Examining Children's Memory Organization of Repeated Events Using a Reaction Time Paradigm: The Rapid Reorganization of Variable Details into Categories

by

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Abstract

Child sexual abuse investigations often hinge on the testimony of child complainants. Children are expected to particularize instances of repeated abuse, but it is unclear whether these expectations align with their memory capabilities. The current study aimed to offer insight into the explanatory strength of script theory versus fuzzy-trace theory for children's natural memory organization of a repeated event. Expanding upon Slinger (2010), this study used a reaction time paradigm to examine children's memory organization of variables details across a repeated event. Children aged 9 to 11 (*N* = 128) watched six magic show videos, each of which contained exemplars from twelve variable detail categories (six taxonomic and six non-taxonomic categories). After a brief delay, participants completed an online recognition memory test. Reaction time, accuracy, and discriminability were measured. Overall, the findings suggest memory reorganizes from instances to a general event script with categorical organization of variable details.

Keywords: Child Witnesses; Fuzzy-Trace Theory; Memory; Repeated Event; Script Theory

Dedication

This thesis is dedicated to Eric Marshall. You are my partner in life, my best friend, and my biggest supporter. I love you most.

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Chapter 1.

Introduction

Child sexual abuse (CSA) is a widespread global issue, affecting children and youth regardless of demographic characteristics (e.g., age, gender, location, socioeconomic status; Collin-Vezina et al., 2013). CSA remains a difficult topic to understand and gather precise data on because there is a lack of consistent definitions of CSA, countries can vary on their criminal laws and cultural norms, and there is global disparity with research quality (Singh et al., 2014). Additionally, factors such as sexual grooming of child victims (van Dam, 2001) and the self-blame and stigma associated with CSA (Collin-Vezina et al., 2015) likely lower rates of disclosure. With that said, the World Health Organization (2014) has estimated CSA is experienced by 18% of girls and 8% of boys globally. Again, it is important to note that this type of offense is vastly underreported and challenging to precisely quantify, so published reports may not capture the true global statistics (Smith et al., 2000). Despite the challenges, researchers continue to seek to understand the characteristics of CSA offenses in order to assist with awareness, prevention, and treatment efforts, as well as offer recommendations for evidence-based practices to legal professionals.

Various researchers have strived to identify common characteristics amongst reported cases of CSA. Essential for the current study, examination of Canadian judicial decisions involving CSA has shown that it is common for abuse in these cases to be repetitive in nature (i.e., sexual abuse occurs more than once; see archival research by Connolly). It has also been noted that lengthy delays to prosecution are associated with repeated abuse. For instance, Connolly and colleagues (2015) analyzed 640 timely CSA cases (i.e., period of less than two years between the alleged abuse and the date of the legal proceeding) and 1317 historic CSA cases (i.e., delay of two or more years between the alleged abuse and the date of the legal proceeding). They found that repeated CSA was experienced more often in historic CSA cases than timely CSA cases (57.3% and 43.1%, respectively). Given the high prevalence of repeated abuse in reported cases of CSA, researchers have sought to understand how children's memory for repeated events differs from memory of a single event. For example, prior research has examined children's accuracy and consistency of memory reports after experiencing a repeated event (e.g., Brubacher et al., 2011; Powell & Thomson, 1996; Price & Connolly, 2013), differences in suggestibility between children who experience a single event versus a repeated event (e.g. Connolly & Lindsay, 2001; Powell et al., 2000; Price & Connolly, 2013), and the effect of various prompts and cues to elicit episodic rather than generic language (e.g., Brubacher et al., 2018; Connolly & Gordon, 2014).

The present study departs from traditional attempts of retrieval of episodic information and instead returns to the most basic question for repeated event research: How are details from repeated events naturally organized in children's memory? To answer this question, the current study replicates and extends the earlier work of Slinger (2010). Applying a novel reaction time paradigm, children experienced a repeated event and after a brief delay, engaged in an online memory recognition test. The study aims to determine if details remain organized in an instance-based manner or if they are reorganized categorically.

Before moving forward with the current study, we will begin by discussing four areas of relevant literature. First, we will review the history of child eyewitness testimony in Canada and the current legal particularization expectations of children who experience repeated abuse. Second, we will compare two applicable theories of memory: script theory and fuzzy-trace theory. Third, we will explain different types of memory details that are often manipulated in repeated event research. Finally, we will introduce the reaction time paradigm and review the findings of Slinger (2010).

1.1. Child Eyewitnesses in the Canadian Legal System

1.1.1. History of Child Eyewitness Testimony

Traditionally, witnesses who testify in a legal setting are asked to take an oath (i.e., be sworn in) or make a solemn affirmation to tell the truth before providing testimony (i.e., sworn testimony). Children "of tender years" were not held to this same requirement (Alberta Law Reform Institute, 2014), and were asked to promise to tell the truth (i.e., unsworn witnesses). Canadian courts have historically barred cases that depended solely on the uncorroborated testimony of an unsworn child (Westman, 2018). Section 659 (abrogated) of the *Criminal Code* (i.e., Doctrine of Corroboration) stipulated an accused could not be convicted based upon the evidence of an unsworn child unless another piece of evidence or testimony corroborated the child's report (Westman, 2018). Individuals justified the Doctrine of Corroboration due to the widespread belief that child witnesses had uncontrollable imaginations and provided weak evidence (Backhouse, 2008; *Kendall v. The Queen*, 1962). Section 659 of the *Criminal Code* was not amended until the late 1980's. The Doctrine of Corroboration was later replaced with a mandatory warning that explained the dangers of convicting when the only evidence was the uncorroborated evidence of an unsworn child. This mandatory warning was abrogated in 1988, but remains optional (Westman, 2018).

1.1.2. Particularization Expectations in Cases of Repeated CSA

Criminal cases involving allegation of repeated abuse, such as repeated CSA, present their own unique prosecution challenges as the prosecution often relies heavily or even solely on the testimonial reports of the child (Meyers et al, 1999). When children describe repeated events in their everyday life, they tend to generally describe what typically happens instead of reporting instance-specific details (Nelson & Gruendel, 1981). However, reliance on generalities can be problematic when prosecuting cases of repeated CSA because a reasonable level of particularization is often needed in law (Woiwod & Connolly, 2017). Importantly, the level of particularization that is expected from a child is not uniform across the various players of the legal system (e.g., Supreme Court of Canada, lawyers, police officers).

Supreme Court of Canada

Particularizing specific instances of repeated CSA is an extremely challenging task for children (*Podirsky v. The Queen*, 1990). Importantly, there is a distinction between particularization and precision. The Supreme Court of Canada ruled one must "lift [the indictment] from the general to the particular" *(R. v. B. [G].*, 1990), but this does not mean that children are required to report precise time and place details for each instance. Time, place, or contextual details need to be reasonably specified, but exact precision is generally not expected to prove the discrete offences (*S. v. The Queen*, 1989; *R. v. B. [G].*, 1990). Typically, it is deemed sufficient if a child can provide a reasonably narrowed timeframe, provide location details to prove the offence took place within a certain jurisdiction, and provide context-specific details to differentiate between the discrete charges (Woiwod & Connolly, 2017).

Legal Professionals and Police Officers

Legal professionals and police officers agree there is a lack of clarity as to what level of particularization is sufficient (Guadagno et al., 2006), which is potentially contributing to the differences seen in their interpretations of particularization. Police officers tend to interpret particularization as meaning they should attempt to elicit precise instance-specific details (Guadagno et al., 2006; Guadagno et al., 2013). For instance, police officers interviewed by Guadagno et al. (2006) reportedly believed that to best assist the prosecution and increase the perceived credibility of the child, they needed to focus on obtaining precise details (e.g., time, place, clothing, positioning) across as many instances as possible. Similarly, police officers in a study by Guadagno et al., (2013) asked a five-year-old specific questions related to precise time and place even though these questions would be considered developmentally inappropriate. The police officers acknowledged this line of questioning strayed from best practices but explained that they perceived this information was essential for the prosecution (Guadagno et al., 2013).

In contrast, studies conducted with lawyers have revealed that they placed more of an emphasis on obtaining broader contextual details than highly specific and precise details, which aligns more with the interpretation seen in the Supreme Court rulings (Burrows & Powell, 2014; Guadagno et al., 2006). While police officers were under the impression that eliciting precise details from many instances boosted the perceived credibility of the child, lawyers expressed such line of questioning can have the opposite effect. For instance, prosecutors interviewed by Burrows and Powell (2014) stated that unless these highly specific details are provided spontaneously by the child, they have the potential to harm the prosecution's case and provide ammunition to the defence during cross-examination because specific questions are seen as more leading than open-ended questions. Furthermore, the legal professions interviewed by Guadagno et al. (2006) voiced these types of interviewing practices can confuse the child and increase the likelihood that inconsistencies or errors will be reported, which can damage the child's perceived credibility.

In sum, the interpretation of particularization is highly variable. As you move down the legal system hierarchy from the Supreme Court of Canada to lawyers and police officers, adults expect children to particularize instances of repeated CSA with more precision. Even though a high degree of particularization is not required in most jurisdictions, lawyers indicate this information can boost a child's credibility if provided spontaneously and this information continues to be sought by police officers as they perceive it helps the prosecution. Thus, it is important to determine whether children are capable of providing such information as it is still unclear if these expectations are congruent with children's memory organization of repeated events.

1.2. Theories of Memory Organization

Memory for repeated events has often been explained by either instance-based or schema-based approaches. Instance-based approaches suggest there are separate memory traces for each instance of a repeated event (Hintzman, 1986). This approach aligns with the assumption of the more stringent particularization expectations that children's memory is organized in such a way that they have the ability to accurately attribute instance-specific details to a target occurrence. On the other hand, schema-based approaches (e.g., script theory) posit individuals create general representations or scripts of what typically happens (Adams & Worden, 1986). In other words, following the logic of script theory, asking children to recall a specific instance of a repeated event will result in a combination of instance-specific details and generalized script-based details (Hudson & Nelson, 1983). Fuzzy-trace theory, a more contemporary theory, is comprised of principles from both instance-based and schema-based approaches, as it conceptualizes two separate memory traces: gist traces for general event memory and verbatim traces for instance-specific memory (Brainerd & Reyna, 2004). Since script theory and fuzzy-trace theory are two of the more prominent theories in the field, it is crucial to further examine the extent to which each is able to explain children's memory organization of repeated events.

1.2.1. Script Theory

Script theory was first proposed by Schank and Abelson (1977). As stated above, this theory conceptualizes that memory for repeated events is organized as scripts, or general representations. When an event occurs repeatedly, a memory script of what typically happens is formed (Hudson & Mayhew, 2009). These scripts can then be used as guides to understand and encode a current experience and to predict what might take place in future experiences (Greenberg et al., 1998).

Young children, even those as young as three years old, have the ability to create general scripts of repeatedly experienced events (Nelson, 1978; Nelson & Gruendel, 1981; Nelson & Gruendel, 1986). Some of the earliest studies to examine children's development of familiar scripts were conducted by Nelson and colleagues (see Nelson & Gruendel, 1981; Nelson et al., 1983). In these studies, young children (aged 3-8 years old) were asked to report the typical sequence of events for familiar scenarios. These scenarios included activities such as grocery shopping, morning routines, and birthday parties. Although at times the responses were quite vague (e.g., "You buy things and then you go home."), the children consistently reported general scripts of what typically happens ("You do X" structure) versus reporting instance specific examples ("I did X" structure). Additionally, early research by Fivush (1984) indicates children are able to create general scripts for an event after just a single exposure.

Script theory suggests generalized scripts of a repeated event can damage one's ability to access an accurate account for a specific instance. While it is not disputed that children are able to create episodic memories, the argument is that these episodic memories are not isolated and can be influenced by the generalized script. Thus, episodic memories are better described as a mixture of new episodic details and previous details from the general script (Farrar & Boyer-Pennington, 1999). As a result of this fusion process and the overall dominance of script information, children either lose key episodic details or become confused when trying to attribute episodic details to the correct instance of interest (Fivush, 1984; Hudson, 1990).

1.2.2. Fuzzy-Trace Theory

Fuzzy-trace theory is unique because it incorporates both instance-based and schema-based memory approaches to describe memory organization. When encoding a memory, fuzzy-trace theory suggests the information is encoded and stored in two separate memory traces: the verbatim trace and the gist trace (Reyna & Brainerd, 1995). The verbatim trace contains the exact experience, while the gist trace contains the underlying general meaning of the experience (Reyna & Brainerd, 2011). Put simply, when experiencing an event, the verbatim trace records *what specifically happened one time* and the gist trace records *the general meaning* of the experience.

Brainerd and Reyna (2004) identified five core explanatory principles of fuzzy-trace theory. The first principle states both verbatim and gist traces are stored in parallel, and as such, partake in the information processing procedures independently. Second, verbatim and gist traces are independently retrieved. Different retrieval cues aid in accessing instance-specific information of verbatim traces versus the general script information of gist traces. Third, verbatim and gist traces have varying rates of decay, with verbatim traces decaying faster than gist traces (Reyna et al., 2002). However, it is posited that portions of the verbatim trace can remain accessible over time with the proper retrieval cues (Reyna, 2000). The fourth explanatory principle discusses differences in retrieval phenomenology. Recollective retrieval is suggested to be more associated with verbatim traces, such that instance-specific information can be recognized though the effective episodic retrieval cues. On the other hand, overall familiarity with the current experience allows for retrieval of gist traces. The fifth explanatory principle discussed by Brainerd and Reyna (2004) focuses on developmental variability, arguing younger children rely on verbatim traces more because they are less adept than older children and adults at identifying the commonalities between experiences that are necessary to trigger a gist trace.

1.2.3. Effect of Delay on Memory Retrieval

It has been well established in prior research that delays between encoding and retrieval negatively impact a child’s ability to accurately attribute instance-specific details to target episodes of a repeated event (e.g., Miller & London, 2020; Powell & Thomson, 2003; Read & Connolly, 2007). From a theoretical perspective, it would be relatively uninformative to test children directly after the final episode of the repeated event because both script theory and fuzzy-trace theory expect instance-specific details to be accessible immediately after exposure. Unlike script theory, fuzzy-trace theory does not predict memory for details reorganizes over time. As mentioned before, delay will only impact the accessibility of instance-specific details, with the verbatim trace decaying faster than the gist trace (Brainerd & Reyna, 2004). Therefore, after a short delay, fuzzy-trace theory predicts instance-based cues should be effective in accurately accessing episodic information.

Script theory, on the other hand, suggests memory is a reconstructive process (Alba & Hasher, 1983; Fivush, 1997). Therefore, memories for details should rapidly shift from being organized by instance into more script-based categories. For example, let us review a scenario in which a different color crayon was used in four play sessions of a repeated event (blue in session 1, green in session 2, yellow in session 3, red in session 4). After a brief delay, the memory for the green crayon begins to separate from the original memory source (session 2) and instead become a slot-filler for the general crayon category. As a result, the child will likely be able to recall that a green crayon was experienced during the repeated event but will have difficulty specifying which number play session the green crayon was experienced. As more time passes, the child will need to rely more on their memory for the general script.

With all this in mind, the current study had a three hour delay period between the final episode of the repeated event and the memory recognition test. This time period was specifically chosen to allow enough time for the reconstructive process to start if memory is organized according to script theory. Importantly, if memory is organized as described by fuzzy-trace theory, this delay is short enough to ensure the verbatim traces are still intact and have not decayed. Therefore, a three-hour delay period should allow us to determine which of these two theories best describes children's natural memory organization.

1.3. Event Details

Before moving forward, it is important to identify and describe the different types of details that can arise in repeated events. The two main types of event details are fixed and variable details. Fixed details refer to details that remain stable or unchanging across instances of the repeated event. In contrast, variable details change across instances (Connolly & Lindsay, 2001). For example, in the context of grocery shopping, it is typically expected that one must go to the check-out line and pay for their food before leaving the store with their items (fixed detail); however, the type of food purchased may vary each time one goes grocery shopping (variable detail).

The types of details that arise in an event can greatly impact an individual's ability to recall episodic details from a specific instance. With regards to fixed details, research has found children have an easier time recalling them and are more resistant to suggestibility compared to other detail types (Connolly & Lindsay, 2001; McNichol et al., 1999; Powell & Thompson, 1996). Fixed details have limited usefulness when investigating memory for instances of a repeated event, as these details appear in every occurrence. Thus, it is not possible to determine which specific instance, if any, the child is recalling the fixed detail from.

On the other hand, variable details are particularly important when examining memory for instances of repeated events. These details can become confused with one another, leading to misattribution of details of one instance to another instance (i.e., internal intrusion errors; Woiwod et al., 2019). Incorporation of variable details into repeated event scenarios makes it possible for researchers to easily identify in which specific instance of the repeated event the detail was presented and to identify misattributions, when they occur.

Multiple studies examining children's memory have used magic shows as a repeated event scenario (e.g., Connolly & Gordon, 2014). Using a magic show as an example, the magician may always say a magic word before performing a trick (expected, part of the scripted memory); however, the exact word said may vary with each show (e.g., presto chango, abra cadabra). Put simply, the magic word is a variable detail and the variable detail options are the particular magic words spoken, which change with each magic show. Following the logic of script theory, children can remember that saying a magic word is part of general magic show structure. However, it will be more difficult for children to identify which particular show the magician said "presto chango" and which show the magician said "abra cadabra" because memory for the general script will be stronger than the memory for specific instances. In contrast, fuzzy-trace theory assumes children will be able to identify the specific show "presto chango" was spoken if the child is able to access the appropriate verbatim trace.

1.3.1. Taxonomic vs. Non-taxonomic Variable Details

Variable detail categories can be either pre-existing taxonomic or non-taxonomic. Categories are classified as pre-existing taxonomic if the variable options within the detail category share enough mutual characteristics that people are easily able to group them into a common category on their first attempt. Importantly, people should be able to do so consistently and independent of context (Barsalou, 1982). We will use the following list of variable options as an example: apple, strawberry, banana, grape. It is highly probable that participants of all ages, without any sort of prior training exercises, would come up with a common label of “fruit” to categorize these variable options. Therefore, this “fruit” category is an example of a pre-existing taxonomic category. However, the following variable options (pillow, tree, paperclip, car) would be considered part of a non-taxonomic category because without context, it is highly unlikely that participants would be able to consistently come up with a common label that could tie all four of these items together.

Taxonomic categories have been researched in the field of cognitive psychology (see work by Barsalou) and has even been applied to the field of marketing (e.g., Feltcher et al., 2001). However, it has rarely been examined in the repeated event literature. One study by Price and Connolly (2006), provides evidence that children as young as three years old organize information taxonomically. In this study, children played a game in which they were told a word or phrase (i.e., the category) and were asked to generate as many distinct exemplars associated with the category. When discussing “Animals”, more than a third of all respondents mentioned tiger, lion, dog, and cat.

In another study, Connolly and Price (2006) examined the degree of association between variable detail options on children’s suggestibility after experiencing a single event or a repeated event. In each play session, children experienced a variable option from 16 variable details. Some variable details had variable options that were highly associated (e.g., baseball, tennis, soccer, hockey, bowling), while others were less associated (e.g., circle, red, stream, police, crayon). The results of this study indicated children who experienced a repeated event were more suggestible than children who experienced a single event, but only for details that had highly associated variable options. Such findings make sense when interpreted through the lens of script theory. Variable details that are highly associated should be more readily incorporated into the general script than variable details that are minimally associated. However, this will also lead to memory errors such as internal intrusions (i.e., misattributing an experienced detail to the wrong source) and external intrusions (i.e., erroneously reporting a non-experienced category exemplar was experienced). Given the lack of attention on taxonomic categories in the repeated event literature, the present study attempts to tease apart how children naturally organize variable options from taxonomic and non-taxonomic categories and whether the memory organization aligns more with the principles of script theory or fuzzy-trace theory.

1.4. Reaction Time Paradigm for Repeated Event Research

Prior research has most commonly used interviews consisting of free recall and cued recall questions to measure children's memory for instances of repeated events (e.g., Brubacher et al., 2011; Connolly & Gordon, 2014; Price & Connolly, 2007). A more novel technique to examine memory organization is the implementation of a reaction time paradigm. While various research domains have used this method to study memory and cognitive capabilities in both adults and children, Slinger (2010) was the first study to our knowledge to have applied a reaction time paradigm to examine children's memory for repeated events.

1.4.1. Slinger (2010)

In the study by Slinger (2010), children (9-11 years old) heard a series of six stories, each one involving a "visit-a-friend" narrative. Every "visit-a-friend" story contained 12 variable details, that was a label for a pre-existing taxonomic category (e.g., clothing, vehicle, insect, candy, etc.). Across stories, the variable options for each variable detail changed, but still remained exemplars from the relevant category. For example, if the variable detail category was vehicle, with each story the type of vehicle described varied (e.g., motorcycle, train, boat, etc.).

During the computer recognition memory test, children were presented with a list of details, presented one at a time, and asked to respond "old" (i.e., press the "b" computer key) or "new" (i.e., press the "n" computer key) as quickly and as accurately as possible. Half of the details displayed on the screen were from the stories (i.e., experienced details) and half had not been presented in any of the six "visit-a-friend" stories but were exemplars from a variable detail category (i.e., foils). The memory test items were either blocked by story or by variable detail category. For the blocked by story condition, test items were presented in a manner consistent with the sequence of the "visit a friend" story. To be clear, test items were not presented in the exact order from each story, but rather items were presented following the general story structure. The first item was always a clothing item (experienced or foil), followed by a color item (experienced or foil), followed by a transportation item (experienced or foil), etc. After an option from the twelfth detail category was presented (i.e., shape), the presentation order restarted with the appearance of one of the remaining clothing items, color items, transportation items, etc.

For the blocked by variable detail category condition, test items were displayed such that every experienced/foil detail corresponding to each of the twelve categories were presented together. For example, for one participant's test, all twelve candy details (6 experienced variable options and 6 foils) were presented together in a random order and afterwards all twelve variable sport details (6 experienced variable options and 6 foils) were presented together in a random order. This process continued until all stimuli from the twelve variable detail categories were presented.

The dependent variables of interest in the study were reaction time, accuracy, and discriminability. Reaction time was measured as the lag between the stimulus onset (appearance of the word on the computer screen) and response key selection. A longer lag represented slower reaction time. Overall accuracy was quantified as the proportion of correct responses for each participant (i.e., number of correct responses divided by the number of total responses). The more correct responses, the higher the overall accuracy. In addition, Signal Detection Theory's sensitivity index (*d*') was used to measure a person's capacity to discriminate signal from noise. This differs from overall accuracy because it measures how an individual makes decisions when they encounter uncertainty. Higher *d*' values signify enhanced discriminability between target items (signal) and foil items (noise; Stanislaw & Todorov, 1999). Response bias (*criterion C*) was also calculated for each participant to further make the distinction between response sensitivity and response bias.

Slinger (2010) found children were faster, more accurate, and had better discriminability when test items were blocked by variable detail category than when test items were blocked by story sequence. The findings provide support for schema-based approaches (i.e., script theory), in which memories for story details are reorganized into general categories (scripts) rather than stories (specific instances). These results need to be replicated, as they are theoretically significant.

1.5. Present Study

1.5.1. Study Purpose

The purpose of the present study was to replicate and extend the work of Slinger (2010) in order to further investigate whether children's memory for a repeated event is better explained by script theory or fuzzy-trace theory. By applying a reaction time paradigm to the field of repeated event research, we hope to better understand the natural organization of repeated event memories after a brief delay period. Given the relatively stringent legal expectations surrounding children's abilities to particularize instance-specific details, the present research aims to understand if these expectations are realistic. Replicating the results of Slinger (2010) would provide strong evidence that children's memory quickly reorganizes in a categorical manner (script theory organization), rather than remaining organized by instances.

Instead of variable details being presented through the medium of stories, children watched a series of six pre-recorded magic show videos. This change was made to address previous concerns from Slinger (2010) that children encoded variable details as a list because the only pictures depicted throughout the stories were of the target items. In the current study, we used a series of magic shows performances as the repeated event (see also Coburn et al., 2021; Connolly & Gordon, 2014; Connolly et al., 2016) because magic shows can be easily repeated, they can evoke emotional reactions from the children, and they are complex enough in their structure to allow researchers considerable opportunities to manipulate critical details. The current study also expanded upon Slinger (2010) by examining whether there are differences in reaction time, accuracy, or discriminability depending on if the variable detail category is a pre-existing taxonomic category versus a non-taxonomic category.

1.5.2. Research Questions

The core research question of this study is the following: Does children's natural memory organization follow more of an instance-based approach (e.g., fuzzy-trace theory) in which variable detail options are organized by general magic show sequence, as presented, or does children's natural memory organization follow a schema-based approach (e.g., script theory) in which variable detail options are quickly reorganized categorically? That is, will blocking memory test stimuli by magic show sequence or variable detail category have an effect on reaction time, overall accuracy, and discriminability? Additionally, will there be differences in reaction time, overall accuracy, and discriminability based on the category type of the variable detail (pre-existing taxonomic vs. non-taxonomic)?

1.5.3. Hypotheses

Based on the research by Slinger (2010), it was anticipated that children's memory for repeated events will be naturally organized according to script theory, in which memory for variable details are rapidly reorganized into categories rather than by instance. The specific hypotheses are listed below:

1. Children will have faster reaction times, higher overall accuracy, and higher sensitivity index (*d*') values when test items are blocked by variable detail category versus blocked by magic show sequence.

2. Children will have faster reaction times, higher overall accuracy, and higher sensitivity index (*d*') values when test items are from pre-existing taxonomic versus non-taxonomic categories.

Chapter 2.

Methods

2.1. Participants

Children aged 9 to 11 years old were recruited from university summer camps and online platforms (e.g., Children Helping Science, Facebook groups) between July 2020 and September 2023. Two hundred participants engaged in some part of the study. However, a moderate level of attrition was observed, with sixty-eight participants failing to complete the memory test portion of the study after the three-hour delay period. Of the 132 participants that successfully completed all aspects of the study, two were excluded for being too young and two were excluded for being suspected "bots[1]." The remaining participants all passed the attention check portion of the experiment (i.e., answered a minimum of three of the five questions correctly). Therefore, the final sample consisted of 128 children (*n* = 95 recruited from camps, *n* = 27 recruited online, and *n* = 6 recruited by word of mouth). Please refer to Figure 1 for a flowchart that breaks down the attrition and exclusion of participants. Based on an a priori power analysis using G*Power (Faul et al., 2007), this was the exact number of children deemed sufficient to detect a medium effect, f = .25, α = .05, power = .80, *N* = 128.

Participants were a mixture of Canadian and American children (*n* = 100, *n* = 28, respectively). The mean age of participants was 123.14 months (*SD* = 10.74). In years, the age breakdown of the sample was the following: age 9 (*n* = 52), age 10 (*n* = 39), and age 11 (*n* = 29). The ages of eight participants were missing from parental consent forms. However, the school grade level listed for each of these participants matched the typical grade levels for the 9 to 11-year-olds (i.e., grades 4-6). Therefore, data from these eight participants were retained in the final analyses. The breakdown in gender was relatively equal between females and males (*n* = 65 female, *n* = 62 male), with one participant self-identifying as non-binary. Given that the stimuli for the study were

[1] Participants were flagged as suspected "bots" due to receiving a mass influx of participation requests after these two participants gained access to the study. Requests were sent from suspicious emails (i.e., names followed by series of numbers). Additionally, similar language was used in the emails sent by all the "guardians." Further, these two participants exhibited abnormal memory test performances (e.g., overall proportion correct of .465).

presented in English, parents were asked to report the primary language spoken in their household and the primary language of instruction at their child's school. At home, children most often spoke English (*n* = 123). Similarly, the language of instruction at school was primarily English (*n* = 100), followed by French (*n* = 28). Consistent with Slinger (2010), the majority of children reported being right hand dominant (*n* = 113).

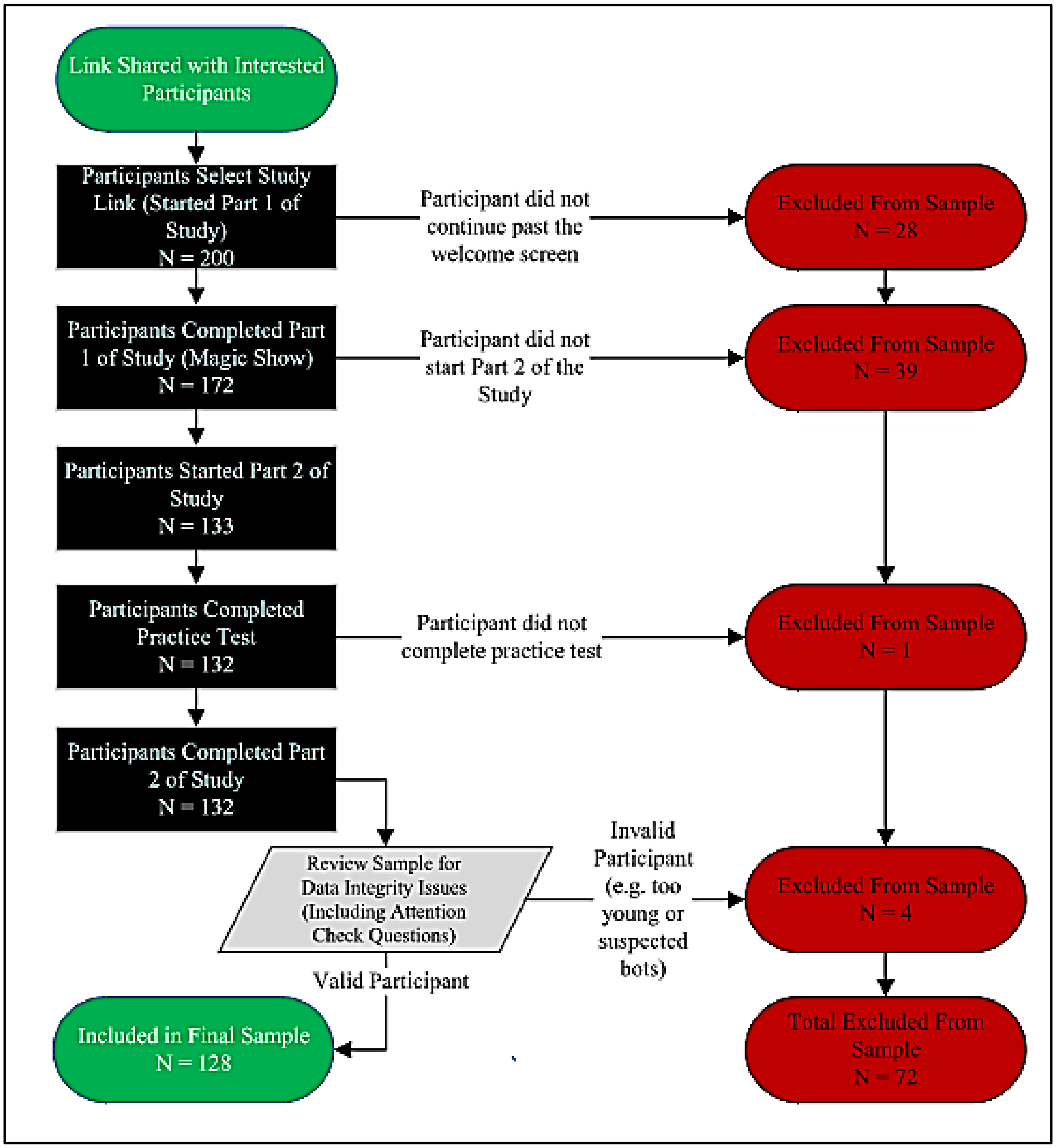

Figure 1. Flowchart for Participant Inclusion Eligibility

2.2. Design

The present study attempted to replicate and extend the findings of Slinger (2010). The study was a 2 (Test Blocking: variable detail category, magic show sequence) x 2 (Category type: pre-existing taxonomic category, non-taxonomic category) mixed factorial design. For brevity, the remainder of the paper will refer to these conditions as detail, magic show, taxonomic, and non-taxonomic. The memory test blocking condition was between-subjects, and the category type condition was within-subjects. Children were randomly assigned to one of the two memory test blocking conditions using a randomizer key in the online experiment program. The experiment was programed with a 1:1 ratio, meaning for every two participants, one was assigned to the blocked by magic show condition and one was assigned to the blocked by detail condition. Each magic show contained variable detail options from twelve variable detail categories, half of which were taxonomic in nature and half were non-taxonomic. Therefore, all children were exposed to both taxonomic and non-taxonomic stimuli during the magic show videos. Similar to Slinger (2010), the primary dependent variables of interest were participants' overall accuracy (i.e., proportion of correct responses), reaction time (i.e., lag between stimulus onset and participant's response in milliseconds), and sensitivity index scores (i.e., *d*': ability to discriminate signal from noise).

2.3. Materials and Procedure

2.3.1. Gorilla Experiment Builder

One strategy to recruit participants from larger and more diverse samples is to utilize online study platforms. COVID-19 also increasingly forced behavioral researchers to adapt to online experiments. The present study used the Gorilla Experiment Builder (gorilla.sc) to design and present study materials in an online format to participants. Gorilla is a web-based interface that uniquely allows researchers to create complex experimental designs without needing substantial technical knowledge of coding (Anwyl-Irvine et al., 2020). Please refer to Figure 2 for a visual depiction of the experimental design and procedure that was created in Gorilla. Each module of the experiment was programmed by the first author. It was not necessary for participants to download Gorilla to participate in the study; instead, participants could access the experiment via a unique study hyperlink. All participant data downloaded from Gorilla were anonymized and stored in excel spreadsheets for further analysis. The specific experiment materials and procedure are discussed in more detail below.

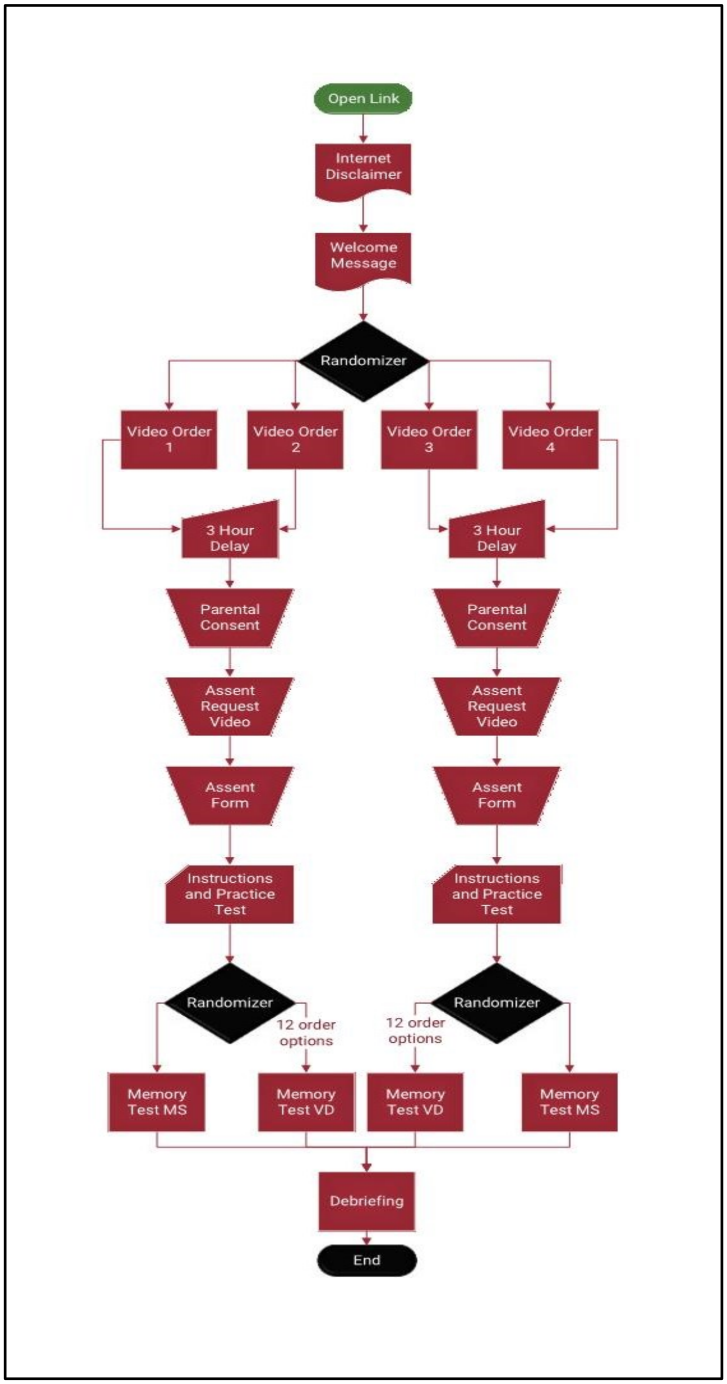

Figure 2. Flowchart of the Study Procedure

Note. For the memory test modules, MS refers to the blocked by magic show sequence condition and VD refers to the blocked by variable detail category condition.

2.3.2. Pre-Magic Show Modules

When participants clicked on the initial study link, they were first shown an internet disclaimer form. The screen displayed text that thanked them for their patience should it take videos a few seconds to buffer. Afterwards, a welcome video was played. In this video, participants were informed that they would be asked to watch six magic show videos. The researcher requested the participant pay close attention to the details of each magic show because they would later be asked to take part in an online memory test. If at any point the child did not wish to continue with the study, the child was reminded to tell their guardian.

2.3.3. Pre-recorded Magic Show Videos

The first half of the study consisted of the repeated event (i.e., sequential presentation of six script-based magic show videos). In total, twelve magic show video performances were created for this study: six magic show videos for video order presentations one and two and six magic show videos for video order presentations three and four. In an attempt to distribute participants randomly into relatively equal groups for each of the four video orders, Gorilla was programmed to assign participants to each video order in a 1:1:1:1 ratio. Essentially, the program would randomly assign the first participant to one of the four possible orders and then the next participant would be randomly assigned to one of the remaining three orders, and so forth. Once all video orders had one participant assigned, the randomization would restart. The program was not sophisticated enough to take into account participant attrition, so there was slightly unequal distribution between video order groups in the final sample (n = 32 in Order 1, n = 30 in Order 2, n = 35 in Order 3, n = 31 in Order 4).

Participants in video orders one and two watched the same six magic shows videos, but in a different sequence. Similarly, participants in video orders three and four watched the same six magic show videos, but in a different sequence. The stimuli presented in video orders one and two functioned as foils during the final memory test for participants who watched video orders three and four, and vice versa. All videos, regardless of order, were led by the same magician and were recorded in the same location, with the magician’s desk being the same distance from the recording camera.

Each magic show contained twelve variable detail options, one exemplar from each of the twelve variable detail categories. Importantly, a different variable option for each detail category was presented in every magic show. Of the twelve possible variable options for each variable detail category, six were presented or experienced in the magic shows and six functioned as foils during the recognition memory test. Items were counterbalanced to ensure they were each presented as experienced or foils for roughly the same number of participants. Within each show, six of the variable detail categories presented options that were from the same taxonomic categories, while the other six variable detail categories presented options that were not taxonomically related. Most of the variable details and associated options have been used in prior research (e.g., Connolly et al., 2016). Because the present study had six magic shows rather than the standard four magic shows, four additional variable options for each variable detail category were created. Two functioned as presented items in magic shows and two functioned as additional foils in the memory test. Please refer to Appendix A for Tables A1 and A2 that breakdown the variable detail options experienced in each magic show across video order presentations.

Below is a description of the general magic show structure, with each of the twelve main detail categories in bolded text. To help differentiate between category types, non-taxonomic categories are bolded, while taxonomic categories are bolded and italicized. Please see Appendix B for an example of a full magic show script. It should be noted that in order to increase salience of the target items, each variable detail option was mentioned three times before moving onto the next one.

To begin, the magician (an SFU PhD student) presented an **admission ticket** with an object attached to it. In preparation to perform the magic trick, the magician **removed an item** and then proceeded to facilitate the children in a ***warm-up exercise***. Afterwards, the magician took a drink from a ***colorful juice***, put on a ***hat***, and showed participants a **special item**. The magician then placed a sticker on a ***part of their body***. Next, the magician introduced their ***stuffed animal assistant*** to the children and then proceeded to begin the magic show by playing a **sound effect**. The children were taught the ***magic word*** and then magician performed their magic trick. Before ending the show, the magician disclosed a **secret** to the children. Finally, the magician ended the show by gesturing **goodbye**. Please see the tables in Appendix A for the complete list of variable options that were presented in each magic show across video order presentations.

A single magic show video lasted approximately five minutes. Each magic show was separated by a brief distraction task. Between magic shows, children were shown a short (one or two minute) educational YouTube video that discussed fun facts about a specific animal. These animal videos not only functioned to provide separation between instances of the repeated event, but also served as attention checks. After each animal video, children were asked to answer a question related to a fact about the animal. In total, five attention check videos and questions were presented to each participant. Children needed to answer a minimum of three questions correctly to be included in the final analyses. In total, the first half of the study took approximately 35-40 minutes for participants to complete.

2.3.4. Brief Delay Period

After watching the sixth and final magic show video, participants were rerouted to the delay screen module. Participants were thanked for being such great listeners and were informed that they would need to wait three hours before they could move on to the second half of the study. Guardians were asked to enter their email address on this page so that Gorilla would be able to email them precisely once the three-hour delay period expired. In this email, the program would provide the participant with a new study link to access the second half of the experiment.

2.3.5. Parental Consent and Child Assent Forms

After the expiration of the delay period, parental consent and child assent were requested. On the parental consent form, guardians were asked to check the consent box should they wish for their child to proceed with the second half of the experiment (memory test portion of the study). If they provided consent, they were asked to fill out general demographic information about their child (e.g., age, language spoken, dominant hand). Parents also had the opportunity to indicate if they wished to receive a summary of group results. Finally, parents selected which prize option their child would like to receive upon completion of the study, which was either a $20 gift card or entering into a prize draw for a $150 gift card. Once parental consent was given, the child watched a video in which a researcher explained what would be expected of them during the memory test portion of the experiment. After watching the video, the child was given the opportunity to either give online assent and move forward with the study or to exit the experiment if they did not wish to continue.

2.3.6. Practice Test

Before beginning the final memory recognition test, a video was shown to participants in which the researcher explained what would be expected of them during the memory test. A series of words and associated pictures would appear one by one on the computer screen and participants would be asked to press the “A” computer key if they believed the item was old (experienced in the magic shows) or the “L” computer key if they believed the item was new (not presented in any of the six magic shows). Children were first given the opportunity to practice so that they could acclimate themselves to pressing the computer keys in a fast, yet accurate manner. The children completed twenty trial sessions in which the words “yes” and “no” appeared in the middle of their computer screen. They were instructed to press “A” (the key designated for “old” and experienced items) if the word on the screen is “yes” and to press “L” (the key designated for “new” items) if the word on the screen is “no”. If the child pressed the wrong key (e.g., pressed L when “yes” appeared), a red “X” would appear, directing the child to press the other key before moving on. Gorilla was programmed to randomly present ten “yes” stimuli and ten “no” stimuli to each child. The words appeared in black font with a white background. All twenty stimuli needed to be correctly responded to before moving forward to the final memory test.

2.3.7. Final Memory Recognition Test

Once the practice test was completed, Gorilla randomly assigned the participant to one of the two test blocking conditions. To help ensure equal groups, for every two participants, one was assigned to the blocked by magic show condition and one was assigned to the blocked by detail condition. Prior to starting the memory test, participants were shown one last video in which the researcher reminded them to press the “A” key if the word and associated picture was from any of the magic show videos they had watched or the “L” key if it was new and not from any of the videos. Participants were encouraged to complete the test in a space that was distraction free. The children were also reminded to answer as fast as they could while still trying to be accurate. Participants were reassured that mistakes were okay and to just try their best. The screen prompted the child to press the space bar when they were ready to begin the test. See Appendix C for complete script of verbal instructions for the memory test.

The final memory test consisted of 150 words and related images, presented sequentially. The image was presented at the top of the screen and the word/phrase appeared in black font underneath the image. All images and font sizes were the same across stimuli. The first three stimuli and last three stimuli were the same for every participant (all foils). The accuracy and reaction times related to these stimuli were not used in analyses. Their function was to give the children time to adjust to the online test format and control for any effects due to items being presented first or last.

Half of the remaining 144 words described things that were presented during the magic shows (target items) and the other 72 words represented things that were not presented in any of the six magic shows (foils). For half of the children, the words/pictures were blocked by magic show, such that the stimuli were presented in a sequence similar to the magic shows. For example, the first stimulus was any of the twelve target or foil options for the first variable detail category (admission ticket item), followed by any of twelve foil or target options from the “remove an item” detail category. This same process continued until one of the twelve variable options for the twelfth detail category (goodbye) was randomly presented. After the goodbye stimulus, the program restarted the process and randomly presented one of the remaining eleven target or foil options from the “admission ticket” category, followed by one of the remaining eleven target or foil options from the “remove an item” category. The presentation of items by the general magic show sequence continued until all 144 stimuli were presented. Please refer to Table D1 in Appendix D for two example presentations of the final memory test for participants in the blocked by magic show condition.

In the other condition, words/pictures were blocked by variable detail such that all stimuli (targets and foils) belonging to one variable detail category (e.g., admission ticket) were presented in a random order before words/pictures from another variable detail category were shown together. For example, one participant might be presented with all twelve of the “warm up exercise” stimuli (both target and foils in a random order) before being presented with all twelve of the “goodbye” stimuli (both target and foils in a random order). This process continued until stimuli from all twelve variable detail categories were presented. Please refer to Table D2 in Appendix D for two example presentations of the final memory test for participants in the blocked by detail condition.

The reaction time (in milliseconds) for each stimulus was recorded by Gorilla. Reaction time was measured as the time lag between stimulus onset and the selection of either the “A” or “L” key. Gorilla also tracked the accuracy of each response. Unlike the practice test, participants did not receive feedback on the accuracy of their responses during the final memory test. Participants typically took between seven and ten minutes to complete the memory test.

2.3.8. Debriefing and Compensation

After completion of the memory test, participants were directed to a debriefing screen. A brief synopsis of the purpose of the current research project was provided. Each participant was thanked for their hard work and participation. Children were also given the opportunity to type any questions in a text box (see Appendix E for complete debriefing script). Finally, an end screen appeared that informed participants that they completed the study, their data has been saved, and they can exit out of the program. Based on their guardian’s response to the prize options on the consent form, the researcher then either compensated participants by emailing their guardian a $20 e-gift card or were entered into the $150 prize draw. The prize draw winner was randomly selected by an online random number generator.

Chapter 3.

Results

3.1. Data Preparation

3.1.1. RT Outliers

For every participant, Gorilla tracked and recorded the RT value (in milliseconds) for each of the 144 stimuli. Using an equation function in Excel, the participant's mean RT value was calculated from their raw dataset (i.e., untrimmed RT mean). Next, Excel was used to calculate the standard deviation of the participant's untrimmed RT mean. Following the outlier procedure commonly performed in RT research (e.g., Berger & Kiefer, 2021; Slinger, 2010), any RT value that deviated ±2 *SD* from the untrimmed RT mean value was flagged and defined as an outlier. These outliers were removed from the child's dataset and were each later replaced with the participant's overall trimmed RT mean value (i.e., the mean of all remaining non-outlier RT values). On average, each child had approximately 6 of the possible 144 RT values flagged as outliers and were consequently replaced by the child's trimmed RT mean value. This number was somewhat consistent with what was observed in Slinger's (2010) study (average of 10 per child). The final analyses were conducted using each participant's trimmed dataset.

3.1.2. Hit Rate and False Alarm Rates

A participant's hit rate (i.e., number of correct acceptance of targets divided by 72) and false alarm rate (i.e., number of false alarms divided by 72) were computed in order to calculate sensitivity index scores and response bias. When examining all 144 stimuli, it was extremely rare for someone to have a hit rate of 1 or a false alarm rate of 0. However, when examining differences between taxonomic and non-taxonomic stimuli, it was more common to have such values because only 72 stimuli were examined in each group. Therefore, in such instances, the participant's hit rate and/or false alarm rate needed to be adjusted following the procedure set out in Macmillan and Creelman

(2005)[2] so that their *d*' and *criterion C* scores could be computed. The hit rate and/or false alarm rate needed to be adjusted for 24 participants. It was more common (n = 16) for the adjustments to be made for participants who were in the blocked by detail condition. Following the logic behind our hypotheses, this finding is unsurprising. We expected that children in the blocked by detail condition would have better accuracy than those in the blocked by magic show condition. If a person is more accurate, they are more likely to have a hit rate of 1 and/or false alarm rate of 0 than an inaccurate person. The dataset containing the participant's adjusted rates and updated sensitivity index and response bias scores were used for the final analyses.

3.1.3. Demographic Information

One-way analyses of variances (ANOVAs) were conducted to ensure that observed differences in RT, overall accuracy, and d' values were not simply a result of various demographic characteristics of the sample. Demographic characteristics such as age, gender, dominant handedness, language spoken at home, and language of instruction were examined. No significant differences were found in any of the analyses.

3.2. Main Analyses

The main analyses were conducted in SPSS using 2 (Test Blocking) x 2 (Category Type) mixed factorial ANOVAs. It should be noted that the current study was only powered to detect main effects. Therefore, findings related to interactions will not be discussed in the body of the results section. For interested readers, please refer to Appendix F for information on interactions.

3.2.1. Reaction Time

The analysis examining the effects of test blocking and category type on trimmed mean RT values revealed significant results. There was a main effect of test blocking, $F(1, 126) = 13.65$, $p < .001$, $\eta_p^2 = .098$. Overall, participants who had test items blocked by detail responded significantly faster (M = 1614.88, SD = 322.48) than participants

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[2] If the hit rate was 1, then the following equation was used to calculate an adjusted hit rate value: $1-(1/(2N))$. If the false alarm rate was 0, then the following equation was used to calculate an adjusted false alarm value: $1/(2N)$. For these equations, N represented the number of stimuli.

who had test items blocked by magic show (M = 1825.49, SD = 441.21). There was also a main effect of category type, $F(1, 126) = 45.71$, $p < .001$, $\eta_p^2 = .266$. Participants responded significantly faster to stimuli from taxonomic categories (M = 1696.59, SD = 384.93) than stimuli from non-taxonomic categories (M = 1785.21, SD = 437.14). Please refer to Figures 3 and 4 for a depiction of the RT results.

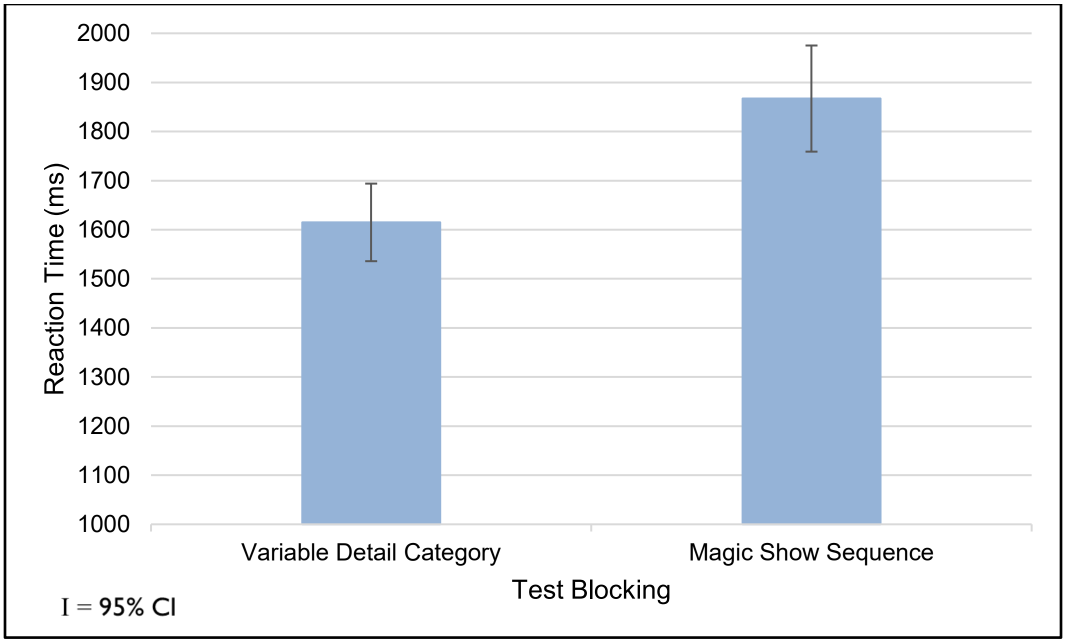

Figure 3. Mean Reaction Time Across Test Blocking Conditions

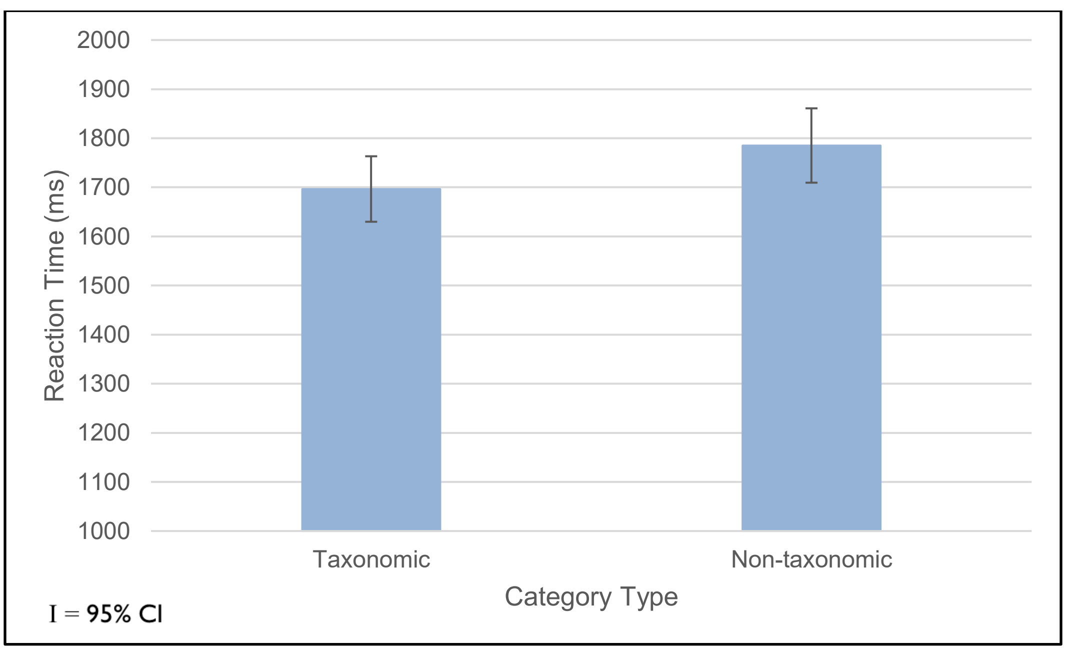

Figure 4. Mean Reaction Time Across Category Type

3.2.2. Accuracy

Correct acceptance of target items and correct rejection of foils were scored 1 point each, while misses and false alarms were scored 0 points. Excel was used to calculate overall accuracy (i.e., proportion of correct responses) by summing the participant's total number of correct responses and dividing that value by the number of total stimuli (144).

The analysis revealed a main effect of test blocking, $F(1, 126) = 14.85$, $p < .001$, $\eta_p^2 = .105$. Participants who had test items blocked by detail were overall significantly more accurate ($M = .87$, $SD = .09$) than participants who had test items blocked by magic show ($M = .80$, $SD = .11$). A similar pattern was observed when looking at the breakdown of accuracy for target items and accuracy for foil items separately, with those in the blocked by detail condition correctly responding "yes" to target items and "no" to foil items more often than those in the blocked by magic show condition. When examining the effect of category type on overall accuracy, there was no significant difference between participant's overall accuracy for taxonomic stimuli versus non-taxonomic stimuli, $F(1, 126) = 1.15$, $p = .287$. However, the analyses that examined the impact of category type on the accuracy for target items and accuracy for foil items separately were significant. Interestingly, the pattern differed from what was observed with the blocking conditions. The mean accuracy (i.e., correct "yes" responses) for target items was higher for taxonomic stimuli ($M =.81$, $SD = .13$) than non-taxonomic stimuli ($M = .78$, $SD = .15$), $F(1, 126) = 14.94$, $p < .001$, $\eta_p^2 = .106$. Conversely, the mean accuracy (i.e., correct "no" responses) for foil items was higher for non-taxonomic stimuli ($M = .89$, $SD = .12$) than taxonomic stimuli ($M = .86$, $SD = .13$), $F(1, 126) = 9.22$, $p = .003$, $\eta_p^2 = .068$. See Table 1 for all results related to overall accuracy, target accuracy, and foil accuracy.

Table 1: Mean Proportion of Correct Responses Across Test Blocking Conditions and Category Type

	Test Blocking		Category Type	
	Variable Detail Category	Magic Show Sequence	Taxonomic	Non-taxonomic
Overall Accuracy	.87 (.09)$_a$	.80 (.11)$_b$	.84 (.11)	.83 (.11)
Target Accuracy	.84 (.11)$_a$	.75 (.13)$_b$	.81 (.13)$_c$	.78 (.15)$_d$
Foil Accuracy	.90 (.09)$_a$	.85 (.13 $_b$	.86 (.13)$_c$	.89 (.12)$_d$

Note. Standard deviations are listed in parentheses. Overall accuracy was calculated by summing the correct acceptance of targets and correct rejection of foils and dividing that number by the maximum potential number of correct responses. The maximum number of overall correct responses varied based on the independent variable (144 for test blocking conditions and 72 for each category type). Subscripts a and b denote a main effect of test blocking condition. Subscripts c and d denote a main effect of category type.

3.2.3. Sensitivity Index Scores and Response Bias

Sensitivity index scores (*d*') were calculated to measure participants' ability to discriminate between signal (i.e., target items, experienced magic show stimuli) and noise (i.e., foils, items not experienced in magic shows). Potential values can range between zero and infinity (Stanislaw & Todorov, 1999), although scores around three are considered to have high discriminability (American Psychological Association, n.d.). Values close to zero indicate a failure to discern targets from foils (Stanislaw & Todorov, 1999), or in other words, a participant is essentially guessing. As stated above, Gorilla was programmed to track each response and give it a score of 1 if a correct target acceptance or correct foil rejection and a score of 0 if the response was a miss or false alarm. Excel equations were then used to calculate the participant's total number of correct target acceptances, correct rejections, misses, and false alarms. The hit rate was calculated by dividing the number of correct target acceptances by 72 (maximum number possible). Similarly, the false alarm rate was calculated by dividing the number of false alarms by 72. These values were then input into the Excel equation for calculating *d*'. The resulting values were used for analyses.

As observed with the overall accuracy analyses, when examining differences in d' scores, there was only a main effect of test blocking, $F(1, 126) = 17.95$, $p < .001$, $\eta_p^2 = .125$. The mean *d*' score was higher in the blocked by detail condition ($M = 2.49$, $SD = .81$) than the blocked by magic show condition ($M = 1.91$, $SD = .83$). In other words, blocking by detail seemed to help participants discriminate between items that were experienced in the magic shows from foil items that were not experienced. However, no difference in *d*' values was observed when examining the effect of category type, $F(1, 126) = .00$, $p = .987$. Please refer to Table 2 for the complete list of *d*' scores and average total number of correct target acceptances, correct foil rejections, misses, and false alarms per condition.

Following the typical procedure in reaction time research, response bias was calculated to help indicate if any differences observed between groups could be potentially explained by one condition's tendency to respond "yes" or "no" more often than another condition. For the present research, response bias was measured with *criterion C*. Scores were calculated in Excel using the calculated hit rate and false alarm rate for each participant. A *criterion C* value of zero indicates no response bias, a value greater than zero indicates a "no" response bias, and a value less than zero indicates a "yes" response bias. Participants tended to have slight "no" bias regardless of blocking condition or category type. There was no significant difference in *criterion C* values when examining test blocking conditions (see Table 2 for means and standard deviations), $F(1, 126) = 3.83$, $p = .053$. There was a main effect of category type, $F(1, 126) = 8.45$, $p = .004$, $\eta_p^2 = .063$. On average, participants had a stronger "no" bias for non-taxonomic stimuli ($M = .26$, $SD = .34$) than taxonomic stimuli ($M = .14$, $SD = .38$).

Table 2: Mean Discriminability Scores Across Test Blocking Conditions and Category Type

	Test Blocking		Category Type	
	Variable Detail Category	**Magic Show Sequence**	**Taxonomic**	**Non-taxonomic**
Hits	60.48 (7.80)$_a$	54.06 (9.69)$_b$	29.38 (4.77)$_c$	27.96 (5.44)$_d$
Misses	11.52 (7.80)$_a$	17.94 (9.69)$_b$	6.69 (4.70)$_c$	8.04 (5.44)$_d$
Correct Rejections	64.69 (6.65)$_a$	61.09 (9.18)$_b$	31.00 (4.67)$_c$	31.89 (4.17)$_d$
False Alarms	7.31 (6.65)$_a$	10.91 (9.18)$_b$	5.00 (4.67)$_c$	4.11 (4.17)$_d$
d'	2.49 (.81)$_a$	1.91 (.83)$_b$	2.26 (.95)	2.26 (.98)
Criterion C	.15 (.21)	.22 (.27)	.14 (.38)$_c$	.26 (.34)$_d$

Note. Standard deviations are listed in parentheses. The total number of stimuli examined for each test blocking condition was 144. The total number of stimuli examined for each category type was 72. *d'* values close to 3 indicate strong discriminability. Positive *criterion C* values indicate a response bias towards "no." Subscripts a and b denote a main effect of test blocking condition. Subscripts c and d denote a main effect of category type.

Chapter 4.

Discussion

The goal of the current study was to implement a reaction time methodology to the field of repeated event research in order to better understand children's natural memory organization for variable details. We sought to replicate the findings of Slinger (2010) and expand upon prior research by examining differences between taxonomic and non-taxonomic detail categories. Overall, the findings in support of hypothesis one and partial support of hypothesis two indicate that children's memory for details that vary predictably across instances of a repeated event quickly reorganize from an instance-based organization into a categorical organization. Therefore, this study offers additional support for a script theory framework for children's memory organization.

The field of experimental psychology has a long history of using reaction times to infer human's memory organization (Kahana & Loftus, 1999; Luce, 1986). It is well understood that cognitive processes are highly structured. Incoming information can take different pathways, which can be measured in response times. Therefore, it has been speculated that examining patterns of response times under differing conditions can offer insight into the way memory is naturally organized (Jastrow, 1890, as cited in Luce, 1986).

Replicating the findings of Slinger (2010), participants responded faster to stimuli when they were presented by detail categories than presented by the general structure of the magic shows. In addition, the current study found children responded faster to stimuli from pre-existing taxonomic categories than stimuli from non-taxonomic categories. This finding is consistent with prior research by Johns (1985) and Neely and colleagues (1983). In both studies, participants responded faster when stimuli from the same taxonomic category were chunked sequentially than when they were separated by unrelated stimuli. According to script theory, repeated exposure to an event leads to the creation of a generalized script of details that typically occur across instances (i.e., script consistent details). With each new experience, novel details that are script consistent will be readily incorporated into the person's script memory. On the other hand, novel details that are script inconsistent are less likely to be incorporated into the person's script memory. Following this logic, taxonomic items would be more easily integrated into children's memory script for the magic shows than non-taxonomic items and would be more quickly recognized during the memory test.

Taken together, the pattern of reaction time results follows a script theory framework of organization. If memory were organized according to fuzzy-trace theory, then the quickest pathway to process information should have been through the verbatim trace. If that were the case, then faster reaction times would have been seen in the magic show condition versus the detail condition and no differences would have been observed between the two category types. However, this was not the reaction time pattern that was observed. Instead, the pattern in our data suggests that during the brief three-hour delay period, memory structures rapidly reorganized to be categorical in nature. As such, children were faster when stimuli were blocked by detail category and when stimuli were from taxonomic categories. A reasonable interpretation is that this presentation of stimuli matched their new memory organization structure.

Until recently, accuracy in the repeated event literature has traditionally been defined in a narrow sense. When a narrow definition of accuracy is used, a response is coded as correct if the participant reports an experienced variable detail option and ties that option to the correct target instance (e.g., Powell & Roberts, 2002). Importantly, when accuracy is assessed in this manner, it often underestimates the memory capabilities of children who have experienced a repeated event versus children who have experienced a single event (Woiwod et al., 2019). Therefore, some researchers have started using broader definitions of accuracy, in which a response is coded as correct if the reported variable option was experienced in any of the instances of the repeated event (e.g., Connolly et al., 2008; Price et al., 2016). Woiwod and colleagues (2019) conducted a meta-analysis in which they analyzed 31 repeated event experiments involving 3,099 children. Importantly, they found that when accuracy is defined broadly, children who experience a repeated event are just as accurate as children who experience a single event.

In the present study, we are unable to examine accuracy in a narrow sense because children were not asked to assign stimuli to specific magic shows. The study assessed recognition memory only. However, our results do align with prior research that implemented a broad definition of accuracy because participants were able to recognize experienced stimuli with high accuracy regardless of their experimental condition. These findings add further evidence that children are strong at identifying what happens during the repeated event as a whole, even though they may have trouble attributing the detail to the correct instance. Additionally, the fact that overall accuracy was highest when stimuli were blocked by variable detail, as also seen by Slinger (2010), offers further evidence that children's memory for the magic shows quickly reorganized categorically rather than by instance.

Contrary to our hypotheses, no differences in overall accuracy and discriminability were observed between category types. Looking at the breakdown of accuracy for targets and foils separately and response bias scores may offer some explanation for these null results. Although similar in overall accuracy, children were slightly more accurate ("yes" is correct and "no" is incorrect) for target responses when stimuli were from taxonomic categories (proportion of correct responses was .81) than from non-taxonomic categories (proportion of correct responses was .78). On the other hand, children were slightly more accurate ("no" is correct and "yes" is incorrect) for foil responses when stimuli were from non-taxonomic categories (proportion of correct responses was .89) than taxonomic categories (proportion of correct responses was .86). Of particular interest is the non-taxonomic stimuli because the difference between the proportion of correct responses for targets and foils was larger (.11) than the difference seen with the taxonomic stimuli (.05). This begs the question: How were children so good at recognizing non-taxonomic foils, but struggled so much with recognizing non-taxonomic experienced items? It is speculated that the answer partially lies within response bias.

Results indicated that participants tended to have a stronger nay-saying bias for non-taxonomic items than taxonomic items. A tendency towards "no" responses would have increased the number of correct rejections and decreased the number of hits. This in turn would have positively impacted accuracy for foils, but negatively impacted accuracy for targets, which may explain why we see a bigger gap between accuracy for foils and targets with the non-taxonomic stimuli than the taxonomic stimuli (difference of .11 and .05, respectively). Having a response bias may indicate that children were answering according to a strategy rather than from their memory (Gee & Pipe, 1995). However, it can be argued that both memory and strategy influenced the current results. If memory is organized according to script theory, then we would expect it to be more difficult to recall experienced details from non-taxonomic categories than taxonomic categories because the non-taxonomic stimuli are minimally related. Due to the limited connection between non-taxonomic stimuli, these details are less likely to be incorporated together into the same category of the general script. When faced with greater question difficulty it appears children's threshold to give a "yes" response becomes more conservative, thus leading to more "no" responses. Similar strategies have been observed in prior work on children's decision making(e.g., Fritzley et al., 2013; Fritzley & Lee, 2003).

Before delving into prior research on children's decision making, it is first important to review how Signal Detection Theory, discriminability, and response criterions are tied into accuracy because these concepts are relevant in the discussion of response bias and strategies in children's decision making. For one to be considered accurate, one must be able to discriminate between target items and non-target items. Signal Detection Theory describes the decision-making process by which individuals can detect the presence of a signal in noisy environments (Green & Swets, 1966). To examine this phenomenon, researchers will often test recognition memory by asking participants to determine whether or not a presented item is new or old. Signal Detection Theory posits two independent processes that drive decision-making performance: discriminability and response criterion. Discriminability is a person's ability to correctly identify the presence of a signal among noise and ability to reject noise when a signal is absent (Meissner et al., 2005). In the context of the present study, high discriminability is linked with the ability to consistently differentiate between test items that were experienced in the magic shows (i.e., signal) and test items that were novel (i.e., noise). A "yes" response can either result in a hit (i.e., correctly identifying the item was experienced) or a false alarm (i.e., erroneously labeling the item as experienced when it was not). A "no" response can either result in a correct rejection (i.e., correctly identifying the item was new and not experienced) or a miss (i.e., erroneously identifying the item as not experienced when it was presented during the event). The response criterion is the threshold that must be exceeded for someone to report the presence of a signal (Meissner et al., 2005). Importantly, criterion thresholds vary across individuals and circumstances. Some individuals may have more conservative response criteria (more evidence is needed to make a "yes" response), while some may have more liberal response criteria (less evidence is needed to make a “yes” response; Wixted & Mickes, 2014).

In the present study, we speculate that children’s response criterion is more conservative when faced with conditions that are incongruent with their memory organization. As mentioned earlier, it was observed that children had more of a nay-saying bias towards non-taxonomic stimuli than taxonomic stimuli. Although not significantly different, there also was a trend for children to have more of a nay-saying bias when stimuli were blocked by magic show than by detail. If memory rapidly reorganizes categorically, as posited by script theory, then it would make sense for these two conditions to be hardest for children to discriminate between targets and foils. Related research on children’s responses to yes-no questions has shown that when faced with unfamiliar and incomprehensible stimuli, children switch from having a “yes” bias to a “no” bias (Fritzley et al., 2013; Fritzley & Lee, 2003; Okanda & Itakura, 2011). For example, Fritzley and colleagues (2013) had children between the ages of 2 and 5 answer closed-ended questions regarding comprehensible actions (e.g., rolling a ball) and incomprehensible actions (e.g., kicking a toothbrush). Interestingly, a nay-saying bias was only observed for older children when they were asked incomprehensible questions. Thus, when faced with difficult questioning and uncertainty, older children appear more likely to shift their response criterion to be more conservative.

In sum, the current study successfully replicated the findings of Slinger (2010) when examining the effects of test blocking. Although, the impact of category type was only partially supported, the lack of difference in overall accuracy can be attributed to a nay-saying bias towards non-taxonomic stimuli. Children appear to experience increased challenges when stimuli are script-inconsistent and are not presented in a manner that is congruent with their natural memory organization. Taken altogether, this study leans towards a script theory than fuzzy-trace theory framework of children’s repeated event memory.

4.1. Implications

The current study has theoretical, methodological, and practical implications. By replicating the findings of Slinger (2010), the present research adds to the growing body of evidence that script theory predictions best explain children’s memory for repeated events. Our study does not dispute that instance-based memories can be accessible immediately after presentation of stimuli. However, these data suggest that episodic details quickly detach from the specific instance and reorganize to a general event script with categorical organization of variable details. If memory were organized according to fuzzy-trace theory, the delay period was brief enough that verbatim traces should have still been intact. Therefore, children should have been better able to recognize instance-based details when cued in a manner consistent with the magic show structure than when they were cued by category. However, the finding that children were faster and more accurate when test items were blocked by variable details than by magic show casts doubt on this framework. Given the repeated nature of the experienced event, one could argue that the gist trace would be stronger than any of the individual verbatim traces because the same gist trace is activated at each exposure. However, as mentioned by Slinger (2010), overreliance on gist traces also cannot explain the results from both studies because children were not substantially prone to false alarm errors (M = 7.23, SD = 5.18 out of a possible 72 per child for Slinger (2010) and M = 9.11, SD = 8.15 out of a possible 72 per child for the current experiment). Therefore, script theory is most consistent with the pattern of results from Slinger (2010) and the present study.

The current study also contributes to the literature by demonstrating the usefulness of applying a reaction time paradigm to examine children's natural memory organization for repeated events. As mentioned earlier, reaction time paradigms have long been used in experimental research (Luce, 1986), but application in this context has been underutilized. To our knowledge, in the 13 years that have passed since Slinger's (2010) experiment, this is the only other study to apply a reaction time paradigm to examine children's recognition memory for a repeated event. The traditional repeated event research paradigm consists of presentation of the repeated event, a delay period, and a memory interview with free and cued recall questions to gather details related to a target instance (see work by Brubacher, Connolly, Powell, Price, and Roberts for examples). However, the present methodology offers researchers an alternative way to answer important questions related to children's memory. Our chances of understanding this complex topic increase if we "attack [it] with an arsenal of methods that have nonoverlapping weaknesses in addition to their complementary strengths" (Brewer & Hunter, 1989, p. 17).

Lastly, the current study has practical implications. As discussed in detail in the introduction, children who allege being victimized sexually will often report that the abuse was experienced on more than once occasion (Connolly et al., 2015). Therefore, the current research is applicable to forensic contexts. Forensic interview protocols (e.g., NICHD) ask questions in a way to try and elicit instance-specific information (Orbach & Lamb, 2007). However, while the current study's findings are consistent with prior research (e.g., Woiwod et al., 2019) in which children are quite accurate in reporting details that were experienced in any instance (accuracy defined broadly), research consistently shows that children struggle to identify the specific instance in which a detail occurred (accuracy defined narrowly). Further, our study suggests that when information is blocked in a manner that is inconsistent with natural memory organization (i.e., by event), children will exhibit a nay-saying bias. Whether intentional or unintentional, forensic interviewers or attorneys may ask children difficult or confusing questions about the alleged sexual activity. An erroneous "no" response can have devastating consequences in a forensic setting, such as a case getting dismissed or resulting in an acquittal. Therefore, it is recommended that adults be mindful in their phrasing of questions to children in forensic contexts. Faulty interviewing techniques can lead to contamination of testimony (Ceci & Bruck , 1995). Therefore, interviewers should utilize open-ended questioning and limit option-posing and suggestive questioning techniques (Lamb et al., 2007). Importantly, questions should be posed in a manner consistent with children's memory organization. For example, some researchers (e.g., Brubacher et al., 2014; Connolly & Gordon, 2014) have recommended forensic interviewers first ask general prompts about what typically happens across all instances prior to asking episodic prompts.

While it is understood that some level of episodic information is needed in legal contexts to balance the rights of the defendants, it should be noted that it may be the case that children are being asked to produce evidence that does not align with their memory capabilities. As discussed, script theory posits episodic memories are typically a mixture of instance-specific details and details from the general script. Following this logic, forensic interviewers, legal professionals, and triers of fact should anticipate children will report inconsistencies when asked to recall episodic memories of repeated CSA. Importantly, the current study and prior work (e.g., Slinger, 2010; Woiwod et al., 2019) have shown external intrusions (i.e., false alarms, reporting details that never occurred) are rare in these cases. Accuracy errors and inconsistencies are more commonly due to internal intrusions (i.e., misattributing an experienced detail to the wrong source; Price et al., 2016). Therefore, until the memory capabilities of children are better understood, legal professionals and tiers of facts should be more lenient towards inconsistencies and should refrain from judging children as less credible if inconsistencies in episodic recall arise.

Considering the memory limitations of children who have experienced repeated CSA, some jurisdictions in Australia and the United States have moved forward with implementing continuous abuse statutes (see Woiwod & Connolly, 2017 for review). The intended purpose of these statutes was to alleviate the stringent particularization requirements needed for discrete charges of repeated CSA. The goal of continuous CSA statutes was to establish a general pattern of abuse, rather than only focus on the discrete instances (California State Assembly, 1989). These statutes do not come without criticism, but the rationale for such statutes is supported by the existing literature on children's memory for repeated events (Woiwod & Connolly, 2017). More discussion and research on continuous abuse statutes is warranted to ensure that they are crafted in such a way that balances the rights of the accused and the memory capabilities of child complainants.

4.2. Limitations and Future Research

The study was not without its limitations. It can be argued that these data are not generalizable to a forensic setting due to the innocuous nature of the chosen repeated event. In forensic interviews and legal proceedings, victims of CSA are asked about upsetting and emotionally arousing events. Due to obvious ethical considerations, researchers are limited in the types of repeated event scenarios child participants can experience. However, it should be noted that experiments that have attempted a repeated event scenario with moderate levels of arousal (e.g., swimming lessons for anxious children) have found no effect of stress on children's memory for instances of the repeated event (Price & Connolly, 2007).

Further, it could be argued that experiencing all instances of the repeated event in a single session in both this study and Slinger (2010) impacted the encoding of individual instances. Rather than encoding each magic show as its own instance, the short event spacing could have promoted children to encode details in massed clusters (Price et al., 2006). Consequently, it could be interpreted that our findings align with script theory due to the close presentation of stimuli and not due to children's natural memory organization. It should be noted that each magic show was separated by educational videos. While these videos served as attention checks, they also functioned to aid in separation between instances. Moving forward, researchers are encouraged to extend the current study to manipulate event spacing. This is especially important given that in a forensic context, repeated experiences of child maltreatment can occur with long delays between instances of the alleged abuse or neglect.

The repeated event experienced in Slinger (2010) was presented in person to children and the memory test was conducted in a laboratory setting under supervision of a researcher. Due to the COVID-19 global pandemic, the present study had to be modified into an online format. One potential concern of conducting this study online was that the researchers could not monitor and minimize distractions, which could negatively impact the results of the memory test. To measure inattention during the magic show video presentation, each magic show was separated by an educational video and a corresponding attention check question. On average, the sample answered 4.79 out of 5 attention questions correctly. As reported above, accuracy and discriminability scores were respectable across the entire sample. Therefore, the attention checks and repeated instructions to pay attention appeared to address participant inattention. Nonetheless, researchers are encouraged to replicate the current study in an in-person format to see if a similar pattern of results is observed when children are in a supervised setting.

Given the nature of this study's design, it is important to discuss reaction time outliers. Reaction times can be flagged as outliers for several reasons, such as quickly pressing a response key as a guess, excessive lag time due to inability to make a decision, or lacking attention to the task at hand (Ratcliff, 1993). In a controlled lab setting, Slinger (2010) reported that each participant had approximately 10 responses flagged as outliers. Because the current study was conducted online, and children completed the memory test without researcher supervision, there was potential concern for more reaction time outliers. However, out of the 144 responses, an average of only 6 reaction time outliers were replaced per child. This finding suggests that outliers are not a contributing factor to the reaction time results.

Another concern that is often voiced in reaction time research is that there will be a speed-accuracy trade-off. Ideally, participants will respond to the presented stimuli in a fast, yet accurate manner. However, a trade-off can occur if participants are highly accurate but have an excessive lag between responses or have quick response times but have poor accuracy (Chittika et al., 2009). The current study does not appear to have experienced such a trade-off. As was observed in Slinger (2010), children were quite accurate in their responses regardless of the condition. In fact, the condition with the lowest overall accuracy, the blocked by magic show condition, still had an overall proportion of correct responses of .80.

This study was also limited by sample size due to attrition. Although adequately powered to examine the main effects of the analyses, the study was underpowered to comment on interactions. Should other researchers wish to replicate the current design, it is recommended that an alternative delay module be implemented in the Gorilla experimental builder. The particular delay module used in the current design would not allow participants to return to complete the second half of the study if an email address was not provided accurately on the screen before exiting out of part 1 of the experiment. As a result, we experienced high levels of participant attrition between part 1 and 2 of the experiment. Therefore, it is advised that any replications use the Gorilla delay module that requires participants to sign in with a login to access the second half of the experiment. If future studies can obtain larger sample sizes, review of any interactions could offer additional insight into the explanatory strength of script theory versus fuzzy-trace theory. For example, if memory is organized following the framework of script theory, then theoretically it would be most difficult for children to respond to non-taxonomic stimuli that are blocked by magic show. Future work is needed to tease apart the nuances in these relationships.

The topic of taxonomic versus non-taxonomic categories is rarely discussed in repeated event literature. Selection of category type is not consistent across research studies. For example, Connolly and Gordon (2014) acknowledged that the variable options for their 16 detail categories were all taxonomic in nature. However, it was pointed out that Brubacher and colleagues (2012) did not have all taxonomic categories in their study (e.g., Sit on: cardboard, rubber mat, garbage bag, white sheet, newspaper). The findings in the present study offer partial support for differing memory organization of taxonomic and non-taxonomic categories since children responded faster to taxonomic stimuli than non-taxonomic stimuli. Inconsistencies in category types across repeated event scenarios may be contributing in part to the mixed findings between research labs across the years. Future research should take into account the relatedness of their stimuli and consider how differences in category type may impact their findings.

Further, it is unclear the extent of the impact category type has in a forensic context. There are some taxonomic details that will be relevant in a forensic context, such as the time of day or the room in the house where the abuse occurred. However, it is also important to consider at what point non-taxonomic details become taxonomic due to repetition over the course of the repeated CSA. For instance, threats may not typically be a pre-existing taxonomic category for children. However, over the course of the repeated abuse, if the perpetrator repeatedly and variously threatens the child (e.g., taken away from family, go to jail, be physically injured if disclose abuse), at some point the child may create a taxonomic category for threats within their event script. More research is needed on the differences in memory organization of taxonomic and non-taxonomic categories so that forensic interviewers can be informed on best practices to accurately obtain information from child complainants.

Finally, future research should widen the scope of participant age groups so that age differences can be examined. Much of the research on children's memory for repeated events has been conducted on children between the ages of 4 and 8 (e.g., Brubacher et al., 2012; Coburn et al., 2021; Powell & Thompson, 1997; Price & Connolly, 2004). However, adolescents are a particularly vulnerable population, with rates of sexual abuse highest amongst those aged 12 to 17 (Cotter & Beaupré, 2014). Therefore, replication of the current study with adolescents is crucial. Similarly, the current research should be extended to adults. Adults are not immune to repeated events within a forensic context. For example, adults experience repeated instances of stalking (Smith et al., 2022), intimate partner violence, and sexual violence (Australian Institute of Health and Welfare, 2018). Few studies have examined adults' repeated-event memory (Dilevski et al., 2021), so it is unclear if a similar pattern of results would be with older age groups.

Chapter 5.

Conclusion

The aim of this study was to better understand children's natural memory organization for a repeated event. To do this, we strayed away from conventional methodologies and instead applied a reaction time paradigm to examine how children organized variable details presented in magic show videos. The findings of Slinger (2010) were replicated, with children being faster, more accurate, and having higher discriminability when test items were blocked by detail than magic show. Findings were mixed regarding category type. Children responded faster to taxonomic stimuli than non-taxonomic stimuli, but no other differences were observed. This study, in combination with Slinger (2010), provides strong explanatory evidence for script theory framework of memory organization. We conclude that children's memory for variables details in a repeated event rapidly reorganizes from instances to a general event script with categorical organization of variable details. The effect of this rapid reorganization needs to be considered in future theoretical, experimental, and forensic applications.

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Appendix A.

Counterbalancing of Magic Show Orders and Variable Details

Table A1 Partially Counterbalanced Variable Details and Variable Options for Video Orders 1 and 2

	Variable Option					
Variable Detail	**A**	**B**	**C**	**D**	**E**	**F**
Admission Ticket	Pebble	Sponge	Pom Pom	Wood	Seashell	Paper Clip
Item Removed	Sunglasses	Ring	Backpack	Shoes	Gloves	Bowtie
Warm-up Exercise	Stretching	Running in Place	Jumping Jacks	Air Punches	Push Ups	Hopping on One Leg
Magic Juice	Cherry (Red)	Lemon (Yellow)	Grape (Purple)	Mango (Orange)	Watermelon (Pink)	Apple (Dark Green)
Hat	Straw Hat	Police Hat	Cowboy Hat	Chef Hat	Construction Hat	Fireman Hat
Special Item	Handkerchief	Coin	Wand	Fan	Spoon	Diamond
Sticker Body Part	Leg	Hand	Cheek	Shoulder	Forehead	Nose
Stuffed Animal	Elephant	Tiger	Bear	Horse	Fish	Gorilla
Sound Effect	Drum Roll	Ocean Waves	Police Siren	Cheering	Bouncing Basketball	Howl
Magic Words	Presto Chango	Abra Cadabra	Shazam	Hocus Pocus	Bippity Boppity Boo	Wingardium Leviosa
Secret	Did Bad on Test	Missed Class	Lost keys	Ripped Jeans	Scratched Car	Broke a Bowl
Goodbye	Wave	Bow	Spirit Fingers	Peace Sign	Salute	Handshake

Note. The six variable detail categories that are bolded represent the non-taxonomic categories. The six magic shows in video order 1 presented variable details options in the following sequence: A, B, C, D, E, F. The six magic shows in video order 2 presented variable detail options in the following sequence: B, A, E, F, D, C.

Table A2 Partially Counterbalanced Variable Details and Variable Options for Video Orders 3 and 4

	Variable Option					
Variable Detail	**A**	**B**	**C**	**D**	**E**	**F**
Admission Ticket	Leaf	Sandpaper	Fur	Ribbon	Sequins	Flower
Item Removed	Scarf	Watch	Sweater	Headband	Cape	Belt
Warm-up Exercise	Sit-ups	Squats	Arm Circles	Plank	High Knees	Lunges
Magic Juice	Blueberry (Blue)	Coconut (White)	Fig (Black)	Crystal (Clear)	Lime (Light Green)	Chocolate (Brown)
Hat	Top Hat	Sun Hat	Tuque	Baseball Hat	Sailor Hat	Bicycle Helmet
Special Item	Magic Dust	Bracelet	Card	Cup	Feather	Crayon
Sticker Body Part	Foot	Neck	Arm	Tummy	Back	Ear
Stuffed Animal	Cat	Cow	Snake	Whale	Bird	Dog
Sound Effect	Piano	Rain	Countdown	Knocking on Door	Rattle	Ticking Clock
Magic Words	Mumbo Jumbo	Open Sesame	Expecto Patronum	Voila	Alakazam	Eureka
Secret	Forgot Homework	Lost Wallet	Ate Ice Cream	Tripped Walking	Broke Phone	Fight with Friend
Goodbye	Thumbs up	Clap	Spin Around	Blow a Kiss	Curtsey	Air Hug

Note. The six variable detail categories that are bolded represent the non-taxonomic categories. The six magic shows in video order 3 presented variable details options in the following sequence: A, B, C, D, E, F. The six magic shows in video order 2 presented variable detail options in the following sequence: B, A, E, F, D, C.

Appendix B.

Example Magic Show Script

Hello boys and girls, my name is Magnificent Maddie and I'm going to teach you the disappearing ball magic trick today. Before I show you the magic trick, I must first complete my preparation routine. I have the same routine for all of my magic shows. First, I will show you the magic show admission ticket. The admission ticket for this show has a pebble attached to it. Isn't that a cool pebble? So now that I've showed you the admission ticket with the pebble attached to it, I am going to prepare for the magic show by removing my sunglasses. Oh, that feels so much better now that I removed my sunglasses! So now that my sunglasses are off, it's time for a warm up exercise. Magicians have to warm up before their shows and you are going to be a magician too, so stand up and follow along as I do my exercises. For this show, we are going to warm up together by stretching. Get ready to stretch for 5 seconds. Okay let's start. 1 2 3 4 5. All done! Wow stretching always make me so tired and thirsty. It's very important that magicians stay hydrated. I'm going to take a drink of my red cherry juice. Yummmm. Do you like red cherry juice? I love red cherry juice. Okay, now it's time to get dressed for the magic show. Magicians always wear cool costumes! For my costume, I like to wear a magic hat and for this trick I'm going to wear my straw hat. Where did I put my straw hat? Oh, here it is! Time to put it on. Now that I'm wearing my magic straw hat, I also need to find my special magic item. My special item for this trick is a handkerchief. I'm going to keep my special handkerchief close to me. The special handkerchief will give me the magical powers to perform the disappearing ball trick. But we still have a few more steps in the routine before we can perform the magic trick. Next, I'm going to place a sticker on a part of my body for good luck. I'm going to put this sticker on my leg. Can you all point to your leg? Great! Now that I put my lucky sticker on my leg, I want to introduce you to my friend. Elephant is my assistant and she is going to help me with my magic trick. Elephant loves magic and knows all of my tricks. If I ever get nervous or forgetful, Elephant is always there to help me. In fact, my assistant just reminded me that I need to listen to my special sound to help me concentrate and calm down before performing the trick. For this show, we are going to listen to a drum roll. Wow, I love the sound a drum roll makes! Now that I have listened to the drum roll, it is time to teach you the magic words to perform our trick. Saying the magic words is one of the most important parts of a magic trick, so it's important to remember them. The magic words we are going to say for this trick are presto chango! Spells are more powerful when we all say them aloud together, so can you say presto change with me? Let's practice - on three say the magic words 1 2 3 Presto chango! Awesome I'm ready to perform the disappearing ball trick now. Once I'm done performing the trick, I will teach you how to do it so you can be a magician too! Alright, so for this trick I am going to make this ball move from my pocket into the vase and back into my pocket. So if you look in the vase right now, it's empty. I'm going to put the lid back on the vase. Now I'm going to move the ball from my pocket into the vase. In order to do this, we need to say the magic words – will you say them with me? Presto chango! There we go, it's in the vase. Now I am going to move the ball back into my pocket. Wait for it…here it is! Isn't that a cool magic trick? Now I will teach you how to do it. It's really easy. So the secret is that there is actually a fake ball that looks like part of the lid for the vase and it fits inside the lid like this. So what you do is you take out the real ball from your vase and put it into your pocket and it stays in your pocket the entire time. Then you put your lid with your secret ball back on top of the vase. Say your magic words and when you lift up the lid make sure you only lift up the top part of the vase, revealing your fake ball in there. Then you put the lid back on and say you are going to move the ball back into your pocket. And this time when you lift up the lid of the vase, lift up both pieces, leaving the vase empty. Then you reach into your pocket, reveal the ball, and amaze the audience. Pretty cool, right? You're going to be a great magician too. Now before I end this show I really need to get something off my chest. Can you keep a secret for me? My secret is that I didn't do very well on a test. It's not like me to not do very well on a test so please don't tell anyone I didn't do well on a test. I'm going to study really hard, so I do better on my next one. Okay, it's time to end the show with a wave. Can you wave? Thank you for waving! Goodbye everyone!

Appendix C.

Verbal Instructions for the Memory Test

Do you guys remember the magic shows you saw this morning? Yeah? Okay good. You are going to sit at your computer and answer some questions about those magic shows.

You're going to be shown a bunch of different words and pictures on the screen. Each picture is going to describe the word that is on the screen with it. Some words and pictures will be old, and are from the magic shows you saw, and others will be new and weren't in the magic shows. When you think about the magic shows, think about all of them! When a word and its picture come on the screen, I want you to press the "A" key whenever you think that the word/picture is old and was in any of the magic shows. So "A" means YES you do remember seeing the word/picture in the magic shows. If the word/picture on the screen is new and wasn't in the any of the magic shows, I want you to press the "L" key. So "L" means NO you do not remember experiencing the item in the magic shows.

So, let's practice. What do you press when you see something from the shows comes onto the screen? That's right, A! And what do you press when you see something that wasn't from the shows comes onto the screen? That's right, L! Awesome! You are so smart! At first, on your screen you will see yes's and no's appearing on the screen, and all I want you to do is practice what we just talked about. Hitting "A" when you see yes, and "L" when you see no. And, I want you to press the key as fast as you can but try really hard not to make mistakes. If you hit the correct key, a green check mark will appear on your screen. If you accidently hit the wrong key, a red X will appear on your screen and you will need to press the other key in order to continue.

Completes Practice Session

Okay, now for the fun part! A bunch of words and pictures are going to come onto your screen one at a time, and I want you to do exactly what we just talked about. I want you to press "A" when you think the word/picture is old and from the magic shows—that means "yes" I did see it, and the "L" button when you think the word/picture is new and wasn’t in the magic shows—that means “no”, I did not see it. While it is important to answer as quickly as you can, I also want you to get as many right as you can. So try really hard to actually press the buttons based on what you remember from the magic shows. And try not to get distracted! You may find this a bit hard, but please do your best. Good luck! Press the space bar when you are ready to begin.

Completes Final Memory Test

Appendix D.

Examples of Memory Tests Blocked by Condition

Table D1 Examples of Memory Tests Blocked by General Magic Show Sequence

Participant Example #1	Stimuli Description	Participant Example #2	Stimuli Description
golf ball	Buffer	golf ball	Buffer
Candle	Buffer	candle	Buffer
Pumpkin	Buffer	pumpkin	Buffer
Flower	Admission Ticket	sequins	Admission Ticket
cape	Remove Item	Scarf	Remove Item
jumping jacks	Warm-up Exercise	hopping on one leg	Warm-up Exercise
dark green apple juice	Magic Juice	yellow lemon juice	Magic Juice
bicycle helmet	Hat	police hat	Hat
wand	Special Item	magic dust	Special Item
foot	Sticker Body Part	Leg	Sticker Body Part
fish	Stuffed Animal	Cow	Stuffed Animal
police siren	Sound Effect	Rain	Sound Effect
alakazam	Magic Word	hocus pocus	Magic Word
forgot homework	Secret	lost keys	Secret
wave	Goodbye	Bow	Goodbye
seashell	Admission Ticket	paperclip	Admission Ticket
backpack	Remove Item	sunglasses	Remove Item
air punches	Warm-up Exercise	air punches	Warm-up Exercise
chocolate (brown)	Magic Juice	lime (light green)	Magic Juice
cowboy hat	Hat	top hat	Hat
magic dust	Special Item	Coin	Special Item
forehead	Sticker Body Part	Ear	Sticker Body Part
bird	Stuffed Animal	Bear	Stuffed Animal
bouncing basketball	Sound Effect	bouncing basketball	Sound Effect
eureka	Magic Word	shazam	Magic Word
scratched car	Secret	broke a bowl	Secret
bow	Goodbye	spin around	Goodbye
sequins	Admission Ticket	flower	Admission Ticket
shoes	Remove Item	sweater	Remove Item
hopping on one leg	Warm-up Exercise	lunges	Warm-up Exercise
purple grape juice	Magic Juice	dark green apple juice	Magic Juice
straw hat	Hat	construction hat	Hat
coin	Special Item	crayon	Special Item
leg	Sticker Body Part	Neck	Sticker Body Part
snake	Stuffed Animal	Bird	Stuffed Animal

Participant Example #1	Stimuli Description	Participant Example #2	Stimuli Description
piano	Sound Effect	Rattle	Sound Effect
abra cadabra	Magic Word	mumbo jumbo	Magic Word
fight with best friend	Secret	slept in and missed class	Secret
peace sign	Goodbye	curtsey	Goodbye
pebble	Admission Ticket	Leaf	Admission Ticket
ring	Remove Item	bowtie	Remove Item
running in place	Warm-up Exercise	high knees	Warm-up Exercise
crystal (clear)	Magic Juice	black fig juice	Magic Juice
police hat	Hat	straw hat	Hat
handkerchief	Special Item	Fan	Special Item
nose	Sticker Body Part	tummy	Sticker Body Part
tiger	Stuffed Animal	Cat	Stuffed Animal
howl	Sound Effect	cheering	Sound Effect
mumbo jumbo	Magic Word	alakazam	Magic Word
broke a bowl	Secret	did bad on a test	Secret
thumbs up	Goodbye	Wave	Goodbye
wood	Admission Ticket	sponge	Admission Ticket
gloves	Remove Item	shoes	Remove Item
plank	Warm-up Exercise	Plank	Warm-up Exercise
orange mango juice	Magic Juice	chocolate (brown)	Magic Juice
sailor hat	Hat	baseball hat	Hat
crayon	Special Item	handkerchief	Special Item
cheek	Sticker Body Part	Hand	Sticker Body Part
whale	Stuffed Animal	snake	Stuffed Animal
ocean waves	Sound Effect	countdown	Sound Effect
voila	Magic Word	abra cadabra	Magic Word
did bad on a test	Secret	fight with best friend	Secret
curtsey	Goodbye	blow a kiss	Goodbye
leaf	Admission Ticket	sandpaper	Admission Ticket
scarf	Remove Item	Belt	Remove Item
squats	Warm-up Exercise	sit-ups	Warm-up Exercise
blue blueberry juice	Magic Juice	white coconut juice	Magic Juice
fireman hat	Hat	sailor hat	Hat
spoon	Special Item	bracelet	Special Item
neck	Sticker Body Part	Back	Sticker Body Part
elephant	Stuffed Animal	gorilla	Stuffed Animal
rain	Sound Effect	ocean waves	Sound Effect
presto chango	Magic Word	wingardium leviosa	Magic Word
tripped walking to show	Secret	ripped favorite jeans	Secret
salute	Goodbye	air hug	Goodbye
paperclip	Admission Ticket	pom pom	Admission Ticket
headband	Remove Item	gloves	Remove Item

Participant Example #1	Stimuli Description	Participant Example #2	Stimuli Description
lunges	Warm-up Exercise	stretching	Warm-up Exercise
yellow lemon juice	Magic Juice	red cherry juice	Magic Juice
tuque	Hat	chef hat	Hat
feather	Special Item	Cup	Special Item
tummy	Sticker Body Part	forehead	Sticker Body Part
horse	Stuffed Animal	Dog	Stuffed Animal
countdown	Sound Effect	knocking on door	Sound Effect
bippity boppity boo	Magic Word	open sesame	Magic Word
broke phone screen	Secret	ate tub of ice cream	Secret
blow a kiss	Goodbye	Clap	Goodbye
sandpaper	Admission Ticket	pebble	Admission Ticket
watch	Remove Item	headband	Remove Item
stretching	Warm-up Exercise	running in place	Warm-up Exercise
red cherry juice	Magic Juice	crystal (clear)	Magic Juice
chef hat	Hat	sun hat	Hat
fan	Special Item	feather	Special Item
back	Sticker Body Part	shoulder	Sticker Body Part
dog	Stuffed Animal	horse	Stuffed Animal
knocking on door	Sound Effect	Howl	Sound Effect
wingardium leviosa	Magic Word	presto chango	Magic Word
ate tub of ice cream	Secret	scratched car	Secret
handshake	Goodbye	spirit fingers	Goodbye
ribbon	Admission Ticket	Fur	Admission Ticket
belt	Remove Item	Ring	Remove Item
push-ups	Warm-up Exercise	squats	Warm-up Exercise
black fig juice	Magic Juice	purple grape juice	Magic Juice
baseball hat	Hat	cowboy hat	Hat
diamond	Special Item	diamond	Special Item
ear	Sticker Body Part	cheek	Sticker Body Part
cat	Stuffed Animal	whale	Stuffed Animal
rattle	Sound Effect	police siren	Sound Effect
expecto patronum	Magic Word	eureka	Magic Word
lost keys	Secret	broke phone screen	Secret
spin around	Goodbye	salute	Goodbye
sponge	Admission Ticket	ribbon	Admission Ticket
bowtie	Remove Item	Cape	Remove Item
sit-ups	Warm-up Exercise	arm circles	Warm-up Exercise
lime (light green)	Magic Juice	blue blueberry juice	Magic Juice
top hat	Hat	bicycle helmet	Hat
bracelet	Special Item	spoon	Special Item
arm circles	Sticker Body Part	Foot	Sticker Body Part
cow	Stuffed Animal	Tiger	Stuffed Animal

Participant Example #1	Stimuli Description	Participant Example #2	Stimuli Description
cheering	Sound Effect	ticking clock	Sound Effect
shazam	Magic Word	bippity boppity boo	Magic Word
slept in and missed class	Secret	tripped walking to show	Secret
air hug	Goodbye	peace sign	Goodbye
fur	Admission Ticket	seashell	Admission Ticket
sunglasses	Remove Item	backpack	Remove Item
high knees	Warm-up Exercise	push-ups	Warm-up Exercise
white coconut juice	Magic Juice	pink watermelon juice	Magic Juice
sun hat	Hat	tuque	Hat
cup	Special Item	Wand	Special Item
hand	Sticker Body Part	arm circles	Sticker Body Part
bear	Stuffed Animal	elephant	Stuffed Animal
ticking clock	Sound Effect	drum roll	Sound Effect
hocus pocus	Magic Word	expecto patronum	Magic Word
lost wallet	Secret	lost wallet	Secret
spirit fingers	Goodbye	thumbs up	Goodbye
pom pom	Admission Ticket	Wood	Admission Ticket
sweater	Remove Item	watch	Remove Item
arm circles	Warm-up Exercise	jumping jacks	Warm-up Exercise
pink watermelon juice	Magic Juice	orange mango juice	Magic Juice
construction hat	Hat	fireman hat	Hat
card	Special Item	Card	Special Item
shoulder	Sticker Body Part	Nose	Sticker Body Part
gorilla	Stuffed Animal	fish	Stuffed Animal
drum roll	Sound Effect	piano	Sound Effect
open sesame	Magic Word	voila	Magic Word
ripped favorite jeans	Secret	forgot homework	Secret
clap	Goodbye	handshake	Goodbye
pinecone	Buffer	pinecone	Buffer
book	Buffer	book	Buffer
monkey	Buffer	monkey	Buffer

Note. In the actual test, one related image will accompany each word/phrase that appears on the screen in order to assist in the child's comprehension the word/phrase. As a reminder, the first and last three stimuli functioned as buffers and were not included in analyses.

Table D2 Examples of Memory Tests Blocked by Variable Detail Categories

Participant Example #1	Stimuli Description	Participant Example #2	Stimuli Description
golf ball	Buffer	golf ball	Buffer
candle	Buffer	Candle	Buffer
pumpkin	Buffer	Pumpkin	Buffer
spoon	Special Item	spin around	Goodbye
fan	Special Item	thumbs up	Goodbye
bracelet	Special Item	peace sign	Goodbye
feather	Special Item	Salute	Goodbye
card	Special Item	Curtsey	Goodbye
cup	Special Item	Bow	Goodbye
coin	Special Item	Wave	Goodbye
magic dust	Special Item	Clap	Goodbye
diamond	Special Item	spirit fingers	Goodbye
wand	Special Item	air hug	Goodbye
crayon	Special Item	blow a kiss	Goodbye
handkerchief	Special Item	Handshake	Goodbye
wood	Admission Ticket	Elephant	Stuffed Animal
sequins	Admission Ticket	Cat	Stuffed Animal
ribbon	Admission Ticket	Fish	Stuffed Animal
flower	Admission Ticket	Bear	Stuffed Animal
seashell	Admission Ticket	Bird	Stuffed Animal
sponge	Admission Ticket	Whale	Stuffed Animal
sandpaper	Admission Ticket	Horse	Stuffed Animal
leaf	Admission Ticket	Dog	Stuffed Animal
pebble	Admission Ticket	Snake	Stuffed Animal
fur	Admission Ticket	Gorilla	Stuffed Animal
paperclip	Admission Ticket	Tiger	Stuffed Animal
pom pom	Admission Ticket	Cow	Stuffed Animal
gorilla	Stuffed Animal	magic dust	Special Item
dog	Stuffed Animal	Wand	Special Item
fish	Stuffed Animal	Handkerchief	Special Item
snake	Stuffed Animal	Cup	Special Item
cow	Stuffed Animal	Spoon	Special Item
elephant	Stuffed Animal	Feather	Special Item
horse	Stuffed Animal	Coin	Special Item
tiger	Stuffed Animal	Bracelet	Special Item
cat	Stuffed Animal	Diamond	Special Item
bird	Stuffed Animal	Fan	Special Item
whale	Stuffed Animal	Crayon	Special Item
bear	Stuffed Animal	Card	Special Item
red cherry juice	Magic Juice	lost keys	Secret
blue blueberry juice	Magic Juice	did bad on a test	Secret

Participant Example #1	**Stimuli Description**	**Participant Example #2**	**Stimuli Description**
black fig juice	Magic Juice	tripped walking to show	Secret
orange mango juice	Magic Juice	ripped favorite jeans	Secret
pink watermelon juice	Magic Juice	broke a bowl	Secret
purple grape juice	Magic Juice	slept in and missed class	Secret
white coconut juice	Magic Juice	lost wallet	Secret
clear crystal juice	Magic Juice	ate tub of ice cream	Secret
yellow lemon juice	Magic Juice	scratched car	Secret
brown chocolate juice	Magic Juice	forgot homework	Secret
light green lime juice	Magic Juice	fight with best friend	Secret
dark green apple juice	Magic Juice	broke phone screen	Secret
presto chango	Magic Words	fur	Admission Ticket
open sesame	Magic Words	leaf	Admission Ticket
bippity boppity boo	Magic Words	pom pom	Admission Ticket
expecto patronum	Magic Words	wood	Admission Ticket
shazam	Magic Words	sandpaper	Admission Ticket
hocus pocus	Magic Words	sponge	Admission Ticket
eureka	Magic Words	ribbon	Admission Ticket
voila	Magic Words	paperclip	Admission Ticket
abra cadabra	Magic Words	sequins	Admission Ticket
alakazam	Magic Words	flower	Admission Ticket
wingardium leviosa	Magic Words	seashell	Admission Ticket
mumbo jumbo	Magic Words	pebble	Admission Ticket
salute	Goodbye	sweater	Remove Item
clap	Goodbye	sunglasses	Remove Item
spirit fingers	Goodbye	shoes	Remove Item
blow a kiss	Goodbye	belt	Remove Item
bow	Goodbye	headband	Remove Item
curtsey	Goodbye	bowtie	Remove Item
handshake	Goodbye	watch	Remove Item
spin around	Goodbye	ring	Remove Item
peace sign	Goodbye	cape	Remove Item
air hug	Goodbye	scarf	Remove Item
wave	Goodbye	gloves	Remove Item
thumbs up	Goodbye	backpack	Remove Item
squats	Warm-up Exercise	lunges	Warm-up Exercise
high knees	Warm-up Exercise	squats	Warm-up Exercise
plank	Warm-up Exercise	running in place	Warm-up Exercise
running in place	Warm-up Exercise	push-ups	Warm-up Exercise
push-ups	Warm-up Exercise	sit-ups	Warm-up Exercise
arm circles	Warm-up Exercise	high knees	Warm-up Exercise
air punches	Warm-up Exercise	stretching	Warm-up Exercise
sit-ups	Warm-up Exercise	jumping jacks	Warm-up Exercise

Participant Example #1	Stimuli Description	Participant Example #2	Stimuli Description
lunges	Warm-up Exercise	hopping on one leg	Warm-up Exercise
jumping jacks	Warm-up Exercise	air punches	Warm-up Exercise
stretching	Warm-up Exercise	plank	Warm-up Exercise
hopping on one leg	Warm-up Exercise	arm circles	Warm-up Exercise
neck	Sticker Body Part	purple grape juice	Magic Juice
arm	Sticker Body Part	white coconut juice	Magic Juice
shoulder	Sticker Body Part	black fig juice	Magic Juice
cheek	Sticker Body Part	clear crystal juice	Magic Juice
nose	Sticker Body Part	brown chocolate juice	Magic Juice
leg	Sticker Body Part	blue blueberry juice	Magic Juice
hand	Sticker Body Part	orange mango juice	Magic Juice
tummy	Sticker Body Part	yellow lemon juice	Magic Juice
ear	Sticker Body Part	dark green apple juice	Magic Juice
back	Sticker Body Part	light green lime juice	Magic Juice
foot	Sticker Body Part	red cherry juice	Magic Juice
forehead	Sticker Body Part	pink watermelon juice	Magic Juice
fireman hat	Hat	open sesame	Magic Words
top hat	Hat	voila	Magic Words
chef hat	Hat	shazam	Magic Words
sailor hat	Hat	eureka	Magic Words
police hat	Hat	presto chango	Magic Words
straw hat	Hat	alakazam	Magic Words
sun hat	Hat	mumbo jumbo	Magic Words
baseball hat	Hat	wingardium leviosa	Magic Words
cowboy hat	Hat	bippity boppity boo	Magic Words
tuque	Hat	hocus pocus	Magic Words
bicycle helmet	Hat	abra cadabra	Magic Words
construction hat	Hat	expecto patronum	Magic Words
police siren	Sound Effect	cheering	Sound Effect
cheering	Sound Effect	drum roll	Sound Effect
ticking clock	Sound Effect	piano	Sound Effect
drum roll	Sound Effect	bouncing basketball	Sound Effect
bouncing basketball	Sound Effect	knocking on door	Sound Effect
piano	Sound Effect	rain	Sound Effect
rain	Sound Effect	howl	Sound Effect
countdown	Sound Effect	police siren	Sound Effect
howl	Sound Effect	countdown	Sound Effect
rattle	Sound Effect	rattle	Sound Effect
knocking on door	Sound Effect	ocean waves	Sound Effect
ocean waves	Sound Effect	ticking clock	Sound Effect
fight with best friend	Secret	tuque	Hat
broke phone screen	Secret	construction hat	Hat

Participant Example #1	Stimuli Description	Participant Example #2	Stimuli Description
lost keys	Secret	police hat	Hat
did bad on a test	Secret	bicycle helmet	Hat
ripped favorite jeans	Secret	sailor hat	Hat
ate tub of ice cream	Secret	chef hat	Hat
scratched car	Secret	cowboy hat	Hat
lost wallet	Secret	baseball hat	Hat
slept in and missed class	Secret	top hat	Hat
tripped walking to show	Secret	sun hat	Hat
forgot homework	Secret	fireman hat	Hat
broke a bowl	Secret	straw hat	Hat
ring	Remove Item	forehead	Sticker Body Part
headband	Remove Item	ear	Sticker Body Part
gloves	Remove Item	foot	Sticker Body Part
shoes	Remove Item	neck	Sticker Body Part
scarf	Remove Item	cheek	Sticker Body Part
belt	Remove Item	nose	Sticker Body Part
sweater	Remove Item	leg	Sticker Body Part
watch	Remove Item	tummy	Sticker Body Part
sunglasses	Remove Item	arm	Sticker Body Part
bowtie	Remove Item	back	Sticker Body Part
cape	Remove Item	hand	Sticker Body Part
backpack	Remove Item	shoulder	Sticker Body Part
pinecone	Buffer	pinecone	Buffer
book	Buffer	book	Buffer
monkey	Buffer	monkey	Buffer

Note. In the actual test, one related image will accompany each word/phrase that appears on the screen in order to assist in the child's comprehension the word/phrase. As a reminder, the first and last three stimuli functioned as buffers and were not included in analyses.

Appendix E.

Children's Debriefing Script

Thank you for agreeing to participate our research study and for trying your best! All of your hard work helps us better understand children's memory; like how you all remember things you have learned in school. In this project, we tested different ways of asking questions about things you experienced to see if one way helped you to remember more.

Do any of you have any questions for the researchers? If you do, please type them into the text box below and be sure have your guardian type their email address in second text box. This will help us know who to contact to answer questions. If you don't have any questions now, but think of some later, tell your parent/guardian. They have our contact information and can email us your questions. Thanks again for all of your help!

Appendix F.

Results on Interactions

Table F1 Mean Proportion of Correct Responses Across Test Blocking Conditions and Category Type

	Taxonomic Category Stimuli		Non-taxonomic Category Stimuli	
	VD	MS	VD	MS
Mean RT	1567.70 (314.19)	1825.49 (407.71)	1661.76 (338.38)	1908.66 (489.65)
Overall Accuracy	.87 (.10)	.80 (.11)	.87 (.10)	.80 (.12)
Target Accuracy*	.85 (.12)	.78 (.13)	.83 (.12)	.72 (.16)
Foil Accuracy*	.90 (.09)	.83 (.15)	.90 (.11)	.87 (.12)
d'	2.57 (.91)	1.95 (.88)	2.57 (.91)	1.94 (.96)
Criterion C	.10 (.28)	.17 (.46)	.20 (.33)	.32 (.34)

Note. MS refers to the blocked by magic show condition and VD refers to the blocked by variable detail condition. Reaction times are measured in milliseconds. Standard deviations are listed in parentheses. The memory test contained 144 stimuli, which breaks down into 72 taxonomic stimuli and 72 non-taxonomic stimuli. * indicates the interaction was significant. Participants in the blocked by detail condition showed no difference in target accuracy (correctly giving a "yes" response) based on category type, but participants in the blocked by magic show condition had poorer target accuracy when presented with non-taxonomic stimuli than taxonomic stimuli, $F(1, 126) = 5.30$, $p = .023$, $\eta_p^2 = .040$. Participants in the blocked by detail condition showed no difference in foil accuracy (correctly giving a "no" response) based on category type, but participants in the blocked by magic show condition had poorer foil accuracy when presented taxonomic stimuli than non-taxonomic stimuli, $F(1, 126) = 5.75$, $p = .018$, $\eta_p^2 = .044$.