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Investigating a Model of False Memory Construction: Is Seeing Believing?

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ACCEPTANCE

This dissertation, INVESTIGATING A MODEL OF FALSE MEMORY CONSTRUCTION: IS SEEING BELIEVING?, by REBECCA BROOKE BAYS, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Education, Georgia State University.

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ABSTRACT

INVESTIGATING A MODEL OF FALSE MEMORY CONSTRUCTION: IS SEEING BELIEVING?

by

Rebecca Brooke Bays

In the current literature review I examine false memory research, including variables that affect memory accuracy, instrumentation, and analyses used to assess false memory construction, as well as possible frameworks accounting for the development of false memories. Do errors in memory occur during encoding of an event or during retrieval of a memory? I discuss two models of false memories, both born from the source-monitoring framework, to highlight the important cognitive processes leading to crucial errors in memory recall. In the study that follows I investigate whether repeated imaginings of an implausible autobiographical event will lead to the creation of false memories. Plausibility, in the form of prevalence ratings, and visual imagery are manipulated for six suggested events that could have occurred during childhood. A model proposed by Pezdek and colleagues supports the roles of plausibility and imagination in false memory construction (Pezdek, Finger & Hodge, 1997; Pezdek, Blandon-Gitlin & Gabbay, 2006). However, their model is based on research conducted using a Life Events Inventory, a survey that assesses a belief rather than a memory construct. In the present study, I use the Autobiographical Belief and Memory Questionnaire, a survey instrument that distinctly measures plausibility, belief and memory (Scoboria, Mazzoni, Kirsch & Relyea, 2004). Confirmatory factor analysis is employed for instrument validation, followed by a 2 (plausibility: high or low) x 3 (number of imaginings: 0, 1, 5) x 2 (time: pre or post) within subjects ANOVA to test the Pezdek model of false memory

construction. Both belief and memory ratings increase significantly when imagination is employed, regardless of event plausibility. However, memory ratings increase as the number of imaginings increase. Belief ratings only increase with one imagining. Present results provide insight into the role of visual imagery on memory accuracy, and inform researchers of appropriate survey instruments and statistical analyses to detect false memories. False memory research is valuable for informing therapeutic techniques, evaluating the reliability of eyewitness testimony, and advising interrogation procedures used by law enforcement and legal officials.

Keywords: False memory, imagination, plausibility, source error, ABMQ

INVESTIGATINGA MODEL OF FALSE
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ABBREVIATIONS

AIC	Akaike Information Criterion
ABMQ	Autobiographical Belief and Memory Questionnaire
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
LV	Latent Variable
LEI	Life Events Inventory
LEI	Life Experiences Scale
LISREL	Linear Structural Relations
MV	Manifest Variable
NFI	Normative Fit Index
RMSEA	Root Mean Square Error of Approximation
SAS	Statistical Analysis System
SEM	Structural Equation Modeling
SMF	Source Monitoring Framework
SRMR	Standardized Root Mean Residual

CHAPTER 1

TOWARD A MODEL OF FALSE MEMORY CONSTRUCTION: A REVIEW OF THE LITERATURE

Everyday activities from therapy sessions to collaborative conversations to day dreaming have a hand in producing errors in memory recall. In this review I examine such memory errors, referred to as false memories in the literature. Research on false memories became increasingly prevalent in the 1990s due to a documented rise in their occurrence. The implications of memory errors can be quite serious. Consider the case of George Franklin as described by Elizabeth Loftus, a prominent memory researcher.

On November 30, 1990, George Franklin was found guilty of a crime he did not commit. Based on a memory recovered by his daughter, he was convicted on charges of first degree murder. The only evidence presented by the prosecution was Eileen Franklin's account of the day her father killed her childhood friend, Susan Nason, twenty years earlier. The jury deliberated for only one day, and returned a guilty verdict.

Eileen, twenty-nine years old at the time, was holding her son while watching her daughter play on the living room carpet with a friend. Suddenly Eileen was overcome by a terrible memory of her father. She tried for weeks to ignore the memory, but eventually Eileen felt compelled to contact authorities. Her description of events that transpired on September 22, 1969 was so detailed that the prosecution rested their entire case on the testimony of a past event she had suddenly remembered. There was no "hard" evidence in this case. In fact, the bits of available tangible evidence pointed to George Franklin's innocence. For instance, the box spring that was used to cover the dead body of Susan Nason was too large to fit into the automobile that George Franklin owned at the time of

the murder. Eileen's recollection of the events that transpired on that day changed significantly to better fit details that were reported in the media at the time of the murder. Elizabeth Loftus, a prominent cognitive psychologist and expert in the development of false memories, was called to testify for the defense. It is Loftus' opinion that Eileen's recovered memory was in fact a false memory created via therapy, specifically hypnosis, while attempting to cope with other dark events in her past, some of which involved her father (Loftus & Ketcham, 1994).

Was Eileen Franklin disclosing details that only an eyewitness could have known? If her memory was false, then where did all of the vivid details come from? In 1996 the National Institute of Justice released a study of several documented cases in which defendants were exonerated by DNA evidence after being convicted. The report concluded that of these false convictions, 90% were the result of positive identifications of innocent suspects from eyewitnesses (Brainerd & Reyna, 2005).

Memories for past events are not perfect. Although such imperfections may be limitations, at times, they may also be adaptive in daily functioning (Conway, Harries, Noyes, Racsma'ny & Frankish, 2000; Schacter, 2001). Imagine remembering every detail of every commercial you have seen on television, or every detail of all the arguments or other unpleasant experiences you have had in your life. Remembering all of the details of events in your life would be overwhelming, making it difficult to focus on what is relevant in the immediate situation. From this perspective, it is fortunate that event memory is not a videotape of the events in our lives. In fact, event memory seems to be a

constructive process in which contexts, scripts, schemas, personal associations, and other organizational devices are used to reconstruct a memory of a past event (Oakes & Hyman, Jr., 2000).

Two Prominent Memory Approaches

Two major cognitive approaches address the functionality of memory. The formerly accepted approach, called the Quantity Oriented Approach, views memory as a storehouse into which discrete items are deposited for later retrieval. This approach focuses not on what is remembered but rather *how much* is remembered. The contents of the memory store are viewed as elementary and discrete units whose significance rests on their ability to be counted. In short, the effectiveness of memory is assessed based upon the number of countable units in the storehouse regardless of whether these units are nonsense or incorrect (Koriat, Goldsmith & Pansky, 2000).

Perhaps the researcher most identified with the Quantity Oriented Approach is Herman Ebbinghaus. Ebbinghaus recited nonsense syllables until he considered them mastered, defined by 150 syllables per minute without error. He studied the rate at which learning and forgetting occur, resulting in learning and forgetting curves as well as the serial position curve. His research demonstrates the effect of fatigue, time of day, list length and repetition on retention. He was the first to look at memory using a system of methods rather than just philosophical speculation. Ebbinghaus is regarded as a pioneer of memory research (see Bays & Zabrucky, in press for a review).

The second cognitive approach to memory is a more recent account born from the work of Sir Fredrick Charles Bartlett in the 1930s. Coined the Accuracy Oriented Approach, this framework outlines a correspondence theory of memory that examines the

contents of an individual’s memory report against the actual events that occurred using the cultural fairytale *The War of the Ghosts*. Bartlett paved the way for investigators to study memory not only for quantity, but also for accuracy. As a result, research became particularly focused on memory errors occurring during the recall of events. The Accuracy Oriented Approach allows memory to be viewed as goal-directed and intentional, and defines memory simply as the perception of the past. Forgetting, viewed as a loss of correspondence between memory reports and the actual events, presumably leads to memory errors and involves the loss of information as well as qualitative memory distortions (Koriat, et al., 2000).

The correspondence theory maintained by the Accuracy Oriented Approach to memory encompasses two major long term memory systems. Procedural memory, or memory for how to do things (Ormrod, p. 203), is the first. This knowledge may not be based on an actual memory. You know how to eat, how to tie a shoe, how to walk; however, you might not actually remember learning these processes. Declarative memory, memory for how things are or will be (Ormrod, p. 203), is the second. Examples of declarative memory include the content you learn from a textbook, or knowledge that the world is round. There are two types of declarative memory: semantic and episodic. Semantic memory involves memory for general world knowledge (Tulving, 1985). An example would be that you know you were born. You most certainly do not have an actual memory for that day; however, you are alive, so you know that your birth must have occurred.

The current review is most concerned with episodic memory, memories of real life experiences (Tulving, 1985), and autobiographical memory, explicit memory of an

event that occurred in a specific time and place in the personal past (Nelson & Fivush, 2004). Some researchers might use these two terms interchangeably. The current literature review considers autobiographical memory to be more personally salient event memories and not just simply memories of episodes that do not hold personal significance.

Autobiographical memories are episodes from an individual's life. What is the function of such a memory system? Such memories are directive because they shape and guide behavior, also allowing us to predict behavior. They are social. Autobiographical memories are the means by which we share with others. They are what form our sense of self. Our identity, who we are, is formed through our memories of personal experiences. They compose our autobiography (Williams, Conway & Cohen, 2008).

How are autobiographical memories formed? How is it that you remember what you did this morning, or on your 16th birthday?   Information Processing Theory and the Multi-Store Model (Atkinson & Shiffrin, 1968) explain the process of turning newly encountered information into memories. Memory functionality in this theory is comparable to the functionality of a computer. An abundance of information, essentially any sensory information in the environment, is taken into the sensory register. The sensory register is bombarded with a tremendous amount of unencoded information. If this information attracts our attention, it is encoded into working memory. Working memory holds a limited amount of information for a short period of time. If we establish connections between this new information and previously stored information, it passes into long term memory. Events are encoded in a variety of sensory modalities including sight (imagery), sound, smell, touch and taste. Different types of information (i.e.,

temporal, spatial, emotional, semantic) are stored in different locations in the brain. During event recall, details are pieced together with these bits of information stored across the brain to form a cohesive memory. This piecing together, referred to as reconstruction, leaves room for errors in memory that may be the result of personal expectations or misconceptions (Bartlett, 1932).

False Memories

Errors that occur during memory reconstruction are referred to as false memories. These errors can involve mistakes that alter an existing memory for an event, generally elicited via misleading postevent information, or these errors can involve entirely fabricated and implanted memories for suggested events. The former memory error is highly associated with eyewitness testimonials as well as interrogation procedures used by police officers and attorneys. Elizabeth Loftus, mentioned in the opening of this review as the memory expert for the defense in George Franklin's murder trial, began studying eyewitness memory when other researchers were still concerned with recall of discrete bits of information such as letters, numbers and nonsense syllables. Loftus began exploring the idea that postevent information can interfere with memory of an event, a phenomenon known as the misinformation effect (see Bays & Zabrucky, in press, for further discussion).

In a well-known study of the misinformation effect by Loftus, Miller and Burns (1978), participants were shown slides of an automobile accident. After viewing the slides, researchers asked questions designed specifically to suggest and mislead participants. For instance the researcher would ask, "Did you see the truck smash into the car while running the yellow light?" Use of stronger adjectives such as "smash" rather

than “hit” influenced participants’ recall of the event leading to descriptions with more details suggesting physical damage.

In Loftus (1974), participants viewed a film depicting a car accident involving multiple vehicles and were later asked questions regarding the footage that differed only in the form of the article, *a* or *the*, used in the question. For example, participants were asked, “did you see a broken headlight”, or “did you see the broken headlight”. Participants given the question using *the* were significantly more likely to report the occurrence of that suggested event. This demonstrates that the simple wording of a question can be misleading.

Unlike the misinformation effect, false memories consist of completely fabricated recollections of events which never actually occurred. Called false autobiographical memories, these recollections are fictitious memories that become implanted for events that never happened (Pezdek & Lam, 2007). False memories in laboratory research are variables that become synonymous with what research designs are measuring. They are constructs that are operationalized and products of measurement in research (Brainerd & Reyna, 2005). Most studies look at a change from a pretest measure to an identical posttest measure with some intervention in between, involving the independent variables in question, to determine if a false memory has occurred.

Loftus and Pickrell (1995) are credited with one of the first investigations of implanting entirely false autobiographical memories for events that never occurred. Twenty-four adult participants were asked to recall events supplied to researchers by close family members. Three of the events were true. The false event involved getting lost in a shopping mall as a child. Results revealed that participants were led to believe

that they had experienced the entirely fabricated event. Suggesting entirely false events as a method for false memory assessment began taking shape in Loftus and Ketcham (1994), and has been refined many times in the literature. Implications of entirely false memories involve allegations of abuse occurring in childhood, and various therapeutic techniques such as hypnosis and dream analysis. Recall of entirely fabricated events from childhood refutes claims made by psychoanalysts regarding repression (Hyman, Husband & Billings, 1995; Loftus, Joslyn & Page, 1998).

Repressed Memory or False Memory?

Is it possible to repress a memory for an event that is highly emotional, and most often stressful, only to recover that memory later via some technique used during therapy? The repressed memory/false memory debate is highly controversial, often pinning clinicians against researchers. The debate began gaining momentum in the mid-1990s. In 1994 over 10,000 adults made claims of recovered childhood memories of sexual abuse (Toglia, 1996).

Sigmund Freud fathered psychoanalysis, a method of systematic investigation, a set of theories and a planned method of treatment for individuals with mental and emotional problems. His theory of repression is one facet of psychoanalysis, and there is no exact definition of what this theory means. Clinicians derive many meanings and applications that fit their personal needs and views. In therapy repressed "recovered" memories often become the focus of the sessions, rather than the issue that drove the patient to therapy in the first place, and the therapeutic focus is lost (Toglia, 1996).

A theory of repression lacks empirical support, as does much of Freud's work. There is even irony in allegations of a theory of repression and traumatic events from

Freud himself. First, he never established that sexual trauma in childhood would result in adulthood pathology. Second, Freud realized and noted that not all recovered memories were true. Third, Freud speculated that psychoanalytic tools might elicit the formation of memories, meaning that these memories are not authentic (Toglia, 1996). Freud even came to believe that many of these recovered memories were patients' repressed fantasies of incest (Freud, Bonaparte, Freud & Kris, 1954).

Loftus addresses the issue of repression, and while she supports the idea that there are genuine cases of recovered memories for traumatic events, she does not believe that repression per se is a common phenomenon. Memories may be lost for a period of time, and this is the result of normal forgetting processes such as decay, retroactive interference or infantile amnesia (Loftus, 2003). Research on hypermnesia, abnormally strong memories for the past, also supports the idea that memory recovery is possible (Henkel, 2007). Experimental approaches to the repressed memory/false memory debate typically use misleading postevent information. One interesting question that should be addressed within this debate pertains to stressful events. Are stressful events subject to more or less scrutiny during encoding?

Characteristics of an event that make it memorable tend to operate during encoding. This includes events that are personally important, emotional or stressful, and are subject to increased scrutiny. Flashbulb memories provide an example. These are unusually detailed and vivid recollections of occasions when some dramatic or surprising event was first discovered. For instance, you probably remember where you were and what you were doing when you first learned of the September 11 attacks on the World Trade Center. According to Brown and Kulik (1977), flashbulb memories are long-

lasting and remain unchanged over time. Neisser (1982) has argued that these memories are reconstructive in nature and are therefore susceptible to the same errors that all memories are. Recent research supports Neisser's view.

What happens if a person directly experiences the stressful event, rather than just seeing it on the news or hearing about it from a friend? The literature on false memories and eyewitness memory attempts to tackle this issue. Deffenbacher, Bornstein, Penrod and McGorty (2004) conducted a meta-analysis on the eyewitness literature regarding memory accuracy. Stressful events elicit the activation mode of attentional control, which, in turn, elicits an elevated physiological response (increased heart rate, increased blood pressure). This increase in stress is debilitating to memory for faces, as with witness identification accuracy, and to recall of events. Both interrogation and free recall are impaired by stress, but free recall suffers the least. However, it is often the case that authorities use an interrogative approach when interviewing witnesses or victims of stressful events.

Payne, Jackson, Ryan, Hoscheidt, Jacobs and Nadal (2006) exposed participants to a psychological stressor prior to presenting a slide show. The stress actually preserved or even enhanced memory for emotional details of the event. Peripheral details also remained well preserved. Central details, which would include details necessary for eyewitness identification, suffered when stress was involved.

Researchers attempt to take a balanced view on the recovery of stressful life events. It might be possible to recover repressed memories from childhood, but these recovered memories probably never happened (Williams, et al., 2008). Postevent information, coupled with less stringent encoding of central details during a stressful

event, interferes with recall of that event.

Two Variables Affecting False Memory Construction: Plausibility and Imagination

The plausibility of an event pertains to whether or not it is feasible, or likely, that a person could have experienced it. An implausible event is operationally defined as one that is perceived as having a low probability of occurrence for individuals in the cohort tested (Pezdek, Blandon-Gitlin, Lam, Hart & Schooler, 2006a). For instance, if a one has never been to a shopping mall, one would not have a memory of getting lost in a mall as a child. Plausibility has been measured as a potential variable affecting false memory creation for over ten years, and one's assessment of plausibility is included in most models of false memory creation as a first step in the process. Increasing the plausibility of an event increases the probability of planting a false memory, or at least increasing false autobiographical belief (Hart & Schooler, 2006; Mazzoni, Loftus & Kirsch, 2001; Pezdek, Finger & Hodge, 1997; Pezdek, Blandon-Gitlin & Gabbay, 2006; Sharman & Scoboria, 2009). Researchers contend that the lack of a false memory effect from low plausibility events is driven by little or no search for details in memory during recall.

Pezdek, et al. (2006a) asked the question: Is plausibility confounded with background knowledge? In other words, is the lack of a false memory effect, or the lack of a search for relevant detail for low plausibility events, due to a lack of background knowledge because the event is so unfamiliar? In this study, participants were provided with either background information or prevalence information for a suggested event. Background information explained how an event occurs, providing a script for the suggested event. Prevalence information involved the frequency that an event occurs. Changes in belief ratings from pretest to posttest administrations of a Life Events

Inventory (LEI) were analyzed. Results demonstrated that belief increased. Plausibility had an effect when prevalence ratings were used to measure the construct of plausibility. Background information had no effect (Pezdek, et al., 2006a).

Hart and Schooler (2006) replicated and extended this finding beyond a belief measure to a measure of memory. After reading prevalence information for suggested childhood events participants were given a self-report measure called the Life Experiences Scale (LES). This scale assesses memory and belief separately. Participants rate how much of a memory they have for an event and how confident they are that they experienced the event. Results showed that belief increased significantly as plausibility increased. Memory did not change significantly, but approached significance, $F(1,66) = 3.085$, $p = .084$.

Sharman and Scoboria (2009) also examined the effects of event plausibility on people's beliefs and memories for imagined events. Plausibility was measured via prevalence ratings provided by participants during phase one. Participants completed three phases of research. First, a measure of plausibility, belief and memory called the Autobiographical Belief and Memory Questionnaire (ABMQ) was administered. Next, participants were asked to visualize three of the events that appeared on the ABMQ during the first phase. Last, participants completed the same ABMQ from phase one.

Results revealed an increase in belief regardless of whether an event was high or low in plausibility. This finding contrasts Pezdek, et al. (2006) because belief increased for all events, regardless of plausibility. The memory measure also increased for all events, contradicting Hart and Schooler (2006) who found no effect on memory. The increase was highest for high plausibility events, then for moderately plausible events,

and least for low plausibility events. These results contradict Hart and Schooler (2006).

Imagery techniques are a second key variable investigated in the false memory literature. An increase in belief with increased imagination has come to be known as imagination inflation. Imagination inflation, the confidence boosting effect that imagined counterfactual events actually occurred (Garry & Polascheck, 2000), has received strong support in the literature as a fundamental causal component of false memories (Goff & Roediger, 1998; Loftus & Pickrell, 1995; Mazzoni & Memon, 2003; Pezdek, et al., 2006; Thomas & Loftus, 2002).

Researchers have used a single imagining (Pezdek, et al., 2006), and multiple imaginings (Thomas & Loftus, 2002) to test for imagination inflation. The imagination inflation effect occurs when the imagination of an event is confused with actually experiencing the event, known as a source monitoring error, which leads to a false memory. When a false memory is created, the source of the memory is misconstrued so that an individual confuses the imagination of the event for its actual occurrence.

Mazzoni and Memon (2003) asked whether imagination can alter autobiographical beliefs and memories. Their study was the first to look at imagination alone and not in conjunction with other variables such as suggestion from a family member or other authority figures. The suggested event selected, “Having a nurse remove a skin sample from my little finger”, is one that is implausible as it is a procedure not done in the United Kingdom where the research took place. Participants imagined events one time, and results revealed a significant increase in belief when the event was imagined, and a significant increase in memory, as measured on a three point scale, when the event was imagined.

Scoboria and Sharman (2009) used more elaborate visual imagery techniques to test for an effect on belief and memory. Participants were guided through the visualization process and given a questionnaire related to the characteristics of the memory in question. Results revealed an increase in memory ratings for imagined events, even for low plausibility events.

Surveys Measuring False Memories: Are Instruments Assessing Belief or Memory?

Research on false autobiographical memories is controversial and complicated. Participants use self-report measures to indicate belief or memory for an event. The scales previously mentioned, the LEI, LES and ABMQ, are all self-report measures. Often researchers have no way of knowing whether the self-reports are veridical. To remedy this issue, most research designs involve three phases. The first and last phases are identical and assess false beliefs and/or false memories as constructs that result from self-report scale items. The variables under investigation are presented during an intervention at phase two (Williams, et al., 2008). Researchers are looking for a change in the self-report scales for each event to determine if a false belief or a false memory has occurred.

Most models of false memories are based on data collected using some version of the Life Events Inventory (LEI) (Mazzoni & Memon, 2003; Pezdek, et al., 2006a; Pezdek, et al., 2006). This inventory lists suggested events and asks participants to rate on a Likert scale of 1 to 8 how confident they feel that they experienced a suggested event during childhood (see Appendix A for a sample LEI). Recently some researchers have criticized use of the LEI in studies claiming false memory creation because the LEI is actually assessing belief. There is no way to determine whether participants actually have

a false memory for the suggested event, or if they simply have a false belief (Scoboria, Mazzoni, Kirsch & Relyea, 2004; Scoboria, Mazzoni, Kirsch & Jiminez, 2006). A false belief would involve an increase in confidence of an event's occurrence, but this does not necessarily imply that the belief is based upon a memory for the event, actually remembering the experience, or just a feeling of knowing that the event occurred.

Belief is influenced semantically based on inferential processes whereas memory judgments are not. Remember judgments reflect episodic memory while know judgments imply semantic memory (Tulving, 1985). As reviewed by Smeets, Merchelbach, Horselenberg and Jelicic (2005), if memory retrieval is accompanied by conscious recollection, participants will experience a remember response. If memory retrieval is accompanied by feelings of familiarity but no conscious recollection, then participants will experience a know response. Many researchers have used the remember/know distinction in previous research on recall and recognition. Remembering involves a recollective experience whereas knowing does not (Mazzoni & Kirsch, 2002). Surveys in false memory literature have been developed that relate this remember/know distinction to autobiographical memories.

Scoboria, et al. (2004), with further support from Scoboria, et al. (2006), developed a new measure of false memories that, unlike the LEI, independently assesses plausibility, belief and memory. The Autobiographical Belief and Memory Questionnaire (ABMQ), mentioned earlier, consists of five questions that assess general plausibility, personal plausibility, autobiographical belief and autobiographical memory, as well as the belief in the frequency of occurrence of an event. The fifth question has yet to be examined by Scoboria and colleagues (see Appendix B for a sample question from the

ABMQ). General plausibility refers to the judgment made regarding whether the event could have occurred to someone in the general population. Personal plausibility refers to the judgment that an event could have happened to one personally (Scoboria, et al., 2004). The distinction between general and personal plausibility is evident in the wording of the question with “some people” and “you personally” used, respectively. The distinction between personal plausibility and belief lies in the wording “could have occurred” and “did in fact occur”, respectively. The memory construct asks “do you actually remember” experiencing the event. Investigators use an 8-point Likert scale to assess the target events (Scoboria, et al., 2004).

The ABMQ has been used six times in the literature to date to assess false memories. Scoboria, et al. (2006) investigated the effects of prevalence ratings and background information on plausibility, belief and memory of autobiographical events. Two unlikely childhood events (receiving a bone density scan and receiving an enema) were rated by participants on all four constructs. Prevalence ratings enhanced general plausibility and personal plausibility for both events, and enhanced autobiographical belief for one of the events. Background information increased general knowledge for both events and increased general plausibility for one event. This contrasts with the findings of Hart & Schooler (2006) and Pezdek, et al., (2006) because general plausibility was affected by background information. However, the scales used by Hart & Schooler and Pezdek did not independently assess two types of plausibility as the ABMQ does. Autobiographical memory was not affected.

Desjardins and Scoboria (2007) asked whether different types of details in a false narrative would affect the development of false memories. Forty-four participants were

assigned to one of four groups: self-relevant and specific details, self-relevant details only, specific details only, no details (control). The false target event in this study involved being punished at school. An ABMQ was administered for five events (including the target). Participants described all they could remember about each event. A qualitative memory questionnaire was administered followed by a second ABMQ. Results suggest that including self-relevant details increases the likelihood that a target event will be accepted as a false memory. There was a trend for higher belief as well as memory ratings in the self-relevant group.

Scoboria, Lynn, Hessen and Fisco (2007) gave false prevalence information to participants coupled with a rationale for why forgetting childhood events is common. Sixty-two undergraduates were given the ABMQ, then provided either prevalence information only, prevalence information coupled with a forgetting rationale, or neither (control). A second ABMQ was then administered. Results revealed an increase in belief for the prevalence and rationale group, but no change in memory ratings. This further supports the distinction between belief and memory.

Golde, Sharman and Candel (2010) used high prevalence information from different sources to determine if belief in experiencing an event can actually decrease as a result. Ninety-three participants were given an ABMQ with ten events. Next, participants received prevalence information related to four of the events, two of which served as low plausibility target events. Information was delivered by one of four sources: third-person descriptions, newspaper articles, cohort data, or no information (control). A second AMBQ was then administered. Participants given high prevalence information in newspaper articles showed an increase in belief, but no effect on memory. No support

was found for the prediction that belief may decrease based upon prevalence information and source.

Smeets, Telgen, Ost, Jelicic and Merckelbach (2009) investigated crashing memories, defined by these researchers as people's false reports of having seen images of non-existent footage of highly public events. Are these truly memories or just beliefs? Eighty-eight participants were given a memory questionnaire and the ABMQ with a target event involving the assassination of a Dutch politician. No footage exists of this assassination. Two thirds of the participants reported a belief in seeing footage. Only 10% of these two thirds reported having an actual memory of viewing the footage. This again reveals that belief and memory are distinct, but related, constructs.

Sharman and Scoboria (2009) examined the effects of event plausibility on people's false beliefs and memories for imagined childhood events. Sixty participants took the ABMQ, then imagined one low, one high and one moderately plausible event. A second ABMQ was then administered. Results refute those of Pezdek, et al. (2006) demonstrating imagination inflation, or increased confidence, for high, moderate and low plausibility events. Pezdek only detected this effect for high plausibility events. Sharman and Scoboria had participants use their own rating at pretest for the basis of the stratification of plausibility to assess changes at posttest rather than providing prevalence ratings. Participants also developed a clearer and more complete memory for the imagined events regardless of their plausibility. These results support the idea that plausibility, belief, and memory are distinct, but related, constructs.

The Nested Model: Setting the Stage for a Cohesive Model of False Memories

Scoboria, et al. (2004) proposed a nested model of false memories based on results obtained using the ABMQ in false memory research to explain the relationship identified between the constructs. This is not a model of false memory formation in the sense of how the process occurs. This model helps to integrate the different constructs involved in the false memory process which are components of most models describing false memory construction. The nested model states that general plausibility is necessary for personal plausibility is necessary for belief is necessary for memory. An individual can find a suggested event plausible for someone else without having a belief or a memory for that event; however, if an individual has a memory for an event, he or she must believe in its occurrence and find it plausible for him or her and the general population. To believe in the experience of an event, an individual must consider that event personally plausible. If a memory for the event exists, an individual must believe in its occurrence. The ABMQ asks a series of questions related to each suggested event (see Appendix B for a sample question) that are geared towards assessing general plausibility, personal plausibility, autobiographical belief and autobiographical memory separately. Their nested relation is revealed in the process.

In relation to Tulving's work, previously cited, a remember response will relate to the measure concerning memory on the ABMQ and a know response will relate to the belief measure on the ABMQ. For instance, to return to the example of semantic memory provided at the beginning of this review, you know that you were born, which corresponds to a belief, but you do not have a memory of the event. There are exceptions to the nested model. For example, if an individual actually shakes hands with the

president, his general plausibility rating for that event would be low but his personal plausibility rating would be high.

Researchers have looked at the impact of plausibility on belief and support the nested relationship (Hart & Schooler, 2006; Mazzoni, Loftus & Kirsch, 2001). Mazzoni (2007) looked at response times, a behavioral measure, to tease apart the constructs of plausibility and belief. Although these constructs are correlated, they are distinct. Participants provided belief ratings and plausibility ratings for six events. A response latency was recorded by a computer to measure the amount of time that elapsed between presentation of the event and rating the event. Results revealed that plausibility is the first step in making a belief judgment, and response times for plausibility ratings correlated more strongly than for belief ratings (Mazzoni, 2007). If an event was initially judged implausible, there was no memory search and response times were larger than for events that were initially considered plausible. This plausibility judgment also correlated with the response latency for each event when asked about belief in experience.

What Statistics Have Been Used to Test False Memory Construction?

Change Scores

Researchers often analyze change scores to assess false memory construction (Pezdek, et al., 2006). Change scores, also called difference scores or gain scores, are the result of subtracting a pretest measurement from a posttest measurement. A change score model holds the following assumptions: a linear relationship between X and Y; Y is normally distributed; residual error variance is constant for all participants; and residual errors are independent of one another and pretest scores. Change scores must be obtained via the same instrument during pretest and posttest and be in the same unit of

measurement with the same amount of time between the pretest and posttest (Bonate, 2000). The measurement of change has appeared in the literature for over 70 years, but is this measurement of change useful?

A large problem with change scores that is addressed time and time again in the literature is the reliability of a change score (Dimitrov & Rumrill, 2003; Raykov, 1999). The reliability of a measure represents the ability of that measure to distinguish among individuals on a particular trait or true score. This is not a fixed property of a test itself but is the product of a test in a certain population. The reliability of an observed test score is equal to the true score variance divided by the observed score variance. The reliability of a change score is defined as the correlation of the score with an independently observed difference (Cronbach & Furby, 1970). When using change scores, the measurement errors impacting reliability become additive, making reliability an issue. However, some researchers have argued that the loss in reliability is not valid because power of the significance testing is highest when the change score reliability is equal to zero. This provides superior basis for rejecting the null hypothesis.

Variance restriction is a second issue that arises when using change scores, evident by smaller variances, larger skewness, more pico-kurtosis, and absolute residuals from the fitted model more strongly correlated with the modeled dependent variable for the difference scores, a condition known as heteroscedasis. The random variables have random variances which lead to an underestimation of variance and standard errors (Balloun & Klein, 1997). Put more simply, change scores are confounded with the baseline when data are skewed. The amount of change is a function of the baseline level.

Finally, and perhaps one of the larger issues when examining change scores obtained from an instrument using a Likert scale, as in the studies assessing false memories using the LEI or the ABMQ, change scores do have large problems with floor and ceiling effects. A ceiling effect in research is an effect wherein a measurement cannot take on a higher value. A floor effect is the opposite. The average score of the bottom half of a sample will probably improve on a retest while the average score of the top half of a sample will probably decline on a retest. False memory research often employs self-report measures administered two times with some intervention occurring in the middle. This regression towards the mean could be a statistical artifact wherein the true scores of the participants do not really change on retest. Or, this regression could be the result of the measure and confound any implications drawn from change scores (Pezdek & Eddy, 2001).

Regression to the mean occurs because of noise (error) in test scores. Noise is simply the typical or standard error of measurement, and can come from the instrument being used to measure changes or the participants themselves. If the noise is only from the instrument then regression to the mean is just an artifact. If the noise is due to within-subject variability then it is real. This is a problem when the dependent variable (change score which is impacted by noise) is measured across groups that differ in their mean scores on one of the tests. This issue can be avoided by correcting the change score, by using a control group or by accounting for baseline differences.

Some researchers split the distribution of change scores into a low group, initial Likert scale rating of 1 – 4, and a high group, initial Likert scale rating of 5 – 8 (Garry, Sharman, Wade, Hunt & Smith, 2001) to remedy regression to the mean in change

analysis. This split should not impact the mean of the sample, and will help to control for floor and ceiling effects. Garry, et al. use a course exam as an example of the effect obtained when the change score distribution is separated. If an instructor decided to readminister an exam, a parallel form would most likely be used that is not perfectly correlated with the first exam. On retest, some students will improve their score while other scores will decrease, but the mean, standard deviation and shape of the distribution in general should remain the same. Answers to test items will change at retest, an example of regression to the mean.

If researchers choose to split the distribution in this manner, research questions must be very clear in both direction and magnitude, and there must be a clear definition and difference between imagination inflation and actual false memory (Garry, et al., 2001; Sharman & Scoboria, 2009). Researchers cannot experimentally manipulate plausibility during intervention, but must allow participants to determine plausibility to analyze change scores divided into categories based on magnitude.

Why are change scores estimated if so many issues arise? For researchers, change scores can provide a dependent variable for measure, provide an estimate of growth rate, indicate deviant development and serve as a construct in theoretical work. Change scores can be used to operationalize a concept. In the literature on false memories the change score (posttest minus the pretest score on some Likert scale measurement of life experiences) often serves as the indicator of the creation of a false memory (Cronbach & Furby, 1970).

If researchers wish to use the actual change scores in their analysis, they have three options. These analyses calculate the actual difference between the posttest and

pretest measure. Options include a between groups ANOVA on the change scores using a control group, a repeated measures ANOVA on the change scores, or ANCOVA using either the change score or the posttest score as the dependent variable.

ANOVA is a collection of statistical models in which observed variance is partitioned into components due to different sources of variation. Variability is divided by attributing portions to the effect that the independent variable has on the dependent measure. The resulting F statistic computes a ratio of between group (treatment) variance divided by within group (error) variance. In its simplest form ANOVA provides a statistical test of whether or not the means of several groups are all equal and generalizes a two sample t-test to more than two groups.

A between subjects ANOVA on change scores, either one-way or factorial, will treat the difference between group scores as no less reliable than the scores themselves, unless the pretest and posttest have equal variances and equal reliability (Dimitrov & Rumrill, 2003). Assumptions of Between Subjects ANOVA are that the populations have the same variances (homogeneity of variance), the populations are normally distributed, X and Y have the same linear relationship, and each value is sampled independently from each other value.

Using ANOVA on change scores results in the problems found in the change scores themselves. There are issues of regression to the mean, especially when comparing treatment and control groups. Issues of reliability are evident because the reliability of a change score decreases as the correlation between pretest and posttest increases toward unity. This statistical analysis is basically a t-test with two independent samples. This method is equivalent to the interaction term in a two-way mixed ANOVA and directly

compares the mean changes exhibited by each group. This analysis tests the hypothesis that mean differences are equivalent, regardless of the pretest differences between groups (Cribbie & Jamieson, 2000).

An alternative analysis of variance is the repeated measures ANOVA, more commonly used in the false memory literature than the between subjects ANOVA. This analysis consists of multiple measurements made on the same participant, and tests for treatment effects based on within subject error, not experimental error. Assumptions are the same as a between subjects ANOVA. This approach seems sensible with change scores as the dependent variable; however, this approach is only valid when multiple posttest measurements are made on the same participant. With only one pre and posttest measurement, the output has a unique interpretation, probably because the linear model assumed by ANOVA is not entirely correct (Bonate, 2000).

Pretest scores are collected prior to exposure to treatment effects, so it is impossible for treatment effects or alleged interaction effects to impact pretest scores. Pretest scores are obtained before random assignment to any groups, so treatment effects impact posttest scores only. As such, the F-test is a biased estimation of the treatment effect, and an increase in Type II error results because the F is too conservative. To remedy this issue and use a repeated measures ANOVA on change scores, an F test of the interaction of the treatment (IV) and time (pre or post) may be calculated. This adds an additional within subjects variable, and the interaction is equivalent to a one-way ANOVA on difference scores (Bonate, 2000).

An alternative to ANOVA using change scores is ANCOVA with the posttest score as the dependent variable, or with the change score as the dependent variable, and

the pretest score as the covariate. Jamieson (2004) found no difference in results when comparing the two dependent measures. With unpredictable change measurement, as with false memory research, there are two components for scores on posttest. One is linearly predictable from pretest and the other is unpredictable (the residual or error) from pretest. ANCOVA uses analysis of posttest scores that have been adjusted for differences in pretest, and is a better test of the hypothesis since there are no differences among the groups in the extent of their unpredictable change. If groups differ significantly at pretest, posttest differences cannot be a treatment indicator.

Randomized studies add more power, especially using ANCOVA, because they assume that any pretest difference is due to sampling error. Randomized pretest-posttest designs using ANCOVA control for threats to internal validity while increasing power. Effects of maturation, selection and instrumentation are controlled, participants serve as their own control, and any leftover effects are attributable to the treatment conditions (Van Breukelen, 2006).

ANCOVA is recommended if baseline noncomparability among groups is suspected, which is generally the case in pre-post experimental designs. More importantly ANCOVA is recommended if regression toward the mean affects the posttest measurement, as with most false memory research using Likert scale surveys. ANCOVA combines regression analysis with ANOVA. This analysis has a statistical control technique because pretest scores are treated as a covariate, a continuous variable that represents a source of variation not controlled in the experiment and believed to affect posttest. ANCOVA has an advantage over other change score analyses: pretests need not be measured using the same device as posttests, but the measures must be correlated in

some way (Bonate, 2000). ANCOVA adjusts the dependent variable to remove the influence of the pretest on the posttest. The hypothesis being tested investigates whether treatment effects are different between groups when participants have the same baseline pretest score. ANOVA tests the assumption of equal mean posttest scores among treatment groups while ANCOVA tests the assumption that the mean posttest score in each group is equal given that the mean pretest score in each treatment group is equal.

A model for ANCOVA aims to estimate a treatment effect on some posttest outcome or impact measure while adjusting for initial pretest scores. This is done by regressing a posttest score on a pretest score and an indicator variable. Then the researcher can statistically control for the pretest by means of regression so that one can study the posttest-freed portion of variance linearly associated with the pretest. Assumptions of ANCOVA are the same as those of ANOVA with the addition of a fifth: a linear relationship between X and Y, that Y is normally distributed, residual error variance is constant for all participants, residual errors are independent of one another and of pretest scores, pretest score X is assumed to be measured without error. In the presence of pretest measurement error, Beta is multiplied by the reliability of the pretest. Because this reliability is always less than 1, Beta is reduced and the estimated treatment effect is altered (Bonate, 2000).

ANOVA using gain scores and ANCOVA yield different results, a phenomenon known as Lords Paradox (Lord, 1967) that presents a potential problem in analysis selection. For example, a group of male and female adolescents are each weighed on consecutive years. Both groups gain an identical number of pounds (posttest difference = pretest difference). ANCOVA will make the conclusion that the males increased

significantly more than the females while change score analysis via ANOVA will find no difference. The reason is that ANCOVA treats the group with higher pretest measurements (the males in this case) as the group that gains significantly more because this group did not regress as much as expected by the posttest. ANCOVA expects pretest mean differences to decrease at posttest.

Deviations of estimates of parameter values depend on the assumption that the covariate is measured without error. The effect of any error in the covariate is twofold. First, error increases the estimate of within groups sum of squares, thus giving a less powerful test of the test of significance of differences among groups. The sum of squares is a measure of variability that estimates observations about their mean value based on degrees of freedom. Second, error results in underestimating the slope of the within groups regression line for posttest scores on pretest scores (McGaw, 1972). ANCOVA should only be used in cases of truly randomized experiments. This analysis is not appropriate for naturally occurring groups because regression to the mean is not expected.

Raw Scores

Researchers interested assessing an intervention using a pretest – posttest design might choose not to use a change score as the dependent measure. Using raw scores will eliminate all of the issues accompanying change scores, and researchers have two options: A repeated measures ANOVA using time as an additional independent variable, and Structural Equation Modeling (SEM).

Assumptions for running a repeated measures ANOVA on raw scores with time as an additional independent variable are the same as previously noted for ANOVA.

Interpretation can be cumbersome with three within subject variables if a three way interaction with time results. However, this analysis is useful as it eliminates issues related to change scores, particularly in the context of false memory research which often uses Likert scales. Researchers should test for any differences in the data at pretest prior to running the ANOVA, and if no three way interaction occurs when testing for a treatment effect, this is a viable option for assessing pretest – posttest data using raw scores.

SEM has been proposed as a technique to handle pretest – posttest designs without using change scores. SEM specifies and estimates models of linear relationships among variables. The variables in a SEM are measured (MVs) or latent (LVs). LVs are hypothetical. They are not directly measured. Each construct in a study is represented by multiple MVs. There can be directional or nondirectional relationships (correlations) between MVs and LVs. SEM has two potential models. One is path analysis which involves the testing of models of relationships among MVs (no LVs included). The second is factor analysis which involves testing a model of relationships between LVs (common factors) and MVs (indicators of common factors) that is driven by existing theory (MacCallum & Austin, 2000).

SEMs express a theoretical model in terms of linear and nonlinear expressions with observed and unobserved variables, and lead to predictions for the means, standard deviations and correlations among variables which can be compared to observed statistics. Several models, or ways of accounting for variables and their influence on constructs, can be compared to find the best fit (McArdle, 2009). Using latent variable modeling is better than actual observed change. Raykov (1999) argues that modeling

change on the latent dimension of interest is a better approach to measuring change then focusing on observed change scores and their properties.

A structural equation model for change scores does not directly measure change. Pretest and posttest scores, or maybe more, are entered into a command equation along with an unobserved variable. The program is instructed to mimic the subtraction of X from Y, and the change score becomes the part of X not identical to Y, a latent change score. Multiple constructs may be measured multiple times, and more than one dependent variable employed, truly addressing a model for change (McArdle, 2009).

Latent variable modeling does not make the assumptions that ANOVA using change scores does. Covariance homogeneity across level of between subject factors is not assumed. Latent variable modeling also does not make the assumptions of ANCOVA. For example, it does not assume regression homogeneity and error free covariates. Cribbie and Jamieson (2000) also found that with SEM, the regression bias that exists with ANCOVA is not a factor due to explicit modeling of error variance for all observed and latent measures.

Advantages of SEM are that causal analysis is not limited to control by partial correlation, moderator analysis is facilitated with multigroup SEM, and time varying covariates and complex correlated error structures are not a problem. This last advantage seems highly relevant as errors become additive when using change scores. SEM is not appropriate if the sample size is too small, often the case in false memory research, or if two congeneric measures are not available. Congeneric means that the measures are assessing the same trait except for any errors that occur during measurement (Cribbie & Jamieson, 2000). ANOVA, including all variations, remains the more effective choice to

date. It is a more powerful test, simpler to execute, more trusted and implications of findings are easier to explain, making ANOVA more desirable for publication.

In sum, selecting the appropriate statistical analysis depends on the unit of measurement the researcher chooses, change score or raw score. Change score analysis potentially introduces issues of reliability, variance restriction and regression to the mean. ANCOVA does not necessarily eliminate these issues and introduces more possible problems as assumptions are hard to meet. Raw score analysis is preferred, and ANOVA with the addition of time as a repeated measure is a viable choice as long as there is no resulting three way interaction. SEM needs further refinement and application as a substitute for change score analysis, but offers a promising alternative.

Up to this point several key aspects of the false memory literature have been addressed. The variables prevalent in most models of false memories, plausibility and imagination, have been explored. Various survey instruments have been identified with one, the ABMQ, used recently in the literature and capable of assessing belief and memory as separate but nested constructs. Statistical analyses for resulting data have been discussed. To explore full models of false memory construction, one should next consider in the memory process a false memory actually occurs.

When Does Erroneous Information Enter our Memory Systems? Encoding or Retrieval?

How do our memories come to be? As discussed at the beginning of this review, Information Processing Theory and the Multi-Store Model (Atkinson & Shiffrin, 1968) provide an account of memory functionality that is comparable to a computer. All sensory information in the environment is taken into the sensory register. If attended to,

the information will pass along to working memory. If enough associations are established with prior knowledge in the memory store, the information passes into long term memory. Events are encoded, or stored into memory, in a variety of sensory modalities including sight (imagery), sound, smell, touch and taste. Different types of information (i.e., temporal, spatial, emotional, semantic) are stored in different locations in the brain. During event recall, details are pieced together with these bits of information to form a cohesive memory. This piecing together is referred to as reconstruction, and this process leaves room for errors in memory (Bartlett, 1932).

What is the cognitive operation that either promotes or reduces false memory formation, including misinformation effects to false autobiographical memories? Does this process occur during encoding or retrieval of a memory?

A theory developed by Brainerd and Reyna (1992) explains a possible cause for false memories that relates to the cognitive processes at work during encoding or storage of information. Fuzzy Trace Theory states that traces of information with varying strengths are encoded simultaneously. Very detailed information regarding events are referred to as verbatim traces, while gist traces lack specific detail but retain the integrity of the overall "big picture" of events, including inferences and general features. Individuals can usually remember the gist of an event much easier and efficiently than an event's specific details. This illustrates an example of the efficiency of the human memory system. If individuals remember all of the details of all experienced events, life would likely be overwhelming (Koriat, et al., 2000). Fuzzy Trace Theory is very much in line with the correspondence theory of memory discussed at the beginning of this review as it posits that a more effective memory system is not concerned with quantity of detail,

but rather accuracy of detail. Because gist traces are stored more effectively and are easier to recall, individuals will fill in the gaps in these memories, supported by the concept of reconstruction, thus leaving room for errors in memory recall.

There are five principal components of Fuzzy Trace Theory. Verbatim and gist traces are stored in parallel, retrieved separately and are differentially accessible and therefore preserved differently. Retrieval of verbatim traces is accompanied by recollective experience whereas retrieval of gist traces is accompanied by only familiarity. Finally, verbatim and gist memory develop at different ages during childhood. True memories are represented by both trace types, but false memories are only represented by gist traces (Williams, et al., 2008).

Gist traces are episodic interpretations of concepts that participants access during encoding of a target. These are meanings, relations, patterns or elaborations. When verbatim trace encoding begins, gist encoding is running in parallel using different storage mechanisms. As such, participants may retain gist information much longer than verbatim information, and because gist traces are meaning based, multiple gist traces may be stored for one event. These multiple gist traces may pave the road to false memories during encoding (Brainerd & Reyna, 2005).

Fuzzy Trace Theory provides a nice example of cognitive shortcomings during encoding; however, what about cognitive deficiencies that occur during retrieval? Deficiencies in retrieval seem to be a likely alternative explanation for false memories, particularly false autobiographical memories that apply to laboratory settings used in research. False memory research does not generally target memory during encoding. Usually a manipulation after encoding is employed and then retrieval is assessed. The

Source Monitoring Framework (SMF) could be the key to understanding the cognitive processes occurring during retrieval that lead to a false memory.

The SMF concerns the ways that individuals differentiate between various memories and various sources. Judgments made within this framework include where and when a past event occurred, how the event was presented, and what individuals were involved (Lindsay & Johnson, 2000). Models of false memory creation (to be discussed in detail later) often incorporate source monitoring judgments. During recall of an event, an individual searches memory for relevant details, subsequently forming a mental image of the suggested event. This imagination is mistaken for perception, called a source monitoring error, and a false memory results.

The source of an event can refer to a variety of characteristics that, collectively, specify the conditions under which a memory is acquired. These characteristics can be spatial, temporal or social contexts of the event, or modalities in which the event was perceived (Johnson, Hashtroudi & Lindsay, 1993). Memories do not innately contain information regarding their source. The source information attached to an event is reconstructed in much the same way as the details of the event itself during memory retrieval (Ghetti, 2008). Numerous active reconstructive and decision processes are at work during source recall and are involved in source memory. The concepts of familiarity and ease of retrieval accompany source recall as they do in item recall. Item memory, which refers to the events occurring in the memory, is not as complex as source memory. As such, item memory is more accurately retrieved than source memory (Kelly, Carroll & Mazzoni, 2000).

The SMF outlines two processes by which individuals make source judgments. The first, strategic reasoning, encompasses cognitive operations based on strategy. Examples of such strategies are the plausibility of an event, identified earlier in this review as an influential variable in false memories, and judgments based upon the familiarity of the event in question. Strategic decision processes are made slowly and deliberately. A second process identified within the SMF used to identify the source of a suggested event is heuristic reasoning. This fairly automatic process uses the qualitative characteristics of a suggested event to determine if the origin of the memory, or the source, is real or imagined. Characteristics considered by heuristic reasoning processes include perceptual, contextual, semantic and emotional details. If an abundance of detail is available, both in quantity and quality, then the event will probably be considered experienced (Johnson, 2006). If the memory is lacking vivid detail, an individual might infer that the event was imagined (Johnson, et al., 1993). Extensive research supports the idea of the differences in type and amount of detail in real versus imagined events (Henkel, 2004; Johnson, 2006; Kelly, et al., 2000).

Toward a SMF Model of False Memories Using *Strategic Reasoning*

Pezdek's 1997 Model

Pezdek, Finger and Hodge (1997) proposed a model of false memory creation wherein a suggested false event is first judged to be true, then details of a generic script and details of related event memories are "transported" in memory and used to construct a memory for a false event. In this study, Catholic and Jewish students were asked to read multiple scenarios, some of which were true and some were false. Based on results, Pezdek, et al. (1997) maintain that events were suggestively planted into memory based

upon personal plausibility and script-relevant knowledge. Catholic students did not falsely remember a Jewish prayer session and Jewish students did not remember attending Communion. These events were not plausible to them.

Pezdek's 2006 Model

Pezdek, Blandon-Gitlin and Gabbay, (2006) further expanded Pezdek, et al.'s (1997) proposed model of false memory in a study involving imagination and event plausibility. Participants completed three phases of the experiment spaced one week apart that included two LEI administrations with an intervention between them. During the intervention participants were given packets with prevalence ratings for each target event. These ratings addressed plausibility as an individual construct, and because no script information was provided, background information was not considered. In addition, imagination instructions for each target event were provided in the packet during intervention. Some events were imagined and some were not. During phase two participants completed a second LEI identical to the one administered during phase one.

The 2006 model of false memory states that false memories occur for plausible events when imagery is used. The model suggests that participants confuse their imagination of the plausible event with its actual occurrence, thereby committing a source monitoring error. Individuals first evaluate the plausibility of the suggested event; second, if the event is judged to be plausible, an attempt is made to retrieve relevant information about the event from memory, and an image is constructed; finally, a source monitoring error occurs and the constructed image is confused for the actual occurrence of the suggested event. Results refute the findings of Hart and Schooler (2006) and support Scoboria, et al. (2006), suggesting that false memories, as defined by the LEI, do

not occur for events reported with low plausibility ratings (Pezdek, et al., 2006).

The 2006 model of false memory creation incorporates not only a clear measure of plausibility, but also the key components of imagination and source monitoring. The source monitoring framework, discussed earlier in detail, helps to explain results obtained by Pezdek, et al. (2006). The researchers found a significant interaction between event plausibility and imagination, suggesting that the number of false memories recalled increased significantly for imagined plausible target events, but not for implausible target events. Pezdek explains that if people are asked to imagine a target event and consider that event plausible, they will search autobiographical memory persistently for relevant details. An image is constructed that is rich in the amount and specificity of detail. When participants are later asked to rate the likelihood of occurrence of the target event, a source monitoring error is more likely to occur due to the nature of the event representation generated during the imagining. Individuals are likely to confuse the imagined event with the actual occurrence of the event and create a false memory of the target event that never actually occurred.

The 2006 model provides a clear and cohesive explanation of false memory and also provides a clear account of why false memories are not created for implausible target events. Perhaps the most striking finding was the lack of a difference between the no imagine and imagine conditions for implausible events. Participants asked to imagine an implausible event were not susceptible to false memory creation for that event. According to the model, if people consider an event to be implausible, they are less likely to search memory for detail while they are imagining the target event. As a result, the constructed image is rather deficient and lacks the qualitative detail necessary for the

target event to be judged as one that actually occurred. Thus, the judgment of a target event as plausible or implausible may play a critical role in the richness of the image generated, which affects the judgment of the likelihood that the target event actually occurred.

The 2006 model asserts that once an event is judged to be implausible, then the false memory process simply stops. No resources are allocated to searching for details in memory. Previous research suggests that events considered unusual or inconsistent with personal expectations can be implanted as false memories using suggestion from a family member (Hyman, Husband & Billings, 1995; Porter, Yuille & Lehman, 1999), or repeated imaginings of a "bizarre" target event (Thomas & Loftus, 2002). According to Pezdek and colleagues, the false memories generated in these studies should not have occurred.

Thomas and Loftus (2002) used repetition of imaginings up to five times and found that false memory creation did occur for actions considered "bizarre" or implausible. Statements such as "sign your name on the paper with the pen" and "stir the water with the spoon" represented the plausible event condition, and statements such as "step into the plastic bag" and "rub lotion on the chair" represented the implausible event condition. A first disadvantage to this study is that the nature of these events was confounded with the plausible and implausible event conditions as they were not experimentally manipulated. Event condition was determined based on the assumed peculiarity of the statement as rated by 74 individuals prior to the experiment and was not counterbalanced across conditions. A second disadvantage to the design was that target events deemed implausible lacked an element of personal plausibility and therefore did

not relate to autobiographical memory as events in the Pezdek, et al. (2006) study.

The possibility that repeated imaginings might result in false memories for implausible events is given some credibility by studies showing that repeated imaginings result in more source monitoring errors. Henkel (2004) discusses the idea that as the number of retrieval attempts increases, participants may recall more detail with each retrieval attempt but, in turn, become more susceptible to source monitoring errors. She also points out that source monitoring errors are more common with events that are imagined rather than performed because events that are actually experienced should contain detail that is richer in quality and quantity. Repeated attempts to remember an event can increase detail, but can also increase source monitoring errors, which, in turn, may become the basis of false memories (Henkel, 2004). However, event plausibility was not considered and autobiographical events were not considered.

Toward a SMF Model of False Memories Using *Heuristic Reasoning*

Dodson and Schacter (2002) have identified a specific heuristic strategy that they believe influences false memories for events during recall. Called the distinctiveness heuristic, it is defined as a mechanism that reduces misattribution errors and a mode of responding in which people expect to remember vivid details of an experience and make recognition decisions based on this metacognitive expectation. The distinctiveness heuristic could be a cognitive operation occurring during retrieval that, depending on the belief, inhibits or encourages false memories, both in the sense of misconstruing event details and creating entirely false autobiographical memories. Put simply, when a new event lacks the expected distinctive information, individuals use this *absence* of evidence to reject the item (Dodson & Schacter, 2002).

Dodson and Schacter (2002) used a modified version of the Deese/Roediger-McDermott (DRM) paradigm, traditionally used in research to investigate errors in memory recall. The DRM paradigm uses word lists that are semantically related. For example, the experimenter might list or read *bed, rest, awake, blanket, snooze, dream*. Participants are later given a list of words and asked if the words were presented in the original list. On this recognition list would be a word that was not present, but is semantically related, such as *sleep*. Individuals are likely to incorrectly state that this lure word was presented in the original list.

Dodson and Schacter modified the traditional DRM paradigm with the addition of pictures of the items that participants would view in conjunction with the visual letter cue of the item word. Results revealed that false recognition of related lure words was reduced significantly when pictorial encoding was involved. Participants had a metacognitive expectation that they should be able to remember the pictorial information because of its distinctive presentation. As such, the absence of a memory for the presented picture led them to determine that the lure item was novel and not previously presented.

Dodson and Schacter (2002) further support their idea via methodological design. Between subjects designs yielded a significant reduction in false recognition when pictorial encoding was employed, but this was not the result using a repeated measures design. Participants in the between subjects condition were only exposed to either the letter word cue or the pictorial cue, creating a stronger heuristic for distinction which in turn activates the distinctiveness heuristic.

Support for the presence of the distinctive heuristic during pictorial encoding is also evident in the false autobiographical memory literature. Though the distinctiveness heuristic is not specifically stated as a metacognitive operation at work in these studies, a parallel can certainly be drawn. Researchers have used doctored photographs in an attempt to create false memories for suggested events. Results indicate that these photos actually convince participants that the suggested events did *not* occur. Narratives have been found to be more effective at eliciting false memories than photographs. Perhaps this is because narratives leave more room for individuals to fill in gaps and reconstruct information surrounding the suggested event (Strange, Gerrie & Garry, 2005; Wade & Garry, 2005). The amount of detail present in a photograph might lead to fewer false memories because participants operate on the metacognitive assumption that they would recall such a distinctive event in their lifetime. Both studies cited used doctored photographs of compelling events such as taking a hot air balloon ride that would be considered low plausibility events.

Research supports the notion of a metacognitive operation at work during the reconstruction of item memory and particularly source memory. Metacognitive beliefs are involved in source memory judgments (Broder & Meiser, 2007). Metacognitive beliefs that people hold about the memory system include what those individuals believe about the processes of encoding and retrieval, the role of attention and any other mechanisms influencing the information that is retained. As previously mentioned, the SMF identifies a heuristic reasoning process whereby individuals use related details to determine the item’s source as perceived or imagined. Dodson and Schacter (2002) use the distinctiveness heuristic to account for the process that determines an event was not

experienced based on the lack or absence of distinctive information surrounding the suggested event and the event's encoding. This results in a second model of false memories, one involving metacognition and false memory. There are numerous suggested models; however, this review will focus on one proposed by Mazzoni & Kirsch (2002) that lends itself specifically to beliefs and false autobiographical memories.

Mazzoni and Kirsch Model of Metacognition and False Memory

This model is consistent with a previous model proposed by Hyman and Kleinknecht (1999), as well as the Pezdek, et al. (2006) model outlined previously in that the content must be plausible, the person must construct an image, and an error in source monitoring results. The proposed model of metacognition and memory from Mazzoni and Kirsch (2002) follows along a correspondence theory of memory using a constructivist approach wherein memories are constructed during encoding and then reconstructed during retrieval. A question is asked about an event which triggers a memory search, simultaneously activating monitoring processes.

Metacognition consists of two components: people's knowledge and beliefs about cognitive processes, and the online control processes used to monitor and guide underlying cognitive processes (Mazzoni & Kirsch, 2002). Metacognition as a set of beliefs, or a naïve theory, encompasses an individual's theory on how cognition works. These are epistemological beliefs about knowledge and its acquisition. A metacognitive belief would be the idea that a person must study harder for difficult exam items than for easy items. Beliefs about memory are also included, such as whether negative memories can be erased or repressed, whether you can remember events that occurred in infancy

and the accuracy of memory as a product of the time between encoding and retrieval (Mazzoni & Kirsch, 2002).

Mazzoni and Kirsch (2002) expanded on previous metacognitive models by clearly distinguishing autobiographical belief and autobiographical memory. Autobiographical belief involves judgment about an event that can be based on more general knowledge. Belief may be held with varying levels of confidence, not necessarily all or none, and may be accurate or inaccurate. Autobiographical memory implies that people access information from their memory store and construct an image. Memories are experiential whereas beliefs may just be inferential. Beliefs may be based on actual memories or on other source information (Mazzoni & Kirsch, 2002).

The Mazzoni and Kirsch (2002) model addresses the metacognitive component of distinctiveness of an event as a way to determine if belief in an event in the absence of a memory is sufficient to lead to a false memory. Decisions using metacognitive heuristics are made based on whether an unremembered event has happened. Individuals assess whether the absence of a memory for an event is diagnostic. This decision relies on three metacognitive beliefs. First, the more time between the event and the attempt to retrieve a memory of the event, the more likely it is to have simply forgotten it. Second, memories from childhood simply decay over time. Third, and in alignment with Dodson and Schacter (2002), the distinctiveness of the event is crucial to memory. The strength of a memory is affected by how rare or striking the event is in content or in the manner in which it is presented at encoding, as in the difference between the letter encoding and pictorial encoding of words in the DRM for Dodson and Schacter. People hold the metacognitive belief that memories are harder to forget if they are rare (Dodson &

Schacter). Therefore, the absence of a memory for an event would equate to the belief that the event did not occur, and failing to remember a common event, such as eating pizza for dinner last week, would *not* likely lead to the conclusion that the event was not experienced.

The first part of the model involves an evaluation of whether one can remember the target event. Remember that memory is a constructive process, not simply a storage container, wherein memories might mingle with thoughts, dreams, and imaginings. The first monitoring task is to determine whether the search has produced a veridical memory. If the conjured image is vivid, clear and processed fluently people are more likely to believe that it's a true memory (Mazzoni & Kirsch, 2002).

Once belief is established, how do individuals create false memories? Two factors interact to influence memory development. First there are changes in the criterion used to judge the authenticity of the memory. Subsequently the memory is enhanced, usually via some form of an imagination technique (Mazzoni & Kirsch, 2002).

The Mazzoni and Kirsch (2002) model specifically addresses false autobiographical memories. Previous metacognitive models encompass memory and all memory errors including mistaken details in existing memories. The Mazzoni and Kirsch model intends to account for memories implanted for events that were never experienced. False memories are created via two means, both of which affect the metacognitive beliefs surrounding the suggested events. One is by way of changes in the memory criterion used to assess the integrity of the memory for the event. These changes occur in the same manner as listed previously when addressing the three metacognitive beliefs that determine whether the memory for the event is diagnostic, including the time between

event occurrence and recall, the age at which the event occurred, particularly if in childhood as these memories decay, and the distinctiveness of the memory during encoding.

The second means involves subsequent enhancement of the mental content corresponding to the event. Research on false autobiographical memories has employed numerous manipulations of this sort to create false memories, including suggestion from authority or family members, false feedback, discussion, doctored photographs, and repeated imaginings (Mazzoni & Kirsch, 2002).

Future Research

Researchers have many avenues for future research in this field. Evaluating various survey instruments and statistical procedures is a key starting point. Is the ABMQ a valid and reliable measure of the four constructs, general plausibility, personal plausibility, belief and memory, related to the false memory process? Should change scores be the dependent measure of investigation, or are raw scores more accurate? What statistical test yields the strongest measure of false memories? Should investigators use a one-way ANOVA, repeated measures ANOVA, ANCOVA or SEM? The literature is deficient in the area of using SEM to assess false memory creation, and this tool should also be used to validate survey instruments used for investigation.

Researchers could also look further into Fuzzy Trace Theory to evaluate the false memory process during encoding; however, finding proper methodology for use in a lab would be difficult. Most paradigms assessing false memories are evaluating retrieval rather than encoding as they involve a manipulation occurring after encoding during

some intervention. Any test of memory will only be assessing retrieval unless manipulations are made while participants are encoding the events.

Much more research is needed to expand the Mazzoni and Kirsch (2002) metacognitive model of false memories. The DRM should be used with a combination of pictures and narrative to further assess the impact of the distinctiveness heuristic in recall of discrete items. Once this impact is more established, studies should look to combine the distinctiveness heuristic and false autobiographical memories. Pictures of episodic memories, both plausible and implausible, could be combined with a narrative and used as a modified DRM procedure to look for the presence of the distinctiveness heuristic in false autobiographical memory construction.

The Pezdek, et al. (2006) model of false memory construction should be further explored using methodology adapted from Thomas and Loftus (2002). Multiple imaginings of an implausible autobiographical event should be investigated to test for changes in belief and memory. A survey instrument, such as the ABMQ, should be used during pretest and posttest so that belief and memory may be considered as distinct constructs. Will belief and memory increase as visual elaboration of plausible and implausible events increases? There is debate in the existing literature.

Implications of false memory research rest in courtroom proceedings such as eyewitness testimony, witness identification of criminals and interrogation techniques employed by attorneys and police officers. Clinicians are also affected as certain therapeutic techniques such as dream interpretation and hypnosis are called into question by the false memory literature. Research on false memories gives us a better understanding of how our memory systems work which helps us to inform educational

practices as we age. Autobiographical memory is who we are. Our memories inform our sense of self, allowing others to come to know who we are and allowing us to form our own identity. It is imperative to understand how memory functions including how memory errors arise.

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CHAPTER 2

FALSE MEMORY OR FALSE BELIEF? ASSESSING THE IMPACT OF PLAUSIBILITY AND VISUAL IMAGERY

Have you ever recalled an event from childhood with utmost confidence, only to watch a home movie and realize your memory was inaccurate? Called false autobiographical memories in the literature, these errors in recall are defined as fabricated memories for events that never happened (Pezdek & Lam, 2007). Research on false memories began gaining momentum in the 1990s due to an upsurge of DNA exonerations thanks largely to the Innocence Project. Eyewitnesses alone were no longer the primary means of conviction, and, even further, eyewitness accounts were often revealed as inaccurate.

The formation of false memories has occurred during allegations of abuse in childhood, police interrogation procedures and various therapeutic techniques such as hypnosis and dream analysis. Previous research has addressed the impact of numerous variables on false memory construction, including pressure from family members, repeated questioning, self-relevant details in narrative, doctored photographs and visual imagery (Desjardins & Scoboria, 2007; Loftus & Pickrell, 1995; Mazzoni & Memon, 2003; Wade, Garry, Read & Lindsay, 2002; Zarzoga & Mitchell, 1996).
Beyond calling into question the nature of attempts to elicit retrieval of information, research on false memories refutes claims made by psychoanalysts regarding repression (Hyman, Husband & Billings, 1995; Loftus, Joslyn & Polage, 1998). Therapists in particular often view the recovery of a repressed memory as a success, but what if these recovered memories are actually false memories, as the literature suggests? What if some

guided imagery technique elicits recovery of inaccurate information? These inaccuracies are not only a detriment to the therapeutic process, but also to legal cases based upon information recalled during eyewitness testimony or police interrogation. The current study will address visual imagery techniques in conjunction with the plausibility of the event in question to detect the occurrence of false memories.

A popular theoretical model of false autobiographical memory construction proposed by Pezdek and colleagues states that when an individual is presented with a suggested event, a subsequent plausibility judgment will determine whether memory is searched for relevant details. If the suggested event is implausible, no memory search occurs. If the suggested event is plausible, the ensuing memory search combines details from episodes related to the suggested event, resulting in a mental image. This image is mistaken for an actual experience, a source monitoring error occurs and a false memory results (Pezdek, Blandon-Gitlin & Gabbay, 2006; Pezdek, Finger & Hodge, 1997).

A source monitoring error arises when the source of a memory, which in the field of false autobiographical memories is often imagination, is mistaken for the actual experience of an event. Accounted for by the source monitoring framework (SMF), this error concerns the ways that individuals differentiate between various memories from various sources. Judgments made within this framework include where and when a past event occurred, how the event was presented and what individuals were involved (Lindsay & Johnson, 2000). The model of false memory construction previously outlined by Pezdek incorporates the SMF in conjunction with event plausibility as the essential steps leading to false memories for autobiographical events.

Thomas and Loftus (2002) conducted a study that refutes the plausibility claim in Pezdek's model. Bizarre action statements such as "kiss the magnifying glass" were implanted as false memories. Participants were asked to either perform or imagine a series of bizarre action statements and later committed a source monitoring error by falsely remembering performing these bizarre actions when they had only imagined them. Repeatedly imagining the action statements up to five times elicited this effect for the bizarre items. Although these actions were bizarre and can be viewed as implausible, they were not autobiographical in nature, and prevalence ratings were not used to manipulate plausibility. The current study will use methodology from Pezdek, et al. (2006) and Thomas and Loftus to examine the Pezdek model of false memories for implausible autobiographical events when multiple imaginings are employed.

The Pezdek, et al. (2006) model is based on data collected using a version of the Life Events Inventory (LEI; see Appendix A). This inventory lists suggested events and asks participants to rate their confidence in experiencing these events during childhood on an 8-point Likert scale. Recently, investigators examining false memories have criticized the use of the LEI in studies claiming false memory creation, arguing that the LEI is actually assessing a belief component. There is no way to determine whether participants actually have a false memory for the suggested event, or if they just have a false belief (Scoboria, Mazzoni, Kirsch & Jiminez, 2006; Scoboria, Mazzoni, Kirsch & Relyea, 2004). A false belief would involve an increase in confidence of an event's occurrence, but this does not necessarily imply that this belief is based upon an actual memory of the event, actually remembering the experience, or just a feeling of knowing that the event occurred.

Scoboria and colleagues developed a new measure of false memory construction that independently assesses plausibility, belief and memory. The Autobiographical Belief and Memory Questionnaire (ABMQ) consists of questions that independently assess general plausibility, personal plausibility, autobiographical belief and autobiographical memory for a suggested event (see Appendix B). The distinction between general and personal plausibility is evident in the wording of the question with “some people” and “you personally” used, respectively. The distinction between personal plausibility and belief lies in the wording “could have occurred” and “did in fact occur”, respectively. The memory construct is addressed by asking for an “actual memory” of the event in question. Investigators use an 8-point Likert scale to assess the suggested events, each having questions independently measuring the four constructs under investigation (Scoboria, et al., 2004).

The ABMQ has been used to evaluate components of the Pezdek model of false memory construction. Sharman and Scoboria (2009) used elaborate visual imagery of low, moderate and high plausibility events and found that imagination equally influenced false memories from all three plausibility categories. Participants completed a three phase design procedure wherein they first rated their confidence in experiencing certain childhood events and provided a rating of their memory for the event. During phase two participants were asked to imagine one low, one moderate and one high plausibility event. The third phase was identical to phase one. Results refute Pezdek and colleagues; however, plausibility was defined by participant ratings during phase one rather than prevalence ratings provided by the researcher.

The ABMQ has been used in the literature three other times to assess false memories specifically, not just the plausibility or belief constructs. Desjardinis and Scoboria (2007) assessed self-relevant details in narrative, Scoboria, Lynn, Hessen and Fisco (2007) coupled a forgetting rationale with prevalence ratings for suggested events, and Smeets, Telgen, Jelicic & Merckelbach (2009) examined memories for images of non-existent footage of highly public events. Results from all three studies suggest an increase in belief but no significant effect on autobiographical memory alone, further supporting the distinction between belief and memory.

In addition to assessing Pezdek's model of false memory construction, I will validate the ABMQ as a measure of plausibility, belief and memory. Responses to Likert scale items are self-report measures that cannot be directly measured. They are estimated by observable variables. Structural equation modeling (SEM) is a two-step analytic tool used when latent constructs are in question. The measurement model in step one consists of a pattern of observed variables, in this case the question asked for each of the suggested events corresponding to one of the four latent constructs. For example, asking the participant "how plausible is it that someone could have gone camping overnight prior to the age of 10?" elicits a Likert scale rating that serves as an observed variable for the latent construct of general plausibility. Confirmatory factor analysis (CFA) produces a measurement model to relate observed variables to latent variables. Modification indices are generated so that prior to testing the structural model, the measurement model is its best. Based on the confirmatory factor analysis, the structural model, step two in SEM, displays the interrelationships among latent variables and observed variables which is used to test the overall model fit (Schreber, Nora, Stage, Barlow & King, 2006).

Scoboria and colleagues proposed a nested relation between the constructs involved in the false memory process based on results obtained via the ABMQ, wherein general plausibility is necessary for personal plausibility, which is necessary for belief, which is necessary for memory. For instance, an individual may find a suggested event plausible for the general population without having a belief or a memory for that event; however, if an individual has a memory for an event, that event must also be considered believable and plausible. I will look for the same nested relation in the current study.

Researchers have looked at the impact of plausibility on belief and support the nested relation (Hart & Schooler, 2006; Mazzoni, Loftus & Kirsch, 2001). Mazzoni (2007) looked at response times, a behavioral measure, to tease apart the constructs of plausibility and belief. This study tested the hypothesis that time spent searching memory when making a belief judgment about an event's occurrence is related to that event's perceived plausibility. Participants provided belief ratings and plausibility ratings for six events. A response latency was recorded by a computer to measure the amount of time that elapsed between presentation of the event and rating the event. Results revealed that plausibility is the first step in making a belief judgment. Belief response times were very short for events considered implausible and increased considerably with plausibility (Mazzoni, 2007).

Finally, false memory construction will be assessed for implausible autobiographical events imagined 0, 1 or 5 times. Sharman and Scoboria (2009) used elaborate visual imagery, but plausibility was manipulated differently and, as with Pezdek, et al. (2006) only one imagination was employed. Thomas and Loftus (2002) used repeated imaginings, but events were not autobiographical in nature and again

prevalence ratings were not used to determine plausibility. Taken from Pezdek, et al., in the current study I assigned prevalence ratings during an intervention phase to determine plausibility. Each event is counterbalanced to occur equally often across all conditions. I predict that belief will significantly increase as the number of imaginings increases, regardless of plausibility, an effect known as imagination inflation (Garry & Polaschek, 2000). The memory construct will not change significantly, regardless of plausibility or number of imaginings.

Method

Participants and Design

Students from Georgia State University taking undergraduate education courses volunteered to participate in this study, receiving extra credit or the ability to satisfy a course requirement. There were 185 participants (143 females, 42 males) who completed phase one of the experiment and are included in the factor analysis. Of these, 135 students (111 females, 24 males) completed all three phases of the experiment and are not excluded from the repeated measures ANOVA based on the exclusion criteria outlined in the results section.

Materials

Materials consisted of a 20-item ABMQ listing events that may have happened in childhood, and six versions of a "packet" adapted from Pezdek, et al. (2006). The six ABMQ target events included in the packet were taken from Garry, Manning, Loftus & Sherman (1996), and four of these target events were also used in Pezdek, et al.: "was almost hit by a car," "had been rescued from the water while swimming," "broke a window with your hand," and "found a $10.00 bill in a parking lot". The two additional

target events that were added to the intervention packet were “got lost in the grocery store” and “got sick and went to the hospital.”

The packets contained prevalence ratings to determine plausibility of the six target events followed by a six-item memory test for each event’s plausibility. Next in the packet were imagination instructions for each event wherein participants must write a detailed description of each imagination. The six target items were counterbalanced across the six within subjects conditions (0, 1, 5 imaginations and high or low plausibility) ensuring that each event occurred equally often in each condition (see Appendix C for a sample intervention packet).

The validation for the prevalence ratings and imagination instructions for the six target events were adapted from Pezdek, et al. (2006). Participants were told that the ratings came from previous surveys of college students regarding life events. Events in the high plausibility condition were reported to have prevalence ratings of 89 or 91% whereas events in the low plausibility condition were reported in the packet with prevalence ratings of 9 or 11%. For the 1-imagination condition, participants were informed that an important aspect of accurately recalling an event from childhood is imagining that event. For the 5-imaginations condition I stated that some of the events were imagined several times to strengthen accuracy. Finally I stated that these data will add to an existing data base of commonly occurring childhood events.

Procedure

Participants completed three sessions in groups comparable to their class size, approximately thirty students per session. There was no time limit and sessions were spaced one week apart.

Phase One

Participants completed the 20-item ABMQ by rating each event on a Likert scale ranging from 1 (definitely did not happen to me prior to the age of 10) to 8 (definitely did happen to me prior to the age of 10).

Intervention

Participants completed one of six versions of the packet adapted from Pezdek, et al. (2006). In the 1-imagination condition participants imagined one low plausibility and one high plausibility target event one time each. After each imagining participants wrote a detailed description of the imagination for a total of one description of a plausible event and one description of an implausible event. In the 5-imaginations condition participants imagined one low plausibility and one high plausibility event five distinct times. After each imagining participants wrote a detailed description of each imagination for a total of five descriptions of a plausible event and five descriptions of an implausible event. Two events appeared in the packet during Intervention with prevalence information but no imagination instructions to comprise the high and low plausibility 0-imagination conditions.

Phase Two

Participants completed the 20-item ABMQ a second time. All participants were then debriefed about the hypotheses, the intent of the study, and the need for the fabricated information in the intervention packet.

Results

Adapted from Pezdek, et al. (2006), participants were excluded from the group analysis based on three criteria: if a Likert scale rating of 8 was given to either of the

suggested events “won a million dollars” or “played for the LA Lakers” on the ABMQ, or if the participant did not correctly answer the six-item memory test of plausibility or properly follow the imagination instructions in the intervention packet.

I used SAS hot-deck imputation to correct for missing data in all analyses. The ABMQ was a reliable survey instrument in this study, $\alpha = .813$ for the six target items, and $\alpha = .905$ for the full twenty items. To establish construct validity, a CFA using LISREL 8.71 was run on the six target items from the ABMQ that were manipulated in the intervention packet. To date, this analysis has not been run on this survey instrument. The rationale for including just the six target items in the CFA is that these are the items necessary for the group analysis of an imagination inflation effect or a false memory effect. Each construct was run independently to test data model fit as this increases control over correlated errors.

First, the general plausibility construct was tested for data fit to the model. The data-model fit was poor, $\chi^2(9) = 104.96$, $p < .01$, RMSEA = .24072 [.20059, .28312], NFI = .62354, CFI = .63510, Model AIC = 128.95638, SRMR = .37473. Three modification indices were implemented sequentially to improve data-model fit (see Figure 1). The resulting fit was good, $\chi^2(6) = 5.84852$, $p = .44037$, RMSEA = .00 [.00, .094057], NFI = .98083, CFI = 1.000, Model AIC = 35.80316, SRMR = .033901.

PATH DIAGRAM FOR THE GENERAL PLAUSIBILITY CONSTRUCT

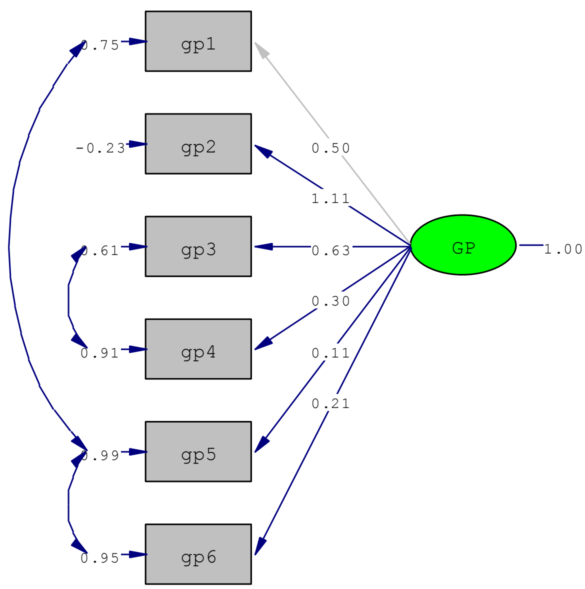

Figure 1. Confirmatory factor analysis path diagram for the general plausibility construct including the three modifications made to allow errors to covary and improve data-model fit.

The personal plausibility construct revealed poor data model fit, $\chi^2(9) = 162.71$, $p < .01$, RMSEA = .30466 [.26465, .34654], NFI = .40656, CFI = .40686, Model AIC = 186.70649, SRMR = .20047. Multiple modification indices were suggested; however, little progress in data model fit occurred beyond the first modification, and fit remained poor, $\chi^2(8) = 58.82085$, $p < .01$, RMSEA = .18269 [.13984, .22865], NFI = 83.12915, CFI = .844714, Model AIC = 83.12915, SRMR = .40559.

The belief construct revealed poor data-model fit, though better than both plausibility factors, $\chi^2(9) = 86.45$, $p < .01$, RMSEA = .21626 [.17603, .25896], NFI = .73665, CFI = .75039, Model AIC = 110.45006, SRMR = .34259. Two modification

indices were implemented sequentially (see Figure 2) that resulted in good data-model fit, $\chi^2(7) = 5.19661$, $p = .63598$, RMSEA = .00 [.00, .072439], NFI = .98642, CFI = 1.00, Model AIC = 32.95790, SRMR = .025641.

PATH DIAGRAM FOR THE BELIEF CONSTRUCT

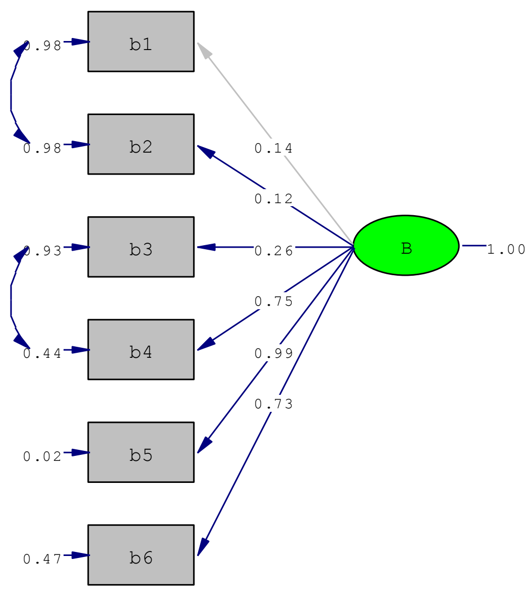

Figure 2. Confirmatory factor analysis path diagram for the belief construct including the three modifications made to allow errors to covary and improve data-model fit.

The memory construct revealed the best data-model fit prior to modification, but the fit was still poor, $\chi^2(9) = 50.69$, $p < .01$, RMSEA = .159 [.11778, .20251], NFI = .84712, CFI = .86827, Model AIC = 74.6888, SRMR = .084582. Two modification indices were implemented sequentially (see Figure 3) that resulted in good data-model fit, $\chi^2(7) = 11.53378$, $p = .11697$, RMSEA = .053626 [.00, .11389], NFI = .95627, CFI = .98570, Model AIC = 38.70391, SRMR = .039847.

PATH DIAGRAM FOR THE MEMORY CONSTRUCT

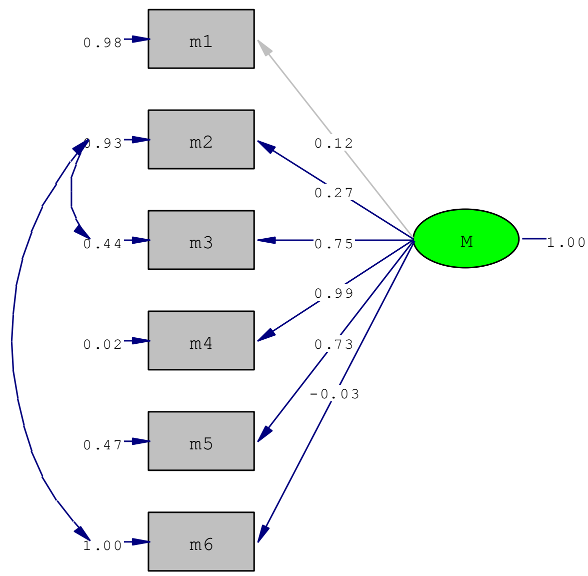

Figure 3. Confirmatory factor analysis path diagram for the memory construct including the three modifications made to allow errors to covary and improve data-model fit.

The belief construct, after two modifications, resulted in the best overall data-model fit, Model AIC = 32.95790, and the personal plausibility construct, regardless of modifications, resulted in the worst data-model fit, Model AIC = 83.12915.

All suggested modifications made to each construct were applied sequentially. These modifications allow errors that are exogenous to the model to covary. These modifications are not problematic to the false memory model based on results from the ABMQ because the model does not account for these errors. For example, the model for the memory construct illustrates that one factor the six items have in common is the memory construct. The model does not, however, account for other possible commonalities, such as errors. Allowing item 1 and item 2 to share another common factor, error in this case, does not affect the false memory model.

Raw Score Analysis of Belief

To control for any initial differences in the data on belief, a 2 (plausibility) x 3 (imagination) repeated measures ANOVA was run on pretest raw scores. Mauchly's test of sphericity was violated for imagination, χ^2 (2) = 16.106, $p < .05$; therefore degrees of freedom were corrected using Huyhn-Feldt ($\varepsilon = .909$). Results revealed no significant interaction effect, $F(2, 268) = 1.603$, $p > .05$, and no main effect of plausibility or imagination, $F(1, 134) = .048$, $p > .05$ and, $F(1.818,243.623) = 2.239$, $p > .05$, respectively. These findings suggest there were no differences in participant ratings for belief at the start of the study, and any significant effects on belief ratings may be attributed to the subsequent manipulations of imagery and plausibility.

A 2 (plausibility) x 3 (imagination) x 2 (time: pre or post) repeated measures ANOVA was run on raw scores to test for an imagination inflation effect. Mauchly's test of sphericity was violated by the imagination condition, $\chi^2(2) = 16.507$, $p < .05$; therefore, the degrees of freedom were corrected using Huynh-Feldt ($\varepsilon = .907$). A significant main effect of imagination was found, $F(1.814, 243.028) = 3.882$, $p = .026$. Bonferroni pairwise comparisons revealed that the significant main effect of imagination occurred between the 0 and 1 imagination conditions. Belief scores did not change significantly between 0 and 5 imaginings, or between 1 and 5 imaginings. Further imaginings did not increase belief ratings. There was no significant interaction effect of plausibility x time, plausibility x imagination, imagination x time, or imagination x time x plausibility, all $p > .05$. There was no significant effect of plausibility, $F(1, 134) = .001$, $p > .05$, or time, $F(1, 134) = 2.456$, $p > .05$.

Raw Score Analysis of Memory

To control for any initial differences in the data on memory a 2 (plausibility) x 3 (imagination) repeated measures ANOVA was run on pretest raw scores. Mauchly's test of sphericity was violated for the imagination condition, $\chi^2(2) = 10.682$, $p < .05$, and the interaction condition, $\chi^2(2) = .963$, $p < .05$; therefore, degrees of freedom were corrected using Huynh-Feldt ($\varepsilon = .940$ and $\varepsilon = .963$, respectively). Results revealed no significant interaction effect, $F(1.925, 254.124) = 2.075$, $p < .05$, and no main effect of plausibility or imagination, $F(1, 132) = .040$, $p > .05$ and, $F(1.880, 248.171) = 1.844$, $p > .05$, respectively. These findings suggest that there were no differences in participant ratings for memory at the start of the study, and any significant effects on memory ratings may be attributed to the subsequent manipulations of imagery and plausibility.

A 2 (plausibility) x 3 (imagination) x 2 (time) repeated measures ANOVA was run to detect a false memory effect. Mauchly's test of sphericity was violated by the imagination condition, $\chi^2(2) = 8.915$, $p < .05$, the plausibility x imagination interaction condition, $\chi^2(2) = 6.763$, $p < .05$, and the time x imagination condition, $\chi^2(2) = 24.465$, $p < .05$. Degrees of freedom were corrected for each of these conditions using Huynh-Feldt ($\varepsilon = .951$, $\varepsilon = .966$, and $\varepsilon = .869$, respectively). A significant main effect of imagination was found, $F(1.903, 251.151) = 5.035$, $p = .008$. Bonferroni pairwise comparisons revealed that the main effect of imagination occurred between the 0 and 1 imagination conditions, and the 0 and 5 imagination conditions. There was no significant difference in memory ratings between 1 and 5 imaginings. Further elaborating on a previously imagined event did not affect memory ratings. There was no significant interaction effect of plausibility x time, plausibility x imagination, imagination x time, or

plausibility x time x imagination, all *p* > .05, and there was no significant main effect of plausibility, *F*(1, 132) = .031, *p* > .05, or time, *F*(1, 132) = .568, *p* >.05.

Table 1 displays the observed power estimates and effect sizes for each belief condition and each memory condition. Power estimates were low, except in the case of imagination alone, and this was likely due to low effect sizes as sample size was sufficient. However, participant ratings are changing from pretest to posttest, as evidenced by standard deviations ranging from 2.01671 to 2.95052 across the six conditions of belief and memory.

Table 1.

Observed Power Estimate and Effect Size for Belief and Memory across all Conditions

Belief	Observed Power	Effect Size	Memory	Observed Power	Effect Size
P	.050	.000	P	.054	.000
T	.343	.018	T	.116	.004
I	.698	.028	I	.799	.037
P x T	.105	.004	P x T	.052	.000
P x I	.186	.006	P x I	.300	.011
I x T	.152	.005	I x T	.374	.015
P x T x I	.239	.008	P x T x I	.172	.005

*P = plausibility; T = time; I = imagination

To investigate the nested model proposed by Scoboria and colleagues, I calculated the percentage of cases wherein general plausibility was nested in personal plausibility was nested in belief was nested in memory. Specifically, Likert scale ratings should be highest for the first construct of general plausibility, and then either remain the same or decrease as participants move through the constructs of personal plausibility, belief and memory. Only the six target events were included in the analysis as these are the events used to detect an effect of imagination inflation or false memory construction.

The nested relation was maintained 75% of the time when all four constructs were included (202 violations out of 810 cases). The personal plausibility construct violated the nested relation prior to the constructs of belief and memory in over half of the cases (115 violations out of 202 cases). Based on this finding as well as the CFA results, I collapsed general plausibility and personal plausibility into one construct, maintaining the highest plausibility rating between the two constructs. The resulting nested relation improved, upholding 88% of the time (97 violations out of 810 cases; see Table 2 for more information). Maintaining two distinct plausibility constructs hindered the nested relation in this study.

Table 2.

Percentage of Violations to the Nested Model

	All constructs: GP, PP, B, M	Collapsed constructs: P, B, M
Overall % violations	25% (202 out of 810)	12% (97 out of 202)
% violations due to PP	57% (115 out of 202)	-------------------------
% violations due to B	26% (53 out of 202)	61% (59 out of 202)
% violations due to M	17% (34 out of 202)	39% (38 out of 202)

*GP=general plausibility; PP=personal plausibility; B=belief; M=memory

Discussion

The most interesting finding in the current study was the detection of a main effect of imagination on memory, refuting Pezdek, et al. (2006), but supporting Sharman and Scoboria (2009), Scoboria, et al. (2006) and Mazzoni and Memon (2003). This false memory effect, a significant increase in participants' raw scores from pretest to posttest, resulted when participants imagined events either one time or five times. There was no difference in memory ratings between one and five imaginings. Elaborating further on an image did not elicit a false memory; however, minimal visual elaboration, one imagining, and rich visual elaboration, five imaginings, produced a false memory when compared to no visual imagery manipulation at all.

A main effect of imagination was also detected on belief. Participants' raw scores increased significantly from pretest to posttest when events were imagined one time. This imagination inflation effect is strongly supported in the literature (Garry, et al., 1996;

Garry & Polaschek, 2000; Thomas, Bulevich & Loftus, 2003). Multiple imaginings had no impact on belief, even when compared to no visual imagery manipulation at all.

In contrast to Pezdek, et al. (2006), plausibility had no effect on the belief or memory constructs regardless of the number times participants imagined events. Visual imagery contributed to false memory construction and imagination inflation, regardless of the plausibility of the suggested event. Experimental manipulation of the prevalence ratings for the six target events during intervention did not elicit a significant change in raw scores from pretest to posttest for belief or memory. This finding suggests that participants' views of event plausibility for suggested events remained intact regardless of any experimental manipulation.

Imagination impacted belief and memory only in a manner of presence versus absence. However, for the memory construct, when participants imagined an event five times versus not at all, enough detail became integrated into the subsequent constructed image that this image was mistaken for actual experience. This error resulted in a false memory. For the belief construct, five imaginings had the opposite effect. By elaborating on a visual image participants became more convinced that their initial belief was accurate, suggesting that memory is more malleable than belief. These results propose that it is harder to convince someone to change their beliefs than it is to change their memory report via visual imagery.

Why would five imaginings significantly alter false memories for events, but not increase belief? A closer look at trends in the raw data offers some explanation. The majority of participants responded with a "1" or "8" to the six target ABMQ items during pretest. Most of these responses did not change at posttest. For the belief construct, the

most movement in the data occurred between the pretest-posttest condition of low plausibility and 0 imaginings (11.38% change in a “1” or “8” rating, or approximately 16 participants out of 135). For the memory construct, the most movement in the data occurred between the pretest-posttest condition of high plausibility and 5 imaginings (12.6% change in a “1” or “8” rating, or approximately 17 participants out of 135). As imaginings became more elaborate, belief ratings decreased, but memory ratings increased.

On 362 occasions, out of 810 cases, belief and memory for a target event were not reported with the same Likert scale response. Of these, 86.46% of the time (or on 313 occasions) belief was given a higher Likert rating. This supports the finding of a false memory effect in the current study because a higher belief rating is more likely to decrease at posttest, a common effect when using Likert scales.

A much larger portion of participants responded at the extreme ends of the Likert scale across all six conditions for the memory construct than for the belief construct (see Table 3). When belief and memory were not reported with the same Likert rating, belief was more often reported with a higher number on the scale. As such there must be a large proportion of “1” responses for the target events on the memory construct. In contrast to the higher ratings given to these events for belief, these memory responses have nowhere to move but in the direction of a false memory effect.

Table 3.

Percentage of "1" and "8" Responses across the Six Conditions for Belief and Memory

Condition	Belief	Memory
PreL0 PoL0	56.4% 45.0%	78.0% 71.0%
PreL1 PoL1	47.4% 51.1%	68.0% 63.7%
PreL5 PoL5	52.6% 51.9%	72.5% 71.1%
PreH0 PoH0	51.9% 47.4%	70.3% 67.4%
PreH1 PoH1	52.3% 44.4%	69.5% 62.2%
PreH5 PoH5	53.3% 47.4%	74.0% 61.4%

*Pre = pretest; Po = posttest; L = low plausibility; H = high plausibility;
0 = 0 imaginings; 1 = 1 imagining; 5 = 5 imaginings

A quick review of the data verified this trend. For the belief construct there were 262 pretest "1" responses and 256 posttest "1" responses. For the memory construct there were 448 pretest "1" responses and 412 posttest "1" responses. All of these data trends taken together illustrate that memory was affected by multiple imaginings but belief was not. These trends may be the result of visual imagery manipulations and participants' belief systems. They may also be explained by regression to the mean, due to the nature of Likert scales themselves, and provide a potential limitation to the current study. The most data movement, though maybe not significant, came from participant ratings of 2-7 on the Likert scale during pretest. These participants comprised a minority of the overall

sample size, and their movements cancelled each other out, again perhaps due to regression to the mean. The result was small effect sizes but large standard deviations for each condition.

Garry, Sharman, Wade, Hunt & Smith (2001) used a course exam to demonstrate an effect of regression to the mean applicable to this study. If an instructor decided to readminister an exam he or she would most likely use a parallel form, so not exactly the same exam, so not perfectly correlated with the first exam. On retest, some students would improve their score whereas other students' scores would decrease. Answers to test items will change at retest, but the mean, standard deviation and shape of the distribution in general should remain the same, illustrating the effect of regression to the mean in the current study.

Sharman and Scoboria (2009), based on the work of Garry, et al. (2001), controlled for regression to the mean when using Likert scales by analyzing only the responses that fall at the low end of the plausibility construct, a 1-4 response, during pretest. This allows researchers to investigate only an increase in constructs without influence from regression to the mean or ceiling effects. Because I manipulated plausibility via prevalence ratings during intervention rather than using participant's pretest ratings to determine this construct, I was not able to only analyze scores ranging from 1-4 at pretest to look for a change at posttest.

To minimize the effect of regression to the mean I chose to analyze data using ANOVA on raw scores with a third within subjects variable entered (time: pre or post) rather than examining change scores with ANOVA[1]. Change score analysis is popular in false memory research, and change scores have value; however, regression to the mean is

a potential issue when change scores are the unit of measurement (Pezdek & Eddy, 2001). Because there was not a three way interaction effect, nor any interaction effect with time, and to avoid any compounding issues of Likert scale floor and ceiling effects with the unit of measurement analyzed, raw scores were the appropriate dependent measure of study.

The CFA revealed that the memory, belief and general plausibility constructs have good data-model fit using the ABMQ survey instrument. The personal plausibility construct is problematic, possibly helping to explain the lack of a plausibility effect on belief and memory. The CFA results partially support the nested model proposed by Scoboria, et al. (2004). Perhaps only one plausibility construct is necessary when identifying the components in the false memory process. When considering the likelihood of experiencing an event individual make just one plausibility judgment, which would be personal, and perhaps asking for two distinct plausibility judgments on the ABMQ is problematic. There will always be exceptions to the nested model. For instance, you know that you were born but do not possess a memory for that event. Or maybe you experienced some remarkable event such as shaking hands with the president. This would then be personally plausible for you, and receive a high belief and memory rating, but probably not be considered generally plausible for others.

There are many avenues for future research in false memory construction. Further analysis to validate the ABMQ is necessary if researchers wish to continue its use in detecting false belief and false memory effects. In addition researchers need to determine if two distinct plausibility constructs add value to a model of false memory construction, or if there are extraneous variables that might be added to the model to account for some

of the error covariance between items on the ABMQ. The nested relation proposed by Scoboria, et al. (2004) can then be further considered to identify the components involved in the false memory process.

Future research should consider allowing participants to determine the plausibility of the event in question, rather than having the experimenter manipulate this variable, so that results may consider the low plausibility events at pretest, a 1-4 Likert rating, to detect a false memory effect due to visual imagery that is not confounded by regression to the mean. If an effect of imagination is again detected on memory, researchers must further explore to what extent, or how many imaginings, elicit this shift in memory criterion, and thereby try to understand why this effect exists, possibly studying the descriptions provided for each imagination to look for patterns of detail amount and type.

Results of the current study have implications for the legal system as a whole, including law officials, police officers, eyewitnesses, and jurors, and for the therapeutic setting. The idea that repetition or elaboration of visual imagery can alter a person's memory for an event, even if told that this event is not common, is critical for understanding the most appropriate methods to use when questioning individuals about events in their past. Asking people to repeatedly envision an event to try and remember as many details as possible, as is common both in interrogation proceedings and guided imagery techniques used by therapists, might result in remembering inaccurate information.

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Footnotes

[1]A 2 (plausibility) x 3 (imagination) repeated measures ANOVA on change scores was computed. For the analysis of belief, results indicated no significant main effect of plausibility, $F(1,134) = .474$, $p>.05$, or imagination, $F(2,133) = .617$, $p>.05$. There was not a significant interaction effect, $F(2, 268) = 1.082$, $p>.05$**.** For the analysis on memory, Mauchly's test of sphericity was violated for imagination, $\chi^2(2) = 24.032$, $p<.05$; therefore, degrees of freedom were corrected using Huynh-Feldt ($\varepsilon = .868$). There was no significant main effect of plausibility, $F(1, 134) = .033$, $p>.05$, or imagination, $F(1.736, 232.679) = 1.755$, $p>.05$. There was not a significant interaction effect, $F(2, 268) = .682$, $p>.05$. Observed power was very low for all conditions, ranging from .105 to .239 for belief, and ranging from .054 to .366 for memory. As such ANOVA was conducted using raw scores.

APPENDIXES

APPENDIX A

Life Events Inventory.

Please rate on a scale of 1 – 8 how confident you feel that you experienced each of the following events:

1. Ran away from home ----------
2. Found a $10 bill in a parking lot ----------
3. Went camping overnight ----------
4. Saw lightning strike a tree ----------
5. Played for the LA Lakers ----------
6. Got lost in the grocery store ----------
7. Adopted a lost animal ----------
8. Cheated on a test ----------
9. Got sick and went to the hospital ----------
10. Gave someone a haircut ----------
11. Helped prepare a meal for your family ----------
12. Broke a window with your hand ----------
13. Won a million dollars ----------
14. Was almost hit by a car ----------
15. Got sick from eating too much candy ----------
16. Had been rescued from the water while swimming ----------
17. Saw an R-rated movie ----------
18. Participated in a wedding ----------

19. Skipped class or skipped school ----------

20. Went to a funeral ----------

APPENDIX B

ABMQ- Childhood Event Inventory

Below are some events that may or may not happen to people before the age of 10. Please answer five questions about each event.

The first question has to do with how plausible it is that events like this happen to people in general. The second question asks how many people out of 100 you believe this happens to. The third question asks how plausible it is that events like this could have happened to you. There are many events that may happen to some people in general but are not plausible for you (e.g. it is very plausible that many people got stung by a hornet when they were younger, regardless of whether they remember it; however, you may have grown up in an area of the world with no hornets and so it is unlikely that this could have happened to you, whether or not it did).

Also, many things happen that people do not remember having happened. People can know something happened to them, without remembering the event (for example, you probably know where you were born, even though you don't remember being born). Therefore, the fourth question asks your belief as to whether you think the event happened to you while the fifth question asks whether you actually remember this event.

Lastly, please keep in mind that all the following events ask questions about events that happen at or before the age of 10 . . .

2. Broke a window with your hand

	Not at all Plausible					Extremely Plausible	
A. How plausible is it that at least some people, before the age of 10, break a window with their hand? 1	2	3	4	5	6	7	8

B. Out of 100 people, how many people, before the age of 10, break a window with their hand? ________ (insert a number between 0 and 100)

	Not at all Plausible					Extremely Plausible	
C. How plausible is it that you personally, before the age of 10, could have broken a window with your hand? 1	2	3	4	5	6	7	8

	Definitely did not Happen					Definitely did Happen	
D. How likely is it that you personally, before the age of 10, did in fact break a window with your hand? 1	2	3	4	5	6	7	8

	No memory of event at all						Clear and complete memory of event
E. Do you actually remember breaking a window with your hand before you were the age of 10?	1	2	3	4	5	6	7	8

APPENDIX C

Phase 2: Packet Administration

Please read the following 6 events and note the reported occurrence ratings for each. The reported occurrence ratings were obtained from previous surveys of college students regarding life events. The survey conducted was specifically interested in how frequently college students reported specific events that happened to them *prior to the age of 10*. You will be asked to imagine some of these events occurring to you as a child. Some of these events are considered to have a high likelihood of occurrence and some to have a low likelihood of occurrence.

Events with reported occurrence ratings of 89% to 91% are considered highly probable. This means that of the 1000 college students previously sampled, 890 to 910 students reported that prior to age 10 they did in fact experience almost being hit by a car, being rescued from the water while swimming, and breaking a window with their hand.

Events with reported occurrence ratings of 9% to 11% are considered to be low probability events. This means that of the 1000 college students previously sampled, 89 to 91 students reported that prior age 10 they did experience getting lost in the grocery store, getting sick and going to the hospital or finding a $10 bill in the parking lot.

Event	Occurrence rating
1. Got lost in the grocery store	9 to 11%
2. Got sick and went to the hospital	9 to 11%
3. Found a $10 bill in the parking lot	9 to 11%
4. Was almost hit by a car	89 to 91%
5. Had been rescued from the water while swimming	89 to 91%
6. Broke a window with your hand	89 to 91%

Before we proceed with the experiment I want to ensure that you remember which of the events listed below are probable or common and which are unusual or improbable.

Please circle whether each event carries a *high* or *low* occurrence rating as reported from results of the previous college student survey.

It is important that you remember these occurrence ratings as you may be asked about these events again at a later date.

Please do not proceed with the remainder of this packet until you know which of these events are considered to have a high occurrence rating and which are considered to have a low occurrence rating.

	Event	Occurrence rating	
1.	Got lost in the grocery store	Low	High
2.	Got sick and went to the hospital	Low	High
3.	Found a $10 bill in the parking lot	Low	High
4.	Was almost hit by a car	Low	High
5.	Had been rescued from the water while swimming	Low	High
6.	Broke a window with your hand	Low	High

The current research is interested in compiling a database of commonly occurring childhood events. Imagination is a technique employed to ensure accuracy.

Please imagine the following 2 events 1 time each.
So, I want you to imagine yourself as a child and that you got lost in the grocery store.
Close your eyes and take some time to imagine yourself as a child in this situation.
Please do not move forward in this packet until you have completed your imagination of this event.
Once you are finished imagining this event, please write a description in the space below including everything that you imagined pertaining to this event. There is no length requirement for the description or time requirement for the imagination.
Next, move on to the next page and repeat this process with the second event.

1. Got lost in the grocery store

Description:

2. Was almost hit by a car

Description:

As you are aware, the current research is interested in compiling a database of commonly occurring childhood events. Imagination is a technique employed to ensure accuracy and is also of interest in the compilation of the database for the current study.

Please imagine the following 2 events 5 times each. After each imagination, please write a detailed description of your imagination. Write five descriptions for each of the two events equaling a total of 10 descriptions.
So, I want you to imagine yourself as a child and that you got sick and went to the hospital. Close your eyes and take some time to imagine yourself as a child in this situation. Please do not move forward in this packet until you have completed your imagination of this event.
Once you are finished imagining this event, please write a description in the space below including everything that you imagined pertaining to this event. There is no length requirement for the description or time requirement for the imagination.
Please repeat this process four additional times for a total of five separate imaginations and five separate descriptions of this event. Please be sure that the 5 descriptions are separated by either leaving space between each or numbering them. You may use the back of this sheet if necessary.
Then, move on to the next page and repeat this process with the second event.

1. Got sick and went to the hospital

Descriptions:

2. Had been rescued from the water while swimming

Descriptions: