

ABSTRACT

BROWN, BENJAMIN T. The Role of Event Plausibility and Age in Children's Recall and Suggestibility. (Under the direction of Lynne Baker-Ward.)

Although a good deal of research suggests that what we know affects what we remember, very little of this research looks at development through childhood. Children remember more as they grow older (Ornstein, Baker-Ward, Gordon & Merritt, 1997). As children gain more experience and expertise, they may also be developing an understanding of event plausibility. It was predicted that event plausibility moderates the relationships between knowledge and recall and between knowledge and suggestibility. Fuzzy trace theory (Reyna & Brainerd, 1995) has shown that older children are better than their younger counterparts in using gist memory. Gist memories are integrated into prior knowledge, preserving only the central concepts of an event. If older children rely more on gist, which is meaningfully connected to knowledge, it may explain why they would be better able to understand event plausibility.

The present research provided younger and older children with knowledge of a novel animal, namely a chinchilla. These children were later read a story about one such chinchilla. This story featured events that would be plausible or implausible given knowledge of the animal. Children were then tested for the recall and suggestibility for the story one day or one week later. In general, plausible events were better recalled than implausible events, and plausible misleading questions led to more suggestibility than implausible questions. As would be expected, age served as a good predictor of recall and suggestibility, with older children displaying better recall and decreased susceptibility to suggestion than younger children. As expected, delay also served as a good predictor of memory and suggestibility, with better recall and less suggestibility in the short delay than the longer delay. There was some evidence that

knowledge was activated to a greater extent in the older children as they made their memory judgments. Older children were more susceptible to plausible suggestion over time and less susceptible to implausible suggestion, while younger children displayed increases in suggestibility to both question types. Due to the limitations of the current design, a full understanding of how age, delay, and plausibility interact is still to come. Future research may shed further light on how an understanding of event plausibility develops across the childhood years, and how this development affects children's recall and suggestibility.

**THE ROLE OF EVENT PLAUSIBILITY AND AGE IN CHILDREN'S RECALL AND
SUGGESTIBILITY**

by
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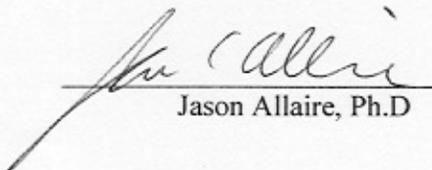
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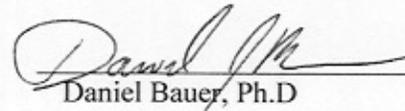
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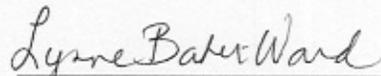
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The Role of Event Plausibility and Age in Children's Recall and Suggestibility

Socrates: "To them... the truth would be literally nothing but the shadows of the images." -Plato, *Allegory of the Cave*

In the *Allegory of the Cave*, Plato explains that the world experienced is nothing but a diminished copy of the real world. Plato describes humankind as being chained in an underground tunnel, only able to perceive the shadows of real objects cast on the wall in front of them. Individuals are never able to directly experience objects or even each other. They can only make sense of the world from the vague shadows before them. Plato's observation that human knowledge is not perfect is a concept that is still relevant today.

In recent years, there has been a focus on how knowledge from previous shadows affects what one will remember of later shadows. More clearly phrased, researchers have examined how prior knowledge affects memory for later events (Greenhoot, 2000; Ornstein & Naus, 1985). People's memories are based on these shadows, or representations of the real world, so their knowledge is not completely accurate. Because knowledge is imperfect, individuals may be susceptible to suggestion when presented with misleading information (Hyman, Husband, & Billings, 1995; Loftus, 1975; Loftus & Pickrell, 1995).

The present investigation is concerned with examining the relationship between children's prior knowledge and their memory and suggestibility for a specific event. An individual's prior knowledge enables that individual to make a judgment about the relative plausibility of any given event. Understanding event plausibility is predicted to moderate the relationship between prior knowledge and children's memory and suggestibility (Pezdek, Finger, & Hodge, 1997). Before examining this relationship, however, it would be beneficial to review what we know about the development of children's memory and suggestibility.

Whereas it has been shown that even very young children can remember impressive amounts of information (e.g., Bahrck, Parker, Fivush & Levitt, 1998), significant developmental differences have been found in children's ability to remember previous experiences. For example, Ornstein, Baker-Ward, Gordon and Merritt (1997) found that older children remember more information and forget less over time than younger children. Developmental differences have been found in children's suggestibility as well. It has been consistently reported that younger children are more prone to suggestion when presented misleading information (Bruck, Ceci, Francouer, & Barr, 1995; Leichtman & Ceci, 1995; Loftus & Pickrell, 1995).

Expertise and Memory

To a large extent, age differences reflect differences in knowledge arising from life experiences (Bjorklund, 1985). So how does prior knowledge affect memory? A large proportion of the research looking at knowledge and memory examines expert versus novice recall. One study (Schneider, Gruber, Gold, & Opwis, 1993) examined the differences between chess experts and novices. It was found that chess experts process chess information faster than novices. Experts were able to recognize and rely on familiar grouping patterns of chess pieces, whereas novices had to rely solely on their memories for individual piece location. Because chess experts were able to group multiple pieces into one meaningful unit, they were able to encode more information than the novices. Both in this study and in others examining expertise in chess (Chase & Simon, 1973; Chi, 1978), the influence of prior information was so strong that child chess experts outperformed novice adults. It is worth noting, however, that this advantage was limited to the children's area of expertise; the expected age-related increase in memory for digits was observed.

The advantage the experts have is not exclusive to chess, but has been found in many other domains, such as science reasoning. Chi, Feltovich, and Glaser (1981) assessed the way physics experts and novices classified physics problems. Physics experts used underlying principles to classify these problems. Novices, on the other hand, often use superficial details of the problem for classification. Thus, prior knowledge, within a specific domain, may lead experts to a deeper understanding of events, which in turn, may lead to greater recall of those events. It has even been argued that developmental differences in memory performance may be the result of increasing experience and expertise (Lindberg, 1980).

Event Consistency and Memory

Another way in which knowledge may affect encoding, and later recall, depends on whether or not the event to-be-remembered is consistent with one's prior knowledge. There is evidence that when an event is plausible, or consistent given one's prior knowledge, that event is easier to integrate into one's memory (Bigler & Liben, 1993; Liben & Signorella, 1980; Pezdek, Finger & Hodge, 1997; Pezdek & Hodge, 1999). Reliance on stereotypes is an example of a situation in which prior information affects encoding and later recall. Individuals enter situations with stereotypes that provide them with expectations for behavior of others. What happens when these expectations are not met, and stereotypes are violated? Bigler and Liben (1993) found that stories that are consistent with children's racial stereotypes tend to be remembered better than stories that violate these stereotypes. Liben and Signorella (1980) found similar results with gender instead of racial stereotypes. Stories that match gender stereotypes were also better remembered. Both of these studies suggest that children's ability to encode and recall

information is diminished if the event is inconsistent with their expectations. In other words, they are better able to remember information that is consistent with their knowledge base.

Some studies, on the other hand, have found that consistency does not always lead to better recall. Pezdek, Whetstone, Reynolds, and Askari (1989) introduced participants to two environments: a graduate student's office or a preschool classroom. Each environment contained some items that were consistent (desk in the office) with expectations and some that were inconsistent (teddy bear in the office). Inconsistent items were actually recalled with greater detail, while consistent details are recalled more generically. Pezdek's research indicates that inconsistent details are more salient, because they don't fit into one's schema, for say, a preschool classroom. So who is right? Is it as Liben says, and consistent information is more easily integrated into existing knowledge? Or Pezdek, who says inconsistent information is more salient, and thus more easily recalled?

Fuzzy trace theory (Reyna and Brainerd, 1995) may have the answer. It makes the distinction between verbatim and gist memories. Verbatim memories contain rich, detailed information, but fade rapidly. On the other hand, gist memories, or "fuzzy traces," are more stable. They are integrated with one's knowledge base, meaningfully connected to other events. When gist memories are integrated into prior knowledge, allowing for a more complete understanding of experience, the level of detail remembered is greatly diminished. Because of this, when asked to make memory judgments, people will generally rely on verbatim memory, if available. If verbatim recall has decayed and is not available, however, people will depend on gist memory for memory judgments.

Fuzzy trace theory applies to the consistency/inconsistency debate in the following way: In Liben's stereotype studies, the stories consistent with their stereotypes are integrated into their

knowledge base, and the inconsistent information most likely decays quickly. It is therefore not surprising that information that matched stereotyped behavior is remembered better. In Pezdek's study, however, the inconsistent information was remembered with greater detail, whereas the consistent information was recalled more generally. This consistent memory was most likely easy to incorporate into one's schemas for a typical preschool classroom. This is gist memory, where detail is lost. The inconsistent information, on the other hand, could not be integrated with other information, and more detail was preserved. As Pezdek tested recall either immediately, or one day after, the exposure to the environment, the verbatim memory of the inconsistent information was not given time to decay. Given all this, it appears that length of delay before recall predicts whether consistent or inconsistent information will be remembered better. Because verbatim information is lost very quickly, it should be noted that in any real-world situations (e.g. children's testimony) the consistent information associated with gist recall would be better remembered.

Plausibility and Suggestibility

As discussed before, it has been shown that new information that is consistent with one's knowledge base will be remembered better than inconsistent information (Bigler & Liben, 1993; Liben & Signorella, 1980). Given the present investigation's focus on both memory performance and suggestibility, it will be worthwhile to examine how consistent and inconsistent information affect suggestibility. Pezdek, Finger, and Hodge (1997) showed that events might be suggestively planted into memory if they are plausible (consistent) given the individual's past experiences. In this study, Catholic and Jewish high school students were read two true events and two false events that were supposed to have taken place when the participants were eight

years of age. The false events described weekly religious events without explicitly naming them. One of the two false events involved a description of the Jewish ritual of Shabbot, while the other involved the Catholic ritual of Communion. Both false events included a potentially embarrassing situation, to differentiate it from the common occurrences of the weekly ritual. Pezdek found that Catholics were more likely to accept the false Catholic event as true than the false Jewish event, and Jews were more likely to accept the false Jewish event than the false Catholic event.

Pezdek and Hodge (1999) found further support that false information would be more likely accepted as true if it was plausible. In this experiment, children were read two false events: getting lost in a shopping mall (plausible) and receiving a rectal enema (implausible). A parent presented each of the scenarios to the children, claiming that they occurred while the child was 4 years old. Children were found to be much more likely to remember the plausible false event than the implausible event. Thus, participants were more likely to accept a false event as true if it was plausible given their previous life experiences.

Manipulating Knowledge

There is another way in which prior knowledge influences memory. Previous life experience can influence how individuals interpret and remember subsequent experiences (see Brainerd & Ornstein, 1991). While it may seem intuitive that what we know shapes what we remember, there is very little empirical research supporting this supposition. As stated by Greenhoot (2000), “research on the linkages between children’s knowledge and memory has generally been limited to correlational studies of the relation between extant knowledge and recall of information that is related to that knowledge. Yet a consideration of changes in the

knowledge base is essential to understanding children's developing abilities to remember information and expectancies" (p. 1311).

Greenhoot (2000) conducted one of the few studies that empirically manipulated knowledge. This study examined the effects of both prospective and retrospective knowledge on children's inferences about, and memory of, a series of stories. First, she manipulated children's knowledge of the protagonist of these stories. The protagonist's name differed by the gender of the participant, Eric for males and Anne for females. For example, Eric was described to male participants as either nice, mean, or neutral. The children were later read stories where Eric's actions are ambiguous in nature. For example, a classmate cannot find his lunchbox. When Eric shows up in the lunchroom carrying the classmate's lunchbox, that classmate is surprised. The story is ambiguous because it does not indicate whether Eric has stolen the lunchbox, or whether he has found it. Children used the prior information to make inferences about Eric's behavior and intentions. Some of the children were then given new, contradictory knowledge about Eric. For example, despite what they heard before, he really is a mean boy. Children incorporated this new information about Eric into their understanding of the previously read stories, and made new inferences about the protagonist's intentions. This experiment gives empirical support for the idea that what we know shapes what we remember, no matter if the knowledge comes before or after the event in question.

Summary

To summarize while keeping a developmental point of view, it has been shown that older children have better memory performance than younger children (Ornstein, Shapiro, Clubb, Follmer, & Baker-Ward, 1997). There is also a vast amount of literature indicating that younger

children are generally more prone to suggestion than older children (Ceci & Bruck, 1993). It has also been demonstrated that consistent, or plausible, information affects both children's memory (Bigler & Liben, 1993; Liben & Signorella, 1980) and children's suggestibility (Pezdek & Hodge, 1999). There is a question that still needs to be answered, however: Through what ages is the ability to understand event plausibility developing? That is, through what ages does development occur in the ability to gauge the likelihood of an event given relevant domain knowledge? Although this question has yet to be answered, it can be assumed that as children grow older, their ability to apply knowledge to assess plausibility will increase. In the present investigation, children evaluated the plausibility of new information in light of recently acquired knowledge. The hypothesis of the present investigation was that older children's better understanding of event plausibility will lead to better recall than younger children, while at the same time making them more prone to plausible suggestion than younger children.

Fuzzy trace theory (Reyna & Brainerd, 1995) predicts the same thing. Younger children rely heavily on verbatim recall. As children age, they become better at using gist memory. It is unclear what through what specific ages the ability to use gist is developing. What is clear is that it is unlikely there is an absolute threshold at which ability to use gist develops. Development in this area is likely to happen over an extended period of time. There are relative differences in ability to use gist when adolescents and younger children (ages 5-11) are compared. This capacity is associated with both advantages and disadvantages. With gist memory, older children are able to get more stable information integrated into their knowledge. However, because gist is not as detailed as verbatim memory, they are more prone to suggestion. A possible confound is that younger children may be equally suggestible to plausible and implausible information, not because they lack the ability to understand relative plausibility, but

because they lack the ability to use gist memory. The present solution was to keep the time between the event to-be-remembered and recall short enough so that both younger and older children were using verbatim recall. Because a short recall period was used, however, it was predicted that older children would accurately remember more present implausible items than present plausible items. Their developing reasoning abilities would allow them to perceive some components of an event as implausible. Because verbatim recall would not have had time to decay, the present implausible items would still be in memory and salient because they were unexpected. In contrast, younger children, whose verbatim recall abilities are relatively limited (Reyna & Brainerd, 1995), were expected to demonstrate more comparable levels of recall for present plausible and implausible items.

The Present Investigation

In this study, 6 to 9-year-old children were taught about the typical characteristics of an exotic animal, a chinchilla. Children were later read a story about a chinchilla, containing actions that were plausible or implausible, given their new knowledge of the animal. Participants were divided into two groups, one tested for recall and suggestibility soon after the story was read, and the other half tested after a one-week delay. It was predicted that in the immediate recall condition, older children's greater ability to understand event plausibility would lead to a better recall of implausible than plausible information, whereas younger children would show smaller differences in their memory for implausible and plausible information. Also, older children, because of their greater ability to understand plausibility, would be more prone to plausible than implausible suggestions, whereas younger children would show less difference in susceptibility to suggestion between plausible and implausible misleading questions. In the

delayed recall condition, it was predicted that older children's greater ability to understand event plausibility would lead to a better recall of plausible than implausible information, because of their reliance on gist memory after verbatim traces have decayed. Younger children, on the other hand, would show smaller differences in their memory for implausible and plausible information. Older children in the delayed recall condition would be even more prone to suggestion than in the immediate recall because of their growing reliance on gist traces, whereas younger children show less differences when presented plausible and implausible suggestions.

If these hypotheses held true, they would have important applications in the realm of children's testimony. First, it would be beneficial to know that older children may be able to better recall events when they are plausible given prior experience. Secondly, if it were found that older children are indeed more prone to plausible suggestions, this would be a counter-intuitive finding. Most of the literature indicates that younger children are usually more prone to suggestion. Whereas this hypothesis may be counter-intuitive, there is some support for it in the literature. Ornstein, Merritt, Baker-Ward, Furtado, Gordon, and Principe (1998) found a similar pattern in 4- and 6-year-old children. When asked to remember an atypical doctor's visit, 6-year-old children were more likely to have spontaneous incorrect recall of expected-but-omitted features than 4-year-old children. It could be argued that the expected-but-omitted features were incorrectly recalled because they were plausible given the 6-year-olds prior knowledge of doctor's visits. The 4-year-old children, on the other hand, might not have the same grasp of event plausibility.

In addition, Brainerd, Reyna, and Forrest (2002) found empirical support for the counter-intuitive hypotheses that in some cases vulnerability to suggestion can increase with age. This study examined developmental differences on the Deese-Roediger-McDermott (DRM)

procedure (Roediger & McDermott, 1995) within a fuzzy trace framework. In the DRM paradigm, individuals study a list of words that are all related to an absent word. For example, the list could contain the words “bed,” “dream,” “snooze,” and “rest,” but would not include “sleep.” When participants are asked to reproduce the list, many of them falsely recognize that “sleep” was, in fact, a part of the list. Brainerd found that young children (aged 5-11 years) were significantly less likely than adolescents and adults to falsely include “sleep” in their lists. Brainerd explained his results from a fuzzy trace perspective. He believed that it was the younger children’s inability to get the “gist” of the list, or their inability to meaningfully connect the words on the list. In essence, the younger children are not falsely reporting “sleep” in their lists because they had no expectations that it should have been on the list.

If older children are indeed increasingly prone to plausible suggestion as they age, this will have important implications for children’s testimony. If older children are able to better recall implausible events after a short delay, and plausible events after a longer delay, this is an important finding. The events that children would be called upon to testify would most likely be implausible given their previous range of experience. Given this, it would be important to minimize the delay between the event and the testimony. It was also predicted that older children would show increased suggestion in some situations. If this counter-intuitive prediction holds true, with older children showing more susceptibility to plausible than implausible suggestion, then this would also have important implications. Older children would be expected to provide accounts of events that were expected but did not actually occur. Forensic experts may have a hard time differentiating between true accounts and confabulations in such situations.

Method

Participants

The participants in this study were recruited from five summer and after-school programs in communities in the vicinity of North Carolina State University. Parental permission was obtained in writing for a total of 56 children before the experiment began (see Appendix A). Nine of the children for whom parental consent was obtained were not present for both of the first two sessions, and so were not interviewed. Two participants who were interviewed were excluded from the sample because the recordings of the interviews were inaudible. A total of 45 participants (21 male, 24 female) remained in the final sample. Participants were originally split into four age groups: 6-, 7-, 8-, and 9-year olds. However, the two younger and two older age groups displayed similar patterns of results on all dependent measures. Given concerns about power, children were collapsed into “younger” and “older” age groups, thus increasing the numbers of children per group. There were 25 in the sample of younger children ($M = 6.5$, $SD = .49$), and 20 older children ($M = 8.75$, $SD = 1.02$). Although socio-economic status was not formally assessed, children were recruited from school facilities predominantly serving middle- to upper-middle income families.

Participants were randomly assigned within age to one of two delay conditions: 24 were in the immediate recall and 21 were in the delayed recall. See the Table 1 below for the distribution within cells for each possible combination of age, delay, and gender.

Table 1

Participant Distribution for Age, Delay, and Gender

Age	Time of Testing		Total
	Immediate	Delayed	
<u>Younger</u>	13	12	25
Male	7	4	11
Female	6	8	14
<u>Older</u>	11	9	20
Male	5	5	10
Female	6	4	10
Total	24	21	45

During the course of an earlier study performed in the same research laboratory, 12 children were used for informal piloting. Their entire involvement for this piloting was responding to the single question “Do you know what a chinchilla is?”

This experiment used a 2 X 2 X 3 mixed factorial design, with age (younger vs. older children) and time of interview (immediate vs. delayed) manipulated between participants, and item type (plausible vs. implausible vs. non-target) manipulated within participants.

Materials

Chinchilla lecture. A specially developed age-appropriate multimedia PowerPoint demonstration about chinchillas, incorporating pictures, sounds, and video was used (see Appendix B for lecture script). Participants were exposed to the typical characteristics and behavior of a chinchilla based on the description provided by Barrie (1997). Chinchillas were chosen because they are relatively exotic animals with which most children have had little to no experience. In order to validate this assumption, informal piloting was conducted to ensure that children have little to no prior knowledge of chinchillas. Indeed, out of 12 six-to-nine year old children sampled in an informal pilot study, only one displayed any knowledge of chinchillas. In

addition, participants in this investigation were asked before the demonstration about their knowledge of chinchillas. Before the lecture began, children were shown a picture of a chinchilla and were asked to identify it. Only one child correctly identified the pictured animal as a chinchilla, and this child was never interviewed, as his parent never returned an informed consent form. Chinchillas were also ideal animals because they have so many distinctive features (group size of 100+ in the wild, bathe in dust, poor eyesight, nocturnal, vegetarian, etc.; Barrie, 1997). All of these distinctive characteristics were featured in the lecture.

“Chinchilla up the Chimney” story. An age-appropriate story, adapted from a commercially marketed children’s book (Daniels, 1999), about an escaped pet chinchilla was used (see Appendix C). In the story, a girl gets a pet chinchilla for her birthday, only to have it escape and hide in the chimney. This story contains some actions that are plausible, given the typical behavior of a chinchilla; for example eating raisins and chewing on a piece of wood. The story also includes some events that are implausible, such as bathing in water and sleeping at night. Children’s memory for this to-be-remembered event was later assessed.

Memory and suggestibility interview. An interview protocol was developed to test participants’ memory for the “Chinchilla up the Chimney” story and to test their vulnerability to suggestion (see Appendix D). This interview was audiotaped for later transcribing. The questions in the interview were ordered from general to specific. This allows an interpretation of the strength with which the information is encoded in memory (Bull, 1995). The most general, open-ended prompts were asked first (e. g., “Tell me everything that happened in the story about the chinchilla.”). The items reported in response to these general questions will presumably have greater trace strength because less prompting was required to activate the item.

These open-ended questions were followed by more specific, “closed” questions, regardless of whether the participant reported the item in question at the open-ended level. Closed questions usually begin with “what”, “where”, “who” or “how.” If the participant indicated that he or she did not know the answer to a closed question, an even more specific question for the corresponding feature was asked. All specific questions are yes/no type questions. There were 6 different types of closed and specific questions in the interview:

1. Plausible Memory: These 4 items tested participants’ memory for events that *did* happen and were *plausible* in that they were consistent with prior knowledge of chinchillas (e. g., “What kind of food did the chinchilla eat? Did the chinchilla eat raisins?”).
2. Implausible Memory: These 4 items tested participants’ memory for events that *did* happen but were *implausible* because they were inconsistent with prior knowledge of chinchillas (e. g., “What did the chinchilla do when the sun went down? Did the chinchilla go to sleep when the sun went down?”).
3. Non-Target Memory: These 4 items tested participants’ memory for events that *did* happen and were *unrelated* to prior knowledge of chinchillas (e. g., “Where did Mr. Hope take Mandy for her birthday? Did they go to Chuck E. Cheese’s?”).
4. Plausible Suggestion: These 4 items tested participants’ vulnerability to suggestion for events that *did not* happen but were *plausible* given prior knowledge of chinchillas (e. g., “What did the chinchilla do in the pile of dust? Did the chinchilla roll around in the pile of dust?”).
5. Implausible Suggestion: These 4 items tested participants’ vulnerability to suggestion for events that *did not* happen and were *implausible* given prior knowledge of chinchillas (e. g., “What did the chinchilla do with the hot dog? Did the chinchilla eat the hot dog?”).

6. Non-Target Suggestion: These 4 items tested participants' vulnerability to suggestion for events that *did not* happen and were *unrelated* to prior knowledge about chinchillas (e. g., "What flavor was Mandy's birthday cake? Was it a chocolate birthday cake?").

Procedure

Forty-five children across the target age range were recruited from five local summer and after-school programs. Informed consent was obtained from a parent or legal guardian before data were collected from any child. In addition, children were asked for their verbal assent and for permission tape-recorded. Participants were then randomly assigned to one of the two delay conditions. Each participant took part in three sessions over the course of the study. Session 1 was run in small groups of about 6 children. During the first session, participants learned the typical features of a chinchilla (bathes in sand, has underdeveloped eyesight, is vegetarian, etc.) via a PowerPoint presentation. Before the presentation began, children were shown a picture of a chinchilla and were asked to identify it. The experimenter proceeded then proceeded with the presentation, making sure that each participant is attentive.

One week later in Session 2, the experimenters returned and read a story in small groups of about 6 children. The story was about an escaped pet chinchilla. This story contained plausible (eating raisins) and implausible (bathing in water) events, given what they have learned about chinchillas. At the teachers' request, the presentation and the story were incorporated into the curriculum and hence were available to all children within the classroom regardless of whether or not their parents provided informed consent. Children for whom written parental permission for participation was not obtained did not interact individually with the researchers.

In Session 3, participants were interviewed individually. In Session 3a, one day after the story had been read, half of the participants were given the memory and suggestibility interview protocol for the story. In Session 3b, one week after the story had been read, the remaining participants were given the memory and suggestibility test. See Figure 1 for a graphical depiction of the experimental design.

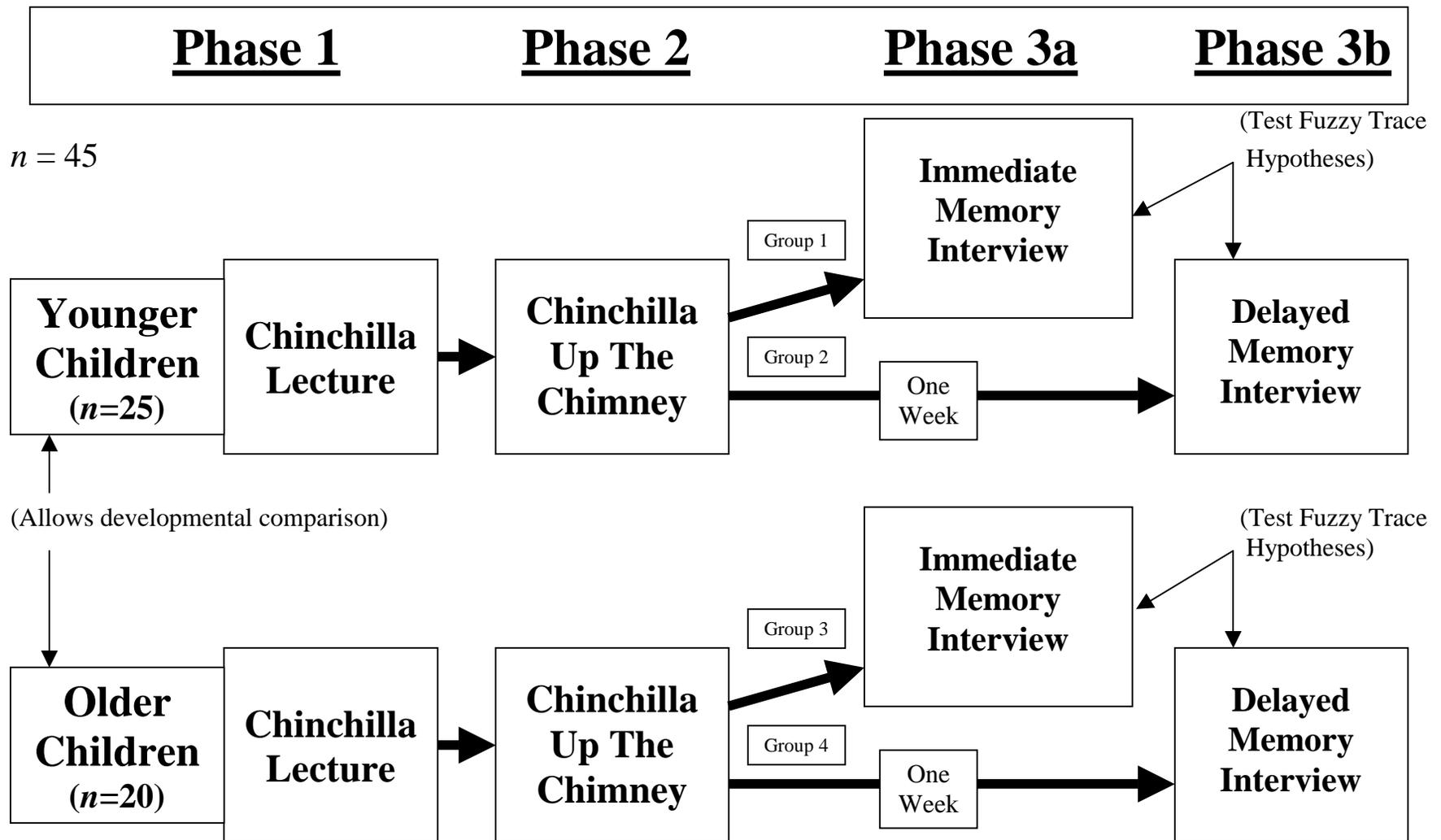


Figure 1. Experimental Design. Participants will learn typical features of a chinchilla (bathe in sand, underdeveloped eyesight, vegetarian) over multiple sessions. Participants will be brought back and read a story about an escaped pet chinchilla. This story will contain plausible (eating fruit) and implausible (swimming in lake) events, given what they have learned about chinchillas. Half of participants will be tested for their memory and suggestibility for the story soon after and the other half one week later.

Coding

All interviews were transcribed verbatim from the video recordings of the interviews. Coding was done from the transcripts (See Appendix E for coding sheet). There were three different types of questions, plausible, implausible, and non-target, defined on the basis of the question's relation to prior knowledge about chinchillas as described above.

Recall. The level of question (open-ended, closed, specific) at which participants reported a feature was coded. The total number of present features recalled, as well as the level of specificity at which the participant reported each feature, was categorized. Correct responses were categorized in one of three ways:

1. Features reported in response to the most general questions were coded as open-ended recall.
2. Features provided as answers to the directed probes that elicited only one feature were coded as closed recall.
3. Answers to questions requiring either a "yes" or "no" answer were coded as specific recall. All responses to specific-level questions required a forced yes/no choice.

Incorrect responses were categorized in one of two ways:

1. If, in response to an open-ended probe, an individual reports an item not present in the Chinchilla up the Chimney story, it was coded as an intrusion.
2. Misinformation provided in response to a closed question or a specific question was coded as incorrect.

Finally, if a "don't know" response is provided to a yes/no question, it was coded as "don't know" recall.

Suggestibility. Responses to the misleading questions were categorized into correct denials and incorrect responses. Responses were coded as correct denials if the participant accurately denied that the item occurred. There were two categories of correct denials:

1. If the question was correctly rejected in response to the closed misleading question, it was coded as a correct denial-closed. For example, if the interviewer asks, “How did the chinchilla clean itself?” and the participant responds, “The chinchilla never cleaned itself,” it was coded as a correct denial-closed.
2. If this individual responds, “I don’t know” to the closed misleading question, a follow up specific misleading question was asked (i.e., “Did the chinchilla decide to clean itself off in a pile of dust?”). If the participant correctly responds “no,” it was coded as a correct denial-specific.

Responses were coded as false alarms if the participant erroneously provided information to the misleading questions, and there are two types:

1. A false alarm – closed code was given to incorrect information provided in response to the closed misleading question (e.g., “The chinchilla cleaned itself off in dirt”).
2. A false alarm – specific code was given when a participant erroneously agreed to the specific misleading question. (i.e. “yes.”)

If, however, the response to the specific misleading question was “I don’t know”, it was coded as a misleading “don’t know” response.

Two coders independently coded approximately 20% of all the interviews. Interrater agreement was calculated as the ratio of number of codes agreed upon divided by the total number of codes. Percentage agreement for the interviews was acceptable, with 92% agreement overall. Percentage agreement for each question type was 87.5% for plausible memory, 92.5 for

implausible memory, 90% for non-target memory, 92.5% for plausible suggestion, 95% for implausible suggestion, and 95% for non-target suggestion.

Results

Preliminary Analyses

The significance level for all statistics tests was $p < .05$. Participants were split into two age groups, younger ($M = 6.5$, $SD = .49$) and older ($M = 8.76$, $SD = 1.02$). There were 21 males and 24 females in the final sample, and gender did not emerge as a predictor of memory or suggestibility. Participants were recruited from five local summer and after-school programs. Finally, seven different interviewers were used over the course of the study. Gender, interviewer, and school did not emerge as significant covariates for any of the analyses.

Statistical Issues

To test the hypothesized relationships between the factors of interest in this study, a series of repeated measures analysis of variances (RM-ANOVAs) were conducted. Unfortunately, for many of these analyses, there were several violations of assumptions required for the RM-ANOVA. Box's test of equality of covariance matrices reached significance on a number of these RM-ANOVAs, suggesting that the observed covariance matrices of the dependent measures were not equal across groups. Mauchly's test of sphericity was also sometimes significant, suggesting a violation of the sphericity assumption. As Mauchly's test is often considered to be too stringent, epsilon values were also considered. Given that many of them were less than a value of 1, it seems safe to assume that there are violations of sphericity in this data. Finally, Levene's test for the homogeneity of variance between groups reached

significance on occasions, suggesting that the error variance of the dependent variables was not equal across groups.

Because so many assumptions are violated in this data set, the F -tests provided by the RM-ANOVAs were of questionable validity. These violations make it impossible to determine if the F -tests and their associated p -values will be conservative or liberal, making both Type I and II errors a concern. Given all of this, effect sizes were of most interest in interpreting the strength of the relationships presented below (D. Bauer, personal communication, 2004). Partial eta squared (η_p^2) were used as a measure of effect size. Partial eta squared can be thought of as the proportion of total variability attributable to a factor or interaction. Cohen (1988) provides the guidelines for interpreting effect sizes from the eta squared value:

- Small effect size = .01
- Medium effect size = .059
- Large effect size = .138

Thus, effect sizes were used to interpret the strength of factors and interaction on recall and suggestibility, and the patterns in the data were represented graphically.

Recall Performance

According to the predictions made by fuzzy trace theory, two hypotheses emerged:

1. In immediate recall, older children (Group 3) will remember more implausible items (in verbatim memory, not yet decayed) than plausible items. Younger children (Group 1), because of their lesser understanding of plausibility, will show no differences in recall between plausible and implausible items.

2. In delayed recall, older children (Group 4) will remember more plausible items (gist memory, fitting in with knowledge from session 1) than implausible items. Younger children (Group 2) will not discriminate between plausible and implausible items and will remember them equally.

Overall Recall

To test these hypotheses, a series of mixed between-within analysis of variances were conducted. The first of these examined overall memory performance, collapsing scores across open-ended, closed, and specific recall. Items reported at the open-ended level that were also subsequently provided in the closed or specific recall were only included as open-ended responses in these analyses. The between-subjects factors were age (younger and older) and time of interview (immediate and delayed). There was one within-subjects variable: question type (plausible, implausible, and non-target). Table 2 shows a summary table of the RM-ANOVA.

Table 2

ANOVA Summary of Overall Recall

Source	<i>df</i>	<i>F</i>	η_p^2	<i>p</i>
Between subjects				
Age (A)	1	20.490	.333	.001
Delay (D)	1	4.176	.092	.047
A * D	1	.112	.003	.711
S within-group error	41	(.807)		
Within subjects				
Question type (Q)	2	56.900	.581	.001
Q * A	2	2.795	.064	.067
Q * D	2	.346	.008	.709
Q * A * D	2	3.100	.070	.050
Q * S within-group error	82	(.511)		

Note. Values enclosed in parentheses represent mean square errors.

For main effects, there was a large effect size of question type and age, and a medium effect size of delay. There were also medium effect sizes for the interaction between question type and age, and the three-way interaction between question type, age, and delay.

First, the relationship between question type and overall recall had a large effect size.¹ The number of implausible items recalled was less than the number of plausible and non-target items. Thus, as expected, it may be that the information gained from the chinchilla lecture made it difficult to recall elements on the chinchilla story that were inconsistent with that knowledge. Figure 2 shows this relationship graphically.

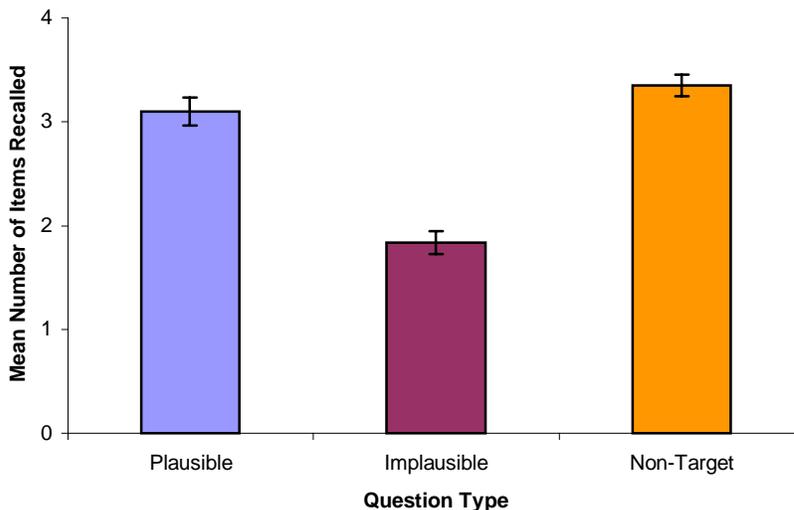


Figure 2. Main Effect of Question Type on Overall Recall. Mean number of items recalled overall for plausible, implausible, and non-target question types.

Next, the relationship between age and overall recall had a large effect size.² The estimated marginal means for overall recall of younger participants was less than the estimated marginal means for older participants. Thus, as would be expected, older children are recalling more information overall than younger children. Figure 3 shows this relationship graphically.

¹ Analyses were repeated with the non-target items deleted. The main effect of question type still had a large effect size. Thus, it appears that plausibility of question type may be a good predictor of memory in children.

² This large effect of age on overall recall remained even after non-target items were removed from the analyses.

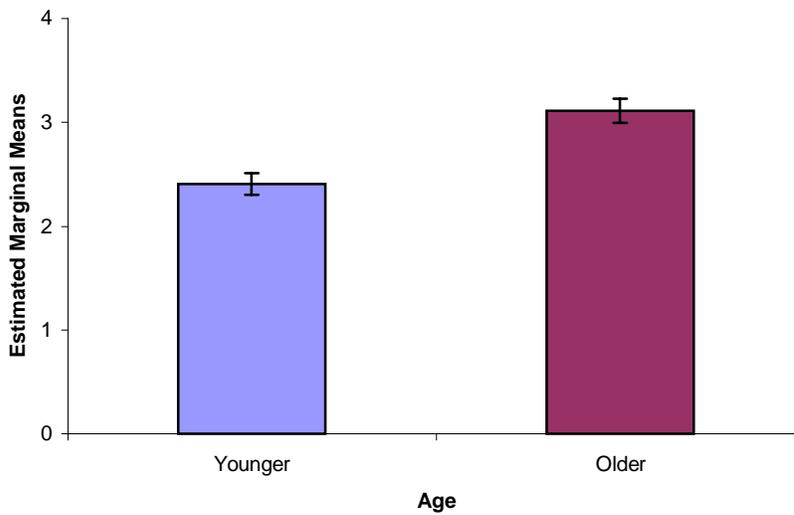


Figure 3. Main Effect of Age on Overall Recall. Estimated marginal means for overall recall for younger and older participants.

There is a final main effect of delay on overall recall, which had a moderate effect size.³ The estimated marginal means for overall recall of participants in the immediate recall condition were less than the estimated marginal means for older participants. This effect was also expected; there is a good deal of previous work showing that older children recall more information than younger children (e.g. Ornstein, Baker-Ward, Gordon and Merritt, 1997). Figure 4 shows this relationship graphically.

³ This moderate effect of delay on overall recall remained even after non-target items were removed from the analyses.

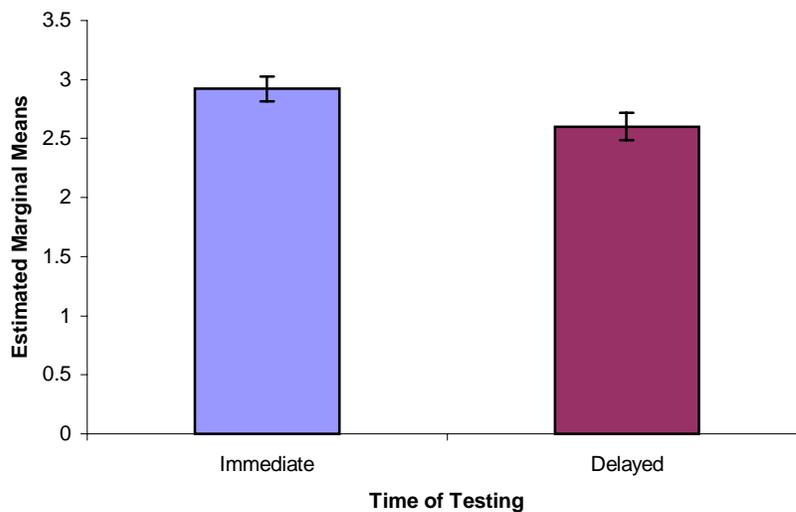


Figure 4. Main Effect of Delay on Overall Recall. Estimated marginal means for overall recall for participants in the immediate and delayed recall conditions.

A moderate effect size was observed in the interaction between question type and age. There seems to be a strong effect of age on overall recall, but the differences become more pronounced for non-target recall. There does seem to be a trend of a greater effect of age on non-target recall than plausible or implausible recall. Figure 5 shows this graphically.

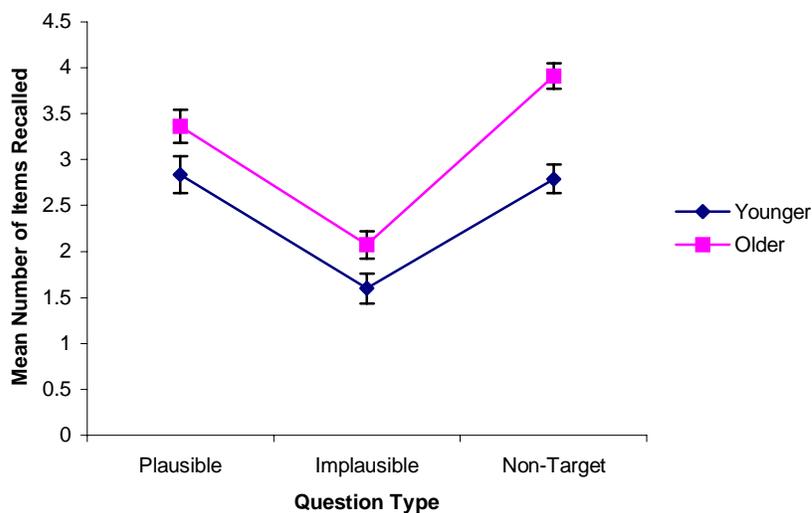


Figure 5. Two-way Interaction Between Age and Question Type on Overall Recall.

Mean number of items recalled overall for younger and older participants on plausible, implausible, and non-target question types.

It should be noted, also, that when the RM-ANOVA was rerun without the non-target items, this interaction disappeared completely. Thus, age differences in memory for non-target items were greater than age differences in memory for items related to chinchilla knowledge.

Finally, there was an interaction between question type, age, and delay that had a medium effect size. A very similar pattern of differences emerges in the immediate recall between younger and older participants. Plausible items were recalled more frequently than implausible items, for both younger and older participants. Non-target items are also recalled more frequently than implausible items, for both younger and older participants. It appears that both age groups recall similar amounts of plausible and non-target information. The interaction becomes evident in the delayed condition. Whereas younger children show the same pattern as participants in the immediate recall condition – with plausible and non-target items recalled more than implausible items, and no significant difference between plausible and non-target items – a different pattern emerges among the older children. Non-target items are recalled more than plausible items, which in turn are recalled more than implausible items. In fact, when the RM-ANOVA was rerun without the non-target items, this interaction disappeared completely. Figure 6 shows this three-way interaction graphically.

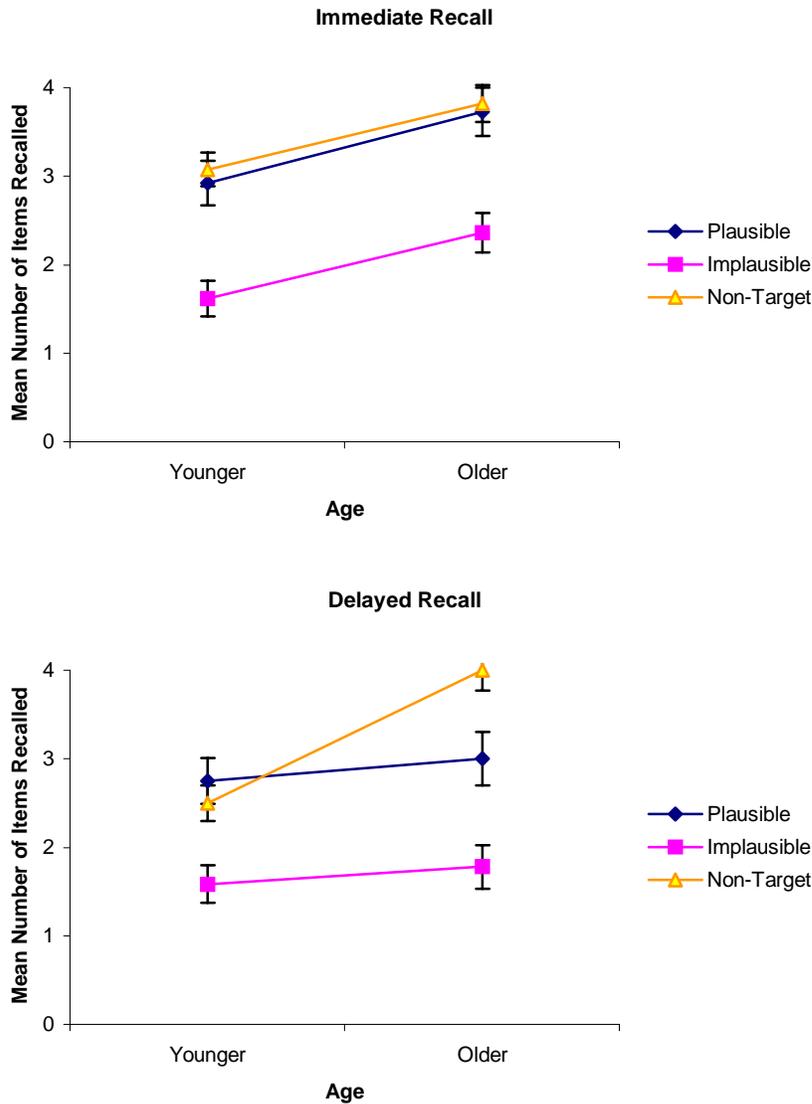


Figure 6. Three-way Interaction Between Age, Delay, and Question Type on Overall Recall. Mean number of items recalled overall for children of both ages in the immediate recall (above) and delayed recall (below) on plausible, implausible, and non-target question types.

Open-Ended Recall

These analyses all examined overall recall, collapsing scores across open-ended, closed, and specific recall. It is possible that important group differences could emerge at the open-ended level of recall, where only very general prompts were given (e.g. “Tell me everything that

happened in the chinchilla story.”). Given this possibility, another mixed between-within analysis of variance was conducted. The same between-subjects factors (age and time of interview) and within-subject factor (question type) were used. The sole difference for these analyses is that closed and specific instances of recall will not be included. Table 3 shows a summary table of the RM-ANOVA.

Table 3

ANOVA Summary of Open-Ended Recall

Source	<i>df</i>	<i>F</i>	η_p^2	<i>p</i>
Between subjects				
Age (A)	1	22.653	.356	.001
Delay (D)	1	2.048	.048	.160
A * D	1	.042	.001	.838
S within-group error	41	(1.445)		
Within subjects				
Question type (Q)	1.361	33.669	.451	.001
Q * A	1.361	6.761	.142	.006
Q * D	1.361	.650	.016	.469
Q * A * D	1.361	1.864	.043	.175
Q * S within-group error	55.818	(.988)		

Note. Values enclosed in parentheses represent mean square errors.

For main effects, there was a large effect size of question type and age, and small-to-moderate effect size of delay. There was also a large effect size for the interaction between question type and age, a small effect size for the interaction between question type and delay, and a small-to-moderate effect size for the three-way interaction between question type, age, and delay.

First, there was a main effect of question type on open-ended recall with a large effect size. The number non-target items recalled was more than the number of plausible and implausible items recalled. Thus, it appears children have less difficulty recalling the aspects of the chinchilla story than were unrelated to knowledge of chinchillas. Figure 7 shows this relationship graphically.

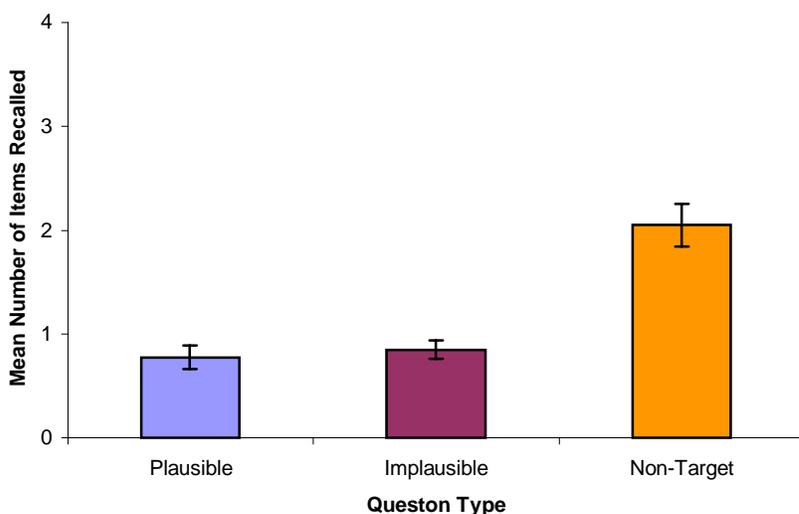


Figure 7. Main Effect of Question Type on Open-Ended Recall. Mean number of items recalled at open-ended level for plausible, implausible, and non-target question types.

Further support for this conclusion emerged when analyses were conducted again with non-target items removed, as the main effect of question type disappeared completely.

Next, there was a main effect of age on open-ended recall that also had a large effect size.⁴ The estimated marginal means for overall recall of younger participants were less than the estimated marginal means for older participants. Thus, as would be expected, older children are recalling more information at the open-ended level than younger children. Figure 8 shows this relationship graphically.

⁴ This large effect of age on overall recall remained even after non-target items were removed from the analyses.

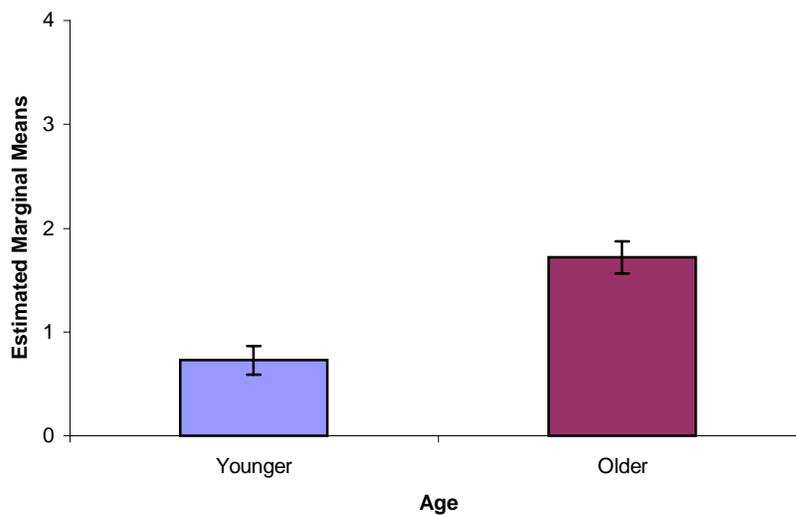


Figure 8. Main Effect of Age on Open-Ended Recall. Estimated marginal means for open-ended recall for younger and older participants.

There was also a small-to-moderate effect size of delay on overall recall. The estimated marginal means for overall recall of participants in the immediate recall were less than the estimated marginal means for participants in the delayed recall. Thus, as would be expected, children are recalling less information over time. Figure 9 shows this relationship graphically.

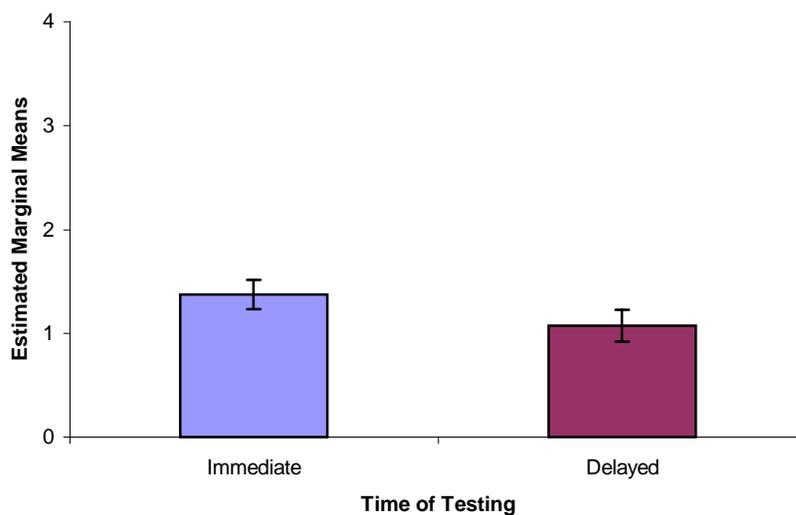


Figure 9. Main effect of Delay on Open-Ended Recall. Estimated marginal means for open-ended recall for participants in the immediate and delayed recall conditions.

This effect was actually strengthened when non-target items were deleted from the analyses. Delay emerged as a moderate-to-large predictor ($\eta_p^2 = .101$) of open-ended recall for items related to chinchilla knowledge.

There was an interaction between question type and age that had a large effect size.⁵ For the younger group, non-target items were significantly recalled more frequently than plausible items, and were significantly recalled more frequently than implausible items. For the older group, the same pattern emerges, but the differences are greater. Non-target items were recalled more frequently than plausible items, and were recalled more frequently than implausible items. While there seems to be a strong effect of age on open-ended recall, there seems to be a disproportional effect of age on non-target recall. Figure 10 shows this relationship graphically.

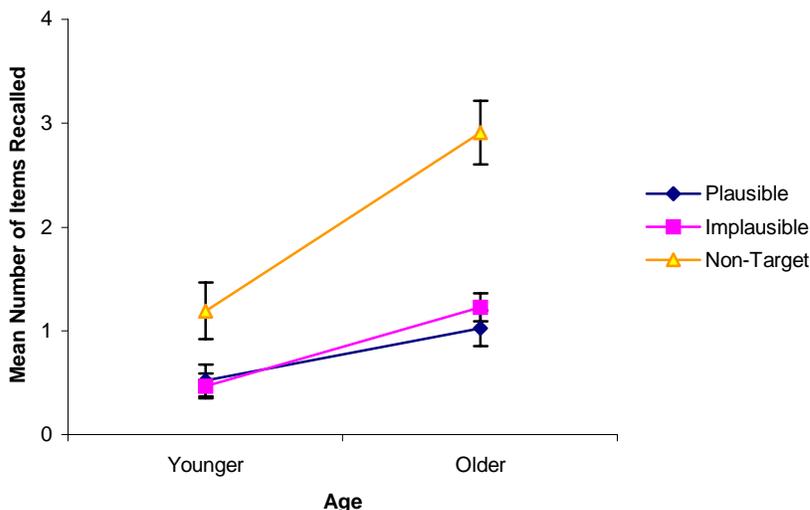


Figure 10. Two-way Interaction Between Age and Question Type on Open-Ended Recall.

Mean number of items recalled at the open-ended level for younger and older participants.

There was also an interaction between delay and question type, although it was a small effect size. Non-target items are recalled more than plausible or implausible items at both

⁵ When non-target items were deleted, there was still an interaction between question type and age. However, this interaction then only had a small effect size.

delays. The interaction seems to emerge when recall for plausible and implausible events are compared. At the immediate recall, implausible items were recalled more than plausible items. However, at the delayed recall, plausible items are better recalled than implausible items. Thus, it seems that as one moved away farther away from the to-be-remembered event, memory for implausible events shows a greater decline than memory for plausible and non-target events. Figure 11 shows this relationship graphically.

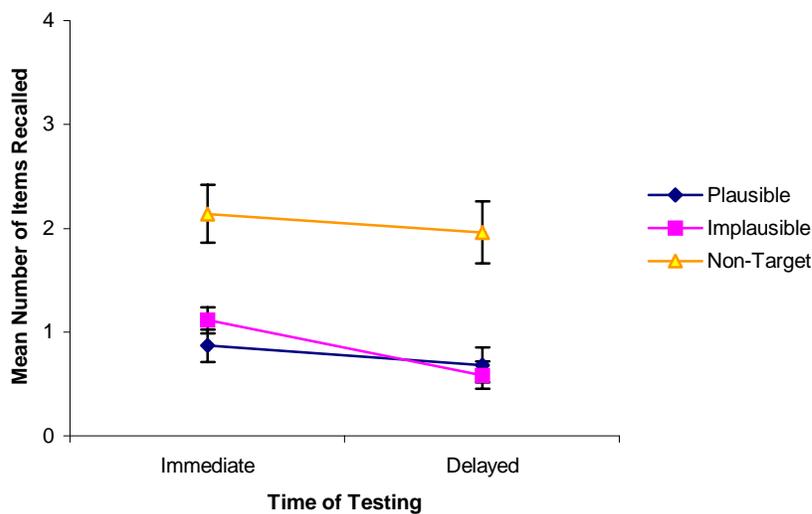


Figure 11. Two-way Interaction Delay and Question Type on Open-Ended Recall.

Mean number of items recalled at the open-ended level for younger and older participants.

Further support for this interaction between plausible and implausible items emerged when non-target items were deleted from the analyses. When non-target items were deleted, the interaction between delay and question type was strengthened, with a moderate small-to-moderate ($\eta_p^2 = .046$) effect size.

Finally, there was a three-way interaction between question type, age, and delay, which had a small-to-moderate effect size.⁶ This interaction is a little more difficult to interpret, but it appears that as we move from immediate to delayed recall, memory performance decreases,

⁶ This interaction remained with a small-to-moderate effect size when non-target items were deleted.

except for non-target recall in the older children. Thus, it seems that non-target items are salient enough for the older children that, for these items, there is no observed decline in memory performance. Figure 12 shows this relationship graphically.

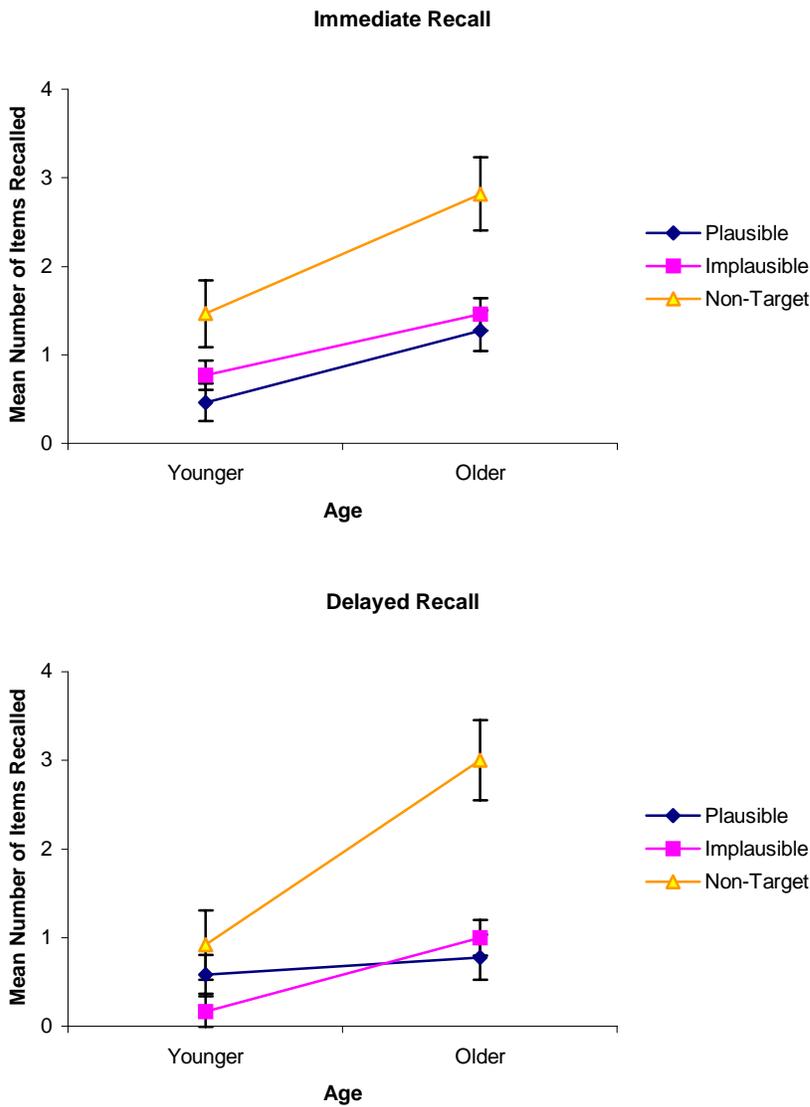


Figure 12. Three-way Interaction Between Age, Delay, and Question Type on Open-Ended Recall. Mean number of items recalled overall for children of both ages in the immediate recall (above) and delayed recall (below) on plausible, implausible, and non-target question types.

Suggestibility Performance

According to the predictions made by fuzzy trace theory, two hypotheses emerge:

1. In both the immediate and delayed recall, older children (Groups 3 and 4) will be more suggestible to plausible items than implausible items, whereas younger children (Groups 1 and 2) will show no differences in suggestibility between items, due to their lesser understanding of plausibility.
2. Older children will be more prone to plausible suggestion in the delayed recall condition (Group 4) than in the immediate recall condition (Group 3) because of the greater reliance on gist memory as verbatim decays.

False Alarms - Specific

To test these hypotheses, a mixed between-within analysis of variance was conducted. Thus, this analysis examined false alarms at the specific level, or erroneous information provided to the misleading yes/no questions. When false alarms were collapsed across closed and specific levels, no effects of age, delay, or question type emerged. In addition, as there were only two cases of false alarms emerging at the open-ended level, these intrusions are not included in these analyses. Correct denials are not considered in these analyses as they are simply the inverse of false alarms. It is for these reasons that specific false alarms are solely reported in these analyses. The same between-subjects factors (age and time of interview) and within-subject factor (question type) were used. Table 4 shows a summary table of the RM-ANOVA.

Table 4

ANOVA Summary of Specific False Alarms

Source	<i>df</i>	<i>F</i>	η_p^2	<i>p</i>
Between subjects				
Age (A)	1	2.167	.050	.149
Delay (D)	1	4.002	.089	.050
A * D	1	1.843	.043	.182
S within-group error	41	(1.112)		
Within subjects				
Question type (Q)	1.745	6.851	.143	.003
Q * A	1.745	2.616	.060	.087
Q * D	1.745	3.390	.145	.044
Q * A * D	1.745	.482	.012	.594
Q * S within-group error	71.550	(.340)		

Note. Values enclosed in parentheses represent mean square errors.

For main effects, there were a large effect size of question type, and a small-to-moderate effect size of age, and a medium effect size of delay. There were also a small-to-moderate effect size for the interaction between delay and age, a medium effect size for the interaction between question type and age, a large effect size for the interaction between question type and delay, and a small effect size for the three-way interaction between question type, age, and delay.

First, there was a main effect of question type on specific (yes/no) false alarms, with a large effect size.⁷ The number of implausible false alarms was less than the number of plausible and non-target false alarms. Thus, as would be expected, children in general were less susceptible to suggestion when the suggested event was implausible given their knowledge of chinchillas. See Figure 13 for a graphical depiction of this.

⁷ This large effect size of question type remained after non-target items were deleted from the analyses.

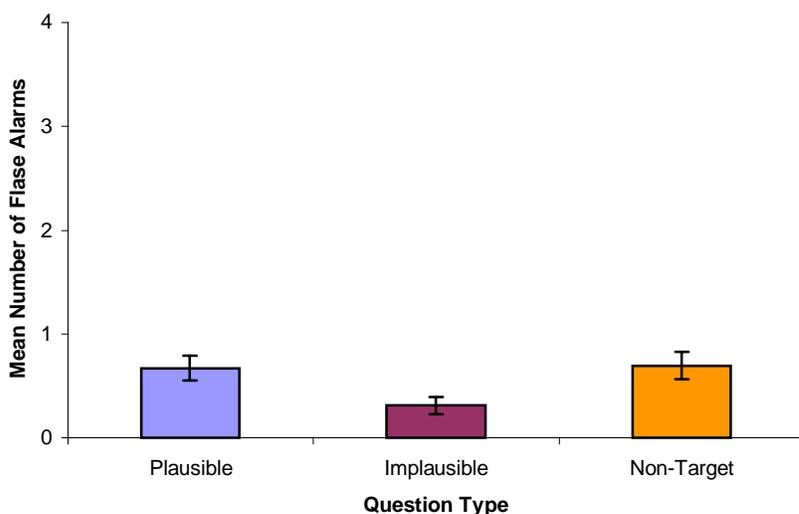


Figure 13. Main Effect of Question Type on Specific False Alarms. Mean number of false alarms for plausible, implausible, and non-target question types.

There was also a main effect of age of false alarms, with a small-to-moderate effect size. As expected, younger children displayed more false alarms than the older children. Thus, age seems to serve as a protective factor against susceptibility to suggestion. See Figure 14 for a graphical depiction of this.

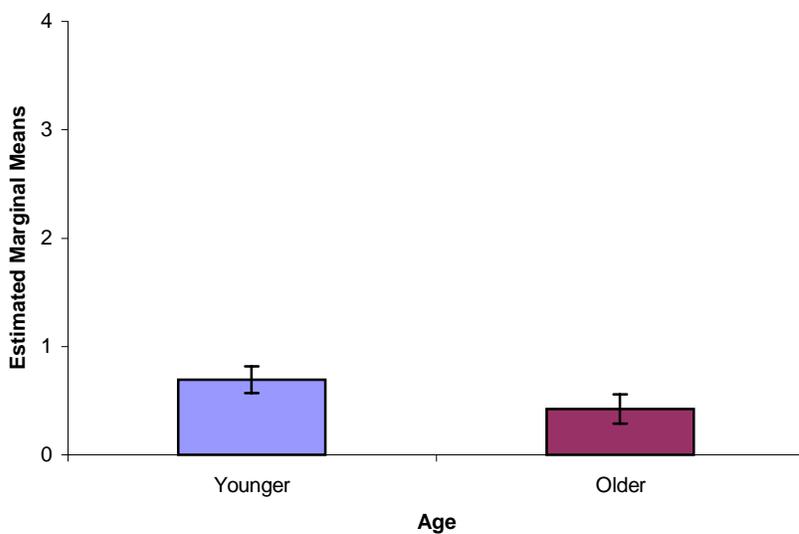


Figure 14. Main Effect of Age on Specific False Alarms. Mean number of false alarms for younger and older children.

This main effect of age remained, but only had a small effect size, when non-target items were deleted.

Next, there was a main effect of delay on specific (yes/no) false alarms, with a moderate effect size of delay.⁸ Those in the immediate recall condition displayed fewer false alarms than those in the delayed recall. This would be predicted by fuzzy trace theory (Reyna & Brainerd, 1995), as susceptibility to suggestion increases as the delay between the to-be-remembered event and recall increases. See Figure 15 for a graphical depiction of this relationship.

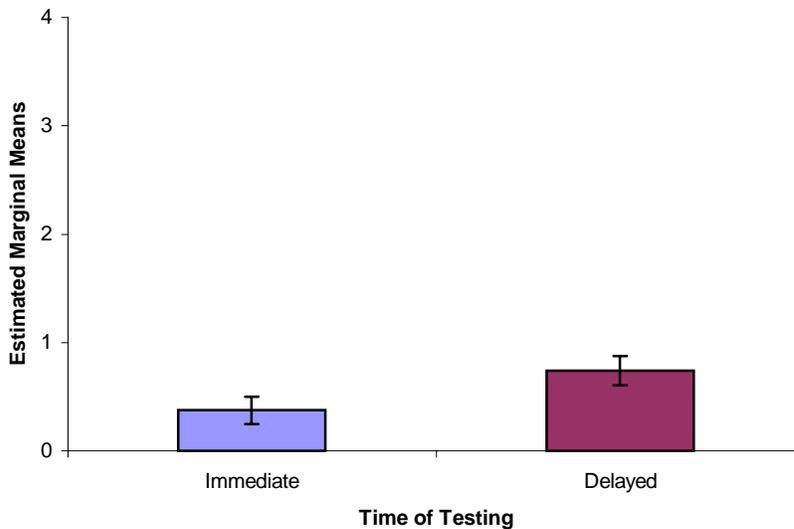


Figure 15. Main Effect of Delay on Specific False Alarms. Estimated marginal means for false alarms for participants in the immediate and delayed recall conditions.

There was an interaction between age and delay that showed a small-to-moderate effect size. Here, we see little difference between the age groups in their number of false alarms at the immediate recall. Also, the number of false alarms seems to increase with delay. However, as expected, we see a disproportionate effect of delay on the younger children's number of false alarms. See Figure 16 for a graphical depiction of this interaction.

⁸ This moderate effect size of delay remained after non-target items were deleted from the analyses.

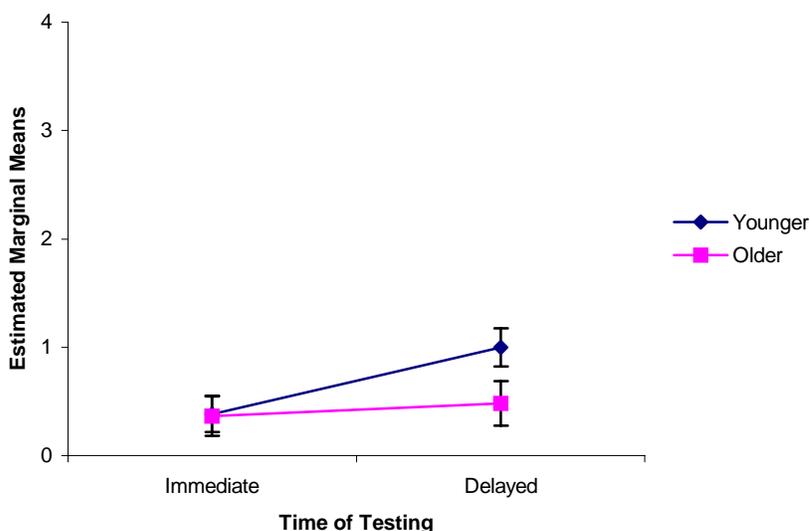


Figure 16. Two-way Interaction Between Delay and Age on Specific False Alarms.

Mean number of false alarms of younger and older participants in both delay conditions.

This effect was strengthened when non-target items were deleted from the analyses; the interaction between delay and age now had a moderate effect size.

There was also a moderate interaction between question type and age in the analyses of specific false alarms.⁹ Younger children showed more suggestibility to plausible and non-target items than implausible items. We see a different pattern in the older children, however, as there are no significant differences in suggestibility between the types of questions. Also, the question type in which there are the largest age differences is non-target suggestibility, with younger children showing a good deal more suggestibility than older children. Figure 17 shows these effects graphically.

⁹ This effect remained after non-target items were deleted, but the effect size was then small.

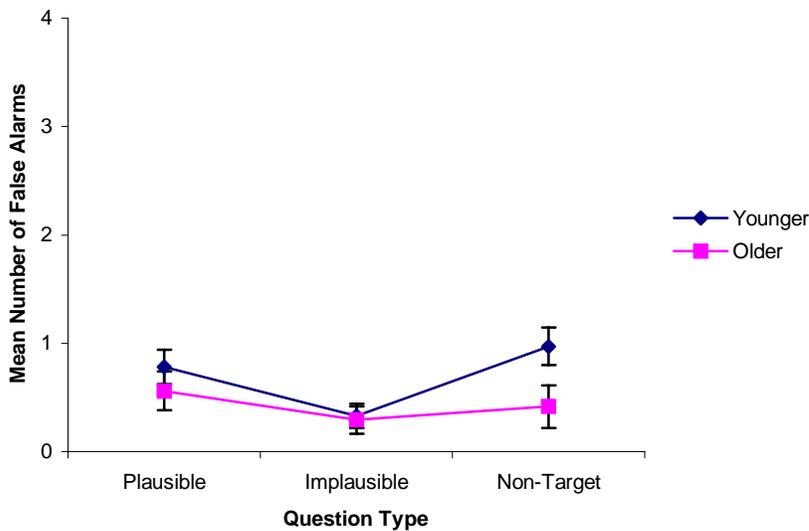


Figure 17. Two-way Interaction Between Age and Question Type on Specific False Alarms.

Mean number of false alarms in younger and older participants for plausible, implausible, and non-target question types.

It is also worth noticing how little the two age groups differ in their false alarms for implausible events. It may be that both groups had knowledge activated and were able to judge these items as relatively implausible, and thus were equally unlikely to show suggestibility.

Next, there was an interaction between question type and delay, with a large effect size. In the immediate recall, there are no differences between the question types.¹⁰ However, in the delayed recall, children were more likely to show suggestibility effects for plausible and non-target than implausible items. Also, the question type in which there the largest delay differences is plausible suggestibility, with delayed interviews containing more plausible false alarms than immediate interviews. Figure 18 shows this relationship graphically.

¹⁰ This effect size remained large even after non-target items were deleted from the analyses.

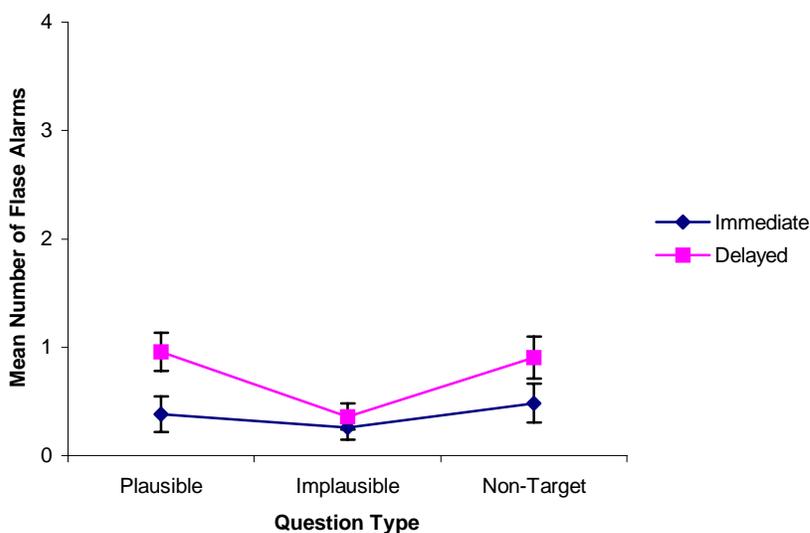


Figure 18. Two-way Interaction Between Delay and Question Type on Specific False Alarms.

Mean number of false alarms in delayed and immediate interviews for plausible, implausible, and non-target question types.

It seems that while with increased delay there is a concomitant increase in suggestibility, this effect is reduced for implausible question types. This may be evidence that participant knowledge about chinchillas is active as they judge whether something happened in the chinchilla story.

Finally, there was a three-way interaction between age, delay, and question type, albeit one with a small effect size.¹¹ As delay increases, we see that older children move to more suggestibility for plausible questions and less suggestibility to implausible questions. On the other hand, younger children show increases in suggestibility for both plausible and implausible suggestion as delay increases, albeit a larger increase for plausible suggestion. See Figure 19 for a graphical depiction of this interaction.

¹¹ The effect size remained small after non-target items were deleted.

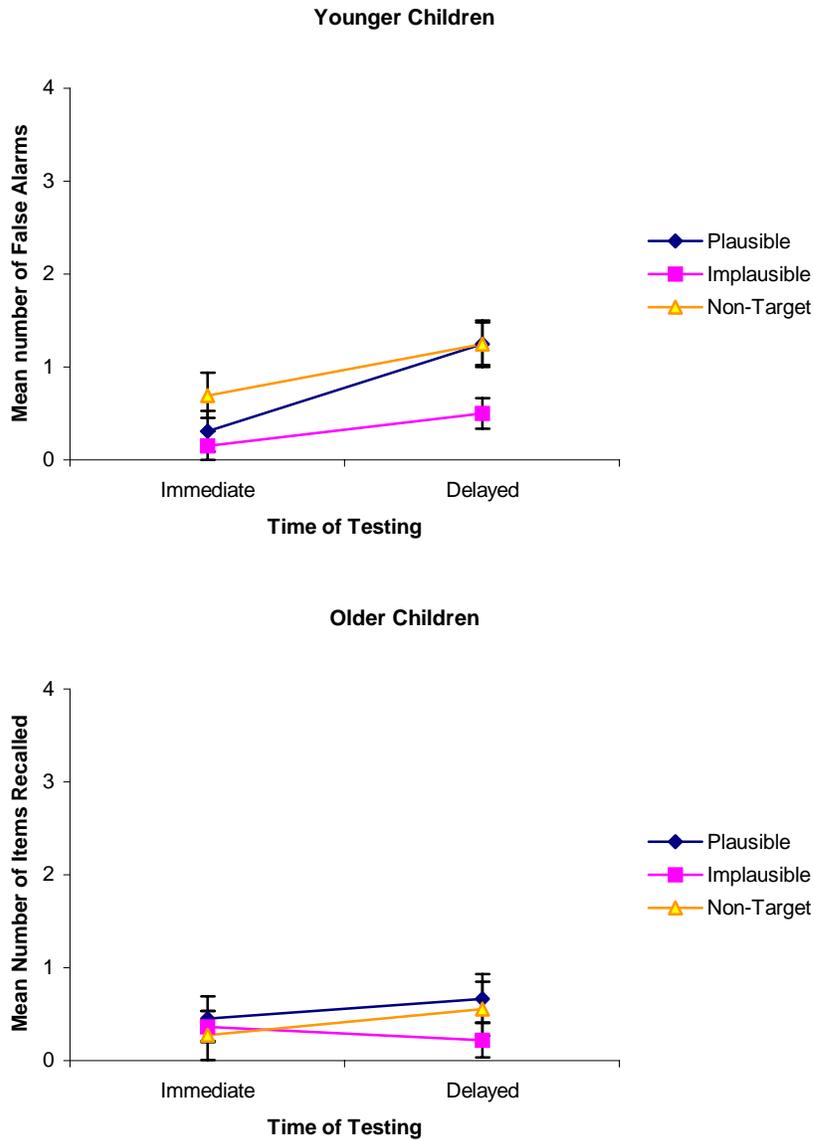


Figure 19. Three-way Interaction Between Age, Delay, and Question Type on Specific False Alarms.

Mean number of false alarms overall in both delay conditions for younger (above) and older children (below).

Discussion

This study offers evidence that age, delay, and the plausibility of questions asked affect children's memory and suggestibility for a previously experienced event. This discussion will first examine the effects of age, delay, and question plausibility on recall. Then, there will be a

consideration of the effects these variables had on suggestibility. Finally, the limitations of this study will be outlined, and appropriate conclusions made.

Memory

To summarize the memory findings, there was a large effect of age on both open-ended and overall recall, as expected, indicating that children in the older group remembered more features of the chinchilla story than the younger children (see Figures 3 and 8). Also, there was moderate effect of delay for overall recall (this effect was small-to-moderate for open-ended recall), indicating that as the testing moved farther away from the to-be-remembered event less information was recalled (see Figure 4). These main effects of age and delay are not surprising. In fact, there is a substantial amount of literature indicated that with increasing age, more information is recalled (Ornstein, Shapiro, Clubb, Follmer, & Baker-Ward, 1997) and that with increasing delay, recall decreases (Reyna & Brainerd, 1995).

There were also large main effects of question type on both open-ended and overall recall. These main effects deserve a closer examination. The main effect of question type on open-ended recall, where non-target items are recalled the most frequently (see Figure 7), may be due to a fault with the study design. It could be that non-target items were more salient in general than either plausible or non-plausible items. For example, one non-target item involved recalling that the protagonist received the chinchilla for her birthday. As this is probably the central piece of the chinchilla story, it may not be surprising that children recalled more non-target items at the open-ended level. Non-target items were intended to provide a measure of general recall ability, absent of knowledge effects, for all groups. Unfortunately, these non-target items may in fact be tapping into the children's knowledge, not of chinchillas, but of

things like birthdays. These non-target questions, for both recall and suggestibility, probably tap into the children's schemas for things like birthdays, from which plausibility may be judged when making decisions. These schemas may be more ingrained than knowledge about chinchillas, which may have led to the observed main effect (Nelson, 1986).

It might also be worthwhile to draw a comparison between Figure 7 (Open-ended recall by question type) and Figure 2 (Overall recall by Question type). At the open-ended level of recall, only non-target items are recalled reliably. However, this same pattern is not seen when overall recall is examined. When children are given more specific, directed prompting, their recall for plausible items resembles that of non-target items. This may be further support for the idea that knowledge about things like birthdays is more readily accessible, as these aspects of the story are recalled well at the open-ended level. However, knowledge about chinchillas may have been activated through directed prompting. It is in overall recall that differences emerge given the relative plausibility of question type and recall of plausible items begins to approximate non-target recall.

In addition to the main effects of age and delay, there was also a large interaction between question type and age in open-ended recall (this interaction was moderate for overall recall). For both older and younger children, there does not appear to be any difference between the number of plausible and implausible events recalled. For both groups, children remember more non-target events than either plausible or implausible events, with this effect stronger in the older group (see Figure 10). The effect can probably be partially explained if the non-target items were indeed more salient features of the chinchilla story. But why would older children recall a disproportional amount of non-target items? Fuzzy trace theory (Reyna & Brainerd, 1995) provides evidence that with age comes a greater ability to use gist traces. If these non-

target questions are central to the story, they may have been easily converted to the gist traces that would provide an organizing framework for the chinchilla story. Thus, older children may remember this disproportional amount of non-target items as they have a greater ability to use gist memory.

Although the effect size was small, there was also an interaction between delay and question type at the open-ended level. At the immediate recall, more implausible items were recalled than plausible items. However, at the delayed recall, plausible items are better recalled than implausible items (See Figure 11). While the effect size is small, this pattern fits very well with fuzzy trace theory. When verbatim traces are likely activated in the immediate recall, implausible information is remembered better. However, at the delayed recall, gist should be relied upon more, and plausible events are better recalled. The effects seen at immediate recall map onto previous research fairly well. Here, we find support for previous research findings where some studies indicate better recall for implausible information (Pezdek, Whetstone, Reynolds, & Askari, 1989) and other studies indicate better recall for plausible information (Bigler & Liben, 1993). Thus, it may be that delay predicts whether plausible or implausible features are more frequently recalled.

Finally, there was a moderate three-way interaction between age, delay, and question type on overall recall. For younger participants in the immediate and delayed recall groups, and for older participants in the immediate recall group, implausible items are recalled with less frequency than either plausible or non-target items. However, a different pattern emerges for older participants in the delayed recall groups, with non-target items recalled more than plausible items, which in turn are recalled more than implausible items (see Figure 6). It seems that the number of non-target items recalled in older children is relatively unaffected by delay. This is

once again more support for the idea that non-target items were central to the chinchilla story, and that older children's reliance on gist traces (which decay slowly) allow them to recall a disproportional number of non-target items in the delayed recall condition.

So how do these results fit with the original hypotheses about recall? It was predicted that in the immediate recall condition, older children's greater ability to understand event plausibility would lead to a better recall of implausible than plausible information, whereas in younger children the differences would be smaller. In the delayed recall condition, it was predicted that older children's greater ability to understand event plausibility would lead to a better recall of plausible than implausible information, because of their reliance on gist memory after verbatim traces have decayed. Younger children, on the other hand, would still show smaller differences. Unfortunately, this predicted 3-way interaction does not seem to find a lot of support in the data. While there was a three-way interaction between age, delay, and question type, it is non-target items that are behind this interaction, and this has nothing to do with the manipulation of plausibility given knowledge of chinchillas. In fact, when analyses are run excluding non-target items, the three-way interaction disappears completely.

However, as seen in Figure 11, there does seem to be a pattern of better recall for implausible items at the initial testing, and better recall for plausible items at the delayed testing. This does seem to provide some support for the predicted delay by question type interaction. However, as just noted above, it does not appear that age interacts with delay and question type when non-target items are excluded. It may be that the age groups are not separated by enough years to reveal this expected interaction. Given a lack of theoretical rationale for the age groups used, this is a possibility that should be addressed in future research.

Suggestibility

To summarize the suggestibility findings, there was a small-to-moderate effect of age on suggestibility to specific misleading questions. As would be expected, older children showed less susceptibility to suggestion than their younger counterparts (See Figure 14). This effect of age on suggestibility is not surprising, as there is a vast amount of research backing this finding (Bruck, Ceci, Francouer, & Barr, 1995; Leichtman & Ceci, 1995; Loftus & Pickrell, 1995).

There was also a moderate main effect of delay for specific false alarms, indicating that as the testing moved farther away from the to-be-remembered event there was increased susceptibility to suggestive questions (see Figure 15). Like the main effects of age and delay on recall, this main effect of delay on suggestibility is also not surprising. Reyna and Brainerd's fuzzy trace theory (1995), for example, shows that susceptibility to suggestion increases as delay increases.

There was also a large main effect of question type on specific false alarms. Here, children were less susceptible to suggestion when the suggestive question was implausible given their knowledge of chinchillas (see Figure 13). Given that children were more suggestible to plausible than implausible questions, it may be that children did have knowledge of chinchillas active as they made their decisions. Without a separate measure of children's knowledge of chinchillas, however, it is hard to say with certainty that knowledge of chinchillas created these differences between plausible and implausible question types.

In addition to the main effect presented above, there was a small-to-moderate interaction between age and delay. While there was little difference in suggestibility at immediate recall between younger and older children, differences emerge in the delayed recall condition. Here, younger children show a disproportionate number of false alarms when compared to their older

counterparts (See Figure 16). It is interesting to note that the younger and older children's performance is very similar when testing occurs soon after the to-be-remembered event. The effects of age on suggestibility seem to become evident as delay increases.

There was a moderate interaction between age and question type. Older children showed no differences by question type in their suggestibility. However, younger children were more suggestible to both plausible non-target misleading questions (see Figure 17). Also, younger and older children scored showed virtually the same suggestibility to implausible misleading questions. Thus, while younger children may show more suggestibility overall, knowledge of typical chinchilla behavior may serve as a protective factor against endorsing implausible misleading questions for both age groups

There was also a large effect size seen in the interaction between question type and delay. There are no differences by question type on suggestibility in the immediate recall, but in the delayed recall, plausible and non-target misleading questions induce more false alarms (See Figure 18). With increased time between the to-be-remembered event and testing, suggestibility increases. However, there is very little increase in suggestibility for implausible items. Therefore, it once again seems safe to assume that knowledge is working here as a protective factor for implausible items. At the same time, this knowledge may increase the probability of falling for a plausible misleading question.

Finally, there was a three-way interaction between age, delay and question type on suggestibility, albeit one with a small effect size. For the younger children, as delay increases, suggestibility also increases for all question types. In the older children, however, a different pattern emerged. Over time, older children showed increased suggestibility to plausible question types, but showed decreased (or at least stable) suggestibility to implausible questions (See

Figure 19). This perhaps provides the best evidence for differences by age in children's use of knowledge when asked misleading questions. Only in older children do we see declines in any of the measures of suggestibility over time.

So how do these results fit with the original hypotheses about suggestibility? It was predicted that older children, because of their greater ability to understand plausibility, would be more prone to plausible than implausible suggestions, whereas younger children would be equally prone to plausible and implausible suggestions. Older children in the delayed recall condition would be even more prone to suggestion than in the immediate recall because of their growing reliance on gist traces, whereas younger children will be equally prone to plausible and implausible suggestions.

In Figure 19, there might be some support for these hypotheses. This three-way interaction between age, delay, and question type that somewhat fits the hypothesized pattern of differences for false alarms. Older children move to more suggestibility for plausible questions and less suggestibility to implausible questions, as delay increases. On the other hand, younger children show increases in suggestibility for both plausible and implausible suggestion as delay increases, albeit a larger increase for plausible suggestion. This pattern is perplexing at first, but fuzzy trace theory may help make some sense of this. For the older children in the immediate delay, it may be that verbatim recall is primarily being used here, as it has not had time to decay. Therefore, older children at this time of testing may not be using their knowledge as much as verbatim traces when making judgments about whether something happened or not. Thus, we see the very small differences between plausible and implausible false alarms in older children in the immediate delay. However, in the delayed recall, there are much larger differences between plausible and implausible question types. Here, verbatim traces may have decayed, leaving older

children with only gist. When judging whether an event happened, children may lean more on knowledge for their decisions. Thus, this may cause the pattern of increased susceptibility to suggestion when the item is plausible given knowledge of chinchillas and decreased susceptibility when the question is implausible.

Limitations and Conclusions

There are a few limitations in this study that make interpretation difficult. First, there is a rather small sample size of 45, considering there are two between group variables in age and delay. For example, the Older Delay group only had 9 total participants. Further work exploring these relationships should strive to include more participants to help avoid any Type II errors.

In the design of this study, there was no strong rationale for the ages of children to be studied. Some of Brainerd's Fuzzy Trace work (e.g. Brainerd & Reyna, 1996; Brainerd, Reyna, & Brandse, 1995) looked at memory for familiar concrete nouns in children between the ages of 5 and 8. In the present experiment, children were tested for their memory of more abstract concepts (e.g. trait-defining features of a chinchilla). Because these concepts may be harder to grasp, the decision was made to use slightly older children than those used in Brainerd's studies. It may be that more distinct age groups are needed for the predicted interactions to occur. There was only about two years difference between the averages of the two age groups. Brainerd, Reyna, and Forrest (2002) found vulnerability to suggestion increases as one moves from childhood, to adolescence, and finally adulthood. It may be that it is not until the teenage years that we might see a pattern of more implausible items recalled at immediate recall, and more plausible at delayed recall. This is certainly worth further investigation.

This study used a within-subject knowledge manipulation of knowledge, namely by presenting plausible, implausible, and non-target questions. It would have been beneficial to have had a between-subject knowledge manipulation also. This would most likely come in the form of a control group that would receive no knowledge of chinchillas. Comparisons between a control group and a knowledge group would enable the research to say with certainty that knowledge affected the relative plausibility of each question, which led to the observed differences in memory and suggestibility.

It also would have been ideal to have had an assessment of each participant's knowledge of chinchillas. This would have served as a valuable manipulation check to ensure that children of both ages had the knowledge available when asked to remember the chinchilla story. It also could have been useful as a covariate in analyses, as the researcher could have controlled for knowledge differences. Also, without this independent assessment of knowledge, the researcher is unable to say with certainty that knowledge produced the observed differences between plausible and implausible question types. It is a little hard to come up with a good alternative explanation for these differences, other than the possibility that the questions themselves were imperfect. For example, it could be that the plausible questions assessed memory for items that were overall more salient than the implausible questions. Future research should include an independent knowledge assessment to help disentangle these two explanations.

Finally, there are some concerns about the statistics used to analyze that data. First of all, as discussed before, there were considerable violations of the assumptions made when using a repeated-measures analysis of variance (RM-ANOVA). Because the assumptions of sphericity and equality of covariance matrices were violated, it is unlikely that the RM-ANOVA would produce unbiased p-values, but we do not know whether they will be conservative or liberal.

Because of this, the p-values provided in the RM-ANOVA are functionally useless (D. Bauer, personal communication, 2004). For this reason, effect sizes are interpreted instead of p-values. While this is a limitation, interpretation of effect sizes may be considered a strength also, as effect sizes are often either not considered or not reported in the literature (Cohen, 1988). Examining the distributions of the dependent measures reveals why so many of the assumptions were violated. There is very little variability within each of the outcome variables; each question type only had a total of four events associated with it. To further complicate matters, the distributions were highly skewed positively for recall, and negatively for suggestibility. In other words, children generally remembered a high proportion of the events that happened, and did not show a lot of suggestibility for events that did not happen. Future research should strive to increase the number of questions within each question type to increase the variability within the dependent measures.

In addition, the RM-ANOVA may not have been the optimal statistical tool for these analyses. If my data were a screw, then using an RM-ANOVA is like using a hammer (D. Bauer, personal communication, 2004). Obviously, what is needed for the job is a screwdriver, or less metaphorically, a multilevel logistic regression model. This technique is becoming increasingly popular for modeling dichotomous data (Hedeker, in press). The RM-ANOVA does not really allow me to test my hypotheses relating to the plausibility of question type. What is of most interest was whether there would be person by plausibility interactions, and these hypotheses in essence remain to be tested. A multilevel logistic model would allow for these hypotheses to be directly tested, as analysis occurs at the level of both person and question type. Future research in this area should employ statistical tools that are better able to uncover the relationships between age, delay, and plausibility.

As proposed earlier, judgments of the plausibility of an event, given one's knowledge, do seem to predict both recall and suggestibility. Plausible events are better remembered than implausible events and plausible misleading questions are more likely to lead to suggestibility than implausible questions. Older children, as would be expected, show better recall and patterns of lower suggestibility than younger children. Delay as served as a good predictor, as increased delay was associated with both poorer recall and increased suggestibility. The exact nature of how these three variables interact is probably still yet to be determined. Research in this area is still in the early stages, but the increasing understanding of plausibility across the childhood years may serve yet emerge as a significant predictor of recall and suggestibility. More in-depth and careful exploration of the relationships between age, delay, and plausibility may shed light on the mechanisms behind recall and suggestibility.

The present research is unable to clearly define the roles of age and plausibility in children's recall and suggestibility. However, the evidence provided here does seem to have some applications to children's eyewitness testimony. Children may be able to better recall implausible events after a short delay, and plausible events after a longer delay. This is an important finding, as many events that children might be asked to testify about may be implausible given their normal range of experience. Also, most of the literature indicates that younger children are usually more prone to suggestion. The present research replicates that finding. However, it also extends that finding, as older children may be more susceptible to plausible than implausible suggestion as delay increases. In this situation, older children should be expected to provide accounts of events that were expected but did not actually occur. Interviewers may want to take extra care in avoiding plausible misleading questions.

References

- Bahrick, L., Parker, J.F., Fivush, R., & Levitt, M. (1998). The effects of stress on young children's memory for a natural disaster. *Journal of Experimental Psychology: Applied*, 4, 308-331.
- Barrie, A. (1997). *Guide to Owning a Chinchilla*. T.F.H. Publications: New Jersey.
- Bigler, R.S., & Liben, L.S. (1993). A cognitive-developmental approach to racial stereotyping and reconstructive memory in Euro-American children. *Child Development*, 64, 1507-1518.
- Brainerd, C.J., & Ornstein, P.A. (1991). Children's memory for witnessed events: The developmental backdrop. In J.Doris (Ed.), *The suggestibility of children's recollections* (pp.10-20). Washington, DC: American Psychological Association.
- Brainerd, C.J. & Reyna V.F. (1996). Mere memory testing creates false memories in children. *Developmental Psychology*, 32 (3), 467-478.
- Brainerd, C.J., Reyna, V.F., Brandse, E. (1995). Are children's false memories more persistent than their true memories? *Psychological-Science*, 6 (6), 359-364.
- Brainerd, C.J., Reyna, V.F., & Forrest, T.J. (2002). Are young children susceptible to the false-memory illusion? *Child Development*, 73, 1363-1377.
- Bjorklund, D.F. & Jacobs, J.W. (1985). Associative and categorical processes in children's memory: The role of automaticity in the development of organization in free recall. *Journal of Experimental Child Psychology*, 39 (3), 599-617.
- Bruck, M., Ceci, S.J., Francouer, E., & Barr R.J. (1995). "I hardly cried when I got my shot!": Influencing children's reports of a pediatric examination involving genital touching. *Child Development*, 66, 193-208.
- Bull, R. (1995). Innovative techniques for the questioning of child witnesses, especially those who are young and those with learning disability. In *Memory and testimony in the child witness. Applied psychology: Individual, social, and community issues*. M.S. Zaragoza, J.R. Graham (Eds.) Thousand Oaks, CA: Sage Publications, pp. 179-194.
- Chase, W.G., & Simon, H.A. (1973). Perception in chess. *Cognitive Psychology*, 4, 55-81.
- Ceci, S.J. & Bruck, M. (1993). Suggestibility of the child witness: A historical review and synthesis. *Psychological Bulletin*, 113, 403-439.

- Chi, M.T.M. (1978). Knowledge structures and memory development. In R.S. Siegler (Ed.), *Children's thinking: What develops?* (pp. 73-96). Hillsdale, NJ: Erlbaum.
- Chi, M.T.M., Feltovich, P.J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science*, 5, 121-152.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd edition)*. New York: Academic Press.
- Daniels, L. (1999). *Chinchilla up the chimney (Animal Ark series)*. London: Hodder Children's Books.
- Greenhoot, A.M. (2000). Remembering and Understanding: the effects of changes in underlying knowledge on children's recollections. *Child Development*, 71, 1309-1238.
- Hedeker, D. (to appear). Multilevel models for ordinal and nominal variables. In Jan de Leeuw and Ita Kreft (Eds.), *Handbook for Quantitative Multilevel Analysis*. Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Hyman, I.E., Husband, T.H., & Billings, F.J. (1995). False memories of childhood experiences. *Applied Cognitive Psychology*, 9, 181-197.
- Leichtman, M.D., & Ceci, S.J. (1995). The effects of stereotypes and suggestions on preschoolers' reports. *Developmental Psychology*, 31, 568-578.
- Liben, L.S., & Signorella, M.L. (1980). Gender-related schemata and constructive memory in children. *Child Development*, 51, 11-18.
- Lindberg, M.A. (1980). Is knowledge base development a necessary and sufficient condition for memory development? *Journal of Experimental Child Psychology*, 30, 401-410.
- Loftus, E.F. (1975). Leading questions and the eyewitness report. *Cognitive Psychology*, 7, 560-572.
- Loftus, E.F., & Pickrell, J.E. (1995). The formation of false memories. *Psychiatric Annals*, 25, 720-725.
- Nelson, K. (1986). *Event knowledge: Structure and function in development*. Hillsdale, NJ: Erlbaum.
- Ornstein, P.A., Baker-Ward, L., Gordon, B.N., & Merritt, K.A. (1997). Children's memory for medical experiences: Implications for testimony. *Applied Cognitive Psychology*, 11, S87-S104.

- Ornstein, P.A., Merritt, K.A., Baker-Ward, L., Furtado, E., Gordon, B.N., & Principe, G. (1998). Children's knowledge, expectation, and long-term retention. *Applied Cognitive Psychology*, 12, 387-405.
- Ornstein, P.A., & Naus, M.J. (1985). Effects of the knowledge base on children's memory strategies. In H.W. Reese (Ed.), *Advances in child development and behavior* (Vol. 19, pp. 113-148). Orlando, FL: Academic Press.
- Pezdek, K., Finger, K., & Hodge, D. (1997). Planting false childhood memories: The role of event plausibility. *Psychological Science*, 8, 437-441.
- Pezdek, K. & Hodge, D. (1999). Planting false childhood memories in children: the role of event plausibility. *Child Development*, 70, 887-895.
- Pezdek, K., Whetstone, T., Reynolds, K., & Askari, N. (1989). Memory for real-world scenes: The role of consistency with schema expectation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 587-595.
- Reyna, V.F. & Brainerd, C.J. (1995). Fuzzy-trace theory: An interim synthesis. *Learning and Individual Differences*, 7, 1-75.
- Roediger, H.L. III, & McDermott, K.B. (1995). Creating false memories: Remembering words not presented on lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 803-814.
- Schneider, W., Gruber, H., Gold, A., Opwis, K. (1993). Chess expertise and memory for chess positions in children and adults. *Journal of Experimental Child Psychology*, 56, 328-349.

Appendix A

North Carolina State University INFORMED CONSENT FORM

Title: Children's memory for a personal experience

Principle Investigator: Benjamin Brown **Faculty Sponsor:** Dr. Lynne Baker-Ward

Your child is invited to participate in a research study. The purpose of the study is to examine the relation between knowledge and memory. The results of this study will also be used to understand how what children know affects what they remember.

INFORMATION:

In this study, participants will meet with a researcher on three occasions. At the first meeting, participants will be presented information on an animal-related topic. This meeting will last approximately 30 - 45 minutes. Within one week of the first meeting, participants will meet with another researcher and be read a story. This session should last approximately 30 - 45 minutes. Either one day or one week later, participants will meet with another research assistant. At this session, participants will be asked a number of questions pertaining to the information presented in earlier sessions. Upon completing the questioning, participants will be asked to take a brief test assessing their knowledge of the information presented. The third session should last approximately 30 minutes.

RISKS:

There are no known risks involved in being a part of this study.

BENEFITS:

Participants will learn information about an animal with which they will likely have had no previous experience. This study will provide investigators with information about developmental changes in knowledge and memory.

CONFIDENTIALITY:

The information in the study records will be kept strictly confidential. Data will be stored securely and will be made available only to the researchers unless given specific, written permission by you, the parent of the participant. No references will be made in oral or written reports that could link individual participants to the study.

COMPENSATION:

Participants in this study will receive no compensation for their participation in this study.

CONTACT:

If you have questions about the study or the procedures, you may contact the principle investigator, Benjamin Brown at Box 7801 or 919-481-9327. You may also contact his faculty advisor, Lynne Baker-Ward, also in the Department of Psychology, telephone 515-1731. If you feel you have not been treated according to the descriptions in this form, or your rights as a

participant in research have been violated during the course of this project, you may contact Dr. Matthew Zingraff, Chair of the NCSU IRB for the Use of Human Subjects in Research Committee, Box 7514, NCSU Campus (919/513-1834) or Mr. Matthew Ronning, Assistant Vice Chancellor, Research Administration, Box 7514, NCSU Campus (919/513-2148)

PARTICIPATION:

Your child's participation in this study is voluntary. If you decide to let your child participate, he/she may withdraw from the study at any time without penalty and without loss of benefit to which you are otherwise entitled. If he/she withdraws from the study before data collection is completed, the data will be destroyed.

CONSENT:

I have read and understand the above information. I have received a copy of this form. I agree to let my child participate in this study.

Parent's signature: _____ Date: _____
Investigators' signature: _____ Date: _____

Appendix B

Chinchilla Lecture Script

(Slide 1) Chinchillas are one of the most interesting animals you have probably never heard of. A chinchilla looks like a mix between a squirrel and a small rabbit. Chinchillas look like they have a rabbit's round, chubby body, large mouse-like ears

(Slide 2) and a squirrel's tail.

(Slide 3) Large hind legs help it hop like a kangaroo, and the small front legs and feet are like those of a squirrel.

(Slide 4) This rodent species typically weighs between 1 and 2 pounds. An adult is on average around 8 inches long and 4 inches wide.

(Slide 5) Baby chinchillas are very small. They can fit into teacups!

(Slide 6) Chinchillas originally came from the desert. At night it can get very cold in the desert. Chinchillas don't get cold, though, because their fur is so thick.

(Slide 7) As you can see, chinchillas have extremely soft fur.

(Slide 8) People realized that these animals would make great pets. Chinchillas have a long life for a pet. Many live between 15 and 20 years of age.

(Slide 9) Chinchillas become very attached to their owners and will even rub their heads on them to show affection. They will welcome your arrival with a soft "chinchilla chuckle."

(Slide 10) Chinchillas are usually gray, but come in many other colors. As you can see in the pictures, chinchillas come in purple, black, brown, and a mix of white and gray.

(Slide 11) Chinchillas are nosy animals. Here is the sound of a chinchilla barking.

(Slide 12) And here is the sound of a mad baby chinchilla.

(Slide 13) Chinchillas cannot see very well. This chinchilla has to get very close to this stuffed animal before she realizes it is not another chinchilla.

(Slide 14) Chinchillas are very curious, and they will jump around a room, exploring. Everything has to be investigated and tasted.

(Slide 15) Chinchillas love to fit into the tiniest spaces, like the top of this VCR.

(Slide 16) They have strong back legs that allow them to move very fast. Watch how fast this chinchilla run up these stairs.

(Slides 17, 18) Pet chinchillas usually have a wheel for running and exercise.

(Slide 19) Their strong back legs also allow them to do back flips.

(Slide 20) They are extremely agile and will jump onto everything within their reach. Sometimes they get themselves into trouble. This one looks like it might need some help getting down off a doorknob.

(Slide 21) Chinchillas like being with other chinchillas. In the wild they sometimes live in groups with 100 other chinchillas. Here we can see two chinchillas playing with each other. Chinchillas love playing with each other and will never fight.

(Slide 22) Chinchillas are nocturnal. That means they sleep during the day.

(Slide 23) At night, they are much more active and want to come out of their cage and explore. Here's a picture of two chinchillas waking up. It must be getting dark outside!

(Slide 24) Chinchillas will eat anything they can. That includes carpet, wallpaper, even the walls themselves...! This chinchilla is leaving teeth marks in a coaster.

(Slide 25) Here's we can see two chinchillas eating some twigs.

(Slide 26) Chinchillas are vegetarians, which means they don't eat any meat. Raisins are a special treat for chinchillas.

(Slide 27) This chinchilla can't wait to get a raisin!

(Slide 28) Chinchillas do not like getting wet. Chinchillas hate it when water gets on their fur. To get clean, they roll around in dust or sand. Most chinchillas take a dust bath everyday.

(Slide 29) Watch how much this chinchilla loves rolling around in the sand!

(Slide 30) Like I said before, chinchillas have very poor eyesight. For example, this chinchilla is completely unaware this he is driving on the wrong side of the street.

Appendix C

CHINCHILLA UP THE CHIMNEY

(adapted from the book of the same name by Lucy Daniels, 1999)

Mandy Hope woke up at six-thirty. It was her birthday, and she couldn't wait to see what present she got. Her father had been telling her for weeks that she was going to love it. She crept out of her room, and quietly walked down the stairs to the living room. Mandy's father, Mr. Hope, was there waiting for her.

"Mandy, you know how you have always wanted a pet? Well, I think you are finally old enough for the responsibility of having a pet."

"Really? Thank you dad!"

Mandy could hardly contain her excitement. She was finally going to have her own pet! But what was it going to be?

"Would you like to meet your new pet, Mandy?" asked Mr. Hope.

"Yes! What kind of animal is it?"

"Well, Mandy, it's an animal you have probably never heard of before. It's called a chinchilla."

"A chinchilla? What is that?"

"Well, why don't you see for yourself?"

Mandy's father walked her into the den. There, in the middle of the room, was an enormous wire cage. The cage was almost as big as Mandy! Inside was a bed for the chinchilla to sleep on. There were some branches for the chinchilla to climb on. There was also a wheel for the chinchilla to run in and a block of wood for the chinchilla to bite on. And there, in the middle of the cage, was the cutest animal Mandy had ever seen!

It was a very strange-looking animal – light brown, about the size of a small rabbit, with a long bushy tail. His large, round ears stood up when he saw Mandy.

"Well, Mandy, the first thing you are going to have to do is name him!" said Mr. Hope.

"His name should be Peanut! He is brown and is shaped like a peanut, so that's his name!"

"Peanut sounds great! Why don't we take Peanut out of his cage so you can get to know him?"

Mandy moved towards the cage with excitement, but she scared the chinchilla. Peanut ran to the other side of his cage and stood up on his hind legs.

“Sorry, Mandy, I should have told you. Chinchillas can get a little scared around strangers. You’ll have to take it slowly with Peanut until he gets to know you.”

“Oh, okay!” said Mandy.

“It’s probably best if we let him get to know you slowly,” Mr. Hope said. “Put your hands in the cage one at a time. He’ll probably sniff and may even nibble you at first, but he’ll soon get used to you and let you pick him up. He’s really friendly!”

Mandy opened the cage door. Peanut sat in the back of his cage and watched as Mandy slowly put her hand in. After a moment, Peanut hopped over. Mandy held her breath as he sniffed her hand. His long whiskers tickled and she tried not to laugh. All of a sudden, Peanut ran to the back of the cage and watched Mandy carefully. Peanut finally decided that Mandy was nice, because he hopped into her hand and sat and looked at her. Mandy noticed how rough his fur was.

“His fur is really scratchy.” Mandy said. “I can’t believe I am actually holding him!”

Mandy’s father reached over and tickled Peanut under his ears and chin. “He really likes it when you pet him like this.”

Just then, Mr. Hope’s cell phone rang. The chinchilla looked frightened by the sudden noise.

Mr. Hope answered the call. “Hello... Okay, I’ll be right there. Mandy, I’m sorry, but there’s an emergency at work that I need to see to. Will you and Peanut be okay?”

“Yes, Daddy. Thank you so much for him! He’s adorable!”

“You’re very welcome! Be careful with him though. He’s probably still a little scared to be in a new home. Here are some treats he might like if he gets hungry.” Mr. Hope handed Mandy a box of raisins before he left.

Mandy liked Peanut so much that she didn’t mind her father leaving for work on her birthday.

“So, Peanut, shall we see what you do when I put you down?” Mandy asked as she gently put her new chinchilla down on the carpet. He explored the room happily. Peanut explored everywhere. He jumped up on some shelves and started looking around there too. Mandy became worried that Peanut might break something. She called out “Here, Peanut!” to try and get him off the shelves. But Peanut was too interested in exploring the shelf to come over.

Peanut began to explore behind a picture frame sitting on the shelf, but his body was too big. He accidentally knocked the picture frame to the floor with a crash!

The loud sound of the frame breaking scared Peanut. He jumped from the shelf and looked around nervously. Mandy was afraid that her new pet would try and run away. She moved a

little towards the chinchilla. Peanut's head shot up in alarm. He stared at Mandy, his eyes wide for a moment, but then to Mandy's relief Peanut seemed to decide he was safe.

Unfortunately, right at that moment, the doorbell rang. Peanut was already nervous, and this loud doorbell was just too much. The chinchilla froze for a second and then streaked towards the door, its ears flat back, its tail flying out behind it.

"Oh NO!" cried Mandy, as the chinchilla ran as fast as it could away from her. Mandy was amazed how fast the chinchilla could move. The chinchilla dashed across the floor with Mandy running close behind. She reached the living room door just in time to see Peanut racing towards the large stone fireplace.

"Oh no!" Mandy gasped, realizing where he was running. With one quick jump, the chinchilla disappeared up the chimney. Mandy looked in horror. What was she going to do?

Mandy went to answer the doorbell. Her best friend James was standing at the door. Mandy was angry that James had rung the doorbell and scared Peanut. Mandy realized, of course, that James had not meant to scare her chinchilla. James had not even known about Mandy's new pet. James felt bad and apologized.

"It's okay James. But what are we going to do?"

"Well, at least it hasn't escaped outside," James said hopefully.

"Yeah, that's good, at least. But you HAVE to help me figure out how to get Peanut out of the chimney."

"Maybe he'll come out if he is hungry. Do you have any food for chinchillas?"

"Of course! You are so smart, James. My dad left me some raisins to give to Peanut as a treat."

As quietly as she could, Mandy took a few raisins out of the box and scattered them near the fireplace. Mandy and James crept over to the other side of the room and waited for Peanut to come out.

After about 20 minutes of waiting, James glanced at his watch. "I'm not sure this is going to work, should we try something else?" Just as they were about to give up, Mandy saw some movement in the chimney.

"Look!" she whispered. James followed her gaze. A pair of long whiskers were poking out. Sitting perfectly still, they watched as two tiny pink paws and a brown head appeared. Two dark eyes peeped out. Two large round ears twitched.

"It's the chinchilla!" James said in delight.

Seeing the raisins, the chinchilla hopped cautiously out of the chimney and crept out. Mandy was shocked by its appearance. Its brown fur was now messy and black. Peanut got very dirty after being in the chimney for so long. Looking around nervously, Peanut seized a raisin in its front paws and started to nibble it.

Mandy and James exchanged looks. They did not know what to do once they got the chinchilla out of the chimney. They were all the way on the other side of the room. They certainly did not want to scare it back into the chimney.

James moved slightly. The movement from the other side of the room scared the chinchilla. Peanut dropped his raisin and jumped back up into the chimney.

“Wow. He’s got really great eyesight if he saw me move from the other side of the room” said James.

“Yeah. We need to be careful not to move next time Peanut comes out. If he sees us move, he’ll just hide in the chimney again” said Mandy. Mandy and James walked over to the chimney and looked up it. There was no sign of the chinchilla.

“So how are we going to get Peanut to come out again?” wondered James.

“Well, I had an idea,” said Mandy. “Did you notice how dirty Peanut was? I bet he would like to clean himself off.”

“It’s worth a try. Let’s get some water so he can take a bath, if he wants.” Mandy and James poured some warm water in a bowl large enough for the chinchilla. They left it right next to the chimney, so that Peanut could clean himself off.

They once again moved to the other side of the room, but this time they hid behind a couch. “Hopefully Peanut doesn’t spot us this time,” said James.

“Look!” James whispered, staring at the chimney. Mandy followed his gaze. A cloud of dirt appeared from the chimney.

“Peanut!” Mandy whispered in delight, as a very dirty chinchilla emerged from the chimney. The little creature landed in the fireplace and crouched down. Looking around fearfully, he started to creep towards the bowl of water.

“Do you think he’ll take a bath?” James whispered to Mandy as Peanut looked over the ledge of the bowl.

“I hope so,” said Mandy.

Peanut hopped over the side of the bowl. The chinchilla rolled around happily in the water. He spun around and water splashed into the air. He flipped and rolled and flipped and rolled. Water sprayed all around the chimney.

Mandy smiled at James. "He loves it!" she said.

Peanut hopped out and shook himself off. Water flew off of him and they could see his brown fur again. He sat up on his hind legs.

"What do you think he'll do if I try and get close?" asked Mandy. James said he thought the chinchilla would run back up the chimney. "I'm going to try," said Mandy. "I'll just go in a little bit. He seems calmer now. Maybe he'll let me get closer."

Mandy took a step towards Peanut. The floor made a creaking noise under Mandy's foot. Peanut ran back towards the chimney and looked at Mandy. Mandy hardly dared to breathe. After a few seconds, Peanut decided that Mandy was probably harmless. Keeping one eye on her, the chinchilla hopped over and started to chew on a wooden handle.

Mandy crept slowly closer to Peanut. "Good boy," she whispered. "There's a good boy."

Peanut turned his head towards her. All of sudden, Peanut seemed to decide that Mandy was too close. He leaped away from the wooden handle and with one jump, he was back up the chimney.

James, who had been watching the whole time, sat next to Mandy. "That was pretty good. He let you get close."

"Yeah, but he's still too afraid for me to get really close. I don't know how I am ever going to get my pet out of the chimney!" said Mandy.

Just then, Mandy heard the front door open. Her dad, Mr. Hope walked in. "What's going on here?" he asked.

Mandy explained to her Dad everything that had happened ever since he left earlier. Mr. Hope seemed to take the news calmly.

"It'll be okay, Mandy. We'll figure out a way to get your new chinchilla out of there. Our best bet might be to give Peanut some time to calm down. Why don't I take you and James out to dinner to celebrate your birthday? How does Chuck E. Cheese's sound?"

"Well... I guess. You think Peanut will be okay?"

"Yeah, this might be exactly what he needs. Some time alone in a quiet house so he can calm down. As soon as we leave, he'll probably come out of the chimney. He is probably eager to explore his new home."

"Okay, Chuck E. Cheese sounds great then!"

So Mr. Hope took Mandy and James to Chuck E. Cheese for dinner. They had a great time eating pizza and playing video games. They had such a good time that Mandy forgot about her new pet at home. But as soon as Mandy, James, and Mr. Hope started their drive home, Mandy began to worry.

What if Peanut was still hiding? If he were hiding, how would they get him out? Would her chinchilla ever get used to her?

Mr. Hope dropped James off at his house on the way. It was dark outside by the time they made it back home. Mandy went straight to the fireplace. She walked as quietly as possible. She didn't want to scare Peanut all over again. She was surprised to see little footprints coming out from the chimney.

“Dad! It looks like Peanut has left the chimney!” Mandy whispered. “Let's follow these footprints and see where they lead.”

They followed the footprints out of the living room and into the den. The footprints lead all the way up to the chinchilla's cage. And there, in the middle of the cage, was Peanut curled up in his bed, asleep.

“Of course!” said Mr. Hope. “Peanut probably couldn't get comfortable enough in the chimney to fall asleep. When it got dark outside, he probably got really sleepy and found his bed!”

“Poor little guy,” said Mandy. “He's so tired. He doesn't even hear us talking.” Mandy quietly shut the door to Peanut's cage so he would not hide again when he woke up in the morning.

“Well, Mandy, you and Peanut had quite an adventure today. I bet you are about as tired as he is. Why don't you go get ready for bed? In the morning, you can Peanut can get to know each other better.”

“Okay Dad! Thank you so much for him! I'm sure me and Peanut will be good friends by the end of tomorrow.”

Peanut wiggled a little bit in his bed, and made a little chirping sound.

Mr. Hope then said, “Sounds like Peanut agrees with you Mandy... you two WILL be good friends!”

THE END

Appendix D

MEMORY INTERVIEW

Chinchilla Up the Chimney

Hello ____! What I'd like to do is find out how much you can remember about the story about the chinchilla in the chimney. If there is anything you don't remember, just tell me that you don't remember or that you don't know.

Tell me everything that happened in the chinchilla story?

What else happened?

Tell me about that.

How did the chinchilla story start?

Tell me about that. What else happened at the beginning of the story?

What happened in the middle of the story about the chinchilla?

Tell me about that. What else happened during the story?

What happened at the end of the chinchilla story?

Tell me about that. What else happened at the end of the story?

Is there anything else you remember about any part of the chinchilla story?

Now I'm going to ask you some more specific questions. Some of these things may not have happened in the book we read. Please answer the question as accurately as you can. Sometimes I will need to ask additional questions to clarify your responses. Sometimes I may ask a question that you have already answered. This is to make sure everyone is asked the same questions. Just answer the best you can.

Rules for the Interviewer:

- Ask all of the CL (closed) question.
- If the subject responds, "I don't know" to a CL question, ask the Yes/No question (Y/N).
- Ask all of the ML (misleading) questions.
- Again, if the subject responds, "I don't know", ask the follow-up question.

1. Why did Mr. Hope give Mandy the chinchilla?

Y/N Did Mandy get the chinchilla for her birthday?

2. What kind of food did the chinchilla eat?

Y/N Did the chinchilla eat raisins?

3. What did the chinchilla do when the sun went down?

Y/N Did the chinchilla go to sleep when the sun went down?

4. Why did Peanut and Mandy's other chinchilla get in a fight?
Y/N Did Peanut and another chinchilla get in a fight?
5. When in the story did Peanut do backflips?
Y/N Did Peanut do backflips?
6. What did the chinchilla do in the bowl of water?
Y/N Did the chinchilla take a bath in the bowl of water?
7. Who moved and scared Peanut back into the chimney?
Y/N Did James move and scare Peanut?
8. Why did Mr. Hope have to leave the house?
Y/N Did Mr. Hope leave because there was an emergency at work?
9. What flavor was Mandy's birthday cake?
Y/N Was it a chocolate birthday cake?
10. What did the chinchilla break while exploring?
Y/N Did the chinchilla break a picture frame?
11. Why couldn't the chinchilla go up the stairs?
Y/N Could the chinchilla go up the stairs?
12. How did James hurt himself?
Y/N Did James trip and fall down?
13. What gift did James give Mandy for her birthday?
Y/N Did James give Mandy a gift?
14. Why did the chinchilla get cold?
Y/N Did the chinchilla get cold?
15. Where did Mr. Hope take Mandy for her birthday?
Y/N Did they go to Chuck E. Cheese's?
16. What did Peanut do with the hot dog?
Y/N Did Peanut enjoy eating the hot dog?
17. What did the chinchilla's fur feel like?
Y/N Did the chinchilla's fur feel rough and scratchy?
18. What did Peanut chew on?
Y/N Did Peanut chew on a wooden handle?
19. Why did the chinchilla make little squeaking noises?

Y/N Did the chinchilla make noises because it was mad?

20. What did Peanut do in the pile of dust?

Y/N Did peanut roll around in the pile of dust?

21. Who rang the doorbell?

Y/N Did James ring the doorbell?

22. Why did the chinchilla run away quickly from Mandy?

Y/N Did the chinchilla run away quickly from Mandy?

23. What did James and Mandy have for lunch?

Y/N Did James and Mandy eat Peanut Butter and Jelly sandwiches?

24. Why did Peanut get in a teacup?

Y/N Was Peanut hiding in the teacup?

Did anything else happen in the chinchilla story?

Appendix E**Coding Sheet**Participant _____
Coder _____**Plausible Memory:**

2. Eat raisins _____
 10. Break frame _____
 18. Chew _____
 22. Run quickly _____

Plausible Suggestibility:

5. Backflips _____
 19. Squeaks _____
 20. Dust _____
 24. Teacup _____

Non-Target Memory:

1. Give chin _____
 8. Dad leave _____
 15. Chuck E. Cheese _____
 21. Doorbell _____

Implausible Memory:

3. Sleep at night _____
 6. Water bowl _____
 7. Moved _____
 17. Fur _____

Implausible Suggestibility:

4. Chin fight _____
 11. Stairs _____
 14. Cold _____
 16. Hot dog _____

Non-Target Suggestibility:

9. Chocolate cake _____
 12. James hurt _____
 13. James gift _____
 23. PB + J _____

Recall:

OE-P: _____	OE-NP: _____
CL-P: _____	CL-NP: _____
Y/N-P: _____	Y/N-NP: _____
IR-P: _____	IR-NP: _____
DK-P: _____	DK-NP: _____

Misleading:

<u>ML-P</u>	<u>ML-NP</u>
CD1: _____	CD1: _____
CD2: _____	CD2: _____
FA1: _____	FA1: _____
FA2: _____	FA2: _____
DK: _____	DK: _____

Non-Target:

<u>Memory</u>	<u>Suggestibility</u>
OE: _____	CD1: _____
CL: _____	CD2: _____
Y/N: _____	FA1: _____
IR: _____	FA2: _____
DK: _____	DK: _____