particularly the ability to switch between mental sets) with large improvements occurring during the ages of 5- to 11-years, peaking at the early 20's (Carlson, 2005; Jacques & Marcovitch, 2010; Diamond, 2006). Cognitive flexibility has been shown to have no relationship with suggestibility to misleading questions in children 3- to 5-years old (Kapinski & Scullin, 2009), perhaps due to its late development when compared to the other components of EF.

Although the core components of EF are developing in preschool (Garon et al., 2008) there is debate on whether the best way to conceptualize EF is by focusing on component processes or a unitary EF ability. Other frameworks of early EF propose that EF may be best represented in a unitary fashion during the first 6-years of life (Wiebe et al., 2011), where the best model to describe the variability among multiple EF tasks is to extract a unitary factor thought to display a common underlying ability known as common EF (i.e., the ability to form and maintain representations that guide lower level processing toward a goal, Miyake & Friedman, 2012). To date, EF links to misleading questioning research has only been investigated in a componential way and suggests that separate abilities in EF such as inhibition and working memory may play a role in suggestibility. However, research suggests that EF at this age should be measured as a unitary factor because component abilities are not fully developed. Examination of a common EF during this period may be informative and align with representational models of EF development (Marcovitch & Zelazo, 2009) suggesting that component abilities are not necessarily key to controlled behavior and memory, rather what underlies these component abilities is the common ability to form and use representations to guide behavior that will be important to long-term memory formation.

Attention Influences. Attention during encoding of an event may also be a major cognitive process that influences suggestibility to misleading questions. More specifically, the executive attention network responsible for control over attention and detecting and resolving conflict (Rothbart, Ellis, Rueda, & Posner, 2003) is likely important to memory. For instance, executive attention is responsible for noticing critical details of a stimulus in the environment to recall later (Klenberg, Korkman, & Lahti-Nuuttila, 2001) and some authors even go so far as to define memory as selective attention to events or representations (Casey, Giedd, & Thomas, 2000). Simply not paying attention during an event can result in encoding problems, such as not storing the information, resulting in recall issues later (Loftus, 2003). Further, one way the legal system identifies an eyewitness as credible and accurate is by determining their level of attention during the event (Lane, 2006).

One way to examine just how important attention is to accurate eyewitness memory in response to misleading questions is to examine memory when attention is impaired. Divided attention (DA) requires the ability to cognitively process multiple stimuli or perform multiple tasks simultaneously (Verhaeghen & Cerella, 2002). Often the results of DA are reflected in diminished performance of a task (Johnston, Greenberg, Fisher, & Martin, 1970). Typically, the effects of DA are measured by comparing one's performance on a single task, with one's performance on the same task, while simultaneously performing another task (i.e., dual-task performance, Verhaeghen & Cerella, 2002). In a DA or dual-task paradigm, participants engage in a primary task focused on memorizing some specific information while also performing a secondary task (e.g., solving mathematical problems or card sorting; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Wimmer & Howe, 2010). This paradigm also has practical applications to the eyewitness testimony literature. Eyewitnesses in real world situations are often in very stressful environments during the event and attentional resources are frequently divided among multiple stimuli (e.g., the event itself, internal details such as thoughts and feelings, and external details such as other nearby events), which can affect the quality of one's memory for the event (Zaragoza & Lane, 1998; Lane, 2006).

Empirical evidence shows that DA during encoding of eyewitness memory can lead to errors in adults. For example, Lane (2006) found that when adult witnesses engage in DA (e.g. listening to music while witnessing the event) during encoding of the event they were more likely to include post-event suggested information into their memory of the event. Further, the decrease in memory is enhanced when the secondary task is more complex (Craik et al., 1996). It has repeatedly been found that DA has a negative impact on the encoding processes of memory (e.g., making the initial memory less detailed) likely because DA reduces the availability of attentional resources for complex cognitive processes, resulting in poorer memory recall (Anderson et al., 2000; Craik et al., 1996; Fernades & Moscovitch, 2000; Kellog, Cocklin, & Bourne, 1982; Park, Smith, Dudley, & Lafronza, 1989). This results in a less elaborate memory representation for the event (Lane, 2006), because DA impairs the actual memory when compared to full attention (Wimmer & Howe, 2010). When memory representations are missing information, we often try to fill in the gaps (Greenberg, Westcott, & Bailey, 1998), this could result in increased vulnerability to suggestive information when attempting to filling in the missing gaps in memory. However, the research examining attention links to eyewitness memory, let alone misleading questions is lacking. A major gap in the literature is the effects of DA on children's memories. While there is a wide breadth of literature with adults, researchers have yet to look at the effects of DA with children when faced with misleading questions, which is surprising given the development of attentional networks in the preschool period (Garon et al., 2008).

In childhood, there are two general attention systems hypothesized to guide attention: the orienting or selective attention system and the executive attention network (Garon et al., 2008). The selective attention system allows for exogenously controlled orientation to and shifting of attention to an external stimulus, while the executive attention network allows for endogenous control where attention is not guided by the environment but rather internally such as through representations (Garon et al., 2008; Rothbart et al., 2003). The executive attention network is hypothesized to emerge later than the selective attention system, with major developments occurring between 3- to 5-years of age in the executive attention network (Garon et al., 2008). Further the development of executive attention has been proposed as a cornerstone of controlled behavior in EF development because of its assistance in focusing attention to a task while avoiding irrelevant information and allowing for control of internal and external information processing (Garon et al., 2008). A more developed executive attention network could through representation lead to a better long-term memory performance, such as in recalling details of an event. Perhaps the development of the executive attention network could also assist in better allocation of attention during a DA task, resulting in less detrimental effects of DA on memory recall.

Developmentally, there are only a few studies examining DA and memory in children and none to my knowledge examining DA and suggestibility to misleading questions in memory. Wimmer and Howe (2010) found that 7- and 11-year-olds showed decreased memory for word recognition when a DA paradigm (e.g., primary task being word memorization and an inhibition Day/Night-Stroop task being the secondary task) was administered during encoding and that 7-year-olds were affected more by DA than 11-year-olds. While Wimmer and Howe (2010) found evidence of the effects of DA on memory recognition in children, they did not find evidence of false memories as a result of DA. Taken together, DA and suggestibility to misleading questions literature suggests older children and adults' memory is influenced when attention is divided during encoding and presentation of misinformation is used during questioning. Development in young children suggest that they may show different patterns or be even more influenced because of underdeveloped executive attention system - but this work has yet to be conducted.

The Present Study

During the preschool period, there are developmental changes in vulnerability to suggestibility, with suggestibility to misleading questions decreasing with age (Bruck & Ceci, 1997, 1999; Ceci & Bruck, 1993). Although this achievement has been linked to development in source memory (Melinder et al., 2006), other major cognitive developments during the preschool years in EF and attention (Jacques & Marcovitch, 2010) have yet to be examined as cognitive influences on suggestibility to misleading questions. The main focus of this research was to determine if cognitive abilities (i.e., EF and DA) influence vulnerability to suggestibility through misleading information, how this affects preschooler (3- to 5-year-olds) suggestibility, and how all preschooler's suggestibility is comparable to adults.

To answer this question, preschoolers ages 3- to 5-years and adults were randomly assigned to two conditions, either receiving dual-tasks (i.e., DA condition) or not receiving dual tasks (i.e., Full Attention or FA condition) at encoding. All participants were administered three EF tasks at the beginning of the session to measure WM, inhibition, and cognitive flexibility. Following this, participants watched a video, which was the eyewitness event. Those in the DA condition were given additional tasks to complete while watching the video. Those in the FA condition were asked to give their full attention to watching the video. Following this, participants were given two addition tasks that served as a delay between the witnessed event and questioning. These tasks included the Maxi theory of mind task and a Day/Night Stroop task. Lastly, participants were asked a series of recognition questions, most of which were misleading, then participants were asked the same questions a second time. Total suggestibility was calculated by including assents to misleading questions (i.e., Yield score) and answers changed from the first time questioned to the second time questioned (i.e., Shift score, Wyler & Oswald, 2016).

I had five hypotheses related to the role that cognitive abilities in EF and DA would play in suggestibility to misleading information. (H1) I expected children to be more suggestible than adults and younger children (i.e., 3- and 4-year-olds) to be more suggestible than older children (i.e., 5-year-olds, Ceci & Bruck, 1993). I also hypothesized (H2) that EF would predict suggestibility (and potentially be an even more important predictor than age), suggesting that age may be a proxy for the rapid development in EF (Garon, et al., 2008; Jacques & Marcovitch, 2010) that assists in individuals resisting suggestibility (e.g., holding and alternating between information in mind may help keep sources straight and result in less suggestibility, Kapinski & Scullin, 2009). With EF I hypothesized (H3) that both unitary and component EF conceptualizations would predict suggestibility, but in different ways. Specifically, when looking at component EF abilities I expected both inhibition and working memory to contribute to suggestibility, however based on the literature I did not expect cognitive flexibility to predict suggestibility in children, primarily because cognitive flexibility has not shown to be related to suggestibility in previous research which could be linked to its late development when compared to other EF components. However, I expected cognitive flexibility to predict suggestibility in adults since this EF component would be developed in this population.

For unitary measures of EF, I expected a better prediction of suggestibility to misleading questions for children 3- to 5-years-old, than the individual components since EF is primarily measured as a unitary component in the preschool period. However, since EF is often measured as components in adults, I expected the EF componential framework to better predict suggestibility to misleading questions for this age group. Regarding attention, I expected (H4) that those in the DA condition would be more suggestible than those in the FA condition (Wimmer & Howe, 2010), but this effect would depend on EF ability (H5). More specifically, the eyewitness memory of individuals with lower EF abilities would be more influenced by DA because they have less cognitive resources to draw from during eyewitness events. Further, if EF abilities are already low, then any disruption in attention would have a greater effect on EF abilities, which I proposed would further result in increased vulnerability to suggestive misleading questions (Garon, et al., 2008). Lastly, I explored the possible age interactions to examine whether age interactions accounts for additional variance once accounting for EF.

II Methods

Participants

Participants included 30 3-year-olds (*M*=3.56, *SD*=.25), 30 4-year-olds (*M*=4.42, *SD*=.26), 30 5-year-olds (*M*=5.37, *SD*=.30), and 80 adults (*M*=19.99, *SD*=1.68). Children were recruited from preschools around the Oxford, MS area and from a database of parents interested in child development research. Children were tested in both preschools and an on-campus laboratory at the University of Mississippi. For their participation, children received a small toy (e.g., toy car, figurine). Adult subjects were students from the University of Mississippi SONA research pool. For their participation adults were given research credit through the SONA site. Of the final child sample, 48 participants were female. Of those who reported demographics the majority of children came from households that made between $100,000 – over $140,000 yearly (68.26%), 31.74% made less than 80,000. Ninety-Six percent of participants primarily spoke English, with 10.1% of participants being bilingual. Eighty-four percent of participants were White (non-Hispanic), 1.5% were Black/African American, 9% were Asian/Pacific Islander, 1.5% affiliated with other, and 4.5% were of multiple races. Ninety-seven percent of children came from households were their parents were married. Of the final adult sample, 57 participants were female. Of those who reported demographics the majority of households made between $80,000 – over $140,000 yearly (65.4%), 30% made less than 79,000, 12% did not report household income. Ninety-three percent of participants primarily spoke English, with 15.8% of participants being bilingual. Sixty-six percent of participants were White (non-Hispanic), 19%

were Black/African American, 10% were Asian/Pacific Islander, and 5% were of multiple races. Only 2.5% of adult participants were married.

Procedure

Participants were randomly assigned into one of two levels of attention, DA condition (i.e., receiving dual-tasks) or FA condition (i.e., not receiving dual tasks) during encoding of the eyewitness event. All participants were administered the three EF tasks in a fixed order at the beginning of the session to measure WM, inhibition, and cognitive flexibility. Following this they watched a video. Those in the DA condition were given an additional task (i.e., Day/Night Stroop) to complete while they watched the video and were instructed to "please pay close attention to the video, as you will be asked some questions about the video later. In addition, you will be playing a sorting game in which you need to try to do as well as you can." Those in the FA condition purely watched the video and were instructed "please pay close attention to the video, as you will be asked some questions about the video later". Following this, participants engaged in a theory of mind task and a secondary Day/Night Stroop which served as a delay between viewing the video and questioning. Participants were then asked a series of yes/no questions about events in the video, where 14 out of 18 questions were misleading, see Appendix A (Scullin & Ceci, 1999; Wyler & Oswald, 2016). The set of questions were asked a second time following negative feedback. All but two tasks (i.e., the SOPT and the DA task) were presented to participants on a Surface Pro 3 via the SuperLab 5.0 programming software.

Pilot Testing

This study was piloted on 13 preschoolers (i.e., seven 3-year-olds, three 4-year-olds, and three 5-year-olds). Early on it was evident that during the DA task children were not sorting the

Day/Night cards while watching the movie. Originally the DA task was performed completely on the computer, with the video playing on the top portion of the computer screen and the Day/Night Stroop game playing in the lower portion of the computer screen. Children were instructed; "please pay close attention to the video located on the top of the screen, you will be asked some questions about the video later. In addition, there will be game displayed at the bottom of the screen for you to engage while the video plays. You must continue to play the game until the video is over. Your score on the game will also be recorded so please try to do as well as you can.". However, children would only sort the card when given reminders "please remember to continue the card game". In addition, some children were performing poorly for their age on the Stroop task (e.g., one 4-year-old got 12/50 correct), likely due to focusing their attention on the video rather than the game. Given this insight, the Day/Night was altered to increase participation by requiring children to physically sort the cards given to them by the researcher into boxes the were located directly below the computer screen. This change resulted in more participation on the task meant to divide attention (i.e., Day/Night Stroop).

In addition, piloting revealed that participants were easily able to accurately recall events from the video during questioning when they were directly questioned after the observation, regardless of attention condition. Many eyewitness studies include some type of delay between witnessing the event and questioning. Researchers suggest that when there is a delay between an event and questioning, that new reports given by children during repeated misleading questions, are commonly false because children's memory of the original event fades over time allowing for misinformation to fill in the gaps in their memory (Bruck & Ceci, 1999). Further, previous research with the VCCS used a delay of 1-3 days and 7-10 days between witnessing the event and being questioned (Scullin & Ceci, 2001). For these reasons, a delay was added into the study. While a delay of a day or longer was not feasible for data collection for this study a shorter delay was implanted. Two tasks, a theory of mind task and a Day/Night Stroop task, were added between viewing the video and questioning. These tasks served as delay but were chosen based on their developmental compatibility to other developmental components and tasks in this study. For instance, theory of mind (ToM, understanding that others have thoughts and beliefs different from our own, and those thoughts and beliefs drive behavior, Gopnik & Astington, 1988) is related to the development of EF throughout the preschool years (Miller & Marcovitch, 2012). In addition, ToM has also been shown to be negatively related to suggestibility (Bruck & Melnyk, 2004; Scullin & Bonner, 2006). With these links to other cognitive processes within the study ToM could serve not only as a delay task but it could potentially serve as an exploratory variable. The Day/Night Stroop was chosen as it was thought that performance on the Day/Night Stroop during the delay could be compared to performance on the Day/Night Stroop during the DA paradigm as a way to check whether attention effectively was divided.

EF Measures

Dimensional Change Card Sort (DCCS; Zelazo, 2006). The DCCS measures cognitive flexibility and is appropriate for individuals from 3 years of age to adulthood (Zealzo, 2006). Children and adult versions of the DCCS differed slightly in the number of cards required to sort for each phase.

Child version. For the first two phases there were two target cards (e.g., a yellow car and a green flower) and six testing cards (e.g., three green cars and three yellow flowers) that participants sorted in a random sequence, see Figure 1. In the preswitch phase participants were instructed to sort cards according to one dimension (e.g., color), after all six cards were sorted participants moved on to the postswitch phase. In the postswitch phase participants were introduced to the same two target cards but were now instructed to sort according to a different dimension (e.g., shape), after all six cards were sorted participants moved onto a second postswitch phase. The second postswitch phase had the same two target cards. In addition, there were four possible test cards, each with a border and without a border. This phase consisted of 12 test cards total, with rules that varied based on whether the card had a border or not. Participants were instructed to sort by one dimension (e.g., color) if there was a border around the picture, however, if there was no border around the picture they were instructed to sort by another dimension (e.g., shape). This task was administered on the computer and the total number of correctly sorted cards on the first postswitch phase and response times were recorded, each response time began as soon as the card appeared on the screen and ended as soon as the participant chose a button.

Adult version. For the first two phases there were two target cards (e.g., a yellow car and a green flower) and 12 testing cards (e.g., three green cars and three yellow flowers) that participants sorted in a random sequence, see Figure 1. In the preswitch phase participants were instructed to sort cards according to one dimension (e.g., color), after all 12 cards were sorted participants moved on to the postswitch phase. In the postswitch phase participants were introduced to the same two target cards but were now instructed to sort according to a different dimension (e.g., shape), after all 12 cards were sorted participants moved onto a second postswitch phase. The second postswitch phase had the same two target cards but consisted of 24 test cards with rules that varied. Participants were instructed to sort cards according to the prompt given on the screen, the prompt “color” or “shape” appeared on the screen for each trail. Trials were mixed so participants could not anticipate which prompt would appear. This task was administered on the computer and the total number of correctly sorted cards on the second postswitch phase and response times were recorded, each response time began as soon as the card appeared on the screen and ended as soon as the participant chose a button.

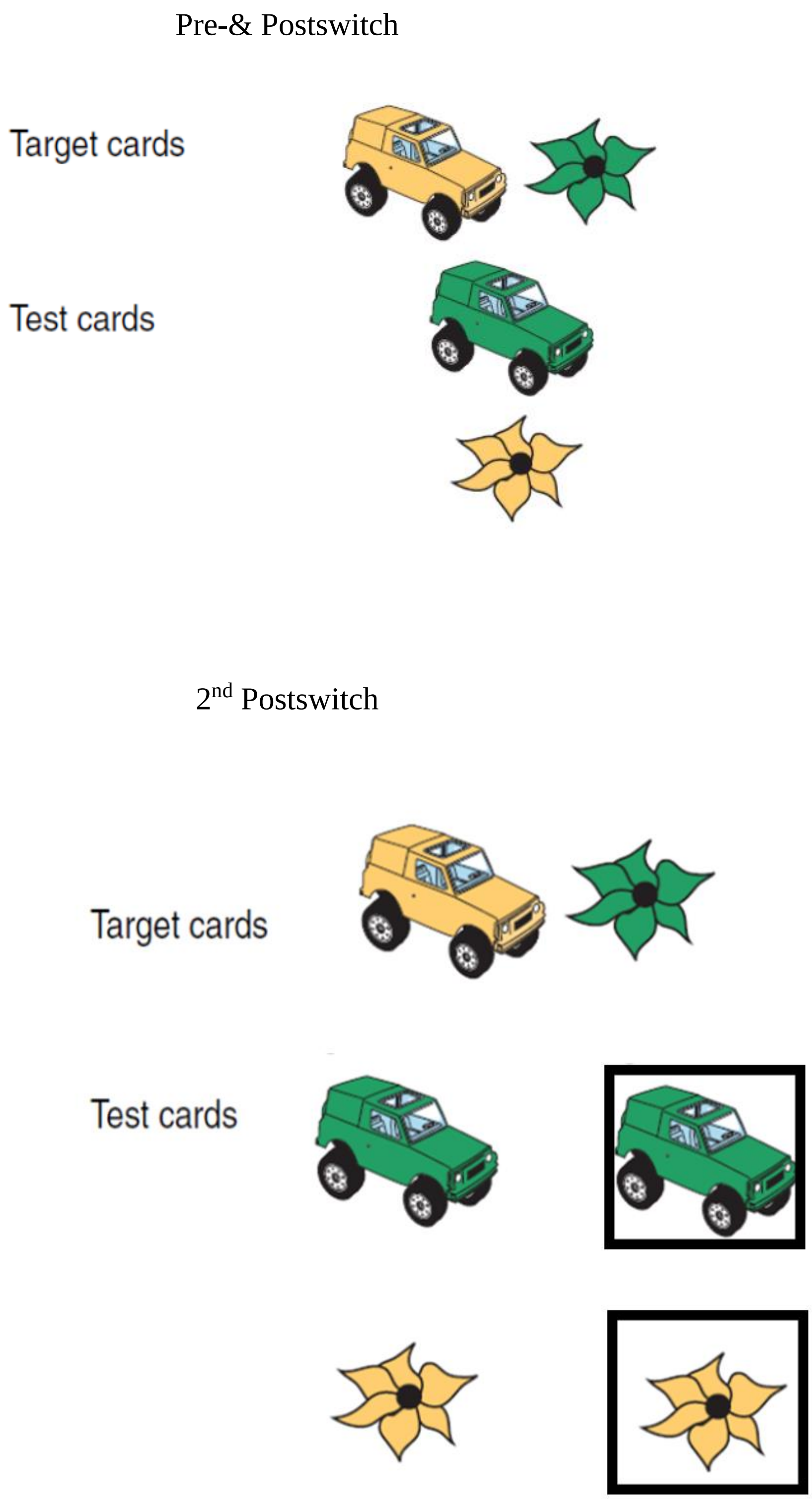
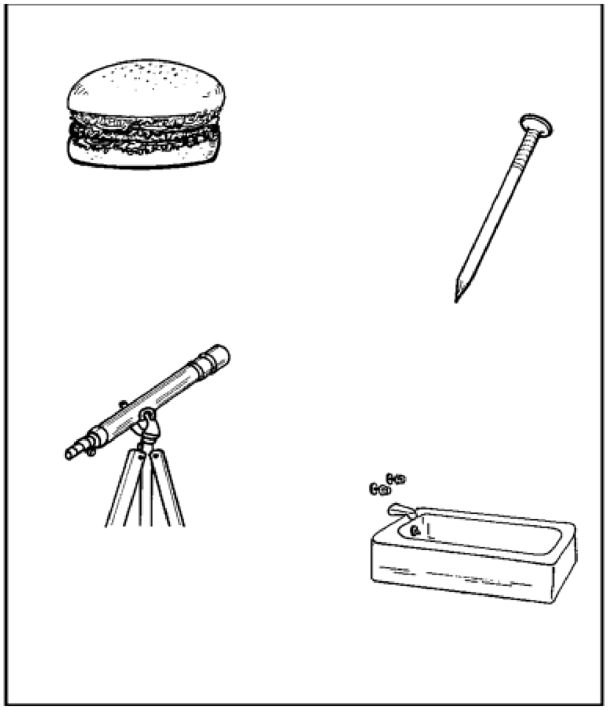
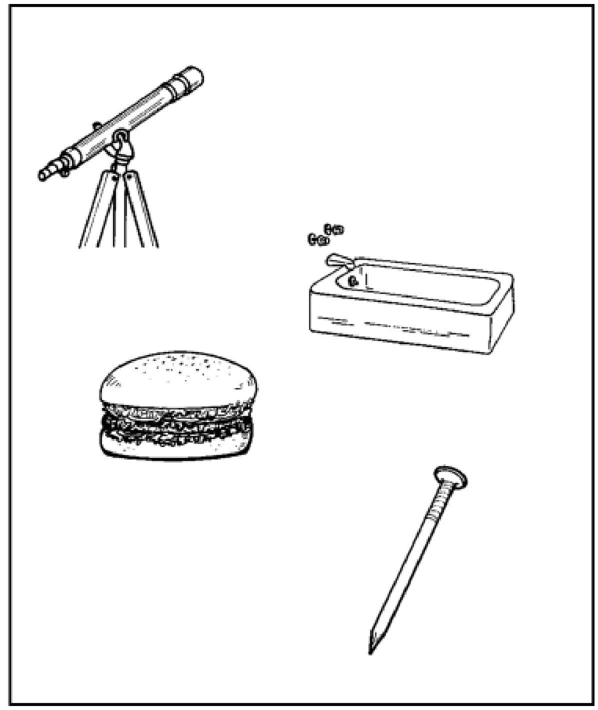


Figure 1. Dimensional Change Card Sort Task

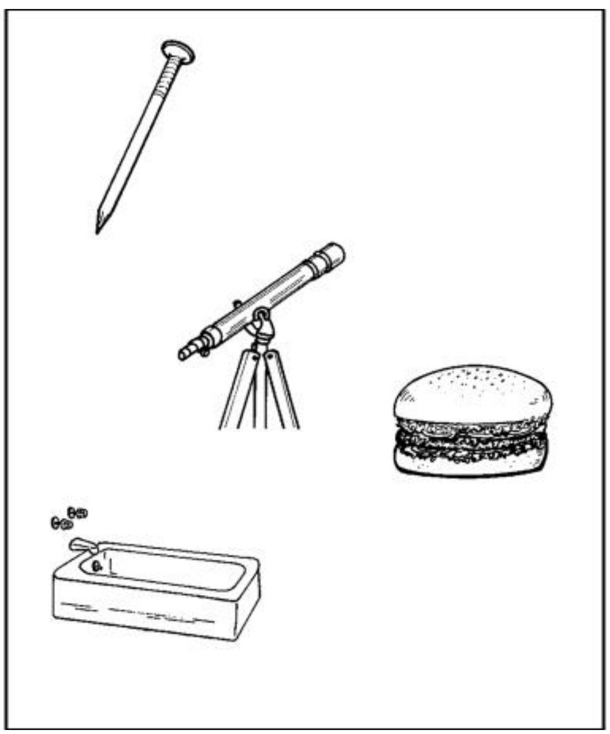
Self-ordered Pointing Task (SOPT; Cragg & Nation, 2007; Petrides & Milner, 1982). The SOPT measures working memory and is appropriate for individuals 3 years of age to adults. There were five levels in this task with each level consisting of multiple cards depicting several pictures presented in a different spatial arrangement, see Figure 2. Each level gets increasingly more difficult than the last, as the number of cards and pictures on each card increases by two. For example, the first level depicted in Figure 2 consisted of four pictures per card with four cards total in the level. Participants were presented with cards one at a time and were required to point to a different picture for each card they saw (i.e., all of the pictures must be touched once), thus they must remember which pictures they pointed to on previous cards to select a new picture. After participants were shown all four cards in level one, they move onto the next level which consisted of a larger set size (i.e., six pictures per card, six total cards). This continued until all five levels were completed, the highest level consisted of 10 pictures per card with 10 cards total. No feedback was given at any time during this task, except to remind participants of the rules prior to beginning a new level (i.e., "do not touch a picture that you've already touched"). The number of correctly selected pictures was recorded for each level as well the overall total number of errors and overall total correct choices which was out of 40. This task was presented in a book format in which the page was turned after each card, there was a blank page between levels to indicate the next level was about to begin. There were two versions of this task, one administered to children the other administered to adults. As with pervious use of this task the child version consisted of pictures on the pages (e.g., balloon, baby, hose, elephant) while the adult version consisted of abstract designs on the pages (e.g., large strips, small stripes, squiggly lines, chevron lines). The number pictures selected only once out of 40 was recorded.



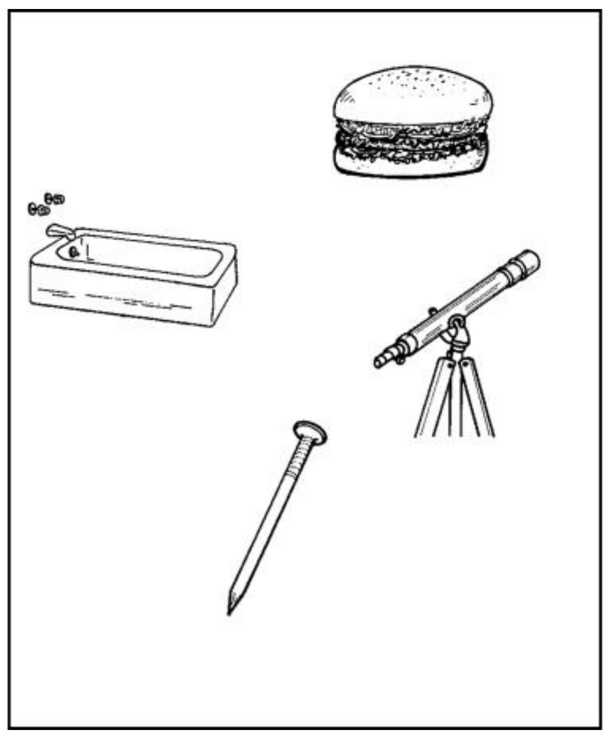
Card 1



Card 2



Card 3



Card 4

Figure 2. Self-Ordered Pointing Task

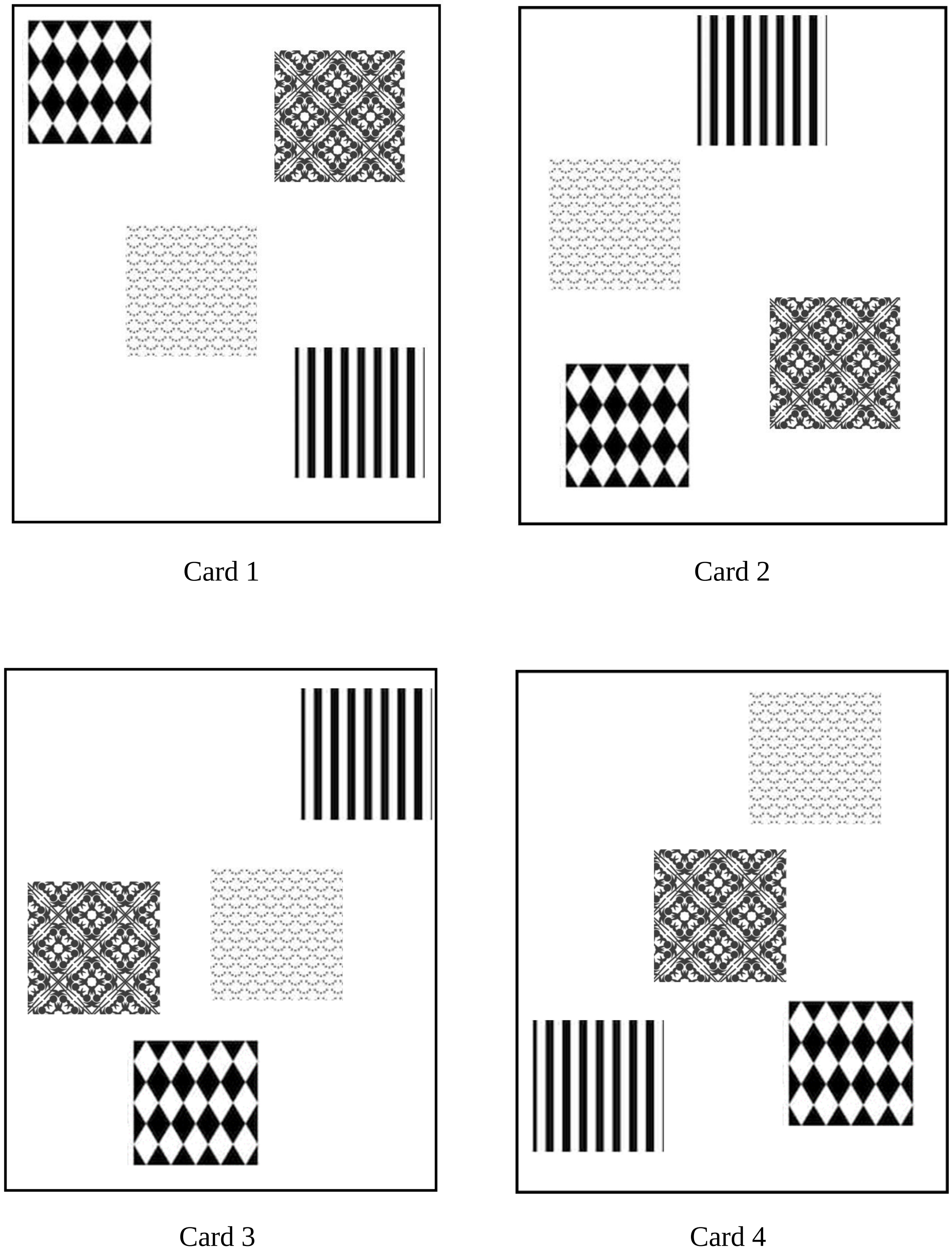


Figure 2. Self-Ordered Pointing Task

Stroop Tasks (Gerstadt, Joo Hong, & Diamond, 1994; Stroop, 1935). The Stroop is a measure of inhibition. Children and adults received different versions of the Stroop to adjust for age appropriateness. Children were administered the Grass/Snow Stroop (Gerstadt, Joo Hong, & Diamond, 1994) and adults were given the Stroop Color-Word Task (Stroop, 1935).

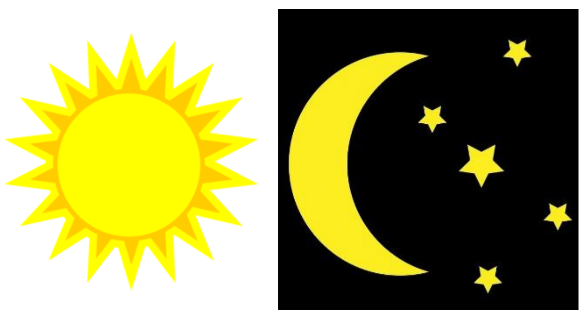
Children Stroop Task Grass/Snow (Gerstadt, Joo Hong, & Diamond, 1994). The Stroop Task Grass/Snow measures inhibition in children 3-years and up. The participant saw a green grass card and a white snow card on the screen. There were corresponding buttons on the response pad with the stimuli. During familiarization, the participant simultaneously heard the word "snow" and saw the "snow" card on the screen and was instructed to select the green grass button and when the participant simultaneously heard the word "grass" and saw the "grass" card on the screen the participant was instructed to select the white snow button, see Figure 3. After instructions there were two training trials in which participants sorted a grass card and a snow card correctly for each trial before moving onto testing. There were a total of 16 testing trials (i.e., presented in random order: g, s, s, g, s, g, g, s, s, g, s, g, g, s, g, s), the total number of cards correctly selected out of 16 was recorded. Participants were instructed to respond as quickly as possible and their first response was recorded. Participants were not given feedback. This task was completed on the computer.

Adult Stroop Color-Word Task (Stroop, 1935). The Stroop Task measures inhibition in adults. Participants were instructed to say aloud the ink color of the word rather than the printed word (e.g., for the word "red" printed in the color "blue", the correct response was "red", see Figure 4). There were three blocks given in the following order; congruent trials (i.e., word "red" printed in the color "red"), color of bar trials (i.e., XXXX's printed in the color "red"), and incongruent trials (i.e., the word "red" printed in the color "blue"). Each block had 24 trials within it. Participants were instructed to say the color of the ink for each word or XXXX's as quickly as possible depending on the block and to leave no errors uncorrected. Reaction times for each block included the time it took to complete all 24 trials with correcting for errors as measured by a stopwatch and the number of correctly labeled trials out of 24 for each block (first responses were recorded) were recorded. Interference scores were calculated by subtracting the number correct on congruent trails from the number correct on the incongruent trials. A negative score would reflect low inhibition while a positive score would reflect higher inhibition. The stimuli was presented on the computer, verbal responses were recorded by voice recorder, and trials were timed with a stopwatch.

Grass/Snow Stroop:

Snow Grass

Sun/Moon Stroop:



Night Day

Figure 3. Children’s Stroop Tasks

Congruent Trials	Color of Bar Trials	Incongruent Trials
Red	XXXX	Green
Green	XXXX	Blue
Yellow	XXXX	Green
Green	XXXX	Red
Yellow	XXXX	Green
Green	XXXX	Blue
Blue	XXXX	Green
Red	XXXX	Yellow
Blue	XXXX	Red
Red	XXXX	Red
Blue	XXXX	Green
Yellow	XXXX	Yellow
Red	XXXX	Green
Blue	XXXX	Red
Yellow	XXXX	Blue
Blue	XXXX	Yellow
Red	XXXX	Blue
Blue	XXXX	Blue
Green	XXXX	Blue
Yellow	XXXX	Red
Red	XXXX	Yellow
Green	XXXX	Red
Yellow	XXXX	Yellow
Green	XXXX	Yellow

Figure 4. Adult Stroop Task

Delay Tasks

The following two tasks were included to serve as delay tasks between participants witnessing the event (i.e., the video) and being questioned about the event.

Maxi False Belief Task (Wimmer & Perner, 1983). This task measures theory of mind and is appropriate for children as young as 3-years-old. Participants were read a story about a character named Maxi who has a false belief about the location of an object, see Figure 5. Maxi puts chocolate into cupboard x. While he is gone his mother puts the chocolate into cupboard y. When Maxi returns participants are asked two questions; where Maxi will look for the object (i.e., false belief question) and where the object really is (i.e., reality question). If participants are able to identify that Maxi has a false belief about the object's location, they would identify cupboard x as the cupboard that Maxi would look in, which is different from their knowledge of where the object is actually located, cupboard y. Participants responses were recorded as correct or incorrect. This task was administered via story book presentation to both child and adult participants. [1]

Stroop Task Day/Night (Gerstadt, Joo Hong, & Diamond, 1994). The Stroop Task Day/Night measures inhibition in children 3- to 6-years of age. The participant saw a white day card and a black night card on the screen. There were corresponding buttons on the response pad with the stimuli. During familiarization, the participant saw the "day" card on the screen and was instructed to select the night button and when the participant saw the "night" card on the screen the participant was instructed to select the day button, see Figure 3. After instructions there were

[1] ToM was not reported in the results for two reasons. First it was not a variable of initial interest. Second, while this variable could be exploratory, preliminary analysis revealed it was not correlated with suggestibility, resulting in no further follow-up analyses, thus it served primarily as a delay task in the present experiment.

two training trials in which participants sorted a day card and a night card correctly for each trial before moving onto testing. There were a total of 16 testing trials (i.e., presented in random order: n, d, d, n, d, n, n, d, d, n, d, n, n, d, n, d), the total number of cards correctly selected out of 16 was recorded. Participants were instructed to respond as quickly as possible and their first response was recorded. Participants were not given feedback. This task was completed on the computer.

There comes Grandpa and Maxi says: "Dear Grandpa please help me get the chocolate from the cupboard." Grandpa asks: "Which cupboard?"

"Where will Maxi say the chocolate is?"

"Where is the chocolate really?"

"Do you remember where Maxi put the chocolate in the beginning?"

Figure 5. Theory of mind, Maxi False Belief Task

Suggestibility and DA Measures

Suggestibility Video (Scullin & Ceci, 2001). The video was of a child's birthday party and was created by Scullin and Ceci (2001) and lasted approximately five minutes. The birthday party was for a boy named Billy and took place at his house with his mother, father, and friends (Tammy, Suzie, Robin). During the party Tammy and Suzie peek inside a bag at a present. Billy describes his friend Robin as clumsy, she later trips and falls, and drops cake on herself. When Billy opens his presents, he sees that his toy (which was in the bag that Tammy and Suzie peeked in) is broken and this upsets him. Following this a cake is brought out, Billy blows out the candles, and a smoke alarm goes off in the kitchen due to the candles on the cake. Everyone is assured that the smoke alarm is a false alarm and the children eat the cake concluding the video. Participants are instructed to pay close attention to the video "story" as they will be questioned about it later.

There were two conditions in this task. Participants in the full attention (FA) condition were instructed to watch the video. Participants in the divided attention (DA) condition were instructed to watch the video, while also engaging in a Day/Night Stroop task (Gerstadt, Joo Hong, & Diamond, 1994). The video appeared on the computer screen and the Day/Night Stroop was conducted manually with the researcher on the table in front of the computer. The Day/Night Stroop was chosen as a secondary task in the DA paradigm because of its previous use as a DA task with children (Wimmer & Howe, 2010). During the ongoing task participants were presented with 50 trials (i.e., 25 day cards and 25 night cards, presented in random order), that were evenly distributed throughout the five minute video in which participants were instructed to place the card in the opposite box of the picture presented (i.e., a Day card goes in the Night box, a Night card goes in the Day box). A researcher handed each card to the participant and reminded the participants to “please remember to continue the card task” if they failed to sort a card after five seconds of it being handed to them. Typically, the Day/Night Stroop is 16 trials however for the task to run for the entire video length it was extended to 50 trials. This adjustment was made based on continuous DA tasks in the adult literature. The overall number of cards sorted, and the number of correctly sorted cards was recorded to ensure that participants engaged in the task as a measure of DA.

For adults, this task was further altered to include the Grass/Snow Stroop task as well, as researchers found it easy to complete the Day/Night task while watching the video without dividing attention. Thus, adults had to sort Day, Night, Grass, and Snow cards into their correct box (e.g., a Day card goes in the Night box, a Night card goes in the Day box, a Grass card goes into Snow box, Snow card goes into Grass box), adults received 100 cards (i.e., 25 day cards, 25 night cards, 25 grass cards, and 25 snow cards, presented in random order) to sort throughout the 5 minute video. The overall number of cards sorted, and the number of correctly sorted cards was recorded to ensure that participants engaged in the task as a measure of DA.

Leading questions (Scullin & Ceci, 2001). A total of 18 forced choice yes/no questions about the video were administered verbally by the experimenter after participants completed all other tasks. These questions were obtained from the Scullin and Ceci’s (2001) paper on suggestibility. Four of the questions were non-suggestive (i.e., where the information was true to the video such as ‘Was there a girl named Suzie at the party?’) with the remaining 14 being suggestive (i.e., where the information was not true to the video, e.g., ‘Did the two girls arrive at the party in a bright red car?’, see Appendix A for a full list of questions). Following all 18 questions participants went through the questions again under the guise of feedback (i.e., ‘you missed a few of the questions. Let’s go through them again and see if you can do better this time’). A yield 1 score was calculated in response to the first administration of the questions (i.e., number of assents to suggestive questions during the first administration of questions). A yield 2 score was calculated in response to the second administration of the questions (i.e., number of assents to suggestive questions during the second administration of questions). A shift score was calculated in response to the re-administration of the questions during feedback (i.e., changes to original answers to the initial question after feedback was given during the second administration of questions). A total suggestibility score was calculated by adding the number of yield 1 scores to the total number of shifts (Scullin & Ceci, 2001). See Appendix B.

III Results

Missing Data and Descriptive Statistics

One adult participant reported being red/green color blind resulting in them being dropped from the hierarchical regression and GLM analysis in a listwise deletion. There were no other instances of missing data. EF tasks were originally proposed to be analyzed in a unitary fashion for children and a componential fashion for adults. However, EF tasks were not highly correlated among children or adults, see Tables 2 & 3. Thus, EF tasks were analyzed in a componential fashion for both children and adults. Descriptive statistics for each EF task by age can be found in Table 1.[2]

[2] EF was run as a unitary component for the child sample and revealed a similar pattern of results.

Table 1

Descriptive Statistics by Age

Variables	3-year-olds			4-year-olds			5-year-olds			Adults		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Stroop	13.17	3.24	2-16	13.93	2.60	6-16	13.97	2.74	7-16	-0.06	0.17	-1.08-0.17
Day/Night Stroop	12.33	4.12	1-16	14.20	1.70	11-16	14.57	1.61	10-16	15.85	0.36	15-16
DCCS	1.17	1.86	0-6	2.57	2.64	0-6	3.80	2.43	0-6	22.91	1.26	19-24
SOPT	34.37	2.80	28-40	35.50	2.56	29-39	36.63	2.06	32-39	35.33	1.96	30-39
Yield 1	8.57	3.32	2-14	7.20	3.44	2-14	5.80	3.60	0-14	1.93	1.81	0-7
Total Suggestibility	13.17	4.20	3-21	11.83	4.23	3-20	11.33	4.39	4-25	6.03	4.59	0-32

Note. Stroop reflects number correct out of 16 on the Grass/Snow Stroop for children and the difference in interference scores between congruent and incongruent Stroop trials for adults. Day/Night Stroop reflects the number of correctly sorted cards out of 16 for both adults and children. DCCS reflects the number correct out of 6 on the postswitch phase for children and number correct out of 24 on the second postswitch phase for adults. SOPT reflects the number of novel picture choices out of 40 for both adults and children. Yield 1 scores reflect the number of times both children and adults assented to suggestive questions, of which there were 14. Total suggestibility reflects the combination of yield 1 scores and shift scores for both adults and children.

Table 2

Correlations Among Measures for Children (N=90)

Variables	1	2	3	4	5	6	7	8	9
1. Exact Age	-	.453**	.362**	.114	-.017	.246*	.455**	-.281**	-.089
2. DCCS Postswitch		-	.195+	.002	-.053	.084	.235*	-.067	-.076
3. SOPT			-	.201+	-.021	.385**	.301**	-.203+	-.082
4. Grass/Snow Stroop				-	.039	.446**	.041	-.119	.008
5. Level of Attention					-	.074	.090	.189+	.109
6. Day/Night Stroop						-	.201+	-.197+	-.110
7. Theory of Mind							-	-.169	-.209*
8. Yield 1								-	.671**
9. Total Suggestibility									-

Note. **p<.01, *p<.05,
+p<.10

Table 3

Correlations Among Measures for Adults (N=80)

Variables	1	2	3	4	5	6	7	8	9
1. Exact Age	-	-.204+	-.160	-.023	.273*	-.047	.066	.060	-.014
2. DCCS Mix Trials		-	.134	-.013	-.050	.082	-.097	.047	.138
3. SOPT			-	.018	-.013	.070	.019	-.107	-.081
4. Interference Stroop				-	-.032	-.055	-.033	-.081	-.020
5. Level of Attention					-	.070	.113	.432**	.225*
6. Day/Night Stroop						-	.268*	.080	.056
7. Theory of Mind							-	.121	.075
8. Yield 1								-	.627**
6. Total Suggestibility									-

Note. **p<.01, *p<.05, +p<.10. Correlations with Interference Stroop N=78 due to missing data for Red/Green colorblind participant. All other correlations N=80.

Performance on EF tasks were converted into Z-scores for the purpose of comparing the child and adult populations performance to create a single predictor variable for each EF task. The number of correctly sorted cards out of 16 on the Grass/Snow Stroop was a measure of inhibition for children, this score was then converted into a standardized Z-score (i.e., averaging the mean across all age groups; 3-, 4-, and 5-year-olds, and calculating how their score varied from the mean). While adults' incongruent-congruent interference scores for the Color Stroop reflected their inhibition score and was converted into a standardized Z-score, to enable merging of scores from the two different populations as a single predictor variable, inhibition performance, as measured through the Stroop.

The number of correct out of 6, on the first postswitch phase of the DCCS was a measure of cognitive flexibility for children, this score was then converted into a standardized Z-score (i.e., averaging the mean across all age groups; 3-, 4-, and 5-year-olds, and calculating how their score varied from the mean). The number of correct out of 24, on the second postswitch phase of the DCCS was a measure of cognitive flexibility for adults, this score was converted into a standardized Z-score to enable merging of scores from the two different populations as a single predictor variable, cognitive flexibility performance, as measured through the DCCS.

The SOPT, which measures working memory was calculated as the number of correct choices out of 40 and was the same measurement for both children and adults. SOPT scores were converted into a standardized Z-score to maintain uniformity with other Z-score converted variables. Z-scores for the SOPT were created for children across all age groups score (i.e., averaging the mean across all age groups; 3-, 4-, and 5-year-olds, and calculating how their score varied from the mean), and for adults to enable merging of scores from the two different populations as a single predictor variable, working memory as measured through the SOPT.

The Effects of Age, EF, and Divided Attention on Total Suggestibility

To test my hypotheses regarding whether age, EF, and divided attention would influence total suggestibility, a hierarchical regression was conducted. Prior to conducting a hierarchical regression, the relevant assumptions of this statistical analysis were tested. The assumptions of independence, homoscedasticity, and linearity were all met. Although total suggestibility was not normally distributed, W (170) = .96, $p < .001$, there were no floor or ceiling effects in the DV and each group has a sample size of 30 or larger, suggesting the use of a hierarchical regression to analyze the data was still appropriate (Field, 2013).

Preschool Aged Children. Results from the hierarchical regression for the preschool sample are presented in Table 4. In the first step, age was entered as a continuous variable to test the prediction that age would influence total suggestibility scores. Unexpectedly, results indicated that age was not a significant predictor of total suggestibility, explaining only 0.81% of the variance in total suggestibility F (1, 88) = 0.71, p = .40.

In step 2, three EF tasks were entered to determine whether EF contributed to the concurrent prediction of total suggestibility scores above and beyond that accounted for by age. This step was not significant and only accounted for an incremental 0.50% of variance in total suggestibility, F (3, 85) = 0.14, p = .93, nor were any of the coefficients related to the individual EF predictors significant, indicating that the individual EF elements did not significantly relate to total suggestibility once age was accounted for in the model.

In step 3, level of attention (i.e., either DA or FA) was entered to test the prediction that those in the DA paradigm would have a higher suggestibility score than those in the FA paradigm. This step was also not significant, indicating that level of attention did not significantly influence total suggestibility and accounted for only 1.11% of additional variance in total suggestibility, F (1, 84) = 0.93, p = .34. In addition, the interaction between level of attention and age on total suggestibility was not significant either and accounted for an incremental 0.47% of variance in total suggestibility, F (1, 83) = 0.40, p = .53, see step 4.

Finally, to test the prediction that the influence of EF performance on total suggestibility would differ by level of attention, step 5 included the interaction of each EF task and level of attention. Results indicated these interactions were not significant and accounted for an incremental 3.42% of total variance in total suggestibility, F (3, 80) = 0.97, p = .41. Suggesting the influence of EF performance on total suggestibility did not significantly differ by level of attention.

Table 4

Summary of Hierarchical Regression Analysis for Children; Influences of Total Suggestibility (Coefficients Listed by Step)

Variable	*B*	*SE B*	β	ΔR^2	*CI 95%*	*Significance*
Block 1				.008		.40
Exact Age	-0.49	0.58	-.09		-1.63 - 0.66	.40
Block 2				.005		.93
Grass/Snow Stroop (No. correct out of 16)	0.11	0.47	.03		-0.83 - 1.06	.81
DCCS (No. correct on postswitch trials)	-0.18	0.52	-.04		-1.21 - 0.86	.77
SOPT (No. correct out of 40)	-0.26	0.51	-.06		-1.27 - 0.74	.60
Block 3				.011		.34
Attention (DA/FA)	0.89	0.93	.10		-0.95 - 2.73	.34
Block 4				.005		.53
Exact Age by Level of Attention	-0.75	1.19	-.40		-3.12 - 1.62	.53
Block 5				.034		.41
Stroop by Attention	-0.85	0.96	-.14		-0.92 - 1.81	.38
DCCS by Attention	-1.55	1.06	-.26		-0.89 - 2.14	.15
SOPT by Attention	-0.14	1.04	-.03		-1.59 - 1.51	.89

Adults. Adults were run in a separate hierarchical regression due to the large age gap between the adult and child sample and because procedures were slightly different for adult and child samples (i.e., DCCS, SOPT, and Stroop are measured differently for age appropriateness). Results from the hierarchical regression are presented in Table 5. A hierarchical regression was conducted to determine the influence of age, EF, and divided attention on total suggestibility in adults. Age was entered as a continuous variable in step 1. As expected, age did not explain any variance ($R^2 < .001$) in total suggestibility, F (1, 76) = 0.01, p = .92.

In step 2, three EF tasks were entered to determine whether EF contributed to the concurrent prediction of total suggestibility scores above and beyond that accounted for by age. This step was not significant and only explained 3.68% of the variance in total suggestibility scores, F (3, 73) = 1.01, p = .43. In addition, the coefficients related to the individual EF predictors were not significant, indicating that the individual EF elements did not significantly influence total suggestibility once age was accounted for in the model.

In step 3, attention (i.e., either DA or FA) was entered to test the prediction that those in the DA paradigm would have a higher suggestibility score than those in the FA paradigm. This step was significant and explained an incremental 5.15% of the variance in total suggestibility scores, F (1, 72) = 4.02, p = .05. Results indicate that those in the DA condition were associated with higher total suggestibility scores than those in the FA condition. However, the interaction between attention and age on total suggestibility was not significant and only explained an incremental 0.19% of variance in total suggestibility scores, F (1, 71) = 0.15, p = .70. Thus, the effect of attention on total suggestibility does not change with age.

Finally, to test the prediction that the influence of EF performance on total suggestibility would differ by level of attention, step 5 included the interaction of each EF task and level of attention. Results indicated this step was not significant and explained an incremental 0.51% of variance in total suggestibility scores, F (3, 68) = 0.13, p = .94. Further, none of the coefficients related to the interaction between EF and attention level was significant, suggesting the influence of EF performance on total suggestibility did not significantly differ by level of attention.

Table 5
Summary of Hierarchical Regression Analysis for Adults; Influences of Total Suggestibility (Coefficients Listed by Step)

Variable	*B*	*SE B*	β	ΔR^2	*CI 95%*	*Significance*
Block 1				.00		.92
Exact Age	-0.04	0.31	-.01		-0.66 - 0.59	.92
Block 2				.04		.43
Color Stroop (Interference score)	-0.07	0.53	-.02		-1.13 - 0.99	.90
DCCS (No. correct on postswitch trials)	0.86	0.58	.18		-0.30 - 2.02	.14
SOPT (No. correct out of 40)	-0.51	0.54	-.11		-1.58 - 0.57	.35
Block 3				.05		.05
Attention (DA/FA)	2.18	1.09	.24		0.01 - 4.34	.05
Block 4				.00		.70
Exact Age by Attention	-0.31	0.82	-.70		-1.94 - 1.32	.70
Block 5				.01		.94
Stroop by Attention	-0.32	1.60	-.06		-3.51 - 2.88	.85
DCCS by Attention	0.63	1.20	.10		-1.75 - 3.02	.60
SOPT by Attention	0.19	1.10	.03		-1.99 - 2.37	.86

Comparing adult and child samples (Age, EF, and Divided Attention) on total suggestibility. In addition to running adult and child samples individually, I also wanted to investigate the effects of age (i.e., comparing children to children and children to adults) on total suggestibility.

To compare the adult and child samples a single GLM was conducted on total suggestibility score with age (discrete), EF tasks (z-scores for DCCS, SOPT, Stroop), attention (DA/FA), age by attention interaction, and EF by attention interaction as predictors. This analysis revealed a significant main effect of age on total suggestibility F (1, 158) = 42.99, $p <$ .001. A follow up one-way ANOVA with Fisher's Least Significant Difference (LSD) post hoc comparisons was conducted to determine how age contributed to total suggestibility. For the purpose of this analysis age was entered as a discrete variable (i.e., grouped by 3-, 4-, 5- year-olds, and adults). While 3-year-olds (M = 13.17, SD = 4.20) have the highest total suggestibility score followed by 4-year-olds (M = 11.83, SD = 4.23), then 5-year-olds (M = 11.33, SD = 4.40), with adults (M = 6.03, SD = 4.59) having the lowest total suggestibility score, there is only a significant difference between 3-year-olds and adults, 4-year-olds and adults, and 5-year-olds and adults ps < .001, see Table 6. Results suggest that there is an influence of age on total suggestibility scores, with children being more suggestible than adults. All other variables did not significantly relate to total suggestibility ps > .07.

Table 6

Mean Suggestibility Scores by Age

Age	Total Suggestibility	Yield 1 Scores
3-year-olds	13.17	8.57
4-year-olds	11.83	7.20
5-year-olds	11.33	5.80
Adults	6.01	1.90

The Effects of Age, EF, and Divided Attention on Yield 1 Scores

In addition to total suggestibility, yield 1 scores were also examined. Previous research suggests that yield 1 scores may be a better indicator of suggestibility than total suggestibility scores (Scullin & Warren, 1999, as cited in Scullin & Ceci, 2001). The following analysis was conducted similar to the hierarchical regression above. Children and adults were analyzed separately due the large age gap and different methodology between the two samples. All steps in the hierarchical regression are the same as the previous hierarchical regression. EF components were all analyzed as Z-scores.

Preschool Aged Children. Results from the hierarchical regression are presented in Table 7. In the first step, age was entered as a continuous variable to test the prediction that age would influence yield 1 scores. Results indicated that age was a significant predictor of yield 1 scores, accounting for 7.89% of the variance in yield 1 scores, F (1, 88) = 7.54, p = .007. This reveals that as children are getting older, they are assenting less to suggestive questions (i.e., fewer yields), indicating an effect of age on suggestibility in preschool aged children. A follow up ANOVA with Fishers LSD post hoc comparisons was run to determine between which age groups this significant difference existed. Results revealed a significant effect of age, F (2, 87) = 4.81, p = .01, with a significant difference between 3- and 5-year-olds, p = .003, only. See Table 6 for mean yield 1 scores by age.

In step 2, three EF tasks were entered to determine whether EF contributed to the concurrent prediction of yield 1 scores above and beyond that accounted for by age. This step was not significant and only explained an incremental 2.12% of variance in yield 1 scores, F (3, 85) = 0.67, p = .57, above and beyond the variance accounted for by age. In addition, none of the coefficients related to the individual EF predictors were significant, indicating that the individual

EF elements did not significantly influence total suggestibility once age was accounted for in the model.

In step 3, attention (i.e., either DA or FA) was entered to test the prediction that those in the DA paradigm would have a higher yield 1 score than those in the FA paradigm. This step was marginally significant and explained an incremental 3.59% of variance in yield 1 scores, $F(1, 84) = 3.49$, $p = .065$, above and beyond the variance accounted for by age and EF. Results indicated that attention may influence yield 1 scores. Specifically, children in the DA condition ($M = 7.87$, $SD = 3.86$) had higher scores than those in the FA condition ($M = 6.51$, $SD = 3.22$), suggesting that DA is may relate to higher suggestibility.

Step 4 tested the interaction between DA condition and age on yield 1 scores, this step was not significant and explained an incremental 0.09% of variance in yield 1 scores, $F(1, 83) = 0.09$, $p = .77$, above and beyond the variance accounted for by age, EF, and attention. Results suggest that age has no influence on the effect of DA on suggestibility to yield 1 scores.

Finally, to test the prediction that the influence of DA on yield 1 scores would differ by EF performance step 5 included the interaction of each EF task and level of attention. Results indicated these interactions were not significant and explained an incremental 0.60% of variance in yield 1 scores, $F(3, 80) = 0.19$, $p = .91$, suggesting the influence of DA on yield 1 scores did not significantly differ by EF performance.

Table 7

Summary of Hierarchical Regression Analysis for Children; Influences of Yield 1 Scores (Coefficients Listed by Step)

Variable	*B*	*SE B*	β	ΔR^2	*CI 95%*	*Significance*
Block 1				.08		.007
Exact Age	-1.28	0.47	-.28		-2.21 - -0.35	.007
Block 2				.02		.57
Grass/Snow Stroop (No. correct out of 16)	-0.24	.38	-.07		-0.99 - 0.52	.53
DCCS (No. correct on postswitch trials)	0.27	0.42	.08		-0.56 - 1.10	.52
SOPT (No. correct out of 40)	-0.39	0.40	-.11		-1.19 - 0.42	.34
Block 3				.04		.07
Attention (DA/FA)	1.36	0.73	.19		-0.09 - 2.81	.07
Block 4				.001		.77
Exact Age by Level of Attention	-0.28	0.94	-.18		-2.15 - 1.59	.77
Block 5				.006		.91
Stroop by Attention	-0.55	0.77	-.11		-2.08 - 0.99	.48
DCCS by Attention	-0.24	0.85	-.05		-1.93 - 1.44	.78
SOPT by Attention	0.15	0.83	.03		-1.51 - 1.80	.86

Adults. Results from the hierarchical regression are presented in Table 8. In the first step, age was entered as a continuous variable to test the prediction that age would influence yield 1 scores. Results indicated that age was not a significant predictor of yield 1 scores, accounting for only 0.40% of variance in yield 1 scores, F (1, 76) = 0.31, p = .58, suggesting that differences in age in adults does not have an effect on suggestibility to yield 1 scores.

In step 2, three EF tasks were entered to determine whether EF contributed to the concurrent prediction of yield 1 scores above and beyond that accounted for by age. This step was not significant and explained an incremental 3.39% of variance in yield 1 scores, F (3, 73) = 0.86, p = .47, above and beyond the variance accounted for by age. In addition, none of the individual EF coefficients significant, indicating that the individual EF elements did not significantly influence yield 1 scores once age was accounted for in the model.

In step 3, attention (i.e., either DA or FA) was entered to test the prediction that those in the DA paradigm would have a higher yield 1 score than those in the FA paradigm. This step was significant and explained an incremental 17.77% of variance in yield 1 scores, F (1, 72) = 16.13, p < .001, above and beyond the variance accounted for by age and EF. Specifically, adults in the DA condition (M = 2.70, SD = 1.91) had higher yield 1 scores than those in the FA condition (M = 1.15, SD = 1.31), suggesting that DA is related to higher suggestibility to yield 1 scores. Step 4 tested the interaction between DA condition and age on yield 1 scores, this step was not significant and only explained an incremental 0.06% of variance in yield 1 scores, F (1, 71) = 0.06, p = .82, above and beyond the variance accounted for by age, EF, and attention. Indicating that while attention influences yield 1 scores, attention does not influence yield 1 scores differently based on age.

Finally, to test the prediction that the influence of DA on yield 1 scores would differ by EF performance, step 5 included the interaction of each EF task and level of attention. Results indicated these interactions were not significant and explained an incremental 4.24% of variance in yield 1 scores, F (3, 68) = 1.29, p = .28. Suggesting that the effect of DA on yield 1 scores is not influenced by EF performance.

Table 8

Summary of Hierarchical Regression Analysis for Adults; Influences of Yield 1 Scores (Coefficients Listed by Step)

Variable	*B*	*SE B*	β	ΔR^2	*CI 95%*	*Significance*
Block 1				.004		.58
Exact Age	0.07	0.12	.06		-0.18 - 0.31	.58
Block 2				.034		.47
Color Stroop (Interference score)	-0.14	0.21	-.08		-0.55 - 0.28	.52
DCCS (No. correct on postswitch trials)	0.26	0.23	.13		-0.20 - 0.71	.26
SOPT (No. correct out of 40)	-0.22	0.21	-.12		-0.64 - 0.20	.30
Block 3				.18		.00
Attention (DA/FA)	1.58	0.39	.44		0.80 - 2.37	.00
Block 4				.001		.81
Exact Age by Attention	0.07	0.30	.42		-0.52 - 0.66	.81
Block 5				.04		.28
Stroop by Attention	0.23	0.57	.12		-0.90 - 1.37	.68
DCCS by Attention	0.46	0.42	.19		-0.38 - 1.31	.28
SOPT by Attention	0.55	0.39	.21		-0.22 - 1.33	.16

Comparing adult and child samples (Age, EF, and Divided Attention) on yield 1 scores. In addition to running adult and child samples individually, I also wanted to investigate the effects of age (i.e., comparing younger children to older children and children to adults) on yield 1 scores.

To compare the adult and child samples a single GLM was conducted on yield 1 scores with age (discrete), EF tasks (z scores for DCCS, SOPT, Stroop), attention (DA/FA), age by attention interaction, and EF by attention interaction. This analysis revealed a significant main effect of age on yield 1 scores F (1, 158) = 81.61, $p < .001$. A follow up one-way ANOVA with Fishers LSD post hoc comparisons was conducted to determine how age contributed to yield 1 scores. For the purpose of this analysis age entered as a discrete variable (i.e., grouped by 3-, 4-, 5- year-olds, and adults) was a significant predictor of yield 1 scores, F (3, 166) = 54.99, $p < .001$. While 3-year-olds (M = 8.57, SD = 3.32) have the highest yield 1 scores followed by 4-year-olds (M = 7.20, SD = 3.44), then 5-year-olds (M = 5.80, SD = 3.60), with adults (M = 1.93, SD = 1.81) having the lowest yield 1 scores, there is only a significant difference between 3- and 5-year-olds, and all three age groups for children (i.e., 3-, 4-, and 5-year-olds) and adults $ps < .001$, see Figure 6. Results suggest that there is an influence of age on yield 1 scores, with younger children being more suggestible than older children and children in general being more suggestible than adults. All other variables did not significantly relate to yield 1 scores $ps > .18$.

Divided Attention Results

This study is one of the first to introduce a divided attention task during an eyewitness event in the preschool years. To ensure that our divided attention paradigm did in fact divide attention, several analyses were run. Since children were given a different divided attention task than adults, separate analyses were run for each sample.

Children. One way to check whether the divided attention paradigm divided attention is to look at the answers to non-suggestive questions. Of the 18 questions asked, four are non-suggestive and should be answered "yes" rather than "no". It would be expected that those in the FA condition would answer more of these non-suggestive questions correctly than those in the DA condition, given that they would have paid more attention to the video and there is no suggestive influence on those questions. A linear regression was run to determine the effect of attention condition on assents to non-suggestive questions. Results revealed no significant effect of attention condition on assents to non-suggestive questions for children, F (1, 88) = 2.157, p = .15, suggesting that DA did not impair memory for non-suggestive questions. More specifically, 51.1% of children in the FA condition assented to all non-suggestive questions, while 40% of children in the DA condition assented to all non-suggestive questions. While there were more children correctly answering non-suggestive questions (i.e., assenting) in the FA condition when compared to the DA condition, this difference was not significant.

Another way to check whether attention was divided during the DA paradigm was to compare performance on the Days/Night Stroop DA task used to divide attention to performance on the Day/Night Stroop task given at the end of the session. Since there were unequal trials between the two tasks, performance was converted into proportion correct to compare in a paired samples t-test. Results revealed no significant difference between performance on the Day/Night Stroop during the DA paradigm (M = .87, SD = .21) when compared to performance on the Day/Night Stroop at the end of the session (M = .87, SD = .16) for children, t (44) = -.112, p = .91.

Adults. One way to check whether the divided attention paradigm divided attention is to look at the answers to non-suggestive questions. Of the 18 questions asked, four are non-suggestive and should be answered “yes” rather than “no”. It would be expected that those in the FA condition would answer more of these non-suggestive questions correctly than those in the DA condition, given that they would have paid more attention to the video and there is no suggestive influence on those questions. A linear regression was run to determine the effect of condition on assents to non-suggestive questions. Results revealed no significant effect of condition on assents to non-suggestive questions for adults, F (1, 78) = 1.362, p = .25. More specifically, 70% of adults in the FA condition assented to all non-suggestive questions, while 62.5% of adults in the DA condition assented to all non-suggestive questions. While there were more adults correctly answering non-suggestive questions (i.e., assenting) in the FA condition when compared to the DA condition, this difference was not significant.

Another way to check whether attention was divided during the DA paradigm was to compare performance on the Days/Night Stroop DA task to performance on the Day/Night Stroop task given at the end of the session. Since there were unequal trials between the two tasks, performance was converted into proportion correct to compare in a paired samples t-test. Results revealed no significant difference between performance on the DA Day/Night Stroop (M = .99, SD = .02) when compared to performance on the delay Day/Night Stroop (M = .99, SD = .02) for adults, t (39) = -.54, p = .59. These results reveal that performance on the Day/Night Stroop was not affected by the DA task.

IV Discussion

The current study sought to examine the influences of cognitive abilities (i.e., EF and DA) on suggestibility through misleading questions in preschoolers and adults. Also, of interest was how age differences may play a role in their influence on suggestibility to misleading questions. There were three major findings of the study. First, children's total suggestibility and yield 1 scores were much higher than adults, however there were only age differences in preschoolers for yield 1 scores. Second, EF did not influence total suggestibility or yield 1 scores in either child or adult populations. Third, while dividing attention did not have any negative effects on total suggestibility in children, it did influence total suggestibility in adults and was related to an increase in yield 1 scores for both children and adults, although the increase in yield 1 scores was only marginal for children. These results indicate that age and attention influence suggestibility to misleading questions, however, in the present study EF was not found to have an effect on one's vulnerability to misleading questions.

Age and Suggestibility. Several researchers have found that age is negatively related to suggestibility, with younger children being more suggestive than older children and adults (Bruck & Ceci, 1999; Ceci & Bruck, 1993; Ceci et al., 1987; Cohen & Harnick, 1980; Ornstein, Gordon, & Larus, 1992). Results of this study showed a significant effect of age on total suggestibility and yield 1 scores, with preschoolers being more suggestible to misleading questions than adults, supporting previous research findings (Ceci & Bruck, 1993; Cohen &

Harnick, 1980). It has been suggested that children are more suggestive than adults because of social pressure and immature but developing cognitive processes (Ceci & Bruck, 1993).

When examining total suggestibility within our preschool sample, our results did not reveal any age differences between the three age groups. Given that Scullin and Ceci (2001) suggested yield 1 scores may be a better indicator of suggestibility than total suggestibility scores (see also, McFarlane & Powell, 2002; Scullin & Bonner, 2006; Scullin & Ceci, 2001), yield 1 scores were also examined as a measure of suggestibility. Results revealed a significant difference between 3- and 5-year-olds on yield 1 scores, with 3-year-olds being more suggestible than 5-year-olds. Further, children were found to have higher yield 1 scores than adults, revealing greater suggestibility to misleading questions in children than adults. These finding supports previous research findings of a negative relationship between age and suggestibility, as age increases suggestibility has been found to decrease (Bruck & Ceci, 1999; Ceci & Bruck, 1993; Ceci et al., 1987; Cohen & Harnick, 1980; Ornstein, Gordon, & Larus, 1992).

Yield 1 scores are ultimately one's initial vulnerability to a misleading question, it is the number of assents to suggestive questions. Whereas, total suggestibility is a combination of both yield 1 scores and shift scores, recall shift scores are the number of times one changes their answer to questions asked previously when given negative feedback. Thus, total suggestibility scores reflect two types of suggestibility, suggestibility to misleading questions but also suggestibility to repeated questioning. Researchers suggested the use of yield 1 scores over total suggestibility to measure suggestibility in preschoolers (Scullin & Ceci, 2001), theoretically this approach makes more sense as it reflects a single measure of suggestibility (i.e., vulnerability to misleading questions). In addition, yield 1 scores are a better measure of suggestibility for the present study since misleading questions were the type of suggestibility of interest.

EF and Suggestibility. The current study did not find any relationship between EF and total suggestibility or yield 1 scores in either the child or adult populations. This is contrary to previous research findings. For instance, two of the three main EF components; inhibition (Alexander et al., 2002; Clarke-Stewart, Malloy, & Allhusen, 2004; Kapinski & Scullin, 2009; Roberts & Powell, 2005) and WM (Clarke-Steward et al., 2004; Kapinski & Scullin, 2009) have been found to be related to suggestibility in children.

However, while many researchers have found different EF components to be related to suggestibility, a review article found that half (i.e., nine out of 18 and possibly more unpublished work) of the studies that examined the relationship between EF and suggestibility in children did not find a significant relationship between EF and suggestibility (Bruck & Melnyk, 2004). Many of these studies examined children under the age of 7-years-old, leading researchers to suggest that null findings between EF and suggestibility may be due to the young population used and that there may be correlations between EF and suggestibility in older children who are in the process of EF growth (Bruck & Melnyk, 2004). However, this argument may not be valid given there are major developments in EF processes within the preschool age years (Garon et al., 2008; Jacques & Marcovitch, 2010). Further young age does not seem to be a valid argument, in the present study EF was not found to be a significant predictor in adults, where EF is considered fully developed (Jacques & Marcovitch, 2010).

Perhaps the inability to find a relationship between EF and suggestibility could be explained by performance on EF tasks, in that EF tasks chosen may have proven to be too easy for the age groups assessed. Previous research has found inhibition and WM to be related to suggestibility, however in the present study participants regardless of age performed at ceiling on measures of inhibition (i.e., Grass/Snow Stroop & Day/Night Stroop) as evidenced by the lack of correlations with age and lack of variability in this measure—this may explain why there was not a relationship between inhibition and suggestibility. Performance on the DCCS (measuring cognitive flexibility) and SOPT (measuring WM) was positively correlated with age, as would be expected. However, cognitive flexibility has not previously been found to be related to suggestibility, and findings from this study were no different. This is likely due to cognitive flexibility's late development compared to other components of EF (Garon et al., 2008). While WM has previously been found to be related to suggestibility, that was not the case in this study. While there was some variability in the WM measure, the inability to find a link between this component of EF and suggestibility may lie within the measure of WM. For instance, counting span, word span, and backward digit span tasks are frequently used as measures for WM in research with suggestibility in young children (Bruck & Melnyk, 2004). The SOPT was chosen because the backward digit span has proven to be difficult for 3- and 4-year-olds (Vandenbrink & Miller, 2019), however the SOPT may have been too easy for this age group as performance on the SOPT was negatively skewed for both 4- and 5-year-olds. While performance on the SOPT was correlated with age, scores were still very high for older children and there may not have been enough variability for there to be a relationship between this measure of WM and suggestibility. In addition, the child version of the SOPT was created from the same source as the images in the SOPT used by Cragg and Nation (2007), however the chosen images and placement of images may have been different and may have resulted in an easier WM task than intended for this age.

There are a number of theoretical reasons for why EF should be related to suggestibility. For example, higher order cognitive processes in EF are believed to assist in encoding and retrieval of information from long-term memory (Alexander et al., 2002; Miller, Chatley, Marcovitch, & McConnell Rogers, 2014; Schacter, Kagan, & Leichtman, 1995). EF is required to form a strong representation of the event for storage in long-term memory, to resist the urge to automatically pull from familiarity in memory (Kelley & Jacoby, 2000) and to consciously reflect on the appropriate memory trace (Marcovitch & Zelazo, 2009). These three actions that allow one to form a memory that can accurately be recalled all rely on EF. Thus, drawing on ones EF should decrease the likelihood of suggestibility. While I expected EF to influence suggestibility and theoretically it made sense for EF to influence suggestibility, it is possible that there may be other cognitive and social abilities that are more related to suggestibility than EF. For instance, the present study found that attention influenced suggestibility. Currently results are inconclusive as to why EF was not related to suggestibility and future research is necessary to determine whether there is a relationship between EF and suggestibility, as current findings are mixed.

DA and Suggestibility. Previous research has found that DA during a witnessed event has negative consequences on memory for the event (Zaragoza & Lane, 1998; Lane, 2006), specifically DA during encoding of eyewitness memory can lead to errors in adults' recall (Anderson et al., 2000; Craik et al., 1996; Fernades & Moscovitch, 2000; Kellog, Cocklin, & Bourne, 1982; Park, Smith, Dudley, & Lafronza, 1989). Findings from this study support previous research on DA and suggestibility in adults. Specifically, the present study found that adults who were in the DA condition during witnessing an event had higher total suggestibility and yield 1 scores compared to adults who were in the FA condition. In addition, findings from the present study were able to extend previous research findings of DA's negative effects on memory to a younger age. The present study found that dividing attention in preschoolers has a marginal negative effect on memory, resulting in higher assents to misleading questions.

These findings align with the theoretical perspective suggesting that when attention is required to process multiple stimuli or perform multiple tasks simultaneously the result is diminished memory recall (Anderson et al., 2000; Craik et al., 1996; Fernades & Moscovitch, 2000; Kellog, Cocklin, & Bourne, 1982; Park, Smith, Dudley, & Lafronza, 1989), as was seen in the present study. Attention was divided between witnessing an event and performing a task simultaneously, which inhibited the executive attention network to properly encode critical details of the witnessed event into long-term memory, resulting in poorer memory recall. When attention is divided between multiple stimuli a less elaborate memory representation for the event is created (Lane, 2006) causing gaps within the memory representations of the event. Recall that when memory representations are missing information we often try to fill in the gaps (Greenberg, Westcott, & Bailey, 1998), which is likely why both children and adults who experienced the DA condition were more vulnerable to the misinformation that was provided to them in the misleading questions than those in the FA condition, resulting in higher assents to false statements.

Developing attention systems may be one possible explanation for why DA's effect on suggestibility in children was only marginal. During preschool children are still relying on the orienting or selective attention system where their attention is guided by their environment, while their executive attention network is developing (Garon et al., 2008). Without the assistance of the executive attention network to allocate attention to a single desired event, their attention may be easily pull in multiple directions between multiple events. I believe the marginal effect of DA on suggestibility is likely due to children's underdeveloped executive attention network, resulting in children in the FA condition also experiencing effects of DA, though not intentional through the design of the study. For instance, attention could be divided between the video and other stimuli in the environment as well as internal events. From this theoretical reasoning I believe that as children's executive attentional network develops the effects of DA on suggestibility will begin to look similar to the relationship that is seen in adult populations. Thus, this difference in DA's influence on suggestibility between children and adults is likely due to the development of the executive attention system.

To my knowledge this is one of the first studies to conduct a DA paradigm within an eyewitness event for preschool age children. While DA did not influence total suggestibility in children, it did have a marginal effect on yield 1 scores in children. Children in the DA condition had higher yield 1 scores than those in the FA condition, suggesting that DA is related to higher assents to misleading questions in children. Future research should investigate the effects of DA on a wider age span in children to assist in determining the influence it may have on children's suggestibility.

In addition, the marginal effect of DA on suggestibility in children may have a less theoretical explanation. The DA paradigm itself may not have effectively divided attention in children. Children should have been able to sort all 54 cards within the 5 minutes given to them, which is how long the video was. However, the majority of children did not sort all 54 cards, suggesting that their attention may have been focus more on the video than on the game. While attention could have been divided between the two tasks, it may have been performance on the Day/Night Stroop that suffered rather than details about the video. While children's performance on the DA Day/Night Stroop and delay Day/Night Stroop was not significantly different, it may be that children performed equally well because when they did sort cards in the DA Day/Night Stroop they sorted them correctly, however the time it took for them to sort the cards may have been longer than the time it took them to sort cards in the delay Day/Night Stroop. In addition, of the 54 cards available to sort during the task, 20% of children sorted all 54 cards. Children's tendency to allocate attention to the video more so than the game may explain why the effects of the DA condition were only marginal. Further, when examining the DA paradigm in adults, of the 100 cards available for adults to sort during the task, 74.5% of adults sorted all the cards. The majority of adults were able to sort all cards throughout the 5-minute video, suggesting that their attention was divided between the two events as was reflected in the significant effect of DA on suggestibility in the adult population.

Divided attention paradigm. The manipulation used to divide attention within this study was novel, as to my knowledge there were no existing divided attention paradigms that involved witnessing an event in a child population used in previous research. For this reason, it was important to examine whether the DA paradigm was effective in dividing attention. Analyses examined performance on the secondary task of the paradigm (i.e., the Day/Night Stroop) compared to performance on the Day/Night Stroop during the delay. Results revealed no significant difference between performance on the DA Day/Night Stroop when compared to performance on the delay Day/Night Stroop for children or adults. These results reveal that performance on the Day/Night Stroop was not affected by the DA task. However, it is important to note that the DA Day/Night Stroop for adults was not as similar to the delay Day/Night Stroop as it was in children, since the adult version contained two addition sorting rules and cards (i.e., Grass and Snow cards). Thus, it may not be reasonable to draw conclusions regarding DA by comparing performance on these two tasks. While this was one way to check whether the DA paradigm was effective, it may not be the best measure of whether attention was divided.

A second way to check whether the divided attention paradigm divided attention is to look at the answers to non-suggestive questions. It was thought that participants in the FA condition would have more assents to non-suggestive questions than those in the DA condition, if the DA paradigm was effective in dividing attention. Results revealed no significant effect of attention condition on assents to non-suggestive questions for children or adults suggesting that DA did not impair memory for non-suggestive questions. The present study was able to find an effect of DA on suggestibility which suggests the DA paradigm was effective. However, the manipulation checks may not be measuring whether the paradigm divided attention as it was intended to. Future research is needed to find a valid and reliable manipulation check for the DA paradigm to ensure that attention is divided when participants are in this condition.

Conclusions. One possible explanation for not finding expected relations between cognitive abilities and total suggestibility to misleading questions may be the tool used for implementing suggestibility, the VSSC. By the authors own admission, in 2006 the VSSC was yet to be verified as a reliable tool for assessing children's suggestibility (Scullin & Bonner, 2006). Researcher's suggested that further research would be needed to determine the VSSC's utility as a tool for assessing children's suggestibility and perhaps this research may lend itself as just that. The findings from this study would suggest that perhaps the video, the questions (both suggestive and non-suggestive), or the combination of both are not creating the appropriate tool to measure suggestibility to misleading questions in children. Further, previous findings from use with the VSSC show that it is much more likely that the yield 1 scores are a better predictor of suggestibility than the total suggestibility score (Scullin & Bonner, 2006; Scullin & Ceci, 2001).

Researchers have even suggested that the yield 1 scores may be acceptable as a measure of overall suggestibility (Scullin & Warren, 1999, as cited in Scullin & Ceci, 2001). Thus, future research should focus on yield 1 scores as a measure of suggestibility rather than total suggestibility scores as this study adds to the findings that yield 1 scores are a better measure of suggestibility in children.

In conclusion, the present study was able to replicate findings of the negative relationship between age and suggestibility. Further, this study was able to replicate the relationship between DA and suggestibility in adults and to extend this relationship to a younger age than previously examined. Lastly, the present study was not able to find a relationship between EF and suggestibility in children or adults.

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List of Appendices

Appendix A

Leading Questions & Video Suggestibility Scale for Children (Video SSC; Scullin & Ceci, 2001):

S; suggestive questions, NS; non-suggestive questions. 1) Did the two girls arrive at the party in a bright red car? (S). 2) Was there a girl named Suzie at the party? (NS). 3) Was there a little white doggie at the party? (S). 4) Did that clumsy girl Robin knock over the lamp? (S). 5) Did the kids break a balloon while they were hitting them around? (S). 6) Did Robin trip and fall on the way to the table? (NS). 7) When the clown juggled, did he drop a ball? (S). 8) Was Billy going to bring his new football to school the next day? (S). 9) Was one of Billy's birthday presents broken when he opened it? (NS). 10) Did Billy break the toy? (S). 11) Did Billy and his friends play with the broken toy after Billy's dad fixed it? (S). 12) Did Billy's dad cut the birthday cake? (S). 13) When Robin dropped the cake on her lap, did she just go ahead and eat it? (NS). 14) When Billy spilled his juice, did he cry? (S), 15) Did Billy get the last piece of cake? (S). 16) Did Billy's dad tell the kids that there wasn't a real fire? (S). 17) Did Billy feel 'all grown up' now that he was five years old? (S). 18) Did Billy's friends stay overnight? (S).

Appendix B

Video Suggestibility Scale for Children (Video SSC): The scale measures suggestibility in two dimensions; Yield, the initial response to the misleading questions. Shift, after responding to the initial questions mild negative feedback is given (e.g. 'you missed a few of the questions. Let's go through them again and see if you can do better this time') and the questions are administered again. Total suggestibility is the combination of scores on the two dimensions (i.e., yield and shift).

Yield 1: Children are given a score of 1 if they assent to a leading question. Four of the questions are true and thus cannot be scored (but are included in questioning) for this part of the analysis resulting in a range of scores from 0-14.

Yield 2: Children are given a score of 1 if they assent to a leading question after receiving negative feedback (i.e., 'you missed a few of the questions. Let's go through them again and see if you can do better this time') from the experimenter and the question is repeated. Again the 4 true questions cannot be scored (but are included in questioning) for this part of the analysis resulting in a range of scores from 0-14.

Shift: During questioning the child is told "you missed a few of the questions. Let's go through them again and see if you can do better this time." If the child changes their response after hearing this they are given a 1. The 4 true questions were included resulting a range of scores from 0-18.

Total suggestibility: A composite suggestibility score was created by summing Yield 1 and Shift scores, resulting in a range of scores from 0-32.

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EDUCATION

Ph.D. Psychology	(2020)	University of Mississippi, University, MS Certificate in Statistics
M.A. Psychology	(2014)	University of North Carolina Wilmington, Wilmington, NC
B.S. Psychology	(2012)	Clemson University, Clemson, SC (Cum Laude)

PUBLICATIONS

Papers in Preparation

Miller, S. E., **Vandenbrink, T**., & Marcovitch, S. (in preparation). Do you see what I see?: Differences between behavioral measures of executive function and parent reports of effortful control in toddlers.

Miller, S. E., Florez, A., Magness, J., Neilson, B., & **Vandenbrink, T.** (in preparation). Associations between executive function and social development: Evidence for a representational framework.

Vandenbrink, T., Neilson, B., & Miller, S. E. (in preparation). Forgetting isolates: Memory for isolates within a directed forgetting paradigm.

Other Publications

The Lafayette-Oxford-University Excel By 5 Early Childhood Education Committee, **Vandenbrink, T.**, Holmes, K., Miller, S.E., Opalko, N., & Shaw, J. (2018). A parent's guide for getting your child ready for kindergarten: A calendar of family activities. A publication of the LOU United Way Excel by 5 Coalition.

GRANTS

2018 Dissertation Fellowship. The University of Mississippi.
2018 Division 7 Dissertation Research Grant in Developmental Psychology. APA.
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2017 Summer Research Assistantship. University of Mississippi.
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2011 Tau Sigma Honor Society Scholarship. Clemson University.

PRESENTATIONS

Professional Conference Talks

Vandenbrink, T. (2017). Can Cognitive Processes Predict Helping Behavior in Toddlers? Graduate Student Council's 7th Annual Research Symposium. University, MS.

Vandenbrink, T. (2015). Examining the Relationship between Executive Function and Helping Behavior in Preschoolers. University of Mississippi Conference on Psychological Science. University, MS.

Published Abstracts and Poster Presentations

Simpson, J., Dickson, A. K., Pearce, R., **Vandenbrink, T.,** Dowling, C., & Miller, S. E. (2018, April). *The Relationship of Parenting Styles & Children per Household.* Poster presented at the University of Mississippi Conference on Psychological Science. University, MS.

Vandenbrink, T. & Miller, S. E. (2018, March). *The Morality of Young Liars*. Poster presented at the biennial meeting of the Society for Research in Child Development (SRCD), Baltimore, MA.

Thomas, D., Winters, R., **Vandenbrink, T.,** & Miller, S. E. (2017, October). *Examining the Influence of Labels and Task Order on Preschoolers' Executive Function and Theory of Mind.* Poster presented at Cognitive Development Society (CDS) Conference, Portland, OR.

Vandenbrink, T., & Miller, S. E. (2017, October). *Does Executive Function and Language Underlie the Development of Moral Disgust?* Poster presented at Cognitive Development Society (CDS) Conference, Portland, OR.

Vandenbrink, T., Miller, S. E., & Sparks, J. (2017, April). *Age and Facial Cues Relate to Preschoolers' Understanding of Disgust.* Poster presented at the biennial meeting of the Society for Research in Child Development, Austin, TX.

Vandenbrink, T., & Miller, S. E. (2017, March). *Can Cognitive Processes Predict Helping Behavior in Toddlers?* Podium presentation at the Graduate Student Council's 7th Annual Research Conference, Oxford, MS.

Vandenbrink, T., Miller, S. E., Dowling, C. B., & Sparks, J. (2016, May). *"What Influences Helping Behavior in Toddlers*?" Poster presented at the 28th APS Annual Convention, Chicago, IL.

Vandenbrink, T. (2015, October). *How helpful are toddlers?* Paper presented at the University of Mississippi Three Minute Thesis (3MT) Competition in Oxford, MS.

Vandenbrink, T., Miller, S. E., & Marcovitch, S. (2015, October). *Examining relationships between executive function and self-control temperament in the toddler years.* Poster presented at the Cognitive Development Society (CDS) Conference, Columbus, OH.

Vandenbrink, T., Miller, S. E., & Dowling, C. B. (2015, April). *Executive function is related to helping behavior in the second year of life.* Paper presented at the Annual University of Mississippi Conference on Psychological Science, University, MS. [awarded best graduate paper presentation]

D’llio, T. A., **Vandenbrink, T.**, & Miller, S. E. (2015, April). *Parent report and behavioral measures of self-control and language: Growth across the second year and relations between measures*. Poster presented at the University of Mississippi Psychology Research Day in Oxford, MS.

Miller, S. E., & Dowling, C., & **Vandenbrink, T.** (2015, March). *Executive function is related to helping behavior in the second year of life.* Poster presented at the biennial meeting of the Society for Research in Child Development, Philadelphia, PA.

Vandenbrink, T., Nguyen, S.P., & Cameron, G.L. (2013, April). *Eat it, it’s good for you; Do young children trust other people’s claims about food.* Poster presented at the University of North Carolina Wilmington Graduate Student Research Symposium, Wilmington, North Carolina.

Ferris, S., Thigpen, N., Huff, J., **Vandenbrink, T**. & Nguyen, S. P. & Gordon, C. L. (2013, April). *Children’s understanding and experience of gratitude in childhood.* Paper presented at the Carolinas Psychology Conference, Raleigh, NC.

Nguyen, S. P., & Gordon, C. L., & **Vandenbrink, T.** (2013, April). *Children’s reactions to untrustworthy sources of information about food.* Poster presented at the biennial meeting of the Society for Research in Child Development, Seattle, WA.

Thigpen, N., Huff, J. H., Ferris, S., **Vandenbrink, T.**, & Nguyen, S. P. (2013, April). *How do children make predictions about people based on their category membership?* Paper presented at the Carolinas Psychology Conference, Raleigh, NC.

Vandenbrink, T., Nguyen, S.P., & Cameron, G.L. (2013, May). *Eat it, it’s good for you; Do young children trust other people’s claims about food.* Poster presented at the Graduate Education Day in Raleigh, North Carolina.

TEACHING EXPERIENCE

University of Mississippi

2018 Lecturer – Developmental (PSY 301) Dept. of Psychology
2017 Lecturer – Introduction (PSY 201) Dept. of Psychology
2016 Lecturer – Introduction (PSY 201) Dept. of Psychology
2016 Lecturer – Introduction (PSY 201) Dept. of Psychology
2015 Lecturer – Introduction (PSY 201) Dept. of Psychology
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SERVICE AND OUTREACH

2018 Developing Self-Control in Toddlers & Preschoolers Talk to Mother of Preschoolers (MOPS)
2018 University of Mississippi Psychology Conference Committee
2018 Member - Excel by 5
2018 Judge, Upper Science Fair (High school students)
2018 Judge, Lower Science Fair (Middle school students)
2017 Peer reviewer, *Infant and Child Development*
2017 University of Mississippi Psychology Conference Committee
2017 Member – Excel by 5
2016 Member – Chair’s Graduate Student Advisory Council
2016 University of Mississippi Psychology Conference Committee
2016 Member - Excel by 5

2016 Judge, Upper Science Fair (High school students)
2016 Judge, Lower Science Fair (Middle school students)
2015 Peer reviewer, *Developmental Psychobiology*

PROFESSIONAL SOCIETY MEMBERSHIPS

2018 American Psychological Association, Division7
2015 American Psychological Association
2015 Cognitive Developmental Society (CDS)
2015 Society for Research in Child Development (SRCD)
2011 Omicron Delta Kappa Leadership Honor Society (ODK)
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HONORS

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2018 Experimental Graduate Student Research Achievement Award. University of Mississippi.

2017 Finalist in the 3 Minute Thesis competition. University of Mississippi.

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2016 Finalist in the 3 Minute Thesis Competition. University of Mississippi.

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2013 Making a Difference in North Carolina (MAD) Award. University of North Carolina Wilmington.