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AGE DIFFERENCES IN FORGETTING FALSE MEMORIES

by

Ambrocio Mojardín Heráldez

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A Thesis Submitted to the Faculty of the
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY
In partial Fulfillment of the Requirements
For the Degree of

MASTER OF ARTS

In the Graduate College

THE UNIVERSITY OF ARIZONA

1997

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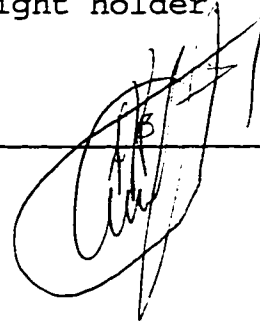
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ACKNOWLEDGEMENTS

This thesis represents an important personal achievement, by no means feasible without the invaluable support of many fine people. Faculty, colleagues, and friends deserve my sincere acknowledgement and thanks. Dr. Charles J. Brainerd was a crucial factor to find and enrich my interest in the developmental study of false memories. His thoughtful and experienced guidance confirmed and increased my commitment with science and its social role. His professionalism, and high human quality made the work for this thesis more educative and easier. Dr. Valerie F. Reyna and Dr. Shitala Mishra, members of my thesis committee, gave additional drive to this endeavor. I received insightful comments and encouragement from them. Dr. Patricia Jones was always a kindly available support for solving doubts on computer statistical procedures. Children who participated, their parents and teachers made this study possible. From all of them I only found enthusiasm and disposition. Lilian M. Stein, Allison Titcomb, and María Romo, three brilliant fellows that were always available to give me ideas to improve this research.

I received deeply human thrust from all members of my family. Jose María and María Carmen, my parents. Jose María, Samuel, Fernando, Paciano, Lucila, Jesús Eduardo, Felipe Rafael, Pedro, Ramiro, Noe Bernardino, Julio Enoc, and María Carmen my twelve siblings. My wife Mercedes, my children María José, Javier Ambrocio, and María Julia represented the highest encouragement and support I could receive to think of and fulfil this stage of my life. For them, I would not have enough words to thank, but all my love.

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ABSTRACT

This study replicated and extended the results of some recent studies concerned with the effects of repeated testing in false-memory creation (e.g. Brainerd and Reyna, 1996), and recent studies concerned with the persistence of false memories over time (Brainerd and Reyna, 1996; McDermott, 1996; Payne et al., 1996). One hundred and twenty children of ages 6, 9 and 12 listened to a series of sentences and took three recognition tests (Immediate, One-week, One-month). Participants made recognition decisions about four items: (1) targets, (2) distractors with the same meaning as targets but different words, (3) distractors with different meaning than targets, but the same words, and (4) distractors with different meaning than targets and different words. Analysis of variance of hits and false alarms showed effects of repeated testing on both. Stochastic dependency analyses showed greater long-term persistence for false alarms than for hits. The effects of testing repetition in creating false memories and the persistence of false memories increased with age. Results are discussed using Fuzzy-Trace Theory as a theoretical framework.

CHAPTER 1

INTRODUCTION

False memories refer to memory reports of information on events never explicitly received. Subjects recalling or recognizing details or either whole structures of events that never happened are considered representative examples of what is referred to as false memories.

Psycholegal interest in studying false memories has increased since it became known that they infect the testimonies of some eyewitnesses. Prominent examples include cases in which people may have been falsely convicted of child sexual abuse (Ceci and Bruck, 1995).

Two classes of false memories have been identified in children (see Reyna, 1995): implanted and spontaneous. Implanted false memories refer to memories created through the influence of external misinformation. Spontaneous false memories, which are the focus of this study, refer to false memories that come about through the operation of endogenous memory distortion process.

Spontaneous false memories are special concern in forensic questioning and sworn testimony. Children are repeatedly interviewed about the same events by lawyers, physicians, social workers, and therapists. Supposedly,

repeated interviews give more information about the events of interest. Moreover, repeated questioning allows interviewers to identify events that are reported consistently and events that are reported inconsistently. The usual assumption is that events that are consistently reported are more likely to be true than events that are inconsistently reported (Brainerd, Reyna and Brandse, 1995).

What are the effects of repeated memory testing on the accuracy of children's reports? Poole and White (1995) reviewed the available literature, and they concluded that repeated testing inoculates true memories against forgetting and does not create false memories. Recently however, Brainerd and Reyna (1996) demonstrated that repeated testing also creates false memories in children. It turns out that the leading theoretical model of false memory, fuzzy trace theory (FTT), predicts this result. FTT also predicts the even more surprising result that these false memories may sometimes be preserved better over time than true memories (Brainerd et.al., 1995).

According to FTT, repeated testing creates false memories for three reasons: (1) Children store verbatim and gist traces of events in parallel. (2) Memory tests provide children with practice at retrieving the gist memories that are the basis of false reports, (3) Therefore, the more prior tests children have received, the more likely they are

to rely on gist and make false reports.

The fact that false reports are gist based leads one to predict high persistence of them. Hence, any memory report (whether true or false) that is based on gist is apt to be highly persistent (Brainerd et.al., 1995). Taking into account that true reports are verbatim based (Reyna, 1995), a lower persistence of them can be expected due to their weaker resistance to forgetting.

This study addressed the effects of repeated testing in false-memory creation and the relative persistence of false memories compared to true memories. Six factors composed the experimental design of this study: The first factor was timing of memory tests. An immediate and two delayed tests were administered to facilitate the evaluation of persistence of false and true memories. It is known that delayed testing, relative to immediate testing, is characterized by reduced accuracy in memory, and that in recognition tests it increases the rates for false alarms. The second factor was type of test items. Children made judgements about on four kind of items: (1) Targets, (2) Distractors with same meaning as targets but different wording, (3) Distractors with different meaning than targets but same wording, and (4) Distractors with different meaning and different wording from targets. The third factor was prior-testing status. Research has shown that items are

better recognized when they have been previously tested than when they have not (Brainerd et.al., 1990; Brainerd and Reyna, 1996). In this study, sentences had three different prior-testing status: no-prior, one-prior, and two-prior testing times. I expected persistence of false memories and persistence of true memories to increase with number of prior testing times. The fourth factor was level of learning. Much research on memory has shown that higher rates of learning prevent forgetting (e.g. Brainerd, et.al., 1990). Higher levels of learning are associated with better memory performance on immediate tests and greater rates of false alarms on delayed tests. Two levels of learning were manipulated. (a) Lower level, subjects heard the sentences once. (b) Higher level, subjects heard the sentences twice. The fifth factor was order of sentences. Few studies have included order of material as a factor in memory performance (e.g. Dallet, 1964). Presenting words in blocking order has given results of increased rates of recall, supposedly as effect of their meaning interconnection. This being true, spontaneous false memories should also increase when sentences are presented in story-like order more than when they are presented in a random order. Children learned sentences either ordered as story (blocks of 3 sentences), or in random order. The sixth factor was age. Children of three different ages (first, third, and sixth-graders) were

chosen as participants. The expectation was to find age increases in persistence for true, as well as persistence for false memories.

The remaining sections of this paper include a chapter on the Historical Background of the study of false memories. This chapter briefly presents the most representative studies conducted within the framework of constructivism and FTT that most directly relate to the nature of this study. A Method chapter describes the design, subjects, materials, procedure, and memory tests and analyses. More detailed information on the stimuli is presented in the Appendices. The Results section describes, first, the effects of repeated testing, and second the persistence of false and true memories. The last chapter discusses the results in light of previous studies, and implications for children's eyewitness testimony.

CHAPTER 2

HISTORICAL BACKGROUND: THE STUDY OF FALSE MEMORIES

Although some research on false memories was reported early in this century (Binet, 1900), most of the work has appeared within the past decade. Two major theoretical positions have guided most of this work. On the one side, constructivism, specifically schema theory, has motivated most contemporary research. However, alternative approaches, such as fuzzy-trace theory (FTT), have been the basis for some studies, especially in recent years.

Constructivists assume that memory is a unitary system constructed out of understanding of experience (Schwartz & Reisberg, 1991). They assume that when information is received, it is selectively stored in well-established schemata. When probes are presented on recognition tests, they are evaluated against that information and rejected or accepted depending on their level of relatedness with respect to that schemata. Concerning false memories, constructivists argue that the tendency of subjects to accept related distractors (e.g. "chair" to the target "seat") is a consequence of how information is stored in memory. Generally speaking, they assume that when information is presented, its particular elements are stored

in a unitary code. When testing comes, this code dominates remembering and creates confusion between what was actually presented and what is close in meaning to it (Paris & Carter, 1973).

In contrast, FTT treats memory as a system in which dissociated representations of the inputs are simultaneously stored; verbatim (traces of targets' surface forms), and gist (senses, meaning). This theory sees false memories as a product of interference between the presented cues, and the kind of traces that support memory for the original information (Reyna, 1995). FTT assumes that when memory probes are presented, verbatim traces support acceptance of targets, whereas gist traces support acceptance of related distractors, as well as acceptance of targets (Brainerd & Reyna, 1996). The following section briefly describes some studies developed under constructivism and FTT. This studies are presented in historical order, underlying their contribution to the study of false memories.

The Constructivist Approach: Illustrative Studies

As stated above, constructivism treats memory as a unitary system in which all received information is stored in a semantic code (e.g., schemata). Bartlett (1932) pioneered the modern constructivist approach to false memories. For Bartlett, memory was schematic. That is, memory tends to store ideas. Those ideas represent

interconnections between what we experience and our understanding of it. These schemata make the acquisition of new information a selective process in which what is consistent with the schemata is stored and reported.

Bartlett's ideas were first developed as a reaction against traditional experimental studies of memory. This experimental tradition had as a salient characteristic the use of nonsense materials. Bartlett rejected the use of nonsense materials because he considered them passive devices that did not tap the true dynamics of memory. Instead, he proposed to study memory with meaningful materials. Bartlett (1932) reported a series of studies that were intended to demonstrate this proposal. The most relevant to the present study were experiments run with college students using an Indian folktale entitled "The war of the ghosts" as the to-be-learned material. "The war of the ghosts" is a folktale featuring information that was unfamiliar to Bartlett's English subjects.

After Bartlett presented subjects with "The war of the ghosts", he asked them to recall it under a novel reproduction procedure: Subject A was presented with the material and asked to recall it; subject B was asked to reproduce what subject A recalled; subject C was asked to recall what subject B had recalled, and so on. The most important result of this experiment was that subjects

reshaped the content of the folktale to conform to their own interpretation of it. Subjects "avoided some passages, and filled in some others with more ordinary and rational events" (P. 128).

Bartlett took this result, and others of the same nature, as evidence that memory is constructive. That is, remembering is influenced by prior knowledge and is constructed by the incorporation of experience into preestablished schemata. How did these results impact subsequent memory research?

Bartlett's (1932) work is widely recognized as the origin of schema theory and of the contemporary constructivist approach to the study of false memories (e.g. McDermott, 1996 ; Roediger, Jacoby, & McDermott, 1996; Hyman & Pentland, 1996). Furthermore, his work provided evidence to support the explanation of false memories as product of the organization of memory into schemata.

Some years later, Underwood (1965) introduced a more objective laboratory-based procedure for studying false memories. He used the continuous recognition paradigm developed by Shepard and Teghtsoonian (1962; see also Anisfeld and Knapp, 1968 ; Felzen and Anisfeld, 1970). Continuous recognition consists of presenting a list of items (e.g. words) and requiring that subjects judge each item as old (previously presented) or new (not previously

presented) as it is presented.

Underwood (1965) ran an experiment in which college students were presented with a list of 200 words. The list contained four kinds of words: a) target words (i.e. give), b) related distractor words (i.e. take), c) control words (i.e. good), and d) filler words (i.e. cloud). The issue of principal interest was whether false-alarm rates were higher for related distractors than for the other types of distractors.

Results were as follows: a) False-alarm rates were higher for related distractors than for unrelated distractors. b) False-alarm rates for related distractors increased as the presentation frequency of their instantiating targets increased. c) Some control (unrelated) distractors also had high rates of false alarms.

Underwood's (1965) analysis of these results focused on the influence of meaning. First, false recognition of the related distractors was explained (and expected) as a product of their semantic association with the critical words. Second, the high rate of false alarms for some control words was explained in terms of semantic properties elicited indirectly. For instance, "bridge" was the control word that produced the highest rate of false alarms. Underwood wrote, "No previous word has formal similarity, and when bridge is thought of as a structure spanning water

no previous word would seem to elicit it as an implicit associative response" (p. 129). However, he reasoned that his subjects had experience in playing the card game bridge and list words such as "major" and "master" are strongly associated with that game.

Thus, Underwood's (1965) position was consistent with Bartlett's (1932). In both cases, the semantic content of the studied material determines how it is stored in memory and is responsible for systematic memory errors. Underwood's (1965) main contribution to the study false memories was the introduction of recognition as paradigm.

The constructivist approach was given further impetus by Bransford and Franks' (1971) studies of false memory. These authors conducted a series of experiments using sentences as the to-be-remembered material. In these experiments, subjects were presented with several sentences, all of which were consistent with a particular idea. This idea could be abstracted by integrating the presented sentences. Bransford and Franks' thesis was that subjects would not retain the particular sentences, but they would retain an integrative idea.

Following sentence presentation, subjects responded to a recognition test. The test list contained studied sentences, some content-related distractors, and some unrelated distractors. Related distractors contained one,

two, three, or four ideas from studied sentences. Subjects made recognition decisions and confidence ratings (1-5 scale) about each test sentence.

The results were as follows: a) Subjects easily rejected the unrelated sentences, but they had difficulty distinguishing studied from related sentences. b) Related sentences were accepted at high rates (in some cases higher than old sentences), and were accepted with higher confidence than studied sentences. c) The frequency of false recognition was directly related to the number of ideas that each distractor included (e.g. four > three > two > one). d) Subjects' confidence increased as the number of ideas expressed in the distractor sentences increased too.

Bransford and Franks (1971) interpreted these results as showing that subjects acquire general, abstract ideas from the integration of separate inputs. In their opinion, individual inputs lose their distinctiveness in memory in favor of more holistic understanding.

So far, I have presented some examples of the contemporary constructivist approach to false memories. A common characteristic of these examples was that they assumed that memory is a unitary system that works by integrating information. Further, integration is semantic and happens at the time of comprehension (Flagg, 1976). Bartlett's (1932) work initiated the contemporary interest

in errors of memory reports, Underwood's (1965) research presented a rigorous laboratory procedure for studying false memories, and Bransford and Franks (1971) demonstrated that false memories could sometimes be as strong as the true memories.

Although constructivist studies of false memories are numerous (.i.e. Anisfeld & Knapp, 1968; Paris & Carter, 1973; Cofer, 1973), they have not gone unchallenged. Research has also been reported that demonstrates that verbatim memories for the exact forms of inputs, not just constructive memory for gist, is important to memory performance. Such research is reviewed below.

Reaction to Constructivism

Constructivist explanations of false memories were tested in several early studies (e.g. Reitman & Bower, 1973; Flagg, 1976 ; Small & Butterworth, 1981 ; Alba & Hasher, 1983 ; Fletcher, 1992). A core criticism of constructivist explanations of false memories was that the results of experiments such as Bransford & Franks' (1971) could be artifacts of the superficial familiarity of the materials. For instance, Small and Butterworth (1981) noted that Bransford and Franks "new" sentences were composed of varying numbers of old words. In particular "new" sentences that were consistent with the meaning of studied sentences contained more old words than "new" sentences with

inconsistent meanings, an obvious confound.

Reitman and Bower (1973) proposed an interference explanation of Bransford and Franks' (1971) results. They pointed out that "Few factors in the Bransford and Franks' design militate against the conclusion that subjects usually retain only the schema and not the particular exemplars" (p. 196). However, they argued that the frequency of presentation of the particular sentences associated to a general idea, plus the presentation of their combinations in longer sentences overloaded subjects' memories producing massive amounts of interference.

Although such arguments opened important lines of research, they did not seriously challenge the constructivist account of false memories. Until recently, it was widely accepted that memory and understanding are interdependent. As Reyna and Brainerd (1995) remarked, "Although there were disputes about the data, observers on both sides accepted the premise that, if the effects were real, memory had to be constructive" (p.21). Accepting the results as real, but disagreeing with the idea of memory as constructive, some studies based on FTT offered evidence that constructivist explanations of false memories were incomplete.

Fuzzy-Trace Theory: An alternative approach
FTT introduced an alternative approach to false

memories that contrasted with constructivism. FTT posits that results such as those obtained by Bransford and Franks (1971) are real, but that the theoretical account of them is wrong.

Under FTT, memory and understanding are not as interdependent as in constructivism (i.e. Brainerd & Reyna, 1993, 1995; Reyna, 1995; Reyna & Kiernan, 1994). Instead, memory and understanding are assumed to be dissociated. The most important assumptions of FTT are that (a) information is stored as dissociated verbatim (memory for surface forms) traces and gist (memory for senses, meaning) traces and that (b) verbatim and gist traces are processed independently on memory and reasoning tasks. Processing leans toward verbatim traces on memory tasks, and it leans toward gist traces on reasoning tasks. Another key principle of FTT, supported by much research (e.g. Gernsbacher, 1985), is that verbatim traces are forgotten more rapidly than gist traces.

Brainerd and Reyna have published several articles dealing with FTT's approach to false memories. Three of these articles motivated my own research: Reyna and Kiernan (1994), Brainerd, Reyna and Brandse (1995), and Brainerd and Reyna (1996). The first article offers clear data supporting FTT's assumption of memory and reasoning dissociation. It also provides evidence about the kind of memory traces that underlie false recognition. The second article provides

evidence on the persistence of false memories in comparison to true memories. The third article offers an analysis of the effects of testing repetition in inoculating true memories, and creating false memories. In the remainder of this section I briefly describe the research that was reported in these articles.

Reyna and Kiernan (1994) presented two experiments in which they modified Bransford and Franks' (1971) material and instructions to test memory and understanding of sentences. Children of ages 6 and 9 listened to a series of sentences organized as short stories (3 sentences per story). The sentences described either spatial (The bird is inside the cage) or linear (The cocoa is hotter than the tea) relationships. Next, the children responded to a recognition test. There were eight types of probes on the test: Targets that had actually been presented (TPO), True distractors with new words (TPN), True inferences with old words (TIO), True inferences with new words (TIN), false distractors with old words (FPO), false distractors with new words (FPN), false inferences with old words (FIO), and false inference with new words (FIN). Examples of these eight types of probes are shown in Table 1.

Some subjects (Experiment 1) received instructions to pay attention to exactly what the sentences said (verbatim instructions), whereas some others (Experiment 2) were

instructed to pay attention to the meaning of the sentences

Table 1

Example of the Stories and Recognition Sentences used by

Reyna & Kiernan (1994).

Story:

Spatial.

The bird is inside the cage.

The cage is under the table.

The bird has yellow feathers.

Linear.

The cocoa is hotter than the tea.

The tea is hotter than the coffee.

The cocoa is very sweet.

Recognition sentences (spatial):

Filler: The bird has yellow feathers.

(TPO) The bird is inside the cage.

(TPO) The cage is under the table.

(TPN) The table is above the cage.

(TIO) The bird is under the table.

(TIN) The table is above the bird.

(FPO) The table is under the cage.

(FPN) The bird is above the cage.

(FIO) The table is under the bird.

(FIN) The bird is above the table.

Recognition sentences (Linear):

Filler: The cocoa is very sweet.

(TPO) The cocoa is hotter than the tea.

(TPO) The tea is hotter than the coffee.

(TPN) The coffee is cooler than the tea.

(TIO) The cocoa is hotter than the coffee.

(TIN) The coffee is cooler than the cocoa.

(FPO) The coffee is hotter than tea.

(FPN) The cocoa is cooler than the tea.

(FIO) The coffee is hotter than the cocoa.

(FIN) The cocoa is cooler than the coffee.

(Table Continues)

Note: (TPO) = True premise original, (TPN) = True premise novel, (TIO) = True inference original, (TIN) = True inference original, (FPO) = False premise original, (FPN) = False premise novel, (FIO) = False inference original, (FIN) = False inference novel.

(gist instructions). During the testing phase, subjects were either instructed to accept only the sentences that were presented (Experiment 1), or to accept presented sentences plus all unpresented sentences that were true (Experiment 2).

The key results were as follows: In Experiment 1, TPO were accepted much frequently than TPN, but TPN were accepted much more frequently than either FPO or FPN. This demonstrated both memory for surface form and systematic misrecognition of gist. In Experiment 2, meaning-consistent probes of all types were accepted at much higher rates than meaning inconsistent sentences. Developmentally, in Experiment 1, older children discriminated presented sentences from other true sentences about twice as well as younger children. Misrecognition of gist was about the same for older and younger children. In Experiment 2, levels of discrimination between false and true sentences also improved with age.

Reyna and Kiernan (1994) concluded that children's memory for the verbatim form of presented sentences was independent of their understanding of those sentences. This is, children could distinguish what was presented from what

was not, and they could distinguish sentences with consistent meaning from sentences with inconsistent meaning, but these abilities were independent. The high rates of gist misrecognition associated with accurate verbatim memory (Experiment 2) was a core finding supporting this conclusion.

Reyna and Kiernan's (1994) view of false memories is that they are gist based rather than verbatim based. When subjects are presented with memory probes without specific instructions to distinguish verbatim from gist, they first retrieve the verbatim traces of the studied items. If these traces are still available, subjects will correctly identify targets. However, if verbatim traces are not accessible and there is gist consistency between the probes and what was studied, subjects will incorrectly accept distractors producing false-memory reports.

Assuming, as FTT assumes, that false memories are gist based and true memories are verbatim based, and knowing that gist memories are more resistant to forgetting than verbatim memories, an obvious question is how do false memories persist over forgetting periods, and how this persistence compares to that of true memories? Brainerd, Reyna and Brandse, (1995) investigated this question. They presented three experiments in which they tested the relative persistence of hits (true memories), and false alarms (false

memories). In these experiments, subjects learned a list of meaningful nouns. A few minutes later, they received standard recognition tests in which they had to make accept-reject decisions about presented words and distractors. Some distractors were related to targets and the rest were unrelated. This recognition test was repeated one week later.

Children of ages 6 and 9 learned lists of nouns (Experiment 1, and 2) or a list with nouns and nonsense words (Experiment 3). Recognition tests were given using lists that included targets (i.e. cat) and meaningful unrelated distractors (i.e. mountain) (Experiment 1), category-name distractors (i.e. animal) and rhyme distractors (i.e. bat) (Experiment 2), meaningful distractors and nonsense distractors from which half rhymed with the nonsense targets (i.e. kef-tef, mivig-tivig) and half did not.

Results showed that; a) Hits, as well as false alarms were well preserved across the one-week forgetting interval. b) The false-alarm rate increased over the forgetting interval. c) The probability of false alarm persistence was higher than the probability of hits persistence when distractors were target related. d) Related nonsense distractors produced high false-alarms rates on the immediate test, but these false alarms did not persist. e)

There was an age increase in hit rates. f) The persistence of false alarms for nominally unrelated distractors, and rhyme distractors increased with age. However, this increase did not occur for category-related distractors.

FTT's assumption that gist memories underlie false alarms, while verbatim underlie hits is consistent with the results of these studies: That false alarms were better preserved than hits can be explained on the ground that gist are more stable than verbatim traces.

Brainerd et al.'s (1995) results are not consistent with constructivism. As Brainerd et.al. (1995) pointed out, under constructivism hits should be more persistent than false alarms. Constructivists see both hits and false alarms as being dependent on the meaning that was extracted during the study phase. Because target probes will necessarily access more of this meaning than distractor probes, hits (targets) should be more persistent than false alarms (distractors). On the other hand, FTT forecasts that the persistence rates of false alarms and hits depend on what kind of traces underlie them. False alarms are gist based, more than verbatim based. As gist memories are much more resistant to forgetting than verbatim memories, false alarms can be as persistent or more persistent than hits.

The third article on which the present study was based is by Brainerd and Reyna (1996). This article presents

evidence that simply testing children's memories can create false memories. This phenomenon is of considerable forensic interest because of the frequency with which witnesses are questioned and requestioned.

Brainerd and Reyna (1996) reported some experiments on this problem using recognition as the method of memory testing. Their main aim was to determine whether or not test repetition creates false memories, as well as inoculating true memories against forgetting.

Kindergarten and third graders were presented with a list of familiar concrete nouns. Half of them were read once (low learning) and half were read three times (high learning). Subjects received an initial test, and a repetition of it one week later. Some subjects received the initial test immediately after the learning phase (Experiment 1). Some others received it a week after the learning phase (Experiment 2). The testing lists had two characteristics of particular interest. First, some distractors were category names of the targets they replaced (e.g. CAT and ROSE replaced by ANIMAL and FLOWER), others typical exemplars of the same category (e.g. STEEL replaced by IRON), and unrelated items to targets. Second, all the items that were tested on the immediate test were also tested in the delayed test, but previously untested items of all three types were also tested.

Results showed that: a) Repeated testing increased hit rates indicating true memory inoculation, as well as false alarms indicating false memory creation. b) The effects of repeated testing were higher for false alarms to meaning-related distractors. c) When initial testing was delayed until a week after learning, false alarms were higher than hits. d) Repeated testing produced more false alarms when the initial test was delayed, than when it was immediate.

Previous research on eyewitness testimony has shown that neutral repeated testing preserves true memories over time (see Brainerd and Ornstein, 1991; Poole and White, 1995). However Brainerd and Reyna's (1996) results show that repeated tests also produce false memories. Their initial recognition tests inoculated true memories, but they also created false-memory responses on delayed tests. The latter effect was more pronounced when distractors shared meaning with targets and when learning level was low.

According to Brainerd and Reyna (1996), the mechanisms behind true memory inoculation and false memory creation are different. While the inoculation of true memories involves the preservation of verbatim traces of the target presentations, the creation of false memories involves either the formation of verbatim memories of distractors, for which source information subsequently becomes inaccessible, or the retrieval of gist memories that

distractors share with presented targets.

Repeated tests always take place after periods of time. This fact makes the accessibility to verbatim memory of the event weaker than the accessibility to gist, becoming an important reason to have higher acceptance of gist-consistent distractors on delayed tests. However, in repeated trials to identify items, as happens in repeated testing, there is a mechanism responsible of the advantage of gist-consistent distractors over targets.

When testing is repeated, items (targets and distractors) provoke re-encoding of their verbatim and gist characteristics giving additional advantages to gist-consistent distractors. Gist-consistent distractors receive verbatim encoding and gist re-encoding to what was originally encoded. The new-encoded verbatim characteristics of the gist-consistent distractors potentiate their acceptance in a repeated test, because they become the first memory source for their identification. Furthermore, the gist source that provoked an initial acceptance of these distractors, had consolidation at the time of their repeated testing with the possibility of staying longer.

CHAPTER 3

METHOD

Subjects

A total of 120 children, 40 first-graders (mean age = 6 years, 3 months), 40 third-graders (mean age = 8 years 8 months), and 40 sixth-graders (mean age = 11 years, 7 months) participated in this experiment. Children were drawn from an elementary school serving a rural area in Sinaloa, Mexico. None of these children was identified as learning or language disabled, and there was an equal number of girls and boys.

In addition to obtaining written parental consent, children signed an assent form before their participation began. Results from children who did not participate in all three sessions were deleted.

Design

The design was a 3x2x2x3x2x3 multifactorial analysis of variance (MANOVA). The first three factors, age (6, 9 and 12 years old), level of learning (higher versus lower), and order of sentences (story vs. random order) were between subject factors. The other three were within subjects factors: testing times (subject were tested three times: immediately, one week, and one month after learning), type

of test items (targets vs. distractors; true meaning/different words, false meaning/same words, and false meaning/different words), and prior-testing status of sentences (no-prior, one-prior, two-prior).

Materials

Two tape recordings containing 45 sentences were used in the learning phase. One tape recording contained the sentences blocked into fifteen stories (Appendix A). Each story consisted of three sentences. One of them was a filler, and it was not tested. The other tape recording contained the same sentences in a random order (Appendix B). Sentences described everyday events that made them easily understandable and imaginable to children. All sentences were presented in Spanish (Appendix G). A private, well illuminated, and quiet cubicle within the children's school was used for testing.

One tape recording containing three testing lists of 40 (Appendix D), 80 (Appendix E), and 120 sentences (Appendix F) was used in the immediate, one week, and one month delayed tests, respectively. All testing lists included presented sentences (targets), and the three types of distractors in equal numbers. The three kind of distractors were: (a) Distractor 1= sentences with true meaning relative to targets, but with new words (tm/dw); (b) Distractor 2= sentences with false meaning relative to targets, but the

same words as targets (fm/sw); and (c) Distractor 3= sentences with false meaning relative to targets and new words (fm/dw).

The immediate testing list had forty sentences, ten targets and ten distractors of each kind. The one-week testing list contained 80 sentences, the forty sentences tested at the immediate test plus forty new (ten of each type). This testing list had twenty targets, and twenty distractors of each kind, half untested and half tested once. The one-month testing list had 120 sentences, the 80 sentences tested at one week plus 40 new sentences (ten of each type).

Procedure

The sentences were presented to half the children in a random order (random-order condition) and in a story-like order to the other half (story condition). Both conditions were divided into higher and lower learning. The lower-learning group heard the material once, and the higher-learning group heard it twice. The general procedure was as follows:

1. Target exposure. After a period of familiarization, children listened to the sentences. Children participating in the low-learning condition listened to the material once, while those participating in the high-learning condition listened to it twice. The second presentation of the

material was immediately after the first. Instructions in the learning phase were adjusted to the particular conditions.

a) Children in the story condition were informed that they would hear a tape recording containing some stories and that they should memorize them. The stories were read at a rate of 2 seconds between sentence, and 4 seconds between each story.

b) Children in the random condition, were informed that they would hear a list of sentences and should try to memorize them. Sentences were presented at a rate of 3 seconds each.

2. Immediate recognition test. After children were presented with the material, there was an attention-consuming buffer activity named "Joining the nine dots" (Appendix 5). In this activity, subjects were presented with a paper containing many sets of nine-dot shapes. They were neither allowed to start in more than one point, nor to repeat lines. Following this activity, a recognition test under standard procedures was administered.

The instructions for the immediate test were the same for all participants. They were told that they would hear some sentences and that their task was to say whether each had been previously heard. Children were carefully instructed to say "yes" only to the sentences that they had

heard previously, and say "no" to any sentence that differed in either words or meaning from what they had heard.

The experimenter presented a series of examples to ensure that the instructions were precisely understood. Testing sessions did not start until instructions were clear for each participant. First graders needed more examples (maximum of 6 examples) than third- and sixth-graders to have a complete understanding of instructions. Examples were neither meaning, nor surface connected with the testing sentences.

3. Delayed test. Two delayed tests were administered: one was administered a week later and the other was administered one month later. All Children were asked to remember the procedure followed in the previous session. Children were told that their task was to say "yes" to sentences that they had heard on the audio tape in the first session (as opposed to sentences from the previous recognition test) and to say "no" to any other sentences.

CHAPTER 4

RESULTS

The analyses reported here were done on the frequencies of affirmative answers that subjects gave for targets and distractors. Analyses of variance, and stochastic dependency analyses (likelihood ratios) of conditional versus unconditional probabilities were performed. All results were considered statistically significant at an alpha level of .05.

Effects of Testing Repetition.

I present the results in three sections. The first section contains the results for the immediate test. The second section presents the effects of testing repetition in true-memory inoculation and false-memory creation obtained on the one-week and one-month delayed tests. In the third section, I present the results on the persistence of true and false memories across testing times. Developmental trends are analyzed within each section.

Immediate Test

Although the main focus of this study was performance on the delayed tests, the results for the immediate test are briefly described first.

Hits

A 3 (grade: first, third, sixth) x 2 (order: story versus random) x 2 (learning: higher versus lower) analysis of variance (ANOVA) was run using total number of hits (0-10) as the dependent variable. This ANOVA showed a main effect for grade $F(2, 108) = 7.04$, $p < .05$. First graders had more hits ($M = 8.55$) than third ($M = 8.15$) and sixth graders ($M = 7.28$). As we shall see below, this grade effects were due to declines in response bias (yea saying). Such declines are common in developmental studies of recognition (Brainerd, Reyna, & Kneer, 1985). d' is therefore a more appropriate measure of age trends in recognition accuracy (e.g. Donalson, 1996). Mean d' values are shown in table 2.

As it can be seen from this table, there were age increases in d' values. A Tukey's HSD test confirmed that the differences among the means were significant. The difference between Third and Sixth graders on d' values for Distractor 1 was not significant, however.

False Alarms

False alarms were analyzed with a 3 (grade: first, third, sixth) x 2 (order: story versus random) x 2 (learning: higher versus lower) x 3 (type of distractor: tm/dw, fm/sw, and fm/dw) ANOVA using total false alarms (0-10) as the dependent variable. The main effects for grade, order, learn, and type of distractors were all significant, all $F_s > 4.50$, and all $p_s < .05$. The interaction of Type of

Distractor x Grade ($F=8.56$, $p < .0001$), and Type of Distractor x Learning ($F=8.97$, $p < .0001$) were also significant.

Table 2

d' Mean Values for the Immediate, One-Week, and One-Month Test.

Immediate Test.

Grade	Type of distractor		
	Distractor 1	Distractor 2	Distractor 3
First	.34	.63	.72
Third	.41	1.54	1.04
Sixth	.40	1.83	1.64

One-week Test

Prior Tests	Distractor 1		Distractor 2		Distractor 3	
	none	one	none	one	none	one
First	.19	.27	.47	.81	.70	.54
Third	.30	.16	1.16	1.42	1.70	1.00
Sixth	.42	.47	2.19	1.49	2.28	1.23

One-month test.

Prior Tests	Distractor 1			Distractor 2			Distractor 3		
	none	one	two	none	one	two	none	one	two
First	.15	.20	-.20	.55	.49	.49	1.26	1.08	.46
Third	.58	.32	0.0	1.29	1.07	1.32	1.40	1.55	1.31
Sixth	.62	.26	-.12	1.88	1.40	1.14	2.35	1.69	.97

As it can be seen from Table 3, the interaction for Type of Distractor x Grade occurred because the false-alarm rate for Distractor 1 declined much less with age than the false-alarm rates for the other two types of distractors.

Table 3

Means for the Grade and Type of Distractor Interaction

Grade	Type of distractor		
	Distractor 1	Distractor 2	Distractor 3
First grade	8.00	7.35	7.30
Third grade	7.48	4.98	5.53
Sixth grade	6.53	3.18	3.88

The interaction of Type of Distractor x Learning occurred because, as can be seen from Table 4, higher learning produced higher rates of false alarms for Distractors 2 and 3 but not for Distractor 1. The difference between Distractors 2 and 3, evaluated by a Tukey's HSD test, was significant at each age level.

Table 4

Means for the interaction between Learning and Type of Distractor.

Learning	Type of Distractor		
	Distractor 1	Distractor 2	Distractor 3
Higher	7.15	5.75	6.06
Lower	7.52	4.58	5.06

True Memory Inoculation and False-Memory Creation

One-Week Test

True-Memory Inoculation

In this design, true-memory inoculation is an increase in hit rates on delayed tests as function of prior testing. To measure true-memory inoculation, I performed a 3 (grade: first, third, sixth) x 2 (order: story versus random) x 2 (learning: higher versus lower) x 2 (prior testing: one prior versus no-prior test) ANOVA of total hits (0-10) on the one week test. The main effects for prior testing $F(1,108) = 14.85$, $p < .0002$, plus the interaction for Prior testing x Learning $F(1,108) = 4.54$, $p < .05$ were significant.

The effects for prior testing showed that there was a true-memory inoculation (Table 5). Mean hits were higher at all three age level for items previously tested (8.43, 7.83, 8.13) than for items previously untested (7.75, 7.33, 7.40).

Table 5

d' Values Indicating the Effects of Testing Repetition on the Immediate and One-Week Tests.

Grade	Testing status	
	Week-No-prior	Week-One-prior
First	.46	.55
Third	1.07	.93
Sixth	1.66	1.13

The interaction for Prior Testing x Learning occurred because lower learning produced a larger true-memory inoculation effect (Table 6). These results on effects of learning deserve a brief commentary. Prior studies have found higher levels of learning associated with better memory performance. However an opposite result was found on the immediate and one-week-delay tests of this study. A possible reason for these results could be that a second presentation of sentences, which differentiated higher from lower learning, produced gist-to verbatim retroactive interference. First memorization of sentences was reduced to gist when subjects started to listen to the sentences again. When testing was given, subjects failed to maintain the verbatim memory of the sentences and made their decisions supported by the gist memories.

Table 6

Means for the interaction between Prior Testing and Learning on the One-Week Test.

Learning	Prior testing status	
	No-prior test	One-prior test
Higher level	7.25	7.93
Lower level	7.73	8.52

False-Memory Creation

To assess false memory creation I examined the false-

alarm rates for the one-week test as function of their prior memory testing. A 3 (grade: first, third, sixth) x 2 (order: story versus random) x 2 (learning: higher versus lower) x 3 (type of distractor: tm/dw, fm/sw, fm/dw) x 2 (prior testing: one prior versus no-prior test) ANOVA was performed on total false alarms (0-10). This ANOVA produced main effects for grade, prior testing, and type of distractor, plus interactions for Prior Testing x Grade, Prior Testing x Type of Distractor, and Prior Testing x Type of Distractor x Grade x Learning, all $F_s > 2.40$, and all $p_s < .05$.

The effects for prior testing ($F(1, 108) = 63.34$, $p < .0001$) showed false memory creation. The false-alarm means increased as function of prior testing in first (6.64 vs. 7.28), third (4.83 vs. 5.83), and sixth graders (3.99 vs. 5.67).

Of primary interest was the interaction for Prior Testing x Grade. This interaction showed age increases in false-alarm rates as a function of prior testing. Older children had greater false-memory creation as an effect of testing repetition. The increase on the mean rate as function of prior testing for sixth graders was greater (Difference = 1.68) than for third (Difference = 1.00), and first graders (Difference = .64) (Table 7).

The Prior Testing x Type of Distractor interaction occurred because repeated testing increased false-alarm

rates more for Distractor 3 than for Distractors 2 and 1 (Table 8), and increased false-alarm rates more for Distractor 2 than for Distractor 1.

Table 7

False-alarm Means for the interaction between Grade and Prior Testing on the One-week test.

Distractor	Prior testing status	
	No-prior test	One-prior test
First	6.64	7.28
Third	4.83	5.83
Sixth	3.99	5.67

Table 8

False-alarm means for the interaction between Prior Testing and Type of Distractor on the One-week test.

Distractor	Prior testing status	
	No-prior test	One-prior test
Distractor 1	6.85	7.59
Distractor 2	4.59	5.04
Distractor 3	4.02	6.14

One-Month Test

On this test, targets and distractors could be: (a) previously untested, (b) previously tested once, and (c) previously tested twice. The main purpose of the ANOVAs that follow was to determine the effects of those levels of prior

testing on hits and false alarms.

True-Memory Inoculation

A 3 (grade: first, third, sixth) x 2 (order: story versus random) x 2 (learning: higher versus lower) x 3 (prior testing: two-prior, one-prior, and no-prior tests) ANOVA was performed on total hits (0-10) as the dependent variable. None of the main effects, nor interactions, was found significant all $F_s < 2.80$, $p_s > .05$. Thus there was no true memory inoculation effect from prior testing.

Table 9

Means for the interaction between Grade and Prior Testing on the One-month test.

Grade	Prior testing status		
	No-prior test	One-prior test	Two-prior test
First grade	7.48	7.55	7.58
Third grade	7.45	7.63	7.63
Sixth grade	8.30	7.88	8.10

As it can be seen from table 9, first and third graders had slightly greater hit rates for the previously tested targets, but neither difference was significant.

False-Memory Creation

A 3 (grade: first, third, sixth) x 2 (order: story versus random) x 2 (learning: higher versus lower) x 3 (type of distractor: tm/dw, fm/sw, fm/dw) x 2 (prior testing: two-prior, one-prior, and no-prior test) ANOVA was performed on

total of false alarms (0-10). There were main effects for grade, prior testing, and type of distractor, plus significant interactions for Order x Learning, Type of Distractor x Grade, Type of Distractor x Order, Prior Testing x Grade, Prior Testing x Order, Prior Testing x Type of Distractor, Prior Testing x Type of Distractor x Order, Prior Testing x Type of Distractor x Grade x Order, Prior Testing x Type of Distractor x Grade x Learning, and an overall interaction for Prior Testing x Type of Distractor x Grade x Order x Learning, all $F_s > 2.40$, and all $p_s < .05$.

Of main interest were the interactions for Prior Testing x Grade, Prior Testing x Type of Distractor, and Type of Distractor x Grade. The interaction for Prior Testing x Grade was due to age differences in memory creation. As Table 10 shows, sixth graders had the highest increase in false alarms, while third graders had a greater increase than first graders. Thus on the One-month test, the tendency of prior testing to elevate false alarms increased with age.

The interaction for Prior Testing x Type of Distractor showed that the increase of false-memory creation was greater for some distractors than for others. As on the one-week test the effects of prior testing was always greater for Distractor 3 than for Distractors 1 and 2. Distractor 1 had greater effects than Distractor 2 (Table 11).

Table 10

Means for the interaction between Grade and Prior Testing on the One-month test.

Grade	Prior testing status		
	No-prior test	One-prior test	Two-prior test
First grade	5.97 (.65)	6.19 (.59)	7.02 (.25)
Third grade	4.64 (1.09)	5.11 (.98)	5.46 (.88)
Sixth grade	4.44 (1.62)	5.00 (1.12)	6.14 (.66)

Note: Numbers within parenthesis are d' values.

Table 11

False-alarm Means for the interaction between Prior Testing and Type of Distractors on the One-month test.

Distractor	Prior testing status		
	No-prior test	One-prior test	Two-prior test
Distractor 1	6.71	7.18	7.93
Distractor 2	4.58	5.04	5.08
Distractor 3	3.76	4.08	5.61

The interaction for Type of Distractor x Grade was due to the age increases in discrimination for all distractors. As table 12 shows first graders made more false alarms than third graders, and third graders made more false alarms than sixth graders. Distractor 1 produced more false alarms than Distractor 2, and distractor 2 produced more false alarms than Distractor 3.

Table 12
False-alarm Means for the interaction between Grade and Type of Distractor.

Grade	Type of Distractor		
	Distractor 1	Distractor 2	Distractor 3
First grade	7.39 (.08)	6.24 (.51)	5.55 (.94)
Third grade	6.93 (.32)	4.35 (1.22)	3.94 (1.42)
Sixth grade	7.52 (.33)	4.10 (1.45)	3.95 (1.64)

Note: Number within parenthesis correspond to d' values

Persistence of Hits and False Alarms

I now consider the question if hits and false alarms on the immediate test persisted to the delayed tests. Age variability in persistence will also be considered.

Persistence simply means that a response (accept or reject) to an item on an earlier test was repeated on a later test. To assess persistence of both false alarms and hits, I used standard stochastic dependency analysis (likelihood ratios) that compared the unconditional probabilities of those responses on a later test to their conditional probabilities given the same response on an earlier test (see Brainerd and Reyna, 1996; Brainerd, Reyna, and Brandse, 1995).

The two delayed tests (one-week, one-month) allowed memory persistence to be tested in three ways. First, items

tested on the one-week test with previous testing on the immediate test gave information about persistence between those tests. Further, the one-month delayed test allowed persistence to also be measured for: (a) items that had been tested on both the immediate and one-month tests, and (b) items that had only be tested on the one-week test.

I present first the results on the persistence of false alarms. Then I consider the relative persistence of hits and false alarms. Table 13 shows all the likelihood ratios and their probabilities.

One-Week Test

Persistence of False Alarms

Persistence of false alarms between the immediate and one-week tests was assessed by conditionalizing distractor responses on the one-week test on distractor responses on the immediate test and then computing the relevant likelihood-ratio test (for statistical development see Brainerd and Gordon, 1994; Brainerd and Reyna, 1995). At each age level, these analyses showed that false alarms persisted over the one-week interval. The values of the likelihood ratio statistic for Distractor 1-3 were:
 $\chi^2(1)=22.00$, $p < .05$; $\chi^2(1)=27.37$, $p < .05$; $\chi^2(1)=10.12$, $p < .05$ for first graders, $\chi^2(1)=29.91$, $p < .05$; $\chi^2(1)=35.91$, $p < .05$; $\chi^2(1)=24.12$, $p < .05$ for third graders, and $\chi^2(1)=7.68$, $p < .05$; $\chi^2(1)=18.21$, $p < .05$; $\chi^2(1)=17.51$, $p < .05$ for sixth

graders. False alarms for Distractor 3 persisted better than for Distractor 2, and the false alarms for Distractor 2 persisted better than the false alarms for Distractor 1, in third and sixth graders. In case of first graders, false alarms for Distractor 3 showed better persistence than false alarms for Distractor 1, and the false alarms for Distractor 1 showed better persistence than the false alarms for Distractor 2.

Relative Persistence of False Alarms and Hits

Hits persisted in a period of one week for first ($\chi^2(1) = 8.15$, $p < .01$) and sixth graders ($\chi^2(1) = 10.35$, $p < .001$), but did not persist for third graders ($\chi^2(1) = 2.23$, $p > .05$). Relative to hits, false alarms showed greater persistence. As it can be seen from part one of the Table 14, the persistence of false alarms exceeded the persistence of hits in all type of distractors at all age levels. However, the persistence of hits exceeded the persistence of false alarms for Distractor 2 in first graders.

One-Month Test

As mentioned, this test allowed persistence over three weeks to be assessed for items (targets and distractors) that had been previously tested once and for items that had been previously tested twice. Results for these two types of items will be presented separately.

Table 13

Likelihood Ratios and Corresponding Probabilities* for all items across testing times.

First Grade

Item/tests	NPI-OPW	NPW-OPM	OPW-TPM	NPI-TPM
Targets	8.15(.004)	10.37(.001)	.74(.39)	.40(.70)
Distractor 1	22.00(.001)	4.22(.04)	2.49(.12)	1.60(.21)
Distractor 2	27.37(.001)	5.85(.02)	11.05(.001)	6.90 (.009)
Distractor 3	10.12 (.001)	3.46(.06)	7.39(.007)	1.72 (.19)

Third Grade

Targets	2.23(.14)	14.13(.001)	15.37(.001)	3.58(.06)
Distractor 1	29.91(.001)	8.95(.003)	17.16(.001)	6.97(.008)
Distractor 2	35.91(.001)	20.14(.001)	36.93(.001)	27.03(.001)
Distractor 3	24.12(.001)	22.07(.001)	13.23(.001)	16.80(.001)

Sixth Grade

Targets	10.35(.001)	22.90(.001)	17.73(.001)	2.21(.14)
Distractor 1	7.68(.006)	13.06(.001)	6.14(.01)	.70(.40)
Distractor 2	18.21(.001)	15.93(.001)	29.77(.01)	11.28(.01)
Distractor 3	17.51(.001)	16.95(.001)	9.78(.002)	2.08(.15)

* Numbers within parenthesis correspond to the probability of each likelihood ratio.

Note: NPI-OPW = Analysis of items initially tested on the Immediate test vs. their repetition on the One-week's, NPW-OPM = Items initially tested on the One-week test vs. their repetition on the One-month's, OPW-TPM = Items tested on the One-week test (initially tested on the immediate test) vs. their repetition on the One-month's, NPI-TPM = Items tested on the immediate test vs. their repetition on the One-month's (items with two prior testing times).

Items With One Prior Test

Persistence of false alarms. Stochastic dependency analyses of false alarms produced by distractors initially tested on the one-week test and repeated on the one-month test were performed. As seen from column two of Table 13, third ($\chi^2(1)=8.95$, $p < .01$; $\chi^2(1)=20.14$, $p < .001$; $\chi^2(1)=22.07$, $p < .001$) and sixth graders ($\chi^2(1)=13.06$, $p < .001$; $\chi^2(1)=15.93$, $p < .001$; $\chi^2(1)=16.95$, $p < .001$) had persistence of false alarms for Distractors 1, 2, and 3. First graders had persistence of false alarms for Distractors 1 and 2 ($\chi^2(1)=4.22$, $p < .05$; $\chi^2(1)=5.85$, $p < .05$), but not for Distractor 3 ($\chi^2(1)=3.46$, $p > .05$). As shown in part two of table 13, persistence of false alarms for Distractor 3 was better than persistence of Distractors 2 and 1 for third and sixth graders. First graders showed greater persistence of false alarms for Distractors 2, and 1 but not for Distractor 3.

Relative persistence of false alarms and hits. Hits persisted for a period of three weeks. This was true for first ($\chi^2(1)=10.37$, $p < .05$), third ($\chi^2(1)=14.13$, $p < .05$), and sixth graders ($\chi^2(1)=22.90$, $p < .04$).

The relative persistence of hits and false alarms varied with age (Table 14). The persistence rate for hits exceeded the persistence rate for false alarms on all type of distractors in first graders. The persistence rate for

hits only exceeded the persistence rate for false alarms for Distractor 1 in third graders. The persistence rate of false alarms for all type of distractors exceeded the persistence rate for hits in sixth graders.

Items With Two Prior Tests

The dependency analyses of these items gave information on two levels of persistence: immediate versus one-month, and one-week versus one-month. Following the same general procedure used in the previous sections, the next section first presents the analysis of persistence for the one-week versus one-month tests, and then presents the analysis of persistence for the immediate versus one-month.

One-Week versus one-month tests.

Persistence of false alarms. Stochastic dependency analysis for distractors on the one-week versus one-month tests showed persistence of false alarms across the three-week interval. As it can be seen in column three of Table 13, third ($\chi^2(1)=17.16$, $p < .001$; $\chi^2(1)=36.93$, $p < .001$; $\chi^2(1)=13.23$, $p < .001$) and sixth graders ($\chi^2(1)=6.14$, $p < .01$; $\chi^2(1)=29.77$, $p < .001$; $\chi^2(1)=9.78$, $p < .01$) had persistence of false alarms for Distractors 1, 2, and 3. First graders had persistence of false alarms for Distractor 2 ($\chi^2(1)=11.05$, $p < .001$) and Distractor 3 ($\chi^2(1)=7.39$, $p < .01$), but no persistence for Distractor 1 ($\chi^2(1)=2.49$, $p > .05$).

Table 14

Conditional and Unconditional Probabilities of Delayed Hits
and False Alarms.

Type of Item	Grade		
	First	Third	Sixth
One-week Test (NPI-OPW)			
$p(Hw)$	.855	.815	.728
$p(Hw|Hii)$	.865	.798	.852
$p(FAw) \text{ Distractor 1}$	.800	.748	.653
$p(FAw|FAi) : \text{Distractor 1}$	.841	.826	.778
$p(FAw) : \text{Distractor 2}$	.735	.498	.318
$p(FAw|FAi) : \text{Distractor 2}$	.739	.578	.575
$p(FAw) : \text{Distractor 3}$	.730	.553	.388
$p(FAw|FAi) : \text{Distractor 3}$	.774	.675	.678
One-month Test (NPW-OPM)			
$p(Hm1)$	.775	.733	.740
$p(Hm1|Hiw)$	.794	.812	.849
$p(FAm1) : \text{Distractor 1}$	.730	.670	.655
$p(FAm1|FAiw) : \text{Distractor 1}$	.737	.746	.806
$p(FAm1) : \text{Distractor 2}$	.663	.420	.293
$p(FAm1|FAiw) : \text{Distractor 2}$	.679	.602	.556
$p(FAm1) : \text{Distractor 3}$	.598	.358	.250
$p(FAm1|FAiw) : \text{Distractor 3}$	.548	.517	.520

(Table Continues)

One-month Test (Persistence for Three Weeks) NPI-OPW			
Type of Item	Grade		
	First	Third	Sixth
$p(Hm2)$	.843	.783	.813
$p(Hm2 | Hiw)$	.765	.808	.852
$p(FAm2) : \text{Distractor 1}$	.790	.755	.733
$p(FAm2 | FAiw) : \text{Distractor1}$	.808	.815	.857
$p(FAm2 : \text{Distractor 2}$	.663	.430	.420
$p(FAm2 | FAiw) : \text{Distractor2}$	.709	.581	.619
$p(FAm2 : \text{Distractor 3}$	.730	.565	.548
$p(FAm2 | FAiw) : \text{Distractor3}$	.703	.545	.626

One-month Test (Persistence for one month) NPI-TPM			
$p(Hm2)$	.855	.815	.728
$p(Hm2 | Hii)$	.763	.783	.828
$p(FAm2) : \text{Distractor 1}$	.800	.748	.653
$p(FAm2 | FAii) : \text{Distractor1}$	.804	.795	.839
$p(FAm2) : \text{Distractor 2}$	.735	.498	.318
$p(FAm2 | FAii) : \text{Distractor2}$	.691	.538	.582
$p(FAm2) : \text{Distractor 3}$	.730	.553	.388
$p(FAm2 | FAii) : \text{Distractor3}$	.682	.557	.600

Note 1:

NPI-OPW = Test of items initially tested on the Immediate test versus their repetition on the One-week test, NPW-OPM = Items initially tested on the One-week test versus their repetition on the One-month test, OPW-TPM = Items tested on the One-week test (initially tested on the immediate test) versus their repetition on the One-month test, NPI-TPM = Items tested on the immediate test versus their repetition on the One-month test (items with two prior testing times).

Note 2:

Hii = Initial hits on the Immediate test, Hiw = Initial hits on the One-week test, Hw = Delayed hits on the One-week test for targets initially tested on the Immediate test, Hm1 = Delayed hits on the One-month test for targets initially tested on the One-week test, Hm2 = Hits on the One-month test for targets initially tested on the Immediate test, and repeated on the One-week test, FAw = False alarms on the One-week test for distractors initially tested on the Immediate test, FAm1 = False alarms on the One-month test for distractor initially tested on the One-week test, FAm2 = False alarms on the One-month test for distractor initially tested on the Immediate test, and repeated on the One-week test.

Relative persistence of false alarms and hits. Hits persisted in this period for third ($\chi^2(1)=15.37$, $p < .001$) and sixth graders ($\chi^2(1)=17.73$, $p < .001$), but did not persist for first graders ($\chi^2(1) = .74$, $p > .05$). Relative to hits, false alarms showed more persistence across this interval. Part three of Table 14 shows that the only persistence rate for hits that exceeded the persistence rate for false alarms was for Distractor 3 in third graders. The persistence rate for false alarms exceeded the persistence rate for hits for all distractors in first and sixth graders.

Immediate versus One-month.

Persistence of false alarms. As it can be seen from column four of Table 13, false alarms for Distractor 2 ($\chi^2(1)=6.90$, $p < .01$; $\chi^2(1)=27.03$, $p < .001$; $\chi^2(1)=11.28$, $p < .001$) persisted in first, third and sixth graders. Third graders had also persistence of false alarms for Distractor

1 ($\chi^2(1)=6.97$, $p < .01$), and Distractor 3 ($\chi^2(1)=16.80$, $p < .001$). False alarms for Distractors 1, and 3 did not persist in first and sixth graders (all p s $> .05$).

Relative persistence of false alarms and hits. Results given in column four of table 13 show that hits did not persist in first ($\chi^2=.401$ $p > .05$), third ($\chi^2=3.58$ $p > .05$) and sixth graders ($\chi^2=2.21$ $p > .05$). False alarms for all distractors showed greater persistence than hits in all age levels. Part four of Table 14 shows that there was an age increase in persistence of false alarms for all distractors.

Summary of Results

Two major questions served as the foci of this study. Does repeated testing create false memories? Do these false memories persist over long-term retention periods? Previous studies found that repeated testing inoculated true memories and produced false memories (Brainerd, & Reyna, 1996), and that false memories persisted more than true memories (Brainerd, Reyna, and Brandse, 1995; Payne, et al, 1996; McDermott, 1996). Those findings were replicated and extended to memory for sentences that describe everyday events.

The effects of testing in creating false memories replicated and extended Brainerd and Reyna's (1996) findings. False alarms were always higher on later tests for distractors that had been previously tested. This was true

on the one-week test and on the one-month test. On the one-month test, distractors that had two prior tests had the highest false-alarm rates of all. However, the effects of repeated testing were different for different distractors. True meaning/different words distractors had always the greatest means, but the impact of testing was bigger for False-meaning/different-words distractors. This was shown by greater increases of their means as effects of prior testing. In the case of true-memory inoculation, hits were preserved by prior testing on the one-week test, but the effect disappeared on the one-month test. False memory creation was more pronounced than true-memory inoculation.

On the persistence of false memories, this study replicated previous findings of greater persistence for false memories than for true memories. Furthermore, previous findings were extended to an interval of one month for three different kinds of distractors.

What about developmental trends? Not surprisingly, older children had better memory than younger children as measured by d' . Also the true memory inoculation effect increased with age: sixth-grade children had higher rates of true memory inoculation (Table 2) than third-graders, and third graders had higher rates than first graders. Concerning false-memory creation, the effects were again greater for older than for younger children.

CHAPTER 6

DISCUSSION

The results obtained in this study replicated and extended recently reported findings on the effects of testing repetition (e.g. Brainerd and Reyna, 1996; Poole and White, 1991; 1995; Wheeler and Roediger, 1992), and on the persistence of true and false memories (e.g. Brainerd, Reyna, and Brandse, 1995; McDermott, 1996, Payne et.al., 1996). In the first section of this chapter I discuss the results for testing repetition and how these results relate to those of previous studies. In the second section, I discuss the results for persistence of true and false memories in relation to constructivism, and FTT. In a final section, I comment on how the results of this study could influence current knowledge and practice in the evaluation of children's eyewitness testimony.

Testing Repetition

Results of this study show that testing repetition had stronger false-memory creation effects than true memory inoculation effects. On the one week test, both hits and false alarms were elevated by prior testing on the immediate test. The effects of prior testing was larger for false alarms than for hits, however. Also, the true-memory

inoculation effect was no longer present on the one-month test, but the false-memory creation effect was.

There were two main differences between the present results and those obtained by Brainerd and Reyna (1996). First, Brainerd and Reyna (1996) reported greater effects of prior testing on meaning-consistent distractors. In this study, the effects of prior testing were greater on meaning-inconsistent distractors. Second, Brainerd and Reyna found greater false memory creation in younger children than in older children. In this study, I found that false memory creation increased with age. It should be noted, in connection with these differences, that Brainerd and Reyna's targets were unrelated word lists, whereas mine were sentences. Moreover, my meaning-inconsistent distractors actually shared considerable meaning with targets.

What are the mechanisms that are responsible for the effects of testing repetition? FTT assumes that repeated testing inoculates true memories and produces false memories via at least two mechanisms. "True-memory inoculation involves the preservation of verbatim traces of target exposure events, whereas the later [false-memory creation] are assumed to involve either the formation of verbatim memories of distractors ... or the retrieval of gist memories that distractors share with presented targets" (Brainerd and Reyna, 1996, p. 471). Hits on an initial test

seem to be supported primarily by verbatim memories of targets (Reyna and Kiernan, 1994), but false-alarms seemed to be supported primarily by gist memories (Brainerd, Reyna, & Kneer, 1995). The high rates of forgetting for verbatim memories cause delayed hits to be based more on gist than immediate tests. However, a prior memory test seems to preserve verbatim memories against forgetting (Brainerd & Reyna, 1996; Curran & Lane, 1995). Thus, a prior memory test tends to make an additional memorial basis for hits available in delayed tests.

Persistence

The results of this study also replicated and extended previously reported results on persistence of true and false memories (e.g. Brainerd, et al., 1995). Prior studies have shown persistence of false alarms for words for one day (Payne, et.al, 1996), two days (McDermott, 1996), and one week (Brainerd, et al., 1995). This study showed persistence of false alarms for sentences for one week, three weeks, and one month. Brainerd, et al., (1995), McDermott, (1996), and Payne et al., (1996) all reported that certain types of false alarms for words were more persistent than hits. I observed the same pattern for sentences.

An informative result of the present study concerns developmental differences in persistence of hits and false alarms. As expected, there were age increases in both

persistence of hits and persistence of false alarms. Sixth-grade children displayed higher levels of persistence than third- and first-grade children at the one-week and one-month tests maintained an overall greater rate of hits and false alarms than third-grade and first-grade children over periods of one week and one month. These results are similar to what Brainerd, et al., (1995) reported.

Another interesting result is that false-alarm rates for distractors were more stable than hit rates for targets, and false-alarm rates for true distractors were more stable than false-alarm rates for false distractors. Although Brainerd, et al., (1995) obtained the former result, their design did not include target falsifying distractors. Although distractors with falsified meaning were most persistent in this study, it should be noticed that they are not totally target unrelated. False-meaning/different-words distractors (e.g. The cat frightens the dog) share most of the gist of target sentences (e.g. The dog scares the cat). Thus, the same gist processes that were assumed to produce false-alarm persistence in Brainerd, et al's., (1995) studies were probably operating here. Further, Reyna, (1996) has reported that distractors that share a great deal of target meaning but also contradict some aspect of meaning are particularly likely to produce stable false memories. Constructivism and FTT.

Classical constructivist accounts of memory are limited in their ability to explain results such as these (Brainerd, et al., 1995). As previously discussed, constructivist theories, such as schema theory assume that both surface and semantic content are integrated in a semantic code. This code later provides the basis for hits and false alarms. When subjects are presented with memory probes, they access the unitary code and make decisions. Hits and false alarms are based on the degree of resemblance between probes and retrieved memories. Hits will always be more probable than false alarms because targets resemble themselves more than they resemble distractors. False alarms will be more probable with distractors that have strong semantic connections to targets. False alarms can persist over time, but they should not be as persistent as hits.

There were some results in this study that are consistent with what constructivism predicts about of false alarms. The overall means of false alarms were always greater for semantically-related distractors than for semantically-unrelated distractors. This is reminiscent of many classical studies reporting higher false-alarm rates for semantically-related distractors than for semantically-unrelated distractors (e.g. Bransford and Franks, 1971). However, constructivism cannot predict the more fine-grained results for testing repetition and persistence. Those

particular results are predicted by FTT.

According to FTT, repeated testing inoculates true memories because it preserves verbatim traces of targets' surface forms. Repeated testing creates false memories both by implanting verbatim traces of distractors, and by providing practice at retrieving gist memories. False memories can be more persistent than true memories because the former are supported by stable gist memory, while the latter are supported by labile verbatim memory (Brainerd and Reyna, 1995; Reyna and Kiernan, 1994).

Eyewitness Testimony

What implications do these results have for children's eyewitness testimony? There appear to be two main implications. First, neutral repeated testing should not be viewed as simply preserving true memories against forgetting (Brainerd & Ornstein, 1991). Such test may also increase the probability of falsified testimony. Second, false memories produced by memory testing can persist across long periods (at least one month).

APPENDIX A

List of Sentences Ordered as Stories
(Learning Phase)

STORY 1

The oil is heavier than the water
The water is clearer than the coffee
The water is healthy

STORY 2

The dog frightens the cat
The cat jumps through the window
The dog is female

STORY 3

The rabbit is faster than the turtle
The turtle is rougher than the frog
The rabbit has short tail

STORY 4

The lake is cooler than the river
The river is dirtier than the pool
The lake is beautiful

STORY 5

The sun comes in the morning
The moon lights at night
The sun is hot

STORY 6

The dictionary is thicker than the magazine
The magazine is cheaper than the journal
The dictionary is more useful

STORY 7

The plane is in the air
The tree is under the plane
The plane is old

STORY 8

The lady looks for the teacher
The teacher is starting the lecture
The teacher is busy

STORY 9

The leader explains to the team
The team will know the new techniques

The leader is experienced

STORY 10

The police accuses the man
The man has a beard
The police has a gun

STORY 11

The judge is stronger than the lawyer
The lawyer is more intelligent
The judge applies the law

STORY 12

The office is noisier than the library
The library is farther than the office
The library has computers

STORY 13

The train is bigger than the bus
The bus is safer than the motorcycle
The bus is comfortable

STORY 14

The pear is softer than the orange
The orange is juicier than the lemon
The pear is green

STORY 15

The book is more real than the movie
The movie is funnier than the life
The movie became famous

APPENDIX B

List of Sentences in Random Order
(Learning Phase)

The pear is green
The water is healthy
The dog frightens the cat
The lawyer is more intelligent
The oil is heavier than the water
The lake is cooler than the river
The movie became famous
The orange is juicier than the lemon
The leader is experienced
The magazine is cheaper than the journal
The teacher is busy
The Police has a gun
The cat jumps through the window
The dictionary is more useful
The library has computers
The river is dirtier than the pool
The train is bigger than the bus
The tree is under the plane
The dog is female
The judge is stronger than the lawyer
The lake is beautiful
The lady looks for the teacher
The moon lights at night
The turtle is rougher than the frog
The plane is in the air
The sun is hot
The teacher is starting the lecture
The water is clearer than the coffee
The leader explains to the team
The dictionary is thicker than the magazine
The judge applies the law
The book is more real than the movie
The police accuses the man
The library is farther than the office
The bus is safer than the motorcycle
The plane is old
The rabbit has short tail
The office is noisier than the library
The team will know the new techniques
The rabbit is faster than the turtle
The sun comes up in the morning
The man has a beard
The movie is funnier than the life

The bus is comfortable
The pear is softer than the orange

APPENDIX C

Sentences Used to Compose the Testing Lists

- (Sm/Sw) The plane is in the air
- (Tm/Dw) The plane is flying
 (Fm/Sw) The tree is in the air
 (Fm/Dw) The plane is on the ground
- (Sm/Sw) The tree is under the plane
- (Tm/Dw) The tree is below the plane
 (Fm/Sw) The plane is under the tree
 (Fm/Dw) The tree is above the plane
- (Sm/Sw) The dog frightens the cat
- (Tm/Dw) The dog scares the cat
 (Fm/Sw) The cat frightens the dog
 (Dm/Dw) The dog calms the cat
- (Sm/Sw) The cat jumps trough the window
- (Tm/Dw) The cat leaves trough the window
 (Fm/Sw) The dog jumps trough the window
 (Fm/Dw) The cat jumps trough the door
- (Sm/Sw) The train is bigger than the bus
- (Tm/Dw) The train is larger than the bus
 (Fm/Sw) The bus is bigger than the train
 (Fm/Dw) The train is smaller than the bus
- (Sm/Sw) The bus is safer than the motorcycle
- (TM/Dw) The bus is more secure than the motorcycle
 (Fm/Sw) The motorcycle is safer than the bus
 (Fm/Dw) The bus is riskier than the motorcycle
- (Sm/Sw) The lake is cooler than the river
- (Tm/Dw) The lake is chillier than the river
 (Fm/Sw) The river is cooler than the lake
 (Fm/Dw) The lake is warmer than the river
- (Sm/Sw) The river is dirtier than the pool

- (Tm/Dw) The river is filthier than the pool
(Fm/Sw) The pool is dirtier than the river
(Fm/Dw) The river is cleaner than the pool
- (SM/Sw) The lady looks for the teacher
- (Tm/Dw) The woman looks for the teacher
(Fm/Sw) The teacher looks for the lady
(Fm/Dw) The teacher seeks the lady
- (Sm/Sw) The teacher is starting the lecture
- (Tm/Dw) The professor is starting the lecture
(Fm/Sw) The lady is starting the lecture
(Fm/Dw) The teacher is ending the lecture
- (Sm/Sw) The leader explains to the team
- (Tm/Dw) The leader tells the team
(Fm/Sw) The team explains to the leader
(Fm/Dw) The leader confuses the team
- (Sm/Sw) The team will know the new techniques
- (Tm/Dw) The club will know the new techniques
(Fm/Sw) The leader will know the new techniques
(Fm/Dw) The team will ignore the new techniques
- (Sm/Sw) The judge is stronger than the lawyer
- (Tm/Dw) The lawyer is weaker than the judge
(FM/Sw) The lawyer is stronger than the judge
(Fm/Dw) The lawyer is more powerful than the judge
- (Sm/Sw) The lawyer is more intelligent
- (Tm/DW) The lawyer is brighter
(Fm/Sw) The judge is more intelligent
(Fm/Dw) The lawyer is duller
- (Sm/Sw) The office is noisier than the library
- (Tm/Dw) The library is more quiet than the office
(Fm/Sw) The library is noisier than the office
(Fm/Dw) The office is more peaceful than the library
- (Sm/Sw) The library is farther than the office
- (Tm/Dw) The library is more distant than the office

- (Fm/Sw) The office is farther than the library
(Fm/Dw) The library is closer than the office
- (Sm/Sw) The sun comes up in the morning
- (Tm/Dw) The sun rises in the morning
(Fm/Sw) The sun comes up at night
(Fm/Dw) The sun goes down in the morning
- (Sm/Sw) The moon lights at night
- (Tm/Dw) The moon illumines the night
(Fm/Dw) The moon lights in the morning
(FM/Dw) The moon obscures the night
- (Sm/Sw) The oil is heavier than the water
- (Tm/Dw) The oil is weightier than the water
(Fm/Sw) The water is heavier than the oil
(Fm/Dw) The oil is lighter than the water
- (Sm/Sw) The water is clearer than the coffee
- (Tm/Dw) The water is more transparent than the coffee
(Fm/Sw) The coffee is clearer than the water
(Fm/Dw) The water is darker than the coffee
- (Sm/Sw) The police accuses the man
- (Tm/Dw) The police charges the man
(Fm/Sw) The man accuses the police
(Fm/Dw) The police releases the man
- (Sm/Sw) The man has a beard
- (Tm/Dw) The man has not shaved
(Fm/Sw) The police has a beard
(Fm/Dw) The man has shaved
- (Sm/Sw) The dictionary is thicker than the magazine
- (Tm/Dw) The dictionary is denser than the magazine
(Fm/Sw) The magazine is thicker than the dictionary
(Fm/Dw) The dictionary is thinner than the magazine
- (Sm/Sw) The magazine is cheaper than the journal
- (Tm/Dw) The magazine costs less than the journal
(Fm/Sw) The journal is cheaper than the magazine

(Fm/Dw) The magazine is more expensive than the journal

(Sm/Sw) The pear is softer than the orange

(Tm/Dw) The orange is harder than the pear

(Fm/Sw) The orange is softer than the pear

(Fm/Dw) The pear is firmer than the orange

(Sm/Sw) The orange is juicier than the lemon

(Tm/Dw) The orange is moister than the lemon

(Fm/Sw) The lemon is juicier than the orange

(Fm/Dw) The orange is drier than the lemon

(Sm/Sw) The rabbit is faster than the turtle

(Tm/Dw) The rabbit is speedier than the turtle

(Fm/Sw) The turtle is faster than the rabbit

(Fm/Dw) The rabbit is slower than the turtle

(Sm/Sw) The turtle is rougher than the frog

(Tm/Dw) The turtle is hardier than the frog

(Fm/Sw) The frog is rougher than the turtle

(Fm/Dw) The turtle is daintier than the frog

(Sm/Sw) The book is more real than the movie

(Tm/Dw) The book is more actual than the movie

(Fm/Sw) The movie is more real than the book

(Fm/Dw) The book is less real than the movie

(Sm/Sw) The movie is funnier than the life

(Tm/Dw) The movie is more comic than the life

(Fm/Sw) The life is funnier than the movie

(Fm/Dw) The movie is more serious than the life

Note: Sm/Sw = Same meaning/same words [Targets], Tm/Dw = True meaning/Different words [Distractor 1], Fm/Sw = False meaning/same words [Distractor 2], Fm/Dw = False meaning/different words [Distractor 3]

APPENDIX D

Testing List Used on the Immediate Test

1. The sun rises in the morning D1
2. The magazine is thicker than the dictionary D2
3. The magazine is cheaper than the journal T
4. The lake is warmer than the river D3
5. The tree is under the plane T
6. The turtle is slower than the rabbit D3
7. The movie is more real than the book D2
8. The women looks for the teacher D1
9. The judge is stronger than the lawyer T
10. The oil is lighter than the water D3
11. The library is farther than the office T
12. The police charges the man D1
13. The teacher looks for the lady D2
14. The library is closer than the office D3
15. The orange is juicier than the lemon T
16. The office is farther than the library D2
17. The teacher is ending the lecture D3
18. The train is larger than the bus D1
19. The turtle is faster than the rabbit D2
20. The dictionary is denser than the magazine D1
21. The tree is in the air D2
22. The dictionary is thinner than the magazine D3
23. The book is more real than the movie T
24. The library is more distant than the office D1
25. The teacher is starting the lecture T
26. The dog scares the cat D1
27. The lady is starting the lecture D2
28. The pear is smoother than the orange D1
29. The coffee is clearer than the water D2
30. The dog calms the cat D3
31. The office is more peaceful than the library D3
32. The dictionary is thicker than the magazine T
33. The turtle is hardier than the frog D1
34. The motorcycle is safer than the bus D2
35. The lemon is juicier than the orange D2
36. The pear is firmer than the orange D3
37. The moon lights at night T
38. The bus is safer than the motorcycle T
39. The orange is moister than the lemon D1
40. The magazine is more expensive than the journal D3

APPENDIX E

Testing List Used on the One-Week Test*

41. The cat leaves trough the window D1
42. The train is bigger than the bus T
43. The police has a beard D2
44. The team will ignore the new techniques D3
45. The lawyer is more intelligent T
46. The rabbit is more rapid than the turtle D1
47. The judge is more intelligent D2
48. The water is heavier than the oil D2
49. The man has a beard T
50. The lawyer is weaker than the judge D1
51. The sun goes down in the morning D3
52. The bus is riskier than the motorcycle D3
53. The man accuses the police D2
54. The bus is more secure than the motorcycle D1
55. The team will know the new techniques T
56. The moon obscures the night D3
57. The lake is cooler than the river T
58. The professor is starting the lecture D1
59. The movie is more comic than the life D1
60. The man has shaved D3
61. The lady looks for the teacher T
62. The frog is more resistant than the turtle D2
63. The river is cooler than the lake D2
64. The orange is drier than the lemon D3
65. The lawyer is stronger than the judge D2
66. The magazine costs less than the journal D1
67. The sun comes up in the morning T
68. The lawyer is duller D3
69. The leader explains to the team T
70. The moon illumines the night D1
71. The leader confuses the team D3
72. The book is less real than the movie D3
73. The river is dirtier than the pool T
74. The man has not shaved D1
75. The cat frightens the dog D2
76. The team explains to the leader D2
77. The dog jumps trough the window D2
78. The oil weights more than the water D1
79. The plane is in the air T
80. The turtle is daintier than the frog D3

APPENDIX F

Testing List Used on the One-Month Test*

81. The cat jumps through the window T
82. The water is darker than the coffee D3
83. The sun comes up at night D2
84. The lake is chillier than the river D1
85. The orange is softer than the pear D2
86. The lawyer is brighter D1
87. The turtle is rougher than the frog T
88. The movie is more serious than the life D3
89. The bus is bigger than the train D2
90. The water is more transparent than the coffee D1
91. The office is noisier than the library T
92. The plane is on the ground D3
93. The dog frightens the cat T
94. The journal is cheaper than the magazine D2
95. The book is more actual than the movie D1
96. The police releases the man D3
97. The leader will know the new techniques D2
98. The library is noisier than the office D2
99. The moon lights in the morning D2
100. The tree is above the plane D3
101. The police accuses the man T
102. The club will know the new techniques D1
103. The movie is funnier than the life T
104. The teacher seeks the lady D3
105. The water is clearer than the coffee T
106. The river is filthier than the pool D1
107. The plane is flying D1
108. The rabbit is faster than the turtle T
109. The lawyer is more powerful than the judge D3
110. The library is more quiet than the office D1
111. The pool is dirtier than the river D2
112. The oil is heavier than the water T
113. The train is smaller than the bus D3
114. The tree is below the plane D1
115. The pear is softer than the orange T
116. The river is cleaner than the pool D3
117. The life is funnier than the movie D2
118. The plane is under the tree D2
119. The cat jumps through the door D3
120. The leader tells the team D1

* This list was added to the previous list

APPENDIX G

List of Sentences Ordered as Stories
Spanish Version

HISTORIA 1

El aceite pesa mas que el agua
El agua es mas clara que el café
El agua es saludable

HISTORIA 2

El perro asusta al gato
El gato salta por la ventana
El perro es macho

HISTORIA 3

El conejo es mas rápido que la tortuga
La tortuga es mas aguantadora que el sapo
El conejo tiene una cola chiquita

HISTORIA 4

El lago es mas frio que el rio
El rio esta mas sucio que la alberca
El lago es muy bonito

HISTORIA 5

El sol sale en la mañana
La luna alumbra en la noche
El sol es caliente

HISTORIA 6

El diccionario es mas grueso que la revista
La revista es mas barata que el diario
El diccionario es mas útil

HISTORIA 7

El avión está en el aire
El árbol está debajo del avión
El avion esta viejo

HISTORIA 8

La dama busca al maestro
El maestro esta empezando la clase
El maestro esta ocupado

HISTORIA 9

El capitán explica al equipo
El equipo va a conocer las técnicas nuevas

El capitán es experto

HISTORIA 10

El policía acusa al hombre
El hombre esta barbón
El policía trae una pistola

HISTORIA 11

El juez es mas poderoso que el abogado
EL abogado es mas inteligente
El juez aplica la ley

HISTORIA 12

La oficina es mas ruidosa que la biblioteca
La biblioteca está mas lejos que la oficina
La biblioteca tiene computadoras

HISTORIA 13

El tren es mas grande que el camión
El camion es mas seguro que la moto
EL camión es comodo

HISTORIA 14

La pera está mas blandita que la naranja
La naranja es mas jugosa que el limón
La pera es verde

HISTORIA 15

El libro es mas real que la película
La película esta mas divertida que la vida real
La película es famosa

APPENDIX H

List of Sentences in Random Order
Spanish Version

La pera es verde
El agua es saludable
El perro asusta al gato
El abogado es mas inteligente
El aceite pesa mas que el agua
El lago está mas frio que el rio
La película es famosa
La naranja es mas jugosa que el limón
El capitán es experto
La revista es mas barata que el diario
El maestro está ocupado
El policía trae una pistola
El gato salta por la ventana
El diccionario es mas útil
La biblioteca tiene computadoras
El rio está mas sucio que la alberca
El tren es mas grande que el camión
El árbol esta debajo del avión
El perro es macho
El juez es mas poderoso que el abogado
El lago está muy bonito
La dama busca al maestro
La luna alumbra en la noche
La tortuga es mas aguantadora que el sapo
El avión está en el aire
El sol es caliente
El maestro esta empezando la clase
El agua es mas clara que el café
El capitán explica al equipo
El diccionario es mas grueso que la revista
El juez aplica la ley
El libro es mas real que la película
El policía acusa al hombre
La biblioteca está mas lejos que la oficina
El camión es mas seguro que la moto
El avion esta viejo
El conejo tiene una cola chiquita
La oficina es mas ruidosa que la biblioteca
El equipo va a saber las técnicas nuevas
El conejo es mas rápido que la tortuga
El sol sale en la mañana
El hombre esta barbón
La película esta mas divertida que la vida real

El camión es cómodo
La pera está mas blandita que la naranja

APPENDIX I

Sentences Used to Compose the Testing Lists
Spanish Version

- (Sm/Sw) El avión esta en el aire
- (Tm/Dw) El avión esta volando
(Fm/Sw) El árbol esta en el aire
(Fm/Dw) El avión esta en el suelo
- (Sm/Sw) El árbol esta debajo del avión
- (Tm/Dw) El árbol esta abajo de el avión
(Fm/Sw) El avion esta debajo del arbol
(Fm/Dw) El arbol esta arriba del avion
- (Sm/Sw) El perro asusta al gato
- (Tm/Dw) El perro espanta al gato
(Fm/Sw) El gato asusta al perro
(Dm/Dw) El perro calma al gato
- (Sm/Sw) El gato salta por la ventana
- (Tm/Dw) El gato sale por la ventana
(Fm/Sw) El perro salta por la ventana
(Fm/Dw) El gato salta por la puerta
- (Sm/Sw) El tren es mas grande que el camion
- (Tm/Dw) El tren es mas largo que el camion
(Fm/Sw) El camion es mas grande que el tren
(Fm/Dw) El tren es mas pequeño que el camion
- (Sm/Sw) El camion es mas seguro que la moto
- (TM/Dw) El camion es menos riesgoso que la moto
(Fm/Sw) La moto es mas segura que el camion
(Fm/Dw) El camion es mas peligroso que la moto
- (Sm/Sw) El lago es mas frio que el rio
- (Tm/Dw) El lago es mas helado que el rio
(Fm/Sw) El rio es mas frio que el lago
(Fm/Dw) El lago es mas tibio que el rio
- (Sm/Sw) El rio esta mas sucio que la alberca

- (Tm/Dw) El rio esta mas cochino que la alberca
 (Fm/Sw) La alberca esta mas sucia que el rio
 (Fm/Dw) El rio esta mas limpio que la alberca
- (SM/Sw) La dama busca al maestro
- (Tm/Dw) La muchacha busca al maestro
 (Fm/Sw) El maestro busca a la dama
 (Fm/Dw) El maestro procura la dama
- (Sm/Sw) El maestro esta empezando la clase
- (Tm/Dw) El profesor esta empezando la clase
 (Fm/Sw) La dama esta empezando la clase
 (Fm/Dw) El maestro esta terminando la clase
- (Sm/Sw) El capitan explica al equipo
- (Tm/Dw) El capitan platica al equipo
 (Fm/Sw) El equipo explica al capitan
 (Fm/Dw) El capitan confunde al equipo
- Sm/Sw) El equipo va a conocer las tecnicas nuevas
- (Tm/Dw) El grupo va a conocer las tecnicas nuevas
 (Fm/Sw) El capitan va a conocer las tecnicas nuevas
 (Fm/Dw) El equipo va a ignorar as tecnicas nuevas
- (Sm/Sw) El juez es mas poderoso que el abogado
- (Tm/Dw) El abogado es mas debil que el juez
 (FM/Sw) El abogado es mas poderoso que el juez
 (Fm/Dw) El abogado es mas fuerte que el juez
- (Sm/Sw) El abogado es mas inteligente
- (Tm/DW) El abogado es mas listo
 (Fm/Sw) El juez es mas inteligente
 (Fm/Dw) El abogado es mas tonto
- (Sm/Sw) La oficina es mas ruidosa que la biblioteca
- (Tm/Dw) La biblioteca es mas tranquila que la oficina
 (Fm/Sw) La biblioteca es mas ruidosa que la oficina
 (Fm/Dw) La oficina es mas pacifica que la biblioteca
- (Sm/Sw) La biblioteca esta mas lejos que la oficina
- (Tm/Dw) La biblioteca esta mas retirada que la oficina

- (Fm/Sw) La oficina esta mas lejos que la biblioteca
(Fm/Dw) La biblioteca esta mas cerca que la oficina
- (Sm/Sw) El sol sale en la mañana
- (Tm/Dw) El sol aparece en la mañana
(Fm/Sw) El sol sale en la noche
(Fm/Dw) EL sol se mete en la mañana
- (Sm/Sw) La luna alumbra la noche
- (Tm/Dw) La luna ilumina la noche
(Fm/Dw) La luna alumbra en la mañana
(FM/Dw) La luna obscurece la noche
- (Sm/Sw) El aceite pesa mas que el agua
- (Tm/Dw) El aceite es mas pesado que el agua
(Fm/Sw) El agua es mas pesada que el aceite
(Fm/Dw) El aceite es mas liviano que el agua
- (Sm/Sw) El agua es mas clara que el cafe
- (Tm/Dw) El agua es mas transparente que el cafe
(Fm/Sw) El cafe es mas claro que el agua
(Fm/Dw) El agua es mas oscura que el cafe
- (Sm/Sw) El policia acusa al hombre
- (Tm/Dw) El policia culpa al hombre
(Fm/Sw) El hombre acusa al policia
(Fm/Dw) El policia defiende al hombre
- (Sm/Sw) El hombre esta barbon
- (Tm/Dw) El hombre no esta rasurado
(Fm/Sw) El policia esta barbon
(Fm/Dw) El hombre es lampiño
- (Sm/Sw) EL diccionario es mas grueso que la revista
- (Tm/Dw) El diccionario esta mas gordo que la revista
(Fm/Sw) La revista esta mas gruesa que el diccionario
(Fm/Dw) El diccionario es mas delgado que la revista
- (Sm/Sw) La revista es mas barata que el diario
- (Tm/Dw) La revista cuesta menos que el diario
(Fm/Sw) El diario es mas barato que la revista

- (Fm/Dw) La revista es mas cara que el diario
- (SmSw) La pera esta mas blandita que la naranja
- (Tm/Dw) La naranja esta mas dura que la pera
- (Fm/Sw) La naranja esta mas blandita que la pera
- (Fm/Dw) La pera esta mas macisa que la naranja
- (Sm/Sw) La naranja esta mas jugosa que el limon
- (Tm/Dw) La naranja esta mas zumosa que el limon
- (Fm/Sw) El limon esta mas jugoso que la naranja
- (Fm/Dw) La naranja esta mas seca que el limon
- (Sm/Sw) El conejo es mas rapido que la tortuga
- (Tm/Dw) El conejo es mas veloz que la tortuga
- (Fm/Sw) La tortuga es mas rapida que el conejo
- (Fm/Dw) El conejo es mas lento que la tortuga
- (Sm/Sw) La tortuga aguanta mas que el sapo
- (Tm/Dw) La tortuga resiste mas que el sapo
- (Fm/Sw) El sapo aguanta mas que la tortuga
- (Fm/Dw) La tortuga es mas delicada que el sapo
- (Sm/Sw) El libro es mas real que la pelicula
- (Tm/Dw) El libro es mas vivencial que la pelicula
- (Fm/Sw) La pelicula es mas real que el libro
- (Fm/Dw) El libro es mas fantasioso que la pelicula
- (Sm/Sw) La pelicula es mas divertida que la vida real
- (Tm/Dw) La pelicula es mas comica que la vida real
- (Fm/Sw) La vida es mas divertida que la pelicula
- (Fm/Dw) La pelicula es mas seria que la vida real

Note: (Sm/Sw)= Same meaning/same words-Targets, (Tm/Dw)= True meaning/Different words [Distractor 1], (Fm/Sw)= False meaning/same words [Distractor 2], (FM/Dw)= False meaning/different words [Distractor 3]

APPENDIX J

Testing List Used on the Immediate Test
Spanish Version

1. El sol sale en la mañana
2. La revista es mas gruesa que el diccionario
3. La revista es mas barata que el diario
4. El lago es mas tibio que el rio
5. El arbol esta debajo del avion
6. La tortuga es mas lenta que el conejo
7. La pelicula es mas real que el libro
8. La mujer busca al profesor
9. El juez es mas poderoso que el abogado
10. EL aceite es mas libiano que el agua
11. La biblioteca esta mas lejos que la oficina
12. EL policia culpa al hombre
13. El maestro busca a la dama
14. La biblioteca esta mas cerca que la oficina
15. La naranja es mas jugosa que el limon
16. La oficina esta mas lejos que la biblioteca
17. El maestro esta terminando la clase
18. El tren es mas largo que el camion
19. La tortuga es mas rapida que el conejo
20. El diccionario esta mas gordo que la revista
21. El arbol esta en el aire
22. El diccionario esta mas delgado que la revista
23. El libro es mas real que la pelicula
24. La biblioteca esta mas retirada que la oficina
25. El profesor esta empezando la clase
26. El perro espanta al gato
27. La dama esta empezandola clase
28. La pera es mas blandita que la naranja
29. El cafe es mas claro que el cafe
30. El perro calma al gato
31. La oficina esmas pacifica que la biblioteca
32. El diccionario es mas grueso que la revista
33. La tortuga resiste mas que el sapo
34. La moto es mas segura que el camon
35. El limon es mas jugoso que la naranja
36. La pera esta mas macisa que la naranja
37. La luna alumbra en la noche
38. El camion es mas seguro que la moto
39. La naranja esta mas zumosa que el limon
40. La revista es mas cara que el diario

APPENDIX K

Testing List Used on the One-Week Test
Spanish Version

41. El gato sale por la ventana
42. El tren es mas grande que el camion
43. El policia esta barbon
44. El equipo va a ignorar las nuevas tecnicas
45. El abogado es mas inteligente
46. El conejo es mas veloz que la tortuga
47. El juez es mas inteligente
48. El agua es mas pesada que el aceite
49. El hombre esta barbon
50. El abogado es mas debil que el juez
51. El sol se mete en la mañana
52. El camion es mas peligroso que la moto
53. El hombre acusa al policia
54. El camion es menos riesgoso que la moto
55. El equipo va a conocer las tecnicas nuevas
56. La luna obscurece la noche
57. El lago esta mas frio que el rio
58. El profesor esta empezando la clase
59. La pelicula es mas comica que la vida real
60. El hombre es lampiño
61. La dama busca al maestro
62. El sapo aguanta mas que la tortuga
63. El rio esta mas frio que el lago
64. La naranja esta mas seca que el limon
65. El abogado es mas poderoso que el juez
66. La revista cuesta menos que el diario
67. El sol sale en la mañana
68. El abogado es mas tonto
69. El capitán explica al equipo
70. La luna ilumina la noche
71. El capitán confunde al equipo
72. El libro es mas fantasioso que la pelicula
73. El rio esta mas sucio que la alberca
74. El hombre no esta rasurado
75. El gato asusta al perro
76. El equipo explica al capitán
77. El perro salta por la ventana
78. El aceite pesa mas que el agua
79. El avion esta en el aire
80. La tortuga es mas delicada que el sapo

APPENDIX L

Testing List Used on the One-Month Test
Spanish Version

81. El gato salta por la ventana
82. El agua es mas oscura que el cafe
83. El sol sale en la noche
84. El lago esta mas helado que el rio
85. La naranja esta mas blandita que la pera
86. El abogado es mas listo
87. La tortuga aguanta mas que el sapo
88. La pelicula es mas seria que la vida real
89. El camion es mas grande que el tren
90. El agua es mas transparente que el cafe
91. La oficina es mas ruidosa que la biblioteca
92. El avion esta en el suelo
93. El perro asusta al gato
94. El diario es mas barato que la revista
95. El libro es mas real que la pelicula
96. El policia defiende al hombre
97. EL capitán va a conocer las nuevas tecnicas
98. La biblioteca es mas ruidosa que la oficina
99. La luna alumbrá en la mañana
100. El arbol esta arriba del avion
101. El policia acusa al hombre
102. El grupo va a conocer las tecnicas nuevas
103. La pelicula es mas divertida que la vida real
104. El maestro procura la dama
105. El agua es mas clara que el cafe
106. El rio esta mas cochino que la alberca
107. El avion esta volando
108. El conejo es mas rapido que la tortuga
109. El abogado es mas poderoso que el juez
110. La biblioteca es mas tranquila que la oficina
111. La alberca esta mas sucia que el rio
112. El aceite es mas pesado que el agua
113. El tren es mas pequeño que el camion
114. El arbol esta abajo del avion
115. La pera esta mas blandita que la naranja
116. El rio esta mas limpio que la alberca
117. La vida es mas divertida que la pelicula
118. El avion esta debajo del arbol
119. El gato salta por la puerta
120. El capitán platica al equipo

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