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Highly Superior Autobiographical Memory (HSAM): Memory Distortion Paradigms and Individual Differences

DISSERTATION

submitted in partial satisfaction of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

in Psychology and Social Behavior

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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ABSTRACT OF THE DISSERTATION

Highly Superior Autobiographical Memory (HSAM):

Memory Distortion Paradigms and Individual Differences

By

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Doctor of Philosophy in Psychology and Social Behavior

University of California, Irvine, 2015

Professor Elizabeth F. Loftus, Chair

This dissertation addresses two basic questions: 1. Are people with highly superior autobiographical memory (HSAM) susceptible to memory distortions? 2. What is different about them that might offer clues that would help explain their ability? To answer the first question thoroughly, HSAM individuals and age match controls participated in a number of memory distortion tasks. In the DRM memory distortion word list paradigm we found that HSAM participants had comparably high rates of critical lure endorsement, indicating a vulnerability to false memories brought about by associations. They also participated in a classic misinformation experiment with photographic slides as the original event, and text narratives containing some pieces of misinformation. At the subsequent memory test HSAM individuals indicated more false memories than control participants, a finding that became non-significant when adjusting for individual differences in absorption. After a subsequent source test, HSAM and control participants had comparable numbers of false memories from misinformation.

In semi-autobiographical memory distortion tasks, HSAM and control participants had fairly similar rates overall. For example, in a nonexistent news footage task using suggestion

(also known as the “crashing memory” paradigm) 10% of HSAM individuals said they had seen the footage (a further 10% indicated maybe/unsure), whilst 18% of controls did (5% maybe; *ns*). A guided imagery task, with the same nonexistent footage as the target event, produced similarly increased rates of false report in HSAM (17% changed from “no” to “yes”) and control (10% from “no” to “yes”) participants. Memory for their emotions in the week after 9/11 was similarly inconsistent in HSAM and control participants. These results suggest that, relative to controls, HSAM individuals are as susceptible to both misinformation and reappraisals when the target events are semi-autobiographical.

The second main research question asked what is different about HSAM individuals that might give us clues as to why they have their ability? To answer this we measured HSAM participants’ and age/gender matched controls’ on a number of behavioral measures to test three main hypotheses: imaginative absorption, emotional arousal, and sleep. HSAM participants were significantly higher than controls on two dispositions—absorption and fantasy proneness. These two dispositions were associated with a measure of HSAM ability within the superior memory participants. The emotional arousal hypothesis yielded only weak support. The sleep hypothesis was not supported in terms of quantity, but sleep quality may be a small factor worthy of further research. Other individual differences are also documented. Speculative pathways describing how absorption and fantasizing could lead to enhanced autobiographical memory are discussed.

Chapter 1: HSAM Introduction

Highly Superior Autobiographical Memory (HSAM; also known as hyperthymesia or hyperthymesic syndrome) is an ability that only recently has been scientifically studied (Parker, Cahill, & McGaugh, 2006; LePort et al., 2012; Ally, Hussey, & Donahue, 2013). HSAM involves a very detailed and accurate recall of personal events, dates, and news events. HSAM individuals can recall events on almost every day, usually from their mid-childhood onwards. Some report they can remember in this fashion as far back as five years old. The history of the phenomena is quite short, with the first documented modern case first published in 2006 (Parker et al., 2006), although there was a possible case documented as far back as 1871 (Henkle, 1871).

Parker et al. (2006) were the first to document a case of what they called hyperthymestic syndrome (to be renamed later as HSAM). Their one subject, given a pseudonym A.J., reported that remembering her personal past ruled her life in a burdensome way. She reported her memory ability to be accurate and reliable in a fashion that was automatic. She excelled specifically in remembering events and knowledge that are personally relevant to her. She reported remembering dates from the past exceedingly well, including the day of the week, and events from that day. She reported that she had a good memory as a young child, but at age 8 her memory improved such that she could remember almost every day. After age 14 her recall improved further so that she reports being able to remember every day. From age 10 onwards she kept diaries. However, she reported that she rarely looked at them later.

A.J.'s strong autobiographical memory did not translate to superior learning at school or into other domains of memory. With autobiographical memory though, her recall was reported as immediate and with emotion, and strong for topics she had an interest in. Interestingly, she reported her memories as running like a movie. Most importantly are the more objective tests of

autobiographical memory that Parker et al. (2006) used. When given 10 dates after 1977 A.J. was able to correctly name the significant news event that happened on those dates. Conversely, when given significant news events in that period, she was able to accurately recall the date on which that happened. The researchers used her diaries to test her recall of dates and personal events that happened to her on a recurring event (Easter) chosen without forewarning by the researchers, and her performance was almost perfect. This case study formed the foundation of superior autobiographical memory studies that followed, but it also raised questions as to whether there had been previous cases that had gone unnoticed.

It is uncertain whether there were cases of HSAM before A.J., but one good candidate is a single case described by Henkle in 1871. Other types of superior memory had been described before the case of A.J. (see next subheading), but Henkle's (1871) case "Daniel McCartney" (D.M.) is the closest match because D.M., similar to today's HSAM individuals, was able to recall the dates extremely well from mid-childhood (in his case, age 9) onward as well as events on those dates (such as the weather). Like A.J., D.M. reported being able to remember events on most dates—not every day in earlier childhood, but every day from mid childhood onwards. D.M., like A.J., reported being able to recall the day of the week on any date, and details such as news events (e.g. the inauguration of General Taylor, the hanging of John Brown) and personal events (e.g. cutting a wood stove for someone, or attending a meeting in Iberia). Interestingly, and in contrast to recent research on HSAM, Henkle reported D.M. as being able to perform extraordinarily well at mathematical calculation: for example the cube-root of large numbers. He therefore showed an elevated cognitive ability outside the domain of HSAM. One of the problems with this case study is uncertainty about how verified D.M.'s reports were, although his case provides at least some circumstantial evidence that HSAM existed before the modern

scientific investigation into it. Possible past cases of HSAM, though unverified, are interesting because they could indicate HSAM is a very rare but naturally occurring ability that has previously existed, perhaps going unidentified and unmeasured by modern scientific measures, until now.

Following the Parker et al. (2006) description of A.J., more people claiming to have HSAM came forward, and some of those were subsequently categorized as HSAM and were tested further. LePort et al. (2012) described 11 HSAM individuals, including A.J., and described how they were identified, their structural brain scans, their performance on standard laboratory memory tests, and a number of other measures. They identified HSAM participants using a Public Events Quiz and a 10 Date Quiz, the same means of categorization used in this dissertation work (detailed at the subheading below "Identifying HSAM Individuals"). The structural MRI brain scans of HSAM participants have shown some areas that are thought to play a role in autobiographical memory are different than age matched controls. As LePort et al. (2012) point out, the structural differences in the temporal gyri and pole, the anterior insula, and the hippocampal gyrus, are regions thought to be part of an autobiographical memory network. These differences may or may not be indicative of a causal relationship between differing brain morphology and increased memory ability (or vice versa). These are, however, interesting clues. If there is a valid connection between anatomy and memory performance in HSAM, it is uncertain whether the brain morphology differences is a cause the superior memory ability (nature) or whether the practice of frequent memory processing caused the brain to change (nurture), or both.

Other Forms of Superior Memory

HSAM abilities are distinct from previously described superior memory individuals (e.g. Luria, 1968; Hunt & Love, 1972; Ericsson & Chase, 1982; Gordon, Valentine, & Wilding, 1984; Wilding & Valentine, 1997) who typically rely upon practiced mnemonics to remember unusually long lists of domain-specific data, yet remain average in their ability to retrieve autobiographical information. Indeed Ericsson and Chase (1982) found that some of these feats of memory could be matched or even surpassed by people with average memory who practiced with effective techniques.

Luria's (1968) case study of patient "S." involved a subject who had no heightened ability in the autobiographical domain. Instead, Luria reported that S. could remember long lists of numbers, words, and nonsense syllables. Subject S. reported synesthesia, and that mixing of the senses could aid in encoding stimuli—that is due to the multi-sensual richness of the stimuli (compared to those without synesthesia). Interestingly, S. himself reported that "to me there's no great difference between the things I imagine and what exists in reality" (Luria, 1968, p. 146) This is interesting because a tendency to imagine in a deeply absorbed way, including into fantasy, has been thought of as a route to memory *error* (e.g. imagination inflation can produce false memory; see Garry et al., 1996). However, the case of S. suggested that a tendency to mix imagination and reality could be a correlate of superior memory performance.

In a similar case to S., Hunt and Love (1972) describe a subject V.P. who used predominantly linguistic associations to group items together to aid memory. Like S., V.P. scored highly on a number of memory tasks, for example V.P. could remember a string of 17 characters on a digit span test. Hunt and Love (1972) pointed out that both S. and V.P. were both educated in a system where rote memorization was encouraged and rewarded. This practice may account for their superior memory. V.P.'s performance on other (non-memory) cognitive tasks

was about average, suggesting a domain specific skill as was also found in many other cases of superior memory.

Other studies have also investigated a variety of similar cases to the mnemonists already mentioned, but with more emphasis on visual recall. These cases tend to vary quite a lot in terms of the domain of memory and the techniques used. For example, Gummerman & Gray (1971) studied a 19 year old college student who could remember many more details than the average person after seeing a picture for just 30 seconds. The researchers noted that her ability was not photographic, and that her visual memory storage was similar to normal memory individuals apart from less decay and more clarity of the image. Coltheart & Glick's (1974) reported that subject “O.” was able to take a short sentence presented to her and quickly spell or speak the sentence out backwards, a very difficult task that most people are unable to do. The researchers suggested that this was due to an ability to visualize the stimuli and hold it in memory long enough to read off the letters in reverse order from that visual image. As with other case studies, the researchers did not conclude that the subject had photographic memory. Reliable studies demonstrating photographic memory are difficult to find, which when combined with decades of memory research in cognitive psychology, raises the possibility that photographic memory is a myth.

Many cases of superior memory use some variation of a mnemonic device to aid memory, while other cases involve individuals that are so highly interested in a given domain that they attend to, process, and/or rehearse more than the average person. For example, Hunter (1977) reported the case of the mathematician Aitken, whose superior memory came about from a strong interest in the stimuli. This resulted in the deep processing of the information semantically in large associative networks, where the meaningful connections between items

seemed to help recall. Aitken did report that he had good memory for some autobiographical events (such as his experience of World War I) but not apparently to the extent of HSAM.

Autistic savants are often reported to have superior memory, often in a single and very limited domain. They also tend to have cognitive deficits in one or more area (Treffert, 2009). There is a long history of reports about savants being unusually good at calculation and/or having a superior memory capacity, while at the same time being limited in other ways (e.g. Mortiz, 1783; Tredgold, 1914; Kanner, 1944; Peek & Hanson, 2008). It has also been noted, by Treffert (2009), that superior memory is fairly rare among those with autism (estimated at 1 in 10). In addition there are more male autistic savants than females, and prodigious memory tends to accompany the narrow skill at which the savant excels. For example, one case involved an individual able to remember phone area codes and postal zip codes for the United States (Peek & Hanson, 2008). Autistic savants are often good at rote memorization of stimuli that would not hold much meaning for normal people of average memory. These cases are quite distinct from other superior memory cases in that they do not usually report complicated use of mnemonics. In fact, Tredgold (1914) called autistic savant's superior memory "automatic." By not using mnemonics, some autistic savants resemble HSAM individuals, but their memory ability is usually not in the domain of autobiographical memory—at least not to the extent of HSAM. While autistic savants have some cognitive deficits in some domains, HSAM individuals for the most part do not.

To summarize, these previous studies describe a subset of people who use various techniques to remember things like long strings of characters. Other superior memory individuals can recall more details in pictures then people with ordinary memory. Some individuals use a particular technique, such as mnemonic devices, while others seem to deeply process the stimuli

in other ways. In contrast to these superior memory cases, HSAM individuals do not tend to use mnemonics, rote practice, and do not uniformly report using memory rehearsal techniques. HSAM individuals exhibit average scores on short-term memory tasks unrelated to autobiographical memory. In addition, they recall their past in great detail in a way that is described in a way that appears to be more automatic, effortless, and less practiced relative to other types of superior memory. Some HSAM individuals have, however, kept diaries, and have reported rehearsing their memory of dates and events as well as categorizing and cataloging their experiences on certain dates in their minds. Importantly, not all HSAM participants have reported using these techniques, so it is still a puzzle as to what the causes are of their enhanced memory.

Identifying HSAM Individuals

Of the hundreds of people claiming to have HSAM who contacted the McGaugh/Cahill laboratories after national news reports (e.g. *60 Minutes* in 2010) of the phenomena, 172 of these were chosen to be fully tested with the quizzes described below. In this dissertation, individuals were categorized as HSAM in the same way as described in LePort et al. (2012). They were identified as HSAM individuals, or not, based on the two objective measures of autobiographical memory, the Public Events Quiz and the 10 Dates quiz.

Public Events Quiz. The Public Events Quiz consisted of thirty questions. It contained two types of questions: 15 asked for the exact date of a given significant public event that took place within the individual's lifetime. For example, "When did an Iraqi journalist hurl two shoes at President Bush?" The other 15 questions asked for the significant public event that took place on a given date that took place within the individual's lifetime (e.g., what public event occurred on October 11, 2002?). In addition, for all 30 questions, individuals were asked to state the day

of the week the date fell on. The significant public events given were selected from five different categories so as to increase the chances that the participant had experienced it. Those categories were, sporting events, political events, notable negative events concerning famous people and holidays. The participant received one point for each correctly identified category (i.e., the event, the day of the week, the month, the date and the year) and could achieve a total of 88 possible points. A very strict score of 50% or above qualified an individual claiming to have HSAM to advance to the second even more challenging round of screening, the 10 Dates Quiz. This conservative measure ensured that the HSAM pool contained only those participants who were proficient at accurately recalling event-related information that they had experienced in their lifetime.

10 Date Quiz. The 10 Dates Quiz consisted of 10 computer generated random dates, ranging from the individual's age of 15 to the day of testing. Individuals were asked to provide three different categories of information for each of the 10 dates generated: (a) the day of the week; (b) a description of a verifiable event (i.e. any event that could be confirmed via a search engine) that occurred within plus or minus one month of the generated date; (c) a description of a personal autobiographical event the individual participated in on that date. One point was awarded for the correct day of the week, for giving a verifiable event confirmed as true, and for giving a personal autobiographical event. A maximum of three points per date could be achieved (30 points total). A score of 65% or above, representing the average of all three categories, qualified the individual as an HSAM participant. This very conservative measure was taken so as to ensure that an HSAM participant was proficient at accurately identifying events, whether in the public or private domain, and the days of the week they occurred.

HSAM individuals showed unusually high scores on both the Public Events Quiz and the 10 Dates Quiz, with a minimum of a score of 53.4% on the Public Events Quiz and a minimum of 69.0% on the 10 Date Quiz. On average, controls (none claiming to have HSAM) scored 11.1% on the 10 Date Quiz and 12.6% on the Public Events Quiz. As a result of testing many participants who thought they might have HSAM, 30 had passed the criteria for HSAM at the time of recruitment (2012) and of these 20 were recruited for this dissertation research.

Chapter 2: Deese-Roediger/McDermott (DRM) Word Lists

In the Deese-Roediger/McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) paradigm, participants are shown a list of words that are all related to a word that is *not* presented—called the critical lure. Typically 10, 12, or 15 words are presented, for example "rest," "bed," "nap," "peace," and the critical lure word "sleep" is not shown. The term critical lure is used to mean the word that is not presented, but is related to the words in a list that are actually shown. In the subsequent memory test, typically a few minutes later, "sleep" is falsely remembered by a remarkably high proportion of participants (recall: 61%; recognition: 80%; Roediger, Watson, McDermott, & Gallo, 2001). This task suggests that memory works in an associative way, whereby one object or event activates a web of objects or events that are related, and that the activation of a related item (Collins & Loftus, 1975) can be incorporated later as a memory for that item when memory is reconstructed at retrieval. The DRM shows that grouping items together to aid recall can lead to false memories. As a word list task, the DRM's strength is that allows for high levels of experimental control and precision and is well suited to uncovering memory mechanisms (i.e. it has high internal validity). Perhaps the DRM's weakness is that it does not closely mimic the typical conditions in which meaningful real-life memory distortions occur (i.e. it has lower external validity than some other memory distortion paradigms).

Deese (1959) presented lists of 12 words and found that individuals would have what he called "intrusions"—recalling words that were not actually presented but were associated to the words that were presented. The more related the words were to the presented words, the higher the probability that they would be intrusions. With a few exceptions (e.g. Underwood, 1965) this line of research was relatively dormant for a few decades, but was reinvigorated by Roediger and

McDermott (1995) who in their article title used the term “false memories” to describe the intrusions of the “words not presented in lists.” It is perhaps due to the reframing of the jargon used (from “intrusions” and “retroactive interference” to the clearer and simpler “false memory”), as well as great interest in false memory research in the 1990s, that led to hundreds of studies using the DRM word lists in the years since 1995 (for a review see Gallo, 2010). They found false memory rates of the critical lures of between 40% and 55% in recall false alarm rates on critical lures. On a recognition test, they found critical lure endorsement rates at a similarly high percentage to endorsement rates of words that were actually shown earlier (in the range 65% to 81%; Roediger & McDermott, 1995).

The phenomenon demonstrated by the DRM word list—that of producing high rates of false recall or recognition of critical lures—is well replicated in several populations. For example Dehon and Brédart (2004) found susceptibility to this type of memory distortion in both young adults and older adults. Young children report false memories in most other false memory paradigms, but Brainerd, Reyna, and Forrest (2002) found that in DRM tests young children in kindergarten (M_{age} = 5.7) showed reduced associative errors perhaps reflecting that they have not yet developed associative semantic networks to the degree that adults have. Metzger et al. (2008) confirmed that in the DRM paradigm young children had fewer false alarms of critical lures than older children and adults. These researchers found the same pattern of results whether they used standard DRM lists designed for adults, or word association lists generated by and for children. Metzger et al. (2008), in a similar way to Brainerd et al. (2002), explained the low false memory rates in young children in terms of semantic networks that develop during periods in childhood. Except for this understandable exception in young children, all other populations studied have been susceptible to the DRM false memory effect.

Memory Ability and Susceptibility to DRM Memory Distortions

There has been some variability from person to person, though, in just how susceptible various groups of people are. Some researchers, for example, have found that those with higher working memory scores have fewer false reports of critical lures in the DRM task (e.g. Lövdén, 2003; Peters, Jelicic, Verbeek, & Merckelbach, 2007; Watson, Bunting, Poole, & Conway, 2005). Working memory involves the active maintenance and manipulation of information, and usually refers to the maintenance in memory of recent stimuli. It should be pointed out that even those with higher working memory ability are still susceptible to the false reports generated by the DRM technique, only less so. This raises the possibility that greater memory ability in general could be related to lower false memory rates. From this, though, it remains unclear whether higher memory ability in the autobiographical domain (as in HSAM, for example) would translate to lower DRM false memory rates.

There are some studies that might give us clues as to the relationship between autobiographical memory ability and false memory rates in the DRM. For example, Platt, Lacey, Iobst, and Finkelman (1998) found that those who were more consistent in their memory for a semi-autobiographical event (e.g. their location when they heard the OJ Simpson verdict) had lower false memory rates on the DRM test.

Another area of research has examined the relationship between autobiographical memories that are almost certainly false (e.g. space alien abduction) and investigated if that is related to performance on the DRM memory distortion test. Clancy, McNally, Schacter, Lenzenweger, and Pitman (2002) found that those reporting alien abduction were more prone to DRM false memories compared with a matched control group (on both recall and recognition tests). Similarly, Meyersburg, Bogdan, Gallo, and McNally (2009) found that those reporting

past lives (again, likely a false autobiographical memory) had higher false recall and recognition of critical lures on the DRM test. This pattern of results has also been found when comparing those reporting repressed memory recovery, to those not, on their DRM endorsement of critical lures (e.g. Clancy, Schacter, McNally, & Pitman, 2000). Those reporting repressed memory recovery had higher false memory on the DRM test. This latter example of probable false autobiographical memory is less clear than the first two (abduction, past lives) because there is some debate as to whether repressed memories are accurate or not (see Patihis, Ho, Tingen, Lilienfeld, & Loftus, 2014).

In this chapter, we investigate the difference in performance on the DRM false memory task between HSAM individuals and controls without superior memory. Given the decreased susceptibility to DRM distortions in people with higher working memory, more consistent autobiographical memory, and less false autobiographical memory, we might predict that those with superior memory will also have less endorsement of critical lures in the DRM task. HSAM participants, however, have performed about equally on non-autobiographical laboratory memory tests (LePort et al., 2012), so there is some uncertainty about such a prediction. What this question can help establish is whether HSAM can be partially explained by HSAM individuals having memory that is less prone to associative memory errors.

Method

Participants

At the time of recruitment (2012) the McGaugh/Cahill/Stark laboratories at UC Irvine, in a project led by Aurora LePort, had identified 30 HSAM individuals. I subsequently recruited 21 of those 30 for the current dissertation research. One participant was excluded from analyses due to visual impairment, leaving 20 HSAM participants. We also recruited 38 age- and gender-

matched controls from the general public who were within 4 years of age to their corresponding matched HSAM individual. Each HSAM participant had at least one, usually two age- and gender-matched controls. As a result the mean age in each group was almost identical (HSAM M_{age} = 38.6, *SD* = 10.8, range 21 to 62; controls M_{age} = 39.0, *SD* = 10.5, range 21 to 60; p = .90). Also recruited were 16 other nonstudent adults were who were not matched by age and gender, including some over the age of 65 to allow for wider age analyses. One hundred and nine undergraduates were also recruited and they participated for course credit. Non-student participants (HSAM and control) were paid $40 each for about 3 hours of participation, and undergraduates received 3.5 hours of course credit. Undergraduates participated between Fall 2011 to December 2012, while non-student participants (HSAM and controls) participated between January 2012 and December 2012.

Twelve HSAM individuals have been described in previous studies (Parker et al., 2006; LePort et al., 2012; Ally et al., 2013). Seven of the participants recruited for this dissertation had previously been identified as having HSAM in previous peer reviewed articles (Parker et al., 2006; LePort et al., 2012), meaning that this dissertation introduces data to the literature from 13 additional HSAM individuals.

Materials and Procedure

General. In the memory distortion part of the study comparing HSAM to control participants, subjects were paid $40 each for approximately 3 hours of participation. Subjects participated at their home on their own computer, with the researcher connected to them via Skype video-chat or phone for the entirety of both Session 1 and 2. We required participants to have the computer on a desk, and to be sitting on a chair. Researchers advised the participants before the study commenced on how to avoid distractions and interruptions. We excluded one

participant from this article's analysis due to visual impairment. We excluded one further participant from only the DRM analysis because that participant indicated they remembered seeing every single word on the test, indicating non-compliance with that part of the study.

To disguise the fact that we were investigating false memories, we gained Internal Review Board approval (UC Irvine IRB; HS#2011-8038) to tell participants the study was about personality, individuality, and slideshows. The instructions they read briefly mentioned that their memory would also be tested in the study, but the instructions did not mention memory distortion or false memory. This was necessary because subjects' awareness of the topic of the study, memory distortion, can bias their memory reports.

DRM. We used well-established validated DRM word list materials (Roediger et al., 2001), in which we presented 20 fifteen-word lists (the study phase) and a few minutes later tested their recognition (see Figure 2.1 below). The lists used in this study had the following critical lures: Lamp, Trash, Slow, Wish, Foot, Window, Soft, Chair, River, Stove, Anger, Justice, City, Rough, Mountain, Music, Thief, Doctor, Cold, and Needle. For our secondary analysis comparing the more emotionally arousing critical lures to more neutral critical lures, we used arousal scores of those critical lures from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999). See Appendix A for a complete list of DRM materials used in this study.

Results

To investigate the relationship between HSAM ability and memory distortion susceptibility, we first compared HSAM individuals to age- and sex-matched controls on the DRM task. We then performed a median split on HSAM participants, comparing the 10 who scored above the HSAM median on the PEQ (one of the objective measures of autobiographical

memory ability), to the 10 who scored below that median. The main results are shown in Figure 2. 1.

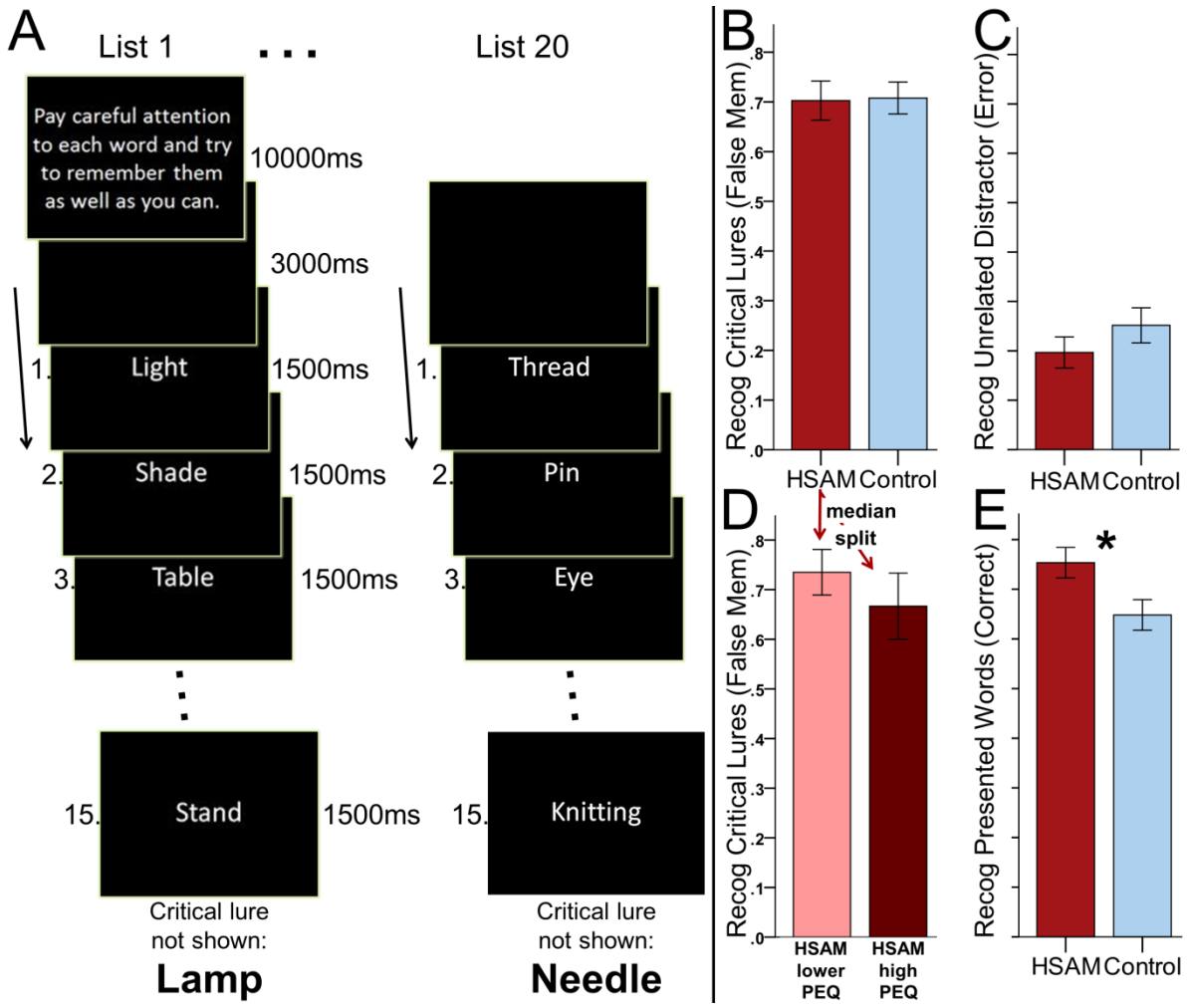

Figure 2.1. The DRM false memory associative word list: a sample of materials and the main results. (*A*) The materials consisted of 20 lists, each 15 words long. Each word in a given list is related to a critical lure that the participants never actually saw. (*B*) The main result showed both HSAM individuals and controls falsely recognized a similarly high proportion of critical lures (M_{HSAM} = 14.1; $M_{Control}$ = 14.2 out of 20). The y-axis indicates the mean proportion. (*C*) Both groups indicated seeing unrelated distractor words at the same proportion as one another, far less often than they endorsed seeing the critical lure words. (*D*) HSAM participants with the highest autobiographical memory ability (highest scores on the Public Events Quiz, PEQ) were not significantly less susceptible to falsely endorsing critical lure words than HSAM participants who performed in the low range. (*E*) HSAM individuals outperformed controls on correctly recognized items that were presented earlier (hit rate), p = .035. Error bars represent standard errors.

Figure 2.1 shows the DRM word-list false-memory task. There was no significant difference between false-memory rates (recognition of critical lures: words not presented earlier, but related to presented words) of HSAM individuals (M = 70.3%, SD = 17.1%) and controls (M = 70.8%, SD = 19.9%); $t(55) = -0.10$, $p = 0.922$, Cohen's d = .01 (Figure 2.1B). HSAM participants and controls incorrectly indicated they had seen an average of 14 of the 20 critical lures (HSAM range 8–20). In addition, there was no reliable difference in false-memory rate for HSAM individuals scoring low (M = 73.5%; SD = 14.5%) and high on the PEQ measure (M = 66.7%, SD = 20.0%) of autobiographical memory ability (Figure 2.1D) $t(17) = 0.86$, $p = 0.403$, d = .39. For a median split analysis on the 10 Dates Quiz, rather than the PEQ, see Figure 2.2. As can be seen in Figure 2.2 (below), the results reflect the PEQ median split, with critical lure endorsement similar in those low on the 10DQ (M = 69.4%, SD = 11.3) compared to those scoring high on the 10DQ (M = 71.0%; SD = 21.8%), $t(13.8) = .85$, $p = .846$, $d = .09$. .

There were also no significant differences in error rates of recognizing unrelated distractor words that were neither presented earlier nor related to presented words (Figure 2.1C) (HSAM participants M = 19.7%, SD = 13.8%; controls M = 25.2%, SD = 21.8; $t(51.9) = 1.16$, $p = 0.323$, d = .30; percentages in keeping with past DRM research). However, we found that HSAM individuals correctly recognized significantly more presented words (M = 76.6%, SD = 14.2%) than controls (M = 64.8%, SD = 19.0%), $t(55) = 2.16$, $p = 0.035$, d = .70.

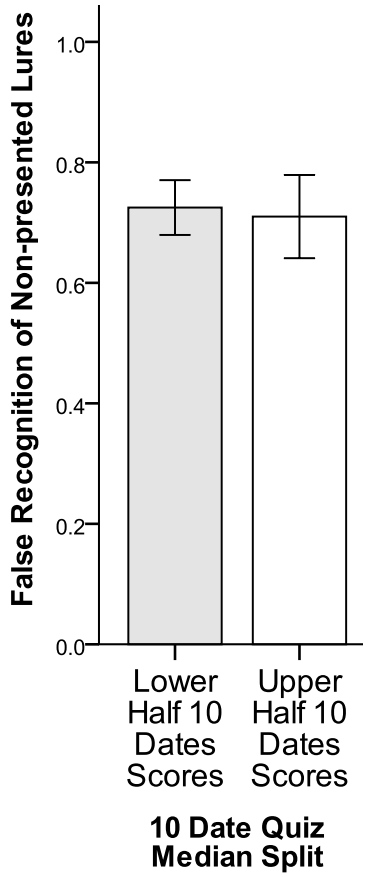

Figure 2.2. A median split of HSAM participants by their 10 Date Quiz score. Similar to the PEQ median split shown in Figure 2.1, HSAM individuals in the upper half of the 10 Date Quiz (10DQ) had no significant difference in DRM false memories than HSAM participants lower on 10DQ. Error bars represent standard errors.

A signal detection analysis revealed HSAM participants were better at discriminating presented words from critical lures than controls, but no better at discriminating unrelated distractors from presented words (Figure 2.3 below).

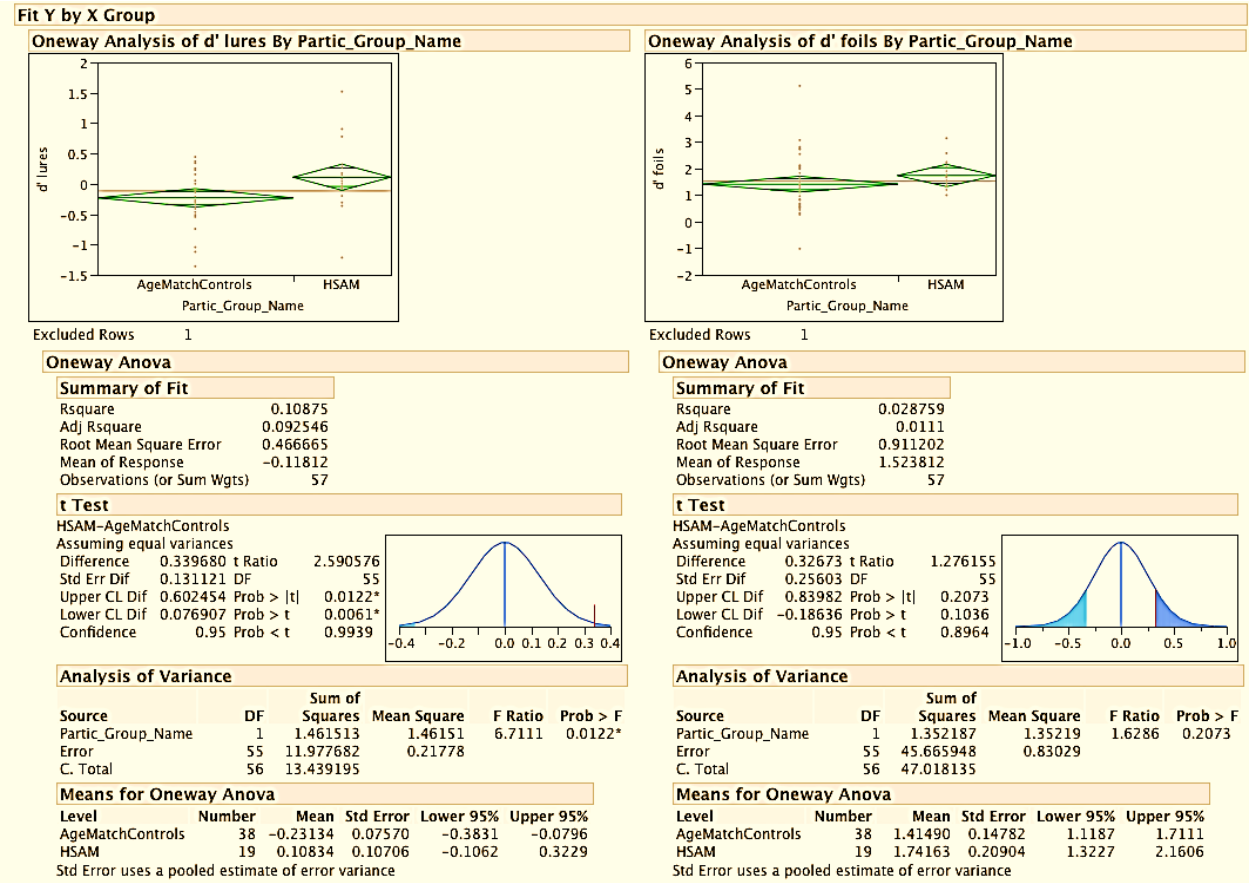

Figure 2.3. A signal detection analysis of DRM using critical lures as false alarms (left) and unrelated distractors as false alarms (right). Although HSAM participants and controls did not differ on overall rates of critical lure endorsement on the DRM task, signal detection analysis using *d'* indicated that HSAM individuals were in fact better able to discriminate between hits and critical lures. HSAM participants had significantly higher d' scores than controls, $t(55) = 2.59$, $p = .012$ (left; Cohen's $d = .70$; $r = .33$). Using the unrelated distractors as false alarms (right), there is no difference in discrimination between HSAM individuals and controls.

We next compared HSAM individuals to controls on their false-recognition rates of the five most emotionally arousing critical lure words, and on the five least arousing critical lures.

This analysis revealed no significant differences between HSAM participants and controls [emotional: $t(55) = -0.39$, $p = 0.699$, $d = .11$; neutral: $t(55) = 0.17$, $p = 0.870$, $d = .05$].

After completing the DRM test, participants were asked "how motivated were you to do well on the memory task you just completed?" with a 7 point Likert scale with two anchors: 1 =

Not Motivated at All to Perform Well on the Memory Task and 7 = *Extremely Motivated to Perform Well on the Memory Task*. We found no differences between HSAM participants (M = 5.15, *SD* = 1.42) and control participants (M = 5.32, *SD* = 1.40) on this self-reported motivation measure, $t(56) = .43$, $p = .671$, $d = .12$.

Discussion

This study documents the first investigation into the DRM false memory task with participants who have superior memory. We found that there were no differences in rates of critical lure endorsement between HSAM and control participants. However, in a signal detection analysis we found that HSAM participants were better at discriminating presented words from critical lures. The difference between the *d*' scores in control and HSAM participants equates to an approximate effect size of Cohen's *d* = .7. Compared to the Cohen's *d* = 25 between HSAM and control participants on the measure for superior autobiographical memory (10 Dates Quiz), this is a relatively smaller effect. The difference at discriminating the presented words from critical lures seems to be due to the fact that HSAM participants were better at recognizing the presented words, rather than having lower rates of false recognition of the critical lures (see Figure 2.1).

It is difficult to interpret this apparent slight superiority in recognizing presented words because HSAM participants have not *consistently* shown superior memory in non-autobiographical laboratory memory tasks (see LePort et al., 2012). It may be that HSAM individuals have slightly elevated ability to recognize presented words as an indirect spin-off of having strong memory in the autobiographical domain. But why, then, do they not have fewer false recognitions of words? One speculation is that the slight advantage they have recognizing presented words is negated by their presumably enhanced ability to make associations. In the

case of the DRM task, making associations may produce false recognition of critical lures, whereas in the autobiographical domain it may help in accurate recall. Another plausible explanation is that they were more motivated to do well in the DRM task, compared to the controls. In which case, such motivation could have led to elevated attention and processing during the word presentation. However, though this is a possibility, we found no differences between HSAM and control participants on a self-reported measure of motivation to perform well on this memory task.

As noted in Chapter 1, HSAM individuals, unlike memory mnemonists, tend not to use mnemonic techniques to help them to remember long lists of words, cards, or numbers. It is hardly surprising, then, that HSAM participants are fairly similar to controls on a word list task like the DRM. It remains to be seen, however, whether people who do practice mnemonic techniques, such as people who compete in memory championships, would be less susceptible to false memory in the DRM task. Researchers are investigating this question, although the results have not been published yet (H. L. Roediger, personal correspondence, October 1, 2014).

Finding susceptibility to associative memory errors in HSAM individuals tells us something important about how their memory works. In effect, it rules out a possible plausible explanation as to why their autobiographical memory is so accurate. It seems unlikely, given our results here, that their memory works in a fundamentally different way in terms of semantic associations and spreading activation of related items. Evidently their memories are not photographic for a certain type of episodic visual event and instead it is likely that the words activate semantic structures that help store the gist of a given list. This associative gist remembering may actually be *helpful* to HSAM individuals in categorizing and storing aspects of autobiographical memory, and may in turn help the individual then recall accurate details.

However, the possibility of errors that can come about in some cases from the associative semantic grouping mechanism become apparent in tasks like the DRM.

The DRM task has been criticized as not being ecologically valid in that is doesn't mimic the real-life occurrences of false memory (e.g. see Pezdek and Lam, 2007). The advantage of the DRM task, though, is its high internal validity and high level of experimental control. A task that is considered to be more applicable to real-life situations is the misinformation paradigm. The misinformation paradigm has the advantage, relative to the DRM, of involving richer stimuli that often mimic realistic scenarios, such as witnessing a crime and later undergoing suggestive questioning to remember the details. We examine the misinformation effect in HSAM individuals in the next chapter.

Chapter 3: Classic Misinformation Experiment

Another approach of examining false memories is called the "misinformation" paradigm (see Loftus et al., 1978; Loftus, 2005). A typical misinformation paradigm involves a three-phase process. Participants initially view an event stimulus (usually photographs or a video) and are later presented with some misleading information about the event. When subsequently tested, they are asked to report their memories of the original stimulus. Often, participants incorporate the misinformation presented at the second phase into their memories of the original event. This is typically taken as evidence that the source of some acquired information can be confused with the original event, called a source monitoring error (Johnson, Hashtroudi, & Lindsay, 1993) and that memories are reconstructed. The misinformation paradigm, as with other memory distortion paradigms and some basic memory research, show that episodic memories are reconstructed, rather than recorded. This research has important theoretical implications related to the fundamental way that memories work, but also practical implications in the legal system and clinical psychology which at times have both sought to retrieve important memories (eyewitness testimony in court, for example) that could be vulnerable to post-event suggestion. Because post event information can be experimentally manipulated, and because the original stimuli mimic real-life visual stimuli, the misinformation effect paradigm, relative to other paradigms, has a balance of both good internal and good external validity.

Loftus and Palmer (1974) was one of the first studies to exhibit some of the elements of the misinformation effect phenomena. It involved an original event (a video of a car crash), post event information embedded surreptitiously into questions (words that might be suggestive of the car having a different speed), and a memory test for details of the car crash.

The finding revealed that those who received a question that suggested that the cars “smashed” into each other were more likely to remember broken glass, even though no broken glass was shown in the video. Those who read that the cars “smashed” into each other also recalled the speed of the crash as higher compared to those told the cars “hit” each other, even those everyone saw the same video. In that study, the wording given to the participant influenced how they remembered seeing the original event.

The effect of post event information on the memory of the original event was researched further in what would become known as the misinformation paradigm. An early example of a misinformation experiment was the well-known stop and yield sign study by Loftus, Miller, and Burns (1978). In this study, participants saw a series of slides of an automobile accident, including a critical slide involving a stop sign or a yield sign. Some participants were later exposed to misleading information about that slide (e.g. that the car was stopped at a yield sign when in fact the participants had actually seen a stop sign). The post event misleading information led to higher rates of memory errors, with the researchers suggesting that the verbal misinformation was incorporated into the visual memory of the original event. This impairment in memory after misleading information is now called the misinformation effect, and has been replicated many times since then.

Another example of a misinformation experiment was done by Powers, Andriks, and Loftus (1979) in which college students looked at a series of photographs depicting a theft of a wallet. One day later, they read a version of the incident that for some of them contained misleading information about certain objects in the scene. Finally, a test was administered to measure the extent to which the misleading information was incorporated into the subject's

recollections. Results showed those assigned to the misinformation condition had significantly more memory errors than those who did not receive misinformation.

More recently, as one of many other examples of a misinformation experiment, Okado and Stark (2005) showed participants photograph slideshows, 8 sets of various scenarios such as someone breaking into a car or someone having a series of interactions with their opposite-sex partner. First the 8 slideshows were shown, with a 3500ms exposure for each slide. In the next session, the participants saw the slideshows again, but this time some participants were exposed to slides that differed from the original set, and this constituted the misinformation in this experiment. The final test phase participants were asked what they remembered of the original slideshow, and given one of three choices the original item (correct answer), the misinformation item (false memory), or a third unrelated foil item. Results showed that those given misinformation indicated a false memory of the original slideshow, and a source monitoring test indicated a substantial majority of these incorrectly believed they saw the misinformation in the original slideshow photographs.

Misinformation and Memory Ability

The question most relevant here is whether people with better memories have less (or more) false memories in the misinformation task. This might shed light on how we might predict people with superior memory might perform on a misinformation experiment. It seems reasonable that general memory may lead to increased susceptibility to source-monitoring errors, especially given the relationship between working memory and the DRM task discussed in the introduction to Chapter 2. In the misinformation paradigm, too, higher working memory has been found to be associated with lower (but nonzero) false memory rates. For example, Jaschinski and Ventura (2002) performed a misinformation experiment

with 38 students, using a video clip from a film as the event, and by supplying misleading information in the form of text later on. They confirmed a significant misinformation effect, and then found that working memory was negatively related to false memory. Zhu et al. (2010) found a similar relationship; this time with a larger sample of 557. Working memory was assessed by presenting characters and using the 2-back technique (see Owen, McMillan, Laird, & Bullmore, 2005). Working memory was significantly negatively correlated with Overall False Memory (false memories produce at first memory test) with an effect size of r = -.17 (accounting for 3% of the variance in Overall False Memory). For Source-Confirmed False Memory, r = -.13 (about 2% of variance). This indicates that although those with high working memory are less susceptible, this difference is relatively slight.

There is some evidence, then, that greater working memory ability is associated with fewer false memories following misinformation. However, working memory differs greatly from autobiographical memory, the type of memory in which HSAM individuals excel. This raises the question: what research has been done on the relationship between measures of autobiographical memory accuracy (excluding autobiographical false memory studies, which are discussed later) and false memory resulting from misinformation? One problem is that it is relatively difficult to measure autobiographical memory accuracy, and most of the literature in this area does not address verified accuracy (e.g., Piolino et al., 2006; Bluck, Alea, Habermas, & Rubin, 2005; Pillemer, 2003). The methodological problem is verifying a detail from the participants' past. However, Barclay and Wellman (1986) used a longitudinal design over a period of 2 ½ years that allowed them to somewhat overcome the verification problem (see also Linton, 1975; Wagenaar, 1986; Merckelbach, Wessel, & Horselenberg, 1997). Flashbulb memory studies about news stories also are able, at least for some basic news-related details,

verify the accuracy of the participants' reports (e.g. Brown & Kulik, 1977; Winograd & Killinger, 1983). As mentioned in Chapter 1, LePort et al. (2012; see also Parker et al., 2006) described alternative ways to measure autobiographical accuracy. However, there appears to be no published study that assesses whether verified autobiographical memory accuracy would be associated with more or less false memories in a classic misinformation experiment. This dissertation addresses this apparent gap in the literature.

For clues as to whether HSAMs might be more or less susceptible to the misinformation effect, we can look at the relationship between autobiographical false memories and misinformation false memories. Assuming that autobiographical accuracy has some overlap with autobiographical memory errors, this may be useful in forming a hypothesis. In a within subjects design whereby each subject participated in both a news event and a misinformation task, Patihis (2012) found that false memories of news-event footage did not correlate with false memories in a misinformation experiment. This held true whether the semi-autobiographical false memory was induced by suggestion or an imagination exercise. It appears that none of the false memory studies involving impossible autobiographical memory studies (such as space alien abduction and past lives; see DRM introduction Chapter 2) used a classic misinformation paradigm. Therefore there are only a few practical clues to help us form a hypothesis.

Given the small, but significant, effect of working memory, and due to the lack of a significant relationship between autobiographical false memory and misinformation (Patihis, 2012), we might expect those with better autobiographical memory to have fewer false memories. However, due to the magnitude of HSAMs ability—for example, being 25 *SD*'s above the mean for controls on the 10 Date Quiz—we might expect any slight differences to

be magnified. Combine this with HSAM individuals reporting rather vivid detail of visual images, it is possible that they may be better at remembering the visual images at the event stage of the misinformation paradigm. If this event stage depicts a story narrative (as does autobiographical memory) they may encode that phase more strongly than controls. Therefore, the fact that the misinformation paradigm has two encoding events (the original event and the misinformation phase) it complicates formation of hypotheses. This is because it is difficult to predict which of the two stages will be most strongly encoded by HSAM individuals. However, because HSAM individuals may generate stronger episodic visual memory traces that would be more resistant to misleading information later, it is possible that HSAM individuals will be less susceptible to false memories in the misinformation paradigm. If HSAM individuals are less susceptible to false episodic memories, it may explain why their memory accuracy is so good in the autobiographical domain. In effect, less malleable episodic memory would help explain the phenomenon of HSAM.

Method

Participants

As described in more detail in Chapter 2, participants were 20 HSAM individuals and 38 age and sex-matched controls.

Materials and Procedure

The misinformation-effect paradigm materials used were those that had worked well in previous research (Okado & Stark, 2005; Patihis, 2012). These materials involve two slideshows of 50 photographs each, depicting stories of two nonviolent crimes. The first photographic slideshow depicted the stealing of a purse, and the second depicted a man breaking into a car and stealing items (see Appendix B). Each photograph was presented on screen for 3500ms. About

40 minutes later, participants were shown two text narrative of these events but they contained six instances of misleading information. Each narrative consisted of 50 sentences that were shown onscreen for 5500ms. About 60 minutes after the original photographs were shown, there was a recognition memory test followed by a source-of-memory test.

Participants were randomly assigned into one of two groups, Group A or Group B. Group A received 6 items of misinformation that differed from the six items of misinformation received by Groups B. In this design, Group B served as the control group on Group A misinformation items, and Group A served as the control group on Group B misinformation items (Appendix B).

Filler tasks between each phase included individual difference measures that are discussed in more detail in Chapter 5. Of most note in this chapter are the individual differences absorption (see Appendix J for materials) and fantasy proneness (Appendix K). General aspects of the procedure that were not specific to the misinformation effect were described in Chapter 2.

Results

On this misinformation task a statistically significant misinformation effect was observed (in both groups A and B). Exposure to misinformation caused participants to incorporate that information into their memory for the original stimulus at significantly higher rates than those who were not exposed (Figure 3.1 below).

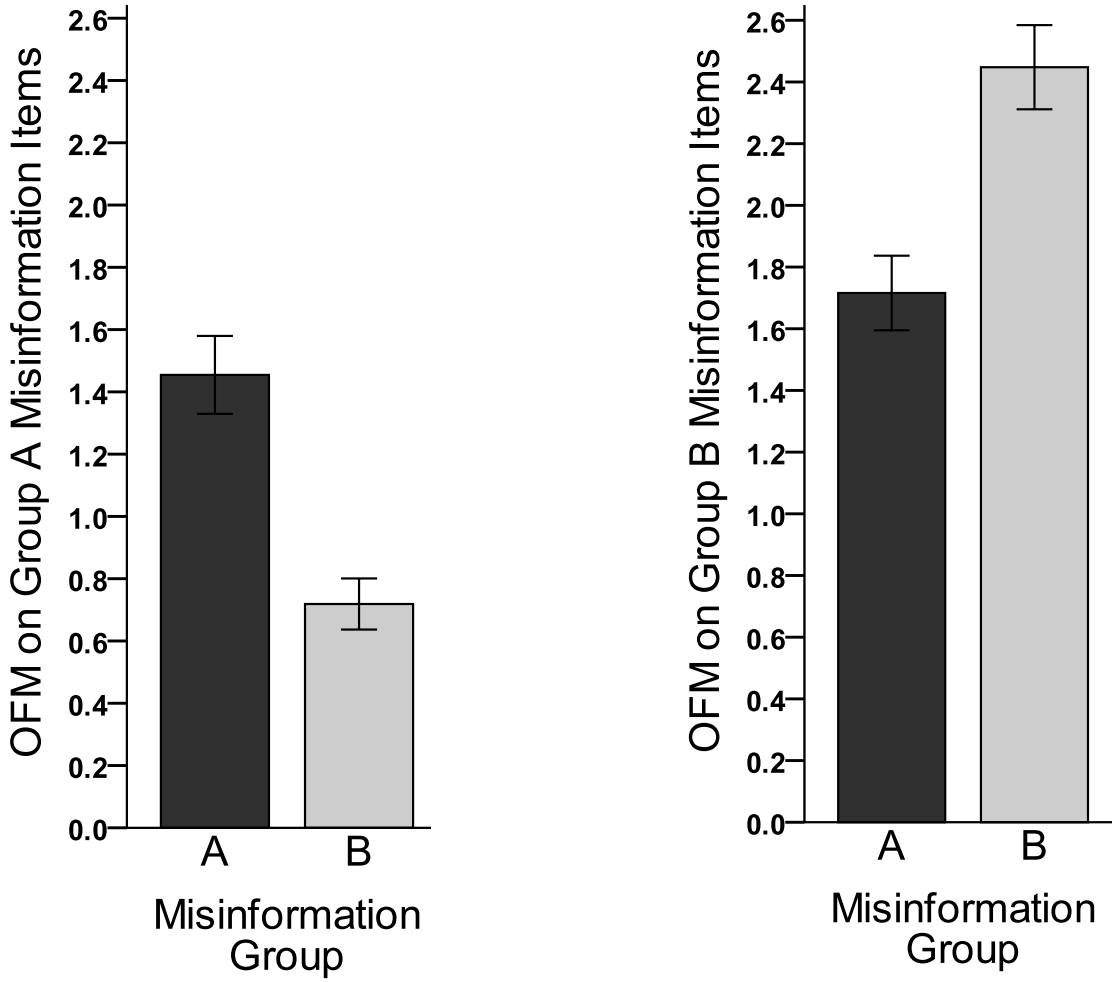

Figure 3.1. The classic misinformation effect experiment replication for Overall False Memory: The misinformation paradigm involved the random assignment of participants into one of two groups, A and B. Group A received misinformation on a different set of six items than Group B, such that each group served as a control group for the other on six items, and as the experimental group on another 6 items. Both Group A items and Group B items replicated the classic misinformation effect (p's < .01). Group B items had a stronger effect overall—so for other comparisons we removed the variance (noise) due to this difference by creating a z-adjusted (group-mean centered z-score calculated within each Group A and B) measure for Overall False Memory (OFM_z) and Source-Confirmed False Memory ($SCFM_z$). This adjustment was taking into account in the main analysis, but had no effect in most of the statistical tests. Error bars represent standard errors.

We quantified the misinformation false memories by two metrics. Consistent with prior research (Zhu et al., 2010), Overall False Memories consisted of trials in which the participant chose the misinformation version during the memory test (e.g. pants pocket; Figure 3.2C).

Source-Confirmed False Memories consisted of trials in which the participant further confirmed during the source test that he or she explicitly remembered seeing the image in the original photographic slideshow (Figure 3.2D). Contrary to being immune from false memories on this test (Figure 3.2E), HSAM participants (M = 2.65, SD = 1.53) had significantly more Overall False Memory than controls, (M = 1.92, SD = 1.10), $t(56) = 2.09$, $p = .041$, $d = .55$. There was no reliable difference in the Overall False Memory score between those HSAM individuals with the highest autobiographical ability (PEQ; M = 3.00, SD = 1.56) and the other HSAM participants (M = 2.30, SD 1.49), $t(18) = 1.02$, $p = .320$, $d = .46$ (Figure 3.2G; OFM_z marginal p value: $t(18) = -1.74$, $p = .098$, $d = .78$). HSAM participants (M =.95, SD = 1.10) and controls (M =.92, SD = 1.08) showed similar Source-Confirmed False Memory scores (Figure 3.2F; $t(56) = .19$, $p = .848$, $d = .03$) and the difference between the two sets of HSAM participants did not reach statistical significance (Figure 3.2H; High PEQ: M = 1.30, SD = 1.16; Low PEQ: M = 0.60, SD = 0.97; $t(18) = -1.47$, $p = .160$, $d = .65$).

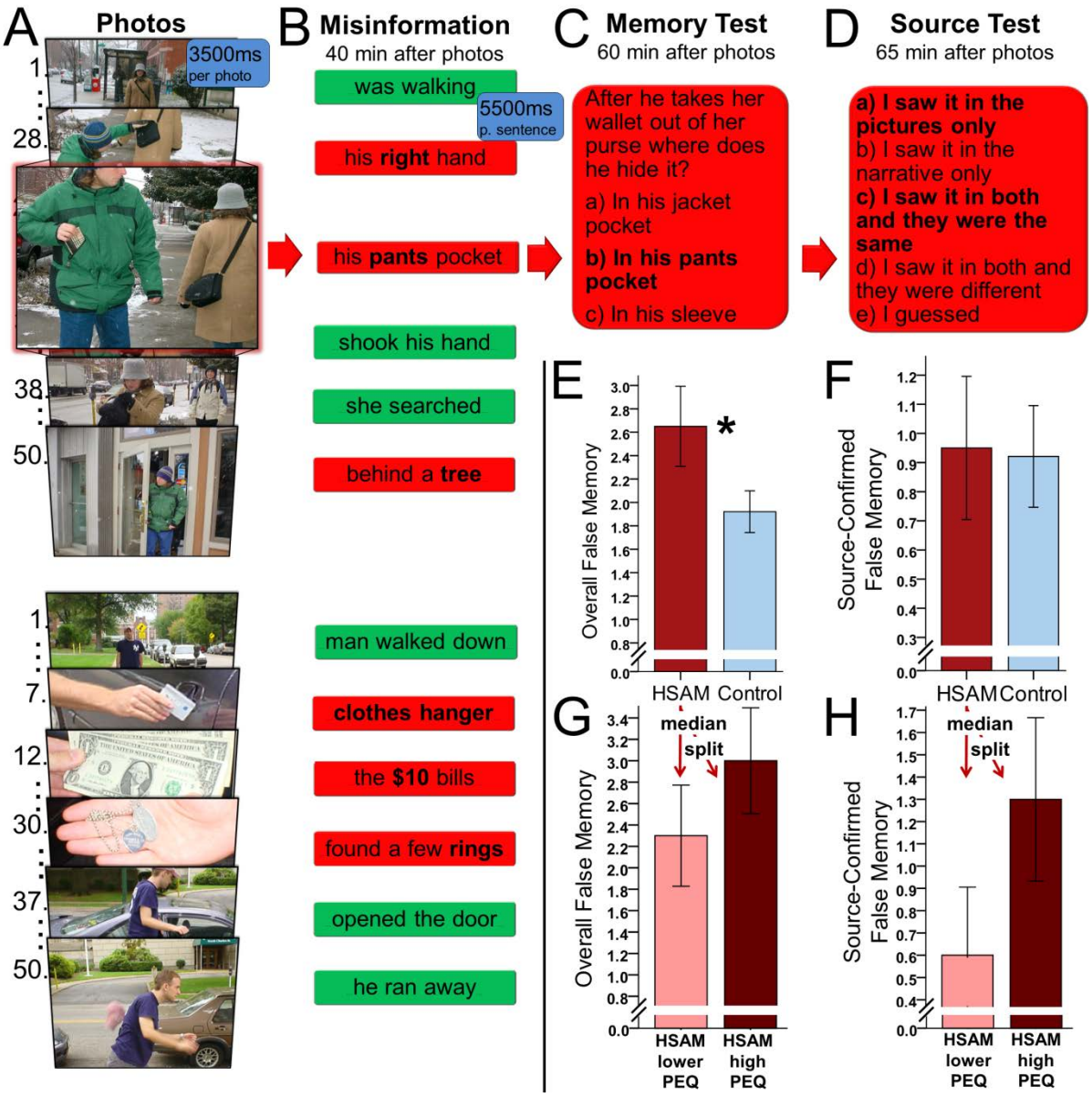

Figure 3.2. The misinformation paradigm materials and results. (*A*) Participants saw two events that unfolded in slideshows consisting of 50 photographs each. The first event featured a man stealing a wallet from a woman while pretending to help, and the second event showed a man breaking into a car with a credit card and stealing $1 bills and necklaces. (*B*) Later, participants read two narratives consisting of 50 sentences each, with 6 items of misinformation (in red) surreptitiously placed in amongst the 94 true sentences (green). (*C*) In the memory test: picking the misinformation consistent response is counted as an Overall False Memories. (*D*) In the source test, if one also indicates it was seen in the photos it is counted as a Source-Confirmed False Memory. The y-axis gives the mean number of false memories. (*E*) HSAM participants had significantly higher Overall False Memory than controls, and (*F*) about the same Source-Confirmed False Memory. There were no statistically significant differences on either Overall False Memory (*G*) or Source-Confirmed False Memory (*H*) between those HSAM individuals who scored highest on the Public Events Quiz (PEQ) and HSAM participants who had lower

PEQ scores. Time intervals between *A*, *B*, *C*, and *D* are approximate. Error bars represent standard errors.

Together, these results indicate that the HSAM group exhibited false memories in the misinformation paradigm. The HSAM individuals with the best autobiographical memory were just as susceptible to developing false memories as HSAM participants with lower scores on the PEQ.

Absorption and Fantasy Proneness

Because the result that HSAM participants had significantly more Overall False Memory than controls was unexpected, an analysis was performed to attempt to better understand this result. We compared HSAM individuals to controls on individual differences measures that could indicate a strong tendency to attend to and visualize the misinformation narratives. Indeed, we found that on the measures of absorption (Tellegen Absorption Scale; TAS) and fantasy proneness (Creative Experiences Questionnaire; CEQ) HSAM participants were significantly higher than controls. The absorption measure captures "openness to absorbing and self-altering experiences" (Tellegen and Atkinson, 1974; p. 268) while the fantasy proneness measure involves the tendency to have vivid childhood memories and fantasize in a way that feels real (Merckelbach, Horselenberg, & Muris, 2001). Adjusting for these measures in a multiple regression eliminated the statistically significant difference between HSAM individuals and controls on Overall False Memory (Table 3.1, below).

Table 3.1

Hierarchical linear regression with Overall False Memory as the predicted measure. Does the difference between HSAM participants and controls on Overall False Memory remain statistically significant when adjusting for fantasy proneness and absorption?

	Model 1			Model 2			Model 3		
	b	SE(*b*)	β	*b*	SE(*b*)	β	*b*	SE(*b*)	β
Group (HSAM 1, Control 0)	**.53**[a]	**.22**	**.30**	.44[b]	.24	.25	.35[c]	.25	.20
Fantasy proneness (CEQ)				.03	.02	.17	.002	.03	.01
Absorption (TAS)							.01	.009	.23
Constant	-.08	.13		-.32	.23		-.81	.50	
F(*df*)	**5.44 (1, 56)**			**3.57 (2, 55)**			**1.85 (3, 54)**		
ΔR^2	.09			.03			.02		
R^2_{adjusted}	.07			.08			.09		
$VIF_{\max}$	1.00			1.11			2.71		

Note. [a] $p = .023$. [b] $p = .07$. [c] $p = .17$. Statistics in **bold** are statistically significant at $p < .05$. $VIF_{\max}$ = largest Variance Inflation Factor in a given model. CEQ = Creative Experience Questionnaire. TAS = Tellegen Absorption Scale. On the measures of absorption and fantasy proneness of HSAM individuals were significantly higher than controls. CEQ: $M_{\text{HSAM}} = 11.3$, $SD = 4.5$, $M_{\text{control}} = 8.1$, $SD = 4.8$, $t(56) = 2.42$, $p = .019$. TAS: $M_{\text{HSAM}} = 90.4$, $SD = 19.9$, $M_{\text{control}} = 72.6$, $SD = 16.9$, $t(56) = 3.57$, $p = .001$. First row: Model 1 mimics the Overall False Memory *t*-test between HSAM participants and controls, while Models 2 and 3 show that that the significant difference between HSAM individuals and controls goes away when adjusting for fantasy proneness and absorption, with absorption having the biggest effect (see β's in Model 3).

Memory Accuracy for Slides without Misinformation

Five questions at the test phase asked questions about slides in the original slideshow that no participants were given misinformation about later. This allowed us to assess general memory accuracy. Summing the correct answers for these 5 questions, there was no significant difference between HSAM individuals (M = 4.00, *SD* = .795) and control participants (M = 4.29, *SD* = .768) on this memory accuracy measure, $t(56) = 1.35$, $p = .183$, $d = .37$.

Self-Reported Motivation

After completing the misinformation task, participants were asked "how motivated were you to do well on the memory task you just completed?" with a 7 point Likert scale with two

anchors: 1 = *Not Motivated at All to Perform Well on the Memory Task* and 7 = *Extremely Motivated to Perform Well on the Memory Task*. We found no differences between HSAM participants (M = 5.30, *SD* = 1.46) and control participants (M = 5.92, *SD* = 1.22) on this self-reported motivation measure, $t(56) = 1.73$, $p = .090$, $d = .46$.

Discussion

In the misinformation effect experiment, we found that HSAM participants had significantly more Overall False Memory than controls. This result indicates that HSAM participants, like others, are vulnerable to source monitoring errors when remembering pictorial stimuli, namely confusing one source (photos) from another (text narratives). To better understand this result, we compared HSAM individuals to controls on individual differences measures that could indicate a strong tendency to attend to and visualize the misinformation narratives. Indeed, we found that on the measures of absorption and fantasy proneness HSAM participants were significantly higher than controls. The absorption measure captures "openness to absorbing and self-altering experiences", and the fantasy-proneness measure involves the tendency to have a vivid imagination and fantasize in a way that feels real. Adjusting for these measures in a multiple regression eliminated the statistically significant difference between HSAM individuals and controls on Overall False Memory (Table 3.1). This analysis raises the possibility that absorption accounts for some of the reason that HSAM participants had more Overall False Memory. One can speculate that the explanation could be that a deeper involvement or visualization during the misinformation narratives led to a strong encoding of the misinformation. Strong encoding of the misinformation narratives, relative to event encoding, could have led to higher Overall False Memory rates.

The results for Source-Confirmed False Memory were less pronounced, with no statistically significant differences between HSAM and control participants. This narrowing of false memory susceptibility between groups using source-test questions is also found when comparing younger to older adults (see Roediger & Geraci, 2007; Wylie et al., 2014; cf. Bulevich & Thomas, 2012), and when comparing women taking oral contraception to naturally cycling women (Petersen, Patihis, & Nielsen, in press). Therefore, care should be taken before concluding that the differences between groups should be disregarded because they disappeared after a source-test. The memory report without a source-test has traditionally taken as the measure of false memories in the misinformation paradigm. This also corresponds somewhat with real-life questioning that usually does not involve source test questions. For these reasons, one could argue that HSAM individuals did show higher susceptibility in the misinformation effect paradigm despite the reduction in such differences after a source-test.

One interesting question is whether HSAM individuals were more motivated than control participants to do well on memory-related tasks, and that this might explain differences in memory on the misinformation task. Perhaps surprisingly, we found a marginal result in an unexpected direction: control participants reported being slightly more motivated. One might have expected HSAMs to report being more motivated. What is clear is that this self-reported measure of motivation does little to help explain why HSAM individuals might have encoded false information more during the misinformation phase.

Memory accuracy for slides shown at the presentation stage, that subsequently were *not* subject to misinformation, was similar in both HSAM and control groups. This sheds doubt on the possibility that the reason that HSAM had higher false memory was due to weak encoding

during the presentation stage. This reinforces the hypothesis stated earlier that the difference could have been due to encoding differences at the *misinformation* stage.

In summary, and as alluded to earlier, the higher Overall False Memory scores in HSAM individuals could be partially due to greater imaginative absorptive visualization during the misinformation narratives. Such tendencies were at least partially captured by the personality constructs fantasy proneness and absorption. Alternative explanations such as motivation or encoding at the presentation stage did not stand up to statistical analysis. If indeed tendencies toward imaginative absorption do lead to higher false memory rates in people who nevertheless benefit from better memory in other ways, it may be worth investigating whether such tendencies somehow paradoxically hurt and help memory. This is congruent with Merckelbach's (2004) finding that fantasy prone individuals created richer stories of both true and false childhood experiences. I explore these questions further in Chapter 5.

Chapter 4: Semi-autobiographical Memory Distortions

When assessing the susceptibility of HSAM individuals to memory distortions, it seems self-evident that autobiographical types of distortions should be investigated. To compare HSAM to control individuals it would be ideal to choose an autobiographical event that is common to every participant. We also need to know with a high degree of certainty whether the event occurred or not. Without the ability to verify the details of some autobiographical events (such as weddings, first day at school), a useful alternative is to use news events that would hold some personal meaning to people. One such nationally important event is that of the terrorist attacks of September 11, 2001 (9/11). By using such an event as the target, we know with some certainty which news events did and didn't take place. We also can be sure that most or all participants experienced the news event. These are important foundations to establish in false memory research. In this chapter, semi-autobiographical memory distortions are investigated surrounding the 9/11 news story in three different ways. The three techniques used for semi-autobiographical memory distortion were nonexistent news footage (also known as the "crashing memory" paradigm), imagination, and memory for emotion. Suggestion and imagination were used to inflate confidence in the participants that they had seen footage of the actual crash of United 93, whilst how the participants felt about 9/11 in the week following the attack was the target for the memory for emotion distortion task.

Non-existent News Footage

In the non-existent news footage paradigm, participants are falsely told that there is news-footage for a well-known news event (see Crombag, Wagenaar, & Van Koppen, 1996).

The event chosen by researchers has often been a crash, but has also involved news stories about other types of upsetting events such as bombings and assassinations (e.g. Smeets, Telgen, Ost, Jelicic, & Merckelbach, 2009). Participants are asked whether they remember the footage in a way that strongly implies that such footage exists. Surprisingly high proportions of participants typically report having seen the nonexistent footage (ranging from 7% to 66% in 18 various studies; see Patihis, 2012) and many report details (between 5% and 45%), which perhaps indicates a *memory* rather than just a *belief* they had seen it. This paradigm has close parallels to real-life traumatic memories that are otherwise either impossible to study due to ethics concerns or difficult to interpret due to uncertainty as to whether the reported event actually occurred. These studies show us that false memories created by post event information are possible for potentially traumatic events, such as news stories of important disasters, and not just confined to word lists or misinformation-effect laboratory studies that sometimes present relatively neutral visual stimuli. The non-existent news footage paradigm has arguably less experimental control than the DRM and misinformation paradigms, but relatively high external validity.

In one of the first crashing memory studies, Crombag et al. (1996) told participants there was videotape of a widely reported Boeing 747 crash into an apartment building in Amsterdam. Although the actual plane crash had not been filmed, 55% in Study 1 and 66% in Study 2 of the participants reported seeing the footage and many reported details of its contents. In a similar type of study Ost, Vrij, Costall, and Bull (2002) asked participants if they had seen footage of the car crash in which Princess Diana was killed, and 44% reported they had. No footage of this crash actually exists. A memory characteristic questionnaire (MCQ) was administered to get detailed information about whether the memory was vivid, or whether it was just a belief without

imagery. The MCQ scores did not reliably distinguish between the false memories and the true memories. False memories looked similar in nature to true memories.

Other researchers have since replicated this remarkably high rate of false recall of nonexistent news footage. Granhag, Stromwall, and Billings (2003) found that 55% of respondents reported that they saw footage of a well-known incident involving a sinking ferry, and again no video recording actually exists. Similarly, Wilson and French (2006) asked participants to recall the details of a total of five news events, only four of which have actual film footage, as well as recall the details of their whereabouts when the news footage was shown. In this case the non-filmed event was a bombing in a Bali nightclub, and 36% reported seeing footage.

Ost, Granhag, Udell, and Hjelmsäter (2008) asked participants, 150 from Sweden and 150 from the United Kingdom, to complete questionnaires about the explosion of the No. 30 bus in Tavistock Square, London. United Kingdom participants were more likely to say they had seen nonexistent computer-generated image of the explosion, and nonexistent television footage of the explosion, compared to the Swedish participants. United Kingdom patrons who claimed to have memories of seeing the bus explode self-reported higher scores on the dissociative experiences scale.

Sjödén, Granhag, Ost, and Hjelmsäter (2009) asked 80 creative arts students and 80 other students of no preferred major if they had seen nonexistent footage of an attack on a Swedish foreign minister. They were then asked for more details of the footage if they answered yes. Although creative arts student did demonstrate more fantasy proneness, they were no more likely than the other students to exhibit false memories. Overall, 19% of the sample had false memories of the footage.

In summary, most of the published studies on the false recall of nonexistent news-footage have found that a large minority of participants not only reported having seen the video footage, but they were also willing to answer detailed questions about the video recordings. This is achieved through misleading information given to the participant. However, there is another way to distort semi-autobiographical memory: imagination.

Imagination Inflation

Research on imagination inflation (Garry, Manning, Loftus, & Sherman, 1996) has shown that guided imagery and suggestion can be used either to increase confidence that an unlikely event happened in a participant's personal past or to plant memories of entire events that did not happen. Sometimes these events are mildly upsetting in an attempt to mimic real-life situations where suggestions are made that something traumatic happened. A period of time between the original event, the imagination exercise (which involves details or events that did not occur), and the time of retrieval, allows the source information attached to a memory or imagining to fade which results in source confusion between the visualization of the real memory and the visual imagery. Such source monitoring errors (Johnson et al., 1993) do a good job explaining how imagination exercises can create memory distortions.

Garry et al. (1996) used a guided imagery exercise whereby the participants would close their eyes and imagine a number of relatively uncommon occurrences in their autobiographical past. For example, some of these events were getting into trouble for calling 9/11, getting stuck in a tree, and breaking a window with one's hand. They succeeded in inflating the confidence that these events had occurred in childhood. These are all events that could plausibly happen in some participant's life, so there is some uncertainty if they were false memories.

Goff and Roediger (1998; see also Thomas and Loftus, 2002) tried to deal with the problem that the target events could have actually happened, by having the participants in the first session actually perform some actions and more importantly *not* perform some other actions (e.g. breaking a tooth pick). Later they would go through a number of imagination exercises whereby they would imagine performing actions that they had not in fact performed. These imagination exercises did indeed lead some participants to belief they had performed actions they had not. The advantage of this paradigm is that there is more certainty that the target event did not occur. The disadvantage is that the target events are not autobiographical in the sense that they are not meaningfully related to the self nor one's life narrative—an important consideration for our study investigating HSAM. One other problem with this method is that it would be unethical to make the target event emotionally upsetting.

Due to the strengthening effect of emotion on consolidating memory (Cahill and McGaugh, 1995), it would most interesting to investigate whether HSAM individuals are susceptible to distortion from imagination of autobiographical events that are at least potentially emotionally arousing. To do this it would behoove us to overcome the three potential problems with previous imagination techniques mentioned above—that the target event may actually have happened, that the target is not autobiographical, and that the target does not mimic stressful stimuli. We can do this by picking a semi-autobiographical target event that certainly did not occur which was also potentially emotional—nonexistent footage of the United 93 plane crash on 9/11.

Memory for Emotion

Although there has long been good evidence that memory in general is reconstructed (see Bartlett, 1932; Loftus and Palmer, 1974; Loftus, 2005), up until recently there was a lack

of evidence about whether this is also true for memories of felt emotion. There is something particularly treasured about emotional memories, and it is particularly comforting to think that memory for our emotions are indelible and unchanging. Indeed, LeDoux, Romanski, and Xagoraris (1989) interpreted their neurobiological research on fear responses in rats as evidence for emotion's indelibility, maintained by feedback loops in the limbic system (see also LeDoux, 1992). There was some suggestion by these authors that emotional memories are stored permanently. This is also compatible with the first conceptualization of flashbulb memories, as reported by Brown and Kulik (1977), in which the idea was that highly consequential and emotional events had a "cut-print" effect: stamping in an enduring emotional memory.

Levine (1997) investigated the indelibility or inconsistency of emotion memory, and was one of the first to find that memory for emotions are reconstructed in a manner that is consistent with present reappraisals of the original emotion-eliciting event. In Levine's study 227 Ross Perot-supporters rated their initial emotional reactions (sad, anger, hope) 2 weeks after Perot withdrew from the 1992 presidential race. Perot reentered the race in October, and after a relatively good showing in the November elections, 147 of the same supporters recalled their initial emotion reactions to his withdrawal. Levine found that how the supporters evaluated Perot at the time of recall influenced their memory for their initial emotions after he originally withdrew. For example, those who stayed loyal to Perot overestimated how hopeful they were when Perot withdrew. Those supporters who left the campaign and then returned to support Perot underestimated their initial anger. Those supporters who turned against Perot underestimated how hopeful and sad they were when he withdrew (in comparison to those loyal and returning supporters). These results suggested that LeDoux (1992) and other

previous theorists may have been wrong when stating that the memories for the emotional significance of events are stored permanently. Levine's findings are more consistent with Ross' (1991) suggestion that emotions are partially reconstructed—much in keeping with the goal-based appraisal theory of emotions.

More recent studies have reinforced Levine's (1997) finding that memory for emotion is biased in the direction of current appraisals. For example, Levine, Prohaska, Burgess, Rice, and Laulhere (2001) found that memory for happiness, anger, and surprise following the jury verdict of O.J. Simpson changed in a way consistent with their appraisals of Simpson's innocence or guilt at the time of recall. In addition, Levine, Whalen, Henker, and Jamner (2005) found that those who appraised the September 11, 2001 attacks as having less impact (adolescents) showed a decrease in the recalled intensity of negative emotion over time, whereas those who reported more impact (parents) showed an increase. This is consistent with the aspect of appraisal theory that requires an event to be highly relevant to oneself and one's goals in order to elicit a strong affective reaction.

This chapter's study compares HSAM individuals to controls on memory distortion in the semi-autobiographical domain. By investigating whether suggestion or imagination can change the memory of some HSAM individuals, or not, we will get a better picture as to why their autobiographical memory appears so accurate. If they are susceptible to false memory on autobiographical target events, it could suggest that their accuracy (LePort et al., 2012) relies upon them having little misleading information or counterfactual imagination episodes in the years since the event. If HSAM individuals are not susceptible to autobiographical false memories that could help explain why they are so accurate in their domain of excellence. If we assume that everybody encounters inaccurate information about past events, or that everyone

imagines events that did not occur, then it could be argued that it is unlikely that people with the accuracy of HSAM would be susceptible to memory distortion in that same domain.

Similarly, we might expect HSAM individuals to be more consistent in remembering their past emotions because they seem to have an elevated ability in remembering events that have some meaning to them. Meaningful autobiographical memories, we might assume, induce some emotion in them that may enhance encoding and consolidation. How participants felt at the time of a national disaster could be considered autobiographical, and we might therefore expect HSAM individuals to be more consistent in their memory for emotion.

Method

Participants

As described in more detail in Chapter 2, participants were 20 HSAM individuals and 38 age and gender-matched controls.

Materials and Procedure

Suggestion of Non-existent News Footage. The United 93 plane crash in Pennsylvania on September 11, 2001 was used as the target news event, in which we suggested there was footage of the actual crash when in fact there is no such footage. We used wording that had worked well in earlier testing in the laboratory (experimental condition from Patihis, 2012), and participants completed both a computer-based suggestive questionnaire about their memory of the non-existent news footage (see Appendix C for materials), and an audio-recorded structured interview about 15 minutes later (Appendix D). In the computer questionnaire, subjects read that video of the crash exists and has been widely shown, and were then asked whether they had seen the footage. They were then asked to indicate details of the footage. This questionnaire is similar to the crashing memory manipulations of previous studies. They then proceeded to fill out a

Memory Characteristics Questionnaire (MCQ; modified from Johnson, Foley, Suengas, & Raye, 1988; Laney, 2006) regarding their memory for the video.

In the audio-recorded structured interview, the research assistant conducting the interview verbally clarified which event we were asking about, then repeated the suggestion about the video of the crash. The participants were then asked if they had seen the footage and whether they remembered any details contained in the footage. No such footage actually exists. In the interview, those participants who said "yes" they had seen the footage were then asked follow up questions about details. Those who said “no” were taken through the imagination exercise, described next.

Imagining Non-existent News Footage. A brief imagination exercise was undertaken with participants who had not initially said they had seen the footage. The exercise involved taking a few minutes to imagine what the footage "might have looked like.” Appendix D contains the instructions that were said to the participants as they imagined various aspects of seeing the footage. Following this exercise, participants were asked whether they might actually now be remembering the footage. This was done to obtain a measure of whether they had been swayed by the guided imagery exercise. Any increase in certainty of seeing this footage after the inflation exercise represented some effect of the imagination exercise on memory.

All interview recordings were independently coded by two research assistants. Coders categorized answers to “yes/no” type questions into three categories: “yes” (coded 1), “maybe/unsure” (coded .5) and “no” (coded 0). Inter-rater reliability was high for the first question asking if they had seen “that footage,” Cronbach’s alpha = .938. Cronbach’s alpha for the similar question asked after the imagination inflation exercise was .887. When a discrepancy

between two codings arose I listened to the recording, often with one or two research assistants present, and we resolved the discrepancy to the most accurate coding.

Memory for emotion. We also asked participants to report how often they experienced several negative emotions in the week following the 9/11 attacks. They reported this twice, once in Session 1 a week before any memory distortion tests were done, and again in Session 2 immediately after the computer questionnaire about United 93's crash on 9/11. This provided a measure of their consistency of their memory of emotions from one week to the next. The negative emotions used and the scale is given in Appendix E. The scale was anchored from *1 = never* to *10 = all the time*. A mix of negative emotions was chosen such that it allowed us to group them by type. These types included post-goal emotions, such as sadness and grief, where there was a perception of an irreversible loss of a goal; and pre-goal emotions such as anger and frustration in which a blocked goal is perceived to be still attainable.

Results

Suggestion of Non-Existent News Footage

In the nonexistent news footage paradigm, we examined the tendency of HSAM participants and controls to report having seen the nonexistent plane crash footage in the computer questionnaire. See Figure 4.1 for both a summary of the materials and the main results. Figure 4.1D shows that in the computer questionnaire, 20% of HSAM individuals reported that they had seen the footage and 29% of controls reported that they had seen it, a difference that was not statistically significant (Fisher's Exact Test, $p = .541$, Cramer's V = .10). There were also no statistically significant differences in the number of false details remembered from the footage (Figure 4.1E) between HSAM participants ($M = 1.20$, $SD = 1.40$) and controls ($M =$

0.68, *SD* = 1.02), $t(56) = 1.61$, $p = .113$, $d = .42$. These results, when combined, suggest comparable susceptibility to false memories in the nonexistent news footage paradigm.

The nonexistent news footage interview provided a more conservative measure of false memory than the computer questionnaire. Even in these interviews, we found both the HSAM group (Figure 4.1F) as a whole and the most capable HSAM individuals (Figure 4.1G) had non-zero susceptibility to semi-autobiographical false memories. Using a 2 (HSAM, control) x 3 ("yes," "maybe," "no") Fisher's Exact Test, we found no evidence for a difference in susceptibility (Figure 4.1F; $p = .608$, Cramer's V = .13). Comparing those HSAM individuals who scored highest on the Public Events Quiz (PEQ), to those HSAM participants with lower PEQ scores (Figure 4.1G) yielded a similar non-significant result (Fisher's Exact Test $p = .721$, Cramer's V = .34). Excerpts from transcripts of a HSAM and control participants demonstrating these false memories are given in Appendix M.

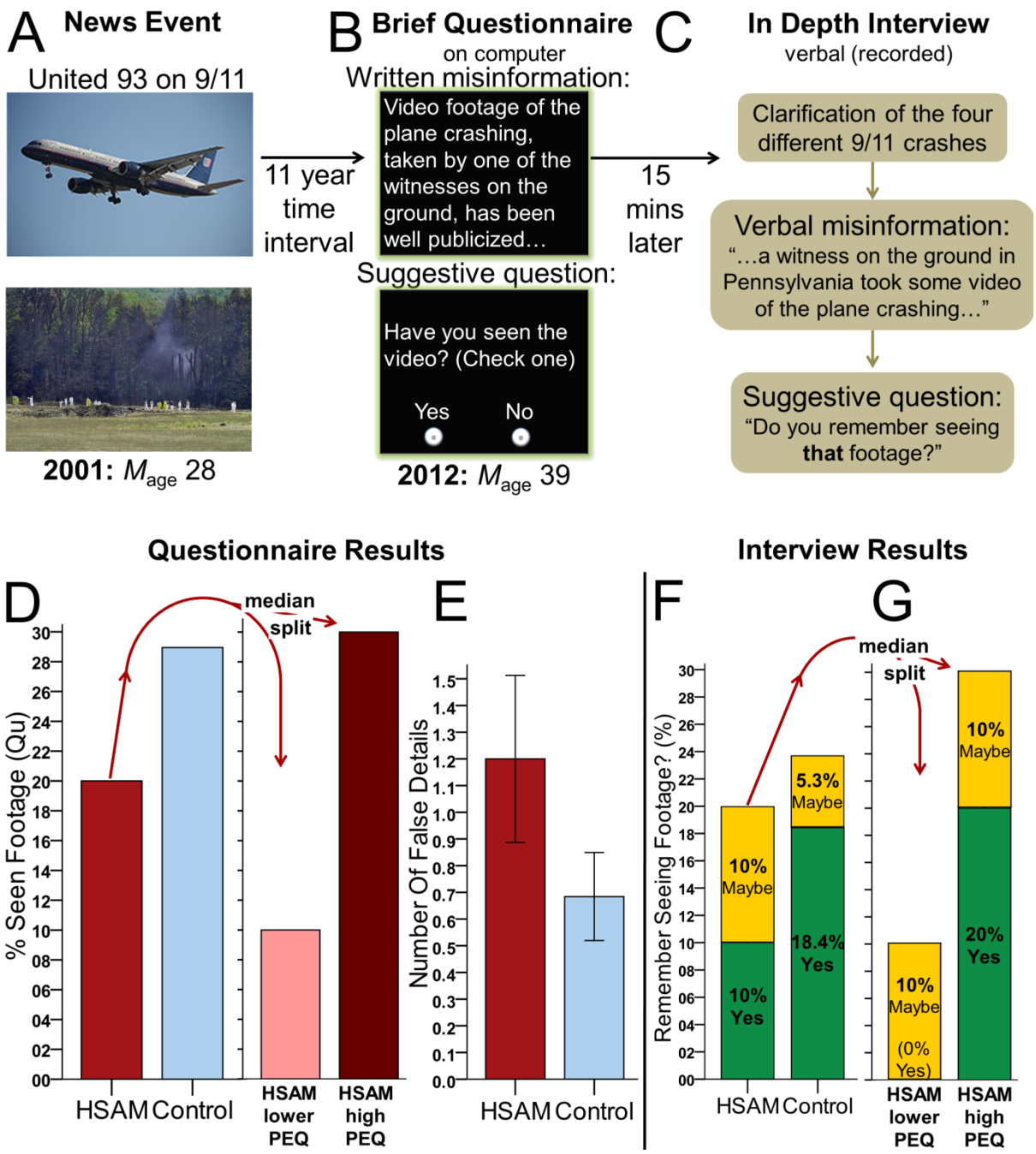

Figure 4.1. Materials and results of the nonexistent news footage paradigm. (*A*) The target news event is the crash of United 93 in Pennsylvania. (*B*) The computer questionnaire stated that footage of the actual crash exists and asked participants to check whether they have seen the footage. (*C*) Later an in-depth interview carefully explained what we were asking about, and asked them if they had seen that footage. (*D*) In the computer questionnaire 20% of HSAM individuals and 29% of controls indicated they had seen the footage. A median split of HSAM participants on the Public Events Quiz (PEQ) revealed 30% with higher PEQ scores indicated "yes" they had seen the footage, and only 10% with lower PEQ scores did so. (*E*) The number of false details (out of a possible 4) indicated HSAM individuals were not statistically significantly

higher than controls (p = .11). (*F*) In the interview 10% of HSAM participants and 18% of the controls said yes they had seen the footage, and (*G*) a median split revealed that the highest scoring HSAM individuals on the PEQ were no less susceptible than those HSAM participants lower on the PEQ. Error bars represent standard errors.

Imagination of Non-existent News Footage

We also found susceptibility to memory distortions using the imagination technique in both HSAM individuals and controls—with no evidence for enhanced resistance to distortion in the HSAM group. Figure 4.2 shows the increase in certainty of having seen the footage increase in HSAM participants (M = .21, SD =.44) was not statistically different from controls (M = .22, SD = .36), $t(45) = -.09$, $p = .928$. A 2 (HSAM, control) x 3 (no inflation, some inflation {e.g. from "no" to maybe"}, full inflation {from "no" to "yes"}) categorical analysis found no significant differences between HSAM individuals and controls on susceptibility to imagination inflation (Fisher's Exact Test $p = .544$). About 17% of HSAM individuals and 10% of controls flipped from saying "no" they hadn't seen the footage before the guided imagery to "yes" after the imagination exercise. Approximately 62% of HSAM and 60% of control participants answered consistently before and after the imagination exercise. Although it is difficult to rule out the possibility of demand characteristics, our measure of change after the imagination exercise was not associated with social desirability in this dissertation study nor in previous work with larger samples (Patihis, 2012; ps > .05).

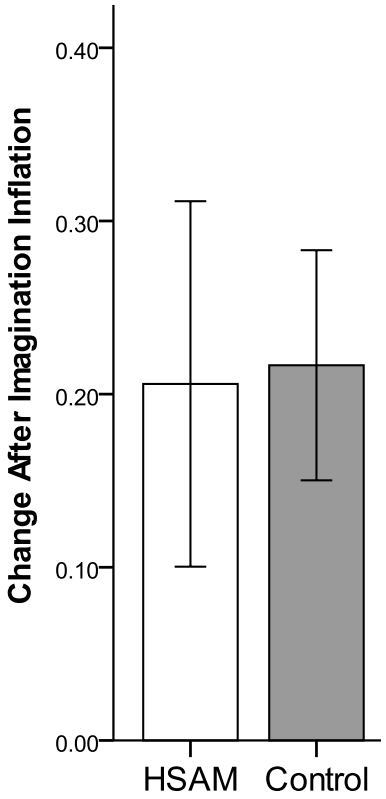

Figure 4.2. Imagination exercise results: The mean change in certainty (from before the imagination exercise to after) of having seen the nonexistent crash footage of United 93. "Yes" was coded 1, "maybe" coded .5, and "no" coded 0. Error bars represent standard errors.

Median Split within HSAM Individuals. Figure 4.3 shows that those HSAM individuals who scored higher on the 10 Date Quiz (a measure of HSAM ability) were no less susceptible to distortion from the imagination exercise, compared to those HSAM participants who scored relatively lower on the 10 Date Quiz (High PEQ: M = .22, SD = .44; Low PEQ: M = .19, SD = .46; $t(15) = .16$, $p = .876$, $d = .07$.

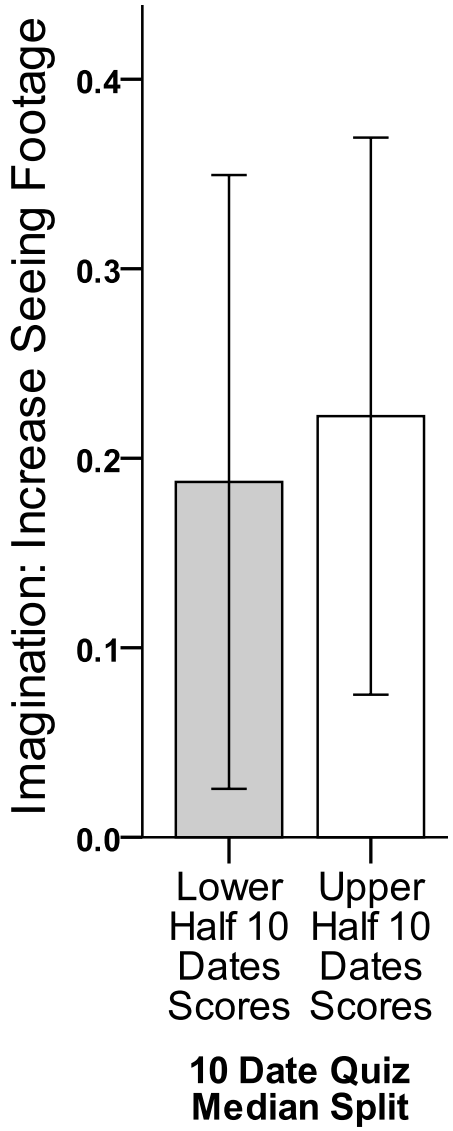

Figure 4.3. A median split of HSAM participants by their 10 Date Quiz score: a comparison of change in imagination of non-existent news footage measures. This comparison was not statistically significant. Error bars represent standard errors.

Inconsistency in Memory for Emotion

As illustrated in Figure 4.4 (below) HSAM participants and controls had non-zero consistency, from Session 1 to 2, in their memory for how often they felt a number of negative emotions in the week following September 11, 2001. HSAM individuals were statistically significantly more consistent than controls at remembering post-goal emotions such as sadness

(left; M_{HSAM} = 0.70, *SD* = 0.98; $M_{control}$ = 1.29. *SD* = 1.09; *t*(56) = 2.03, *p* = .047, *d* = .57), but equally as inconsistent in their memory for pre-goal obstructed emotion such as anger (right; M_{HSAM} = 1.05, *SD* = 1.00; $M_{control}$ = 1.18, *SD* = 1.29; *t*(56) = 0.41, *p* = .687, *d* = .11). Post-goal negative emotions are those elicited by a goal that has been thwarted in the past, whereas pre-goal negative emotions are responses to obstacles to a goal that is nevertheless perceived be still attainable in the future.

In a secondary analysis ignoring relatively small changes of 1 point on the Likert scale, and counting only changes of 2 points or more, HSAM individuals and controls were statistically similar in their absolute emotion memory change on post-goal (M_{HSAM} = .85, *SD* = 1.01; $M_{control}$ = 1.22. *SD* = 1.19; *t*(56) = 1.17, *p* = .245, *d* = .34) and pre-goal obstructed emotion (M_{HSAM} = 1.08, *SD* = 1.31; $M_{control}$ = 1.16, *SD* = 1.33; *t*(56) = .23, *p* = .822, *d* = .06).

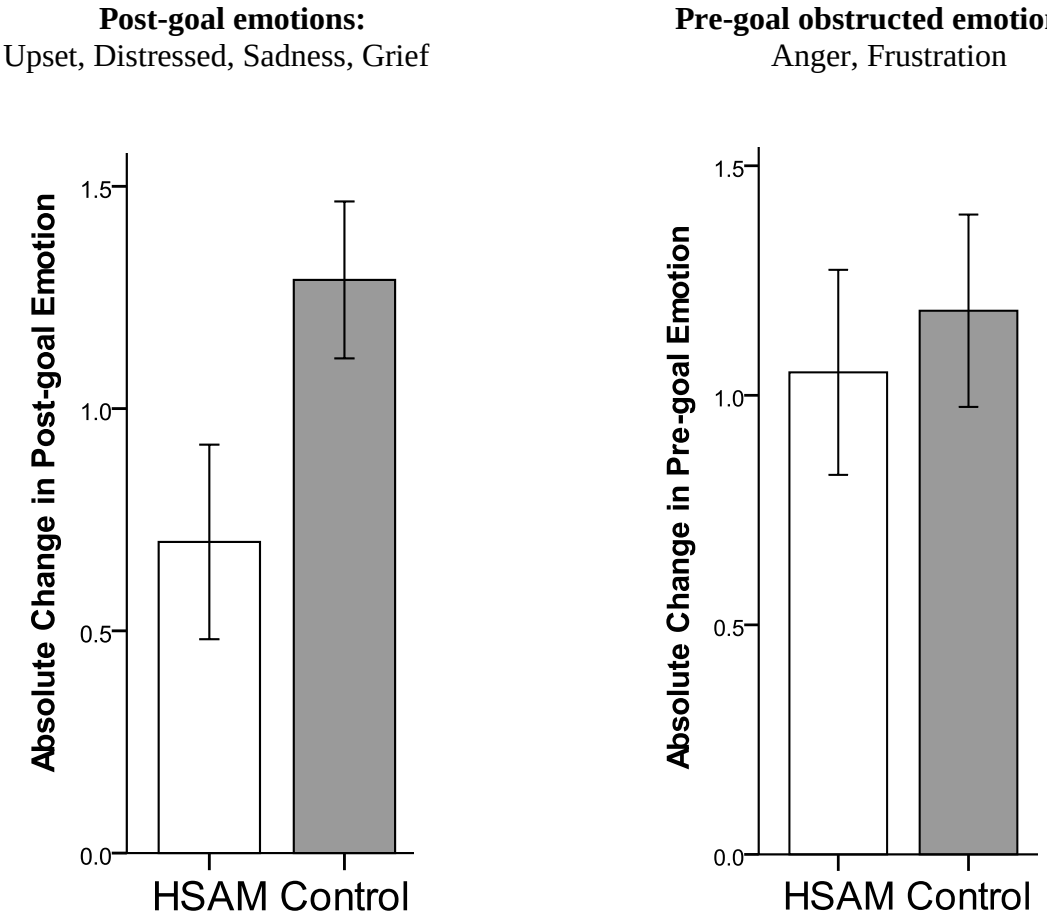

Figure 4.4. Memory for emotions felt in the week after 9/11: Inconsistency (change scores) from Session 1 to Session 2. Error bars represent standard errors.

Comparing Within HSAM Individuals. As shown below in Figure 4.5, those with the highest HSAM ability (as measured on the 10 Date Quiz) were not statistically significantly more consistent at remembering their emotions after 9/11 from one week to the next. This was true on both post goal (left; Low 10DQ: $M = 0.80$, $SD = 1.14$; High 10DQ: $M = 0.60$, $SD = 0.84$; $t(56) = 0.45$, $p = .660$, $d = .20$) and pre-goal obstructed negative emotions (right; Low 10DQ: $M = 1.00$, $SD = 1.05$; High 10DQ: $M = 1.10$, $SD = 0.99$; $t(56) = 0.22$, $p = .830$, $d = .10$).

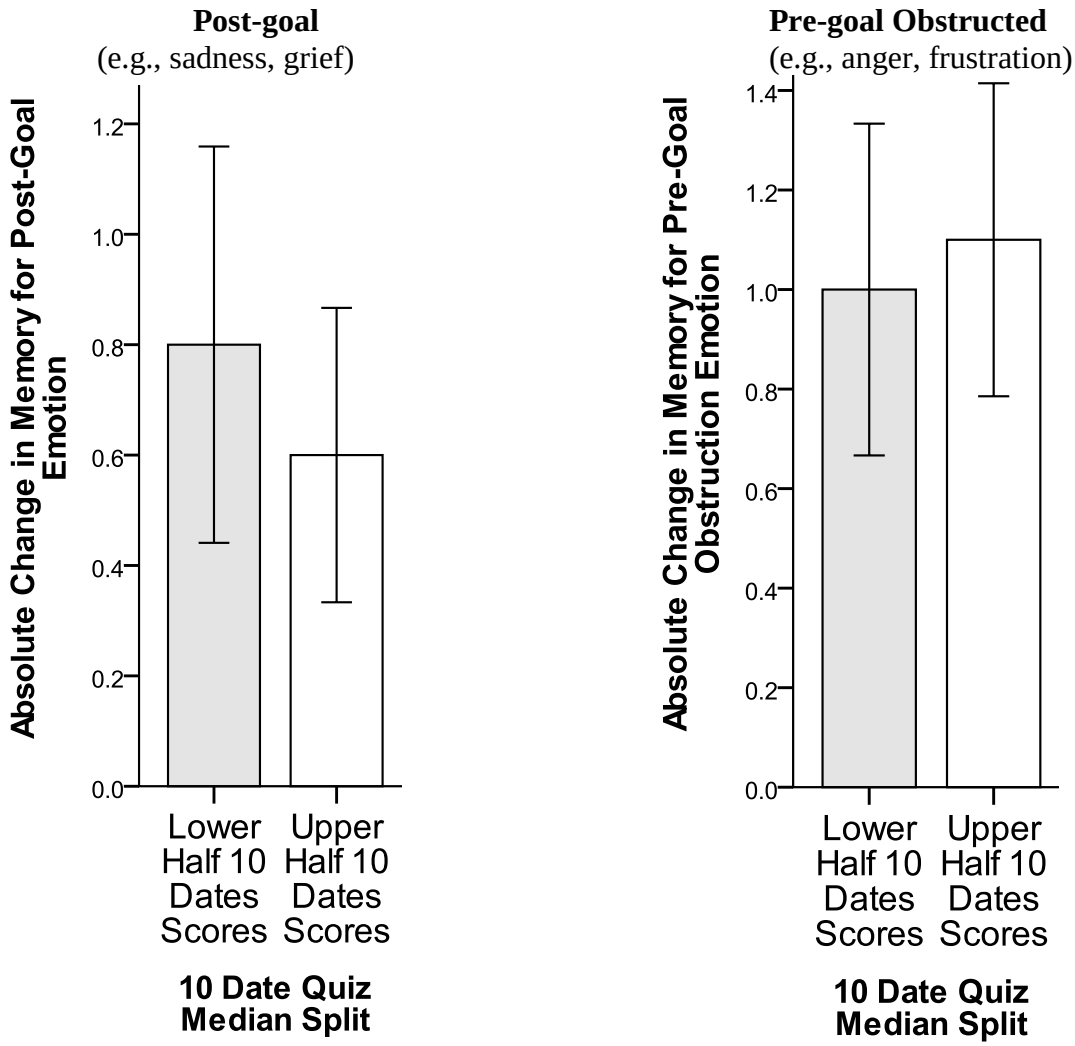

Figure 4.5. A median split of HSAM participants by their 10 Date Quiz score: a comparison of inconsistency in postgoal (left) and pregoal obstructed emotions (right). Error bars represent standard errors.

Discussion

Given HSAM individuals' extraordinary enhanced ability in remembering autobiographical memory, we might have predicted very little distortion in this domain. In fact HSAM participants were not reliably lower on most measures of autobiographical memory malleability. On susceptibility to suggestion of seeing nonexistent news footage for United 93, HSAM participants and control participants were about equal. This approximate equality is a

reasonable conclusion if one takes into account both false affirmations, in which controls were slightly but not significantly higher, and false details, in which HSAM individuals were slightly higher (*ns*). This is a surprising result because HSAM individuals excel in being given a random date and being able to recall significant news events from around that date. This raises the question as to why they are by far better at news event recall in the absence of misinformation, but similar to people with ordinary memory when false suggestion is introduced. One explanation could be that they are superior at encoding and consolidating new information, but about average in their ability to monitor the source of memories.

In the circumstance where no misleading post-event information is presented about a news story, HSAM individuals' advantage in recall can be simply accounted for by the idea that they have consolidated the original event better. Why they encode and consolidate better is speculated about in Chapter 5. In the more complex situation where misleading post-event *is* presented, there are two encoding stages. It may be that HSAM individuals encode and consolidate memories better not only at the time of the original news story, but also do so at the time at which the misinformation is presented. We might speculate, then, that HSAM individuals have two strong memory traces to distinguish between, whereas people with average memory have two weak memory traces. If HSAM individuals have about average source monitoring ability, they will have about the same rates of memory error as controls when trying to distinguish between two sources of information of about equal memory strength. The apparent paradox that HSAM individuals show between accurate news story recall, and yet inaccurate reports in the crashing memory paradigm, is clarified when one understands that the former involves a single encoding event, and the latter involves two encoding events.

The imagination exercise revealed that a similarly sized minority of both HSAM and control groups inflated their confidence of having seen the footage for United 93. This again demonstrates that general memory ability in a given domain, in this case for news events, is a different entity than susceptibility to distortion. A number of things may be going on in the imagination exercise results, though we can only hypothesize which explanation is correct. One possible explanation is that HSAM individuals may indeed have stronger event memory for 9/11, but they also, perhaps due to being higher in fantasy proneness, may visualize more vividly during the imagination exercise, and these two forces act in opposing directions, leading to apparently similar susceptibility to imagination distortion as controls. It may be the case that although HSAM individuals really do have stronger autobiographical memory, this is counteracted by their greater absorption into the imagination exercise.

The memory for emotion measure is the only autobiographical distortion measure to suggest that HSAM individuals might be marginally more consistent. For post-goal emotions, such as sadness, HSAM individuals were more consistent from one week to the next than controls, though not perfectly consistent. Such consistency in remembering one's negative emotions after a life event has been thwarted a goal might aid in the kind of accurate autobiographical memory that HSAM individuals report. However, on pre-goal emotions, such as anger, HSAM and control participants were equally inconsistent. HSAM participants may be less consistent on pre-goal emotions because the perceived ability to manipulate the goal can vary and cause current reappraisals. Whatever the reason for this pattern, it is clear that these moderate differences do not explain the tremendous differences in autobiographical memory ability in the two groups, suggesting that other possible explanations are needed. I propose and examine some alternative hypotheses in the next chapter.

Chapter 5: How are HSAM Individuals Different?

In order to understand why HSAM individuals have the ability they do, perhaps one can find clues by examining individual differences—how they differ from people without HSAM. What is different about HSAM individuals, compared to people with normal memory, that predisposes then (or perhaps causes them) to consolidate autobiographical memory so strongly? Below is a brief review examining whether there is any evidence of a relationship between an array of individual differences and autobiographical memory accuracy. Many of the individual difference measures chosen for consideration in this study have previously been found to be associated with some type of memory measure (accuracy or error measures), or are measures that potentially could be important from a theoretical standpoint.

This introduction will specifically hone in on research into specific individual differences that could be used to explain HSAM, or be ruled out as an explanation. It is not known, for example, if HSAM individuals are simply more likely to be excited about the personal events that happen to them—predisposing them perhaps to epinephrine release during and after the experience that then aids in the consolidation of memory. This "excitability" could take the form of anxiety, high reactivity to high-arousal emotions, or perhaps more emotionality towards others (e.g. empathy). In addition, it is not known whether HSAM individuals sleep more than people without HSAM, which could explain why consolidation of personal memories is stronger. In addition, it is not known the degree to which HSAM might be related to dispositional tendencies that have previously been linked to memory, such as absorption and fantasy proneness. These individual differences, and others, of this newly discovered group will be documented here in the research literature for the first time.

The field of autobiographical memory research is quite broad, as is the field of personality and emotion, so here the specific focus is on areas that might shed light on HSAM and the individual differences we measured. First, an imaginative absorption hypothesis of autobiographical memory consolidation in HSAM is examined. Later, an emotional arousal hypothesis and the sleep consolidation hypothesis of HSAM are outlined.

The Imaginative Absorption Hypothesis

Possible causes of HSAM could be personal dispositions and tendencies towards certain behaviors, i.e. personality factors, that could result in greater encoding and/or consolidation of autobiographical events. For purposes of clarity, tendencies to become emotionally involved in personal events are discussed in the later section on emotional arousal. Other tendencies, such as the disposition to pay close attention to new experiences or perhaps the tendency to fantasize about personal events, are discussed below.

Absorption. The "absorption" (Tellegen Absorption Scale; TAS) construct attempts to capture "openness to absorbing and self-altering experiences" (Tellegen and Atkinson, 1974; p. 268). Absorption, related to hypnotizability, is the "disposition for having episodes of 'total' attention that fully engage" perceptive and imaginative resources, and it results in a heightened sense of reality towards the object of attention (p. 268). The items used in the absorption scale are given in Appendix J, and include items such as "If I stare at a picture and then look away from it, I can sometimes 'see' an image of the picture almost as if I were still looking at it" and "If I wish I can imagine (or daydream) some things so vividly that they hold my attention as a good movie or story does." Openness to absorbing experience that impacts on the self (autobiographical) could be associated with deeper attentive processing of such experiences, and perhaps stronger autobiographical memory. Therefore, we might expect people with HSAM to

get absorbed in events that involve some connection to their self. Getting absorbed into new experiences, and altered by them, might be a recipe for encoding more autobiographical memory for longer.

However, absorption has been implicated with memory errors in previous research. For example a study by Eisen and Carlson (1998) found those scoring higher on absorption had more false memory from misinformation. Likewise, in Chapter 3 we found that absorption could be a mediator of false memory from misinformation in HSAM individuals, compared to controls. These findings could be explained by those higher on absorption visualizing the misinformation more, processing it more, and therefore encoding the misleading information well.

Platt et al. (1998) found that absorption was negatively correlated with a measure of autobiographical memory accuracy. Their measure of autobiographical memory involved asking participants where they were, what they were doing, and who told them, when they heard the news of the O.J. Simpson case. Participants were asked the evening of the verdict, and then again 6, 12 or 18 months later. Indeed, accuracy did falter with time, and this was especially true in those scoring high on absorption. Given the possibility disparity between the possibility that increased absorption and "total" attention towards new experiences might improve the encoding and consolidation of autobiographical memory, and studies that have shown absorption to be associated with memory errors, it will be interesting to see how absorption relates to performance in autobiographical accuracy measures in the present study.

Fantasy Proneness. The Creative Experiences Questionnaire (CEQ; Merckelbach, Horselenberg, & Muris, 2001; Merckelbach, Muris, & Rassin, 1999) is a measure of fantasy proneness (for earlier work on this construct see Lynn & Rhue, 1986; Wilson & Barber, 1982). The materials for the scale are given in Appendix K, and include items such as "Many of my

fantasies have a realistic intensity" and "I am never bored because I start fantasizing when things get boring." Fantasy proneness is a construct refers to the tendency to fantasize in a deeply imaginative way that can feel real. It is a construct used to explain hypnotizability, and has some overlap with the aforementioned construct absorption (Kihlstrom, Glisky, & Angiulo, 1994).

Of most interest here is that some studies have shown fantasy proneness to be associated with some types of memory errors. For example, Horselenberg, Merckelbach, van Breukelen, and Wessel (2004) found that participants higher on fantasy proneness (CEQ) were less able to discriminate real autobiographical events that they themselves had documented 6 months earlier from false events. Spanos, Burgess, and Burgess (1994) reported that fantasy prone individuals were more likely to produce detailed accounts under hypnosis of memories of past lives, which is surely indicative of memory error. Interestingly, though, in Merckelbach (2004) fantasy proneness was implicated in both memory accuracy and errors: fantasy prone individuals created richer stories of childhood experiences, on both true and fabricated stories. This latter finding could mean that there is a possibility that fantasy proneness, despite its association with memory errors, might actually be beneficial in remembering content for events for which no misleading information has been given. This might be possible if the fantasizing occurs in relation to actual life events that have just occurred. Given this, it will be interesting to see if fantasy proneness would help or hinder the type of autobiographical recall in which HSAM individuals excel.

The Emotional Arousal Hypothesis

Another possible explanation of HSAM is that enhanced emotional arousal helps encode and consolidate autobiographical memory. Perhaps HSAM individuals consistently have a more emotional reaction to autobiographical events, compared to people without HSAM. It is established that strong emotional arousal can help encode memory (Cahill & McGaugh, 1995)

and that one of the mechanisms for this is epinephrine that is released during the consolidation period following the event (in animals: Gold & Van Buskirk, 1975; and humans: Cahill & Alkire, 2003). Cahill and Alkire (2003) not only observed that post-event injection of epinephrine led to stronger performance in a memory test one week later, but they also observed that the emotional arousal at the time of encoding also enhanced memory. These findings, when combined with other findings pointing to a similar conclusion (e.g. Christianson & Loftus, 1987) indicate that emotional arousal at the time of the event, and afterwards, can strengthen memory. An important brain structure that is associated with enhancement of memory is likely the amygdala (Cahill et al., 1996). This is true not just for memory for lab stimuli—emotional autobiographical memory has also been associated with activation in the amygdala (Fink et al., 1996). In addition, Schmolck, Buffalo, and Squire (2000) found that autobiographical accuracy surrounding the O.J. Simpson verdict 32 months after the verdict significantly correlated with the strength of the participant's emotional reaction to the event. These findings suggest that anything that might increase emotional arousal during and after the event might be interesting measures to look at when comparing HSAM to control participants.

Anxiety. Anxiety involves a state of vigilance and unrest and nervous behavior without a clear actual threat being present. This excited state has been linked to epinephrine in that epinephrine administered to people can lead to anxiety and its physical feelings (Basowitz, Korchin, Oken, Goldstein, & Gussack, 1956; Breggin, 1964; Hosseini & Tadayon, 2013). Indeed Hosseini and Tadayon (2013) found a strong correlation (r = .85) between epinephrine and anxiety. So there is theoretical reason to hypothesize that anxiety, through the mechanism of epinephrine levels, may lead to strong consolidation of memory. If epinephrine levels are high during and after daily autobiographical events in highly anxious people, perhaps that could

explain people who remember most of their past. Combine this with preliminary data (LePort et al., 2012) that HSAM individuals tend to be high on a scale of subclinical obsession and compulsive tendencies, which are related to a disorder that is classified as an anxiety disorder (obsessive compulsive disorder; OCD), then there is further reason to investigate anxiety levels in HSAM individuals.

There has been little reliable research on autobiographical memory *accuracy* (for verified details) and trait anxiety. There has however, been research on other aspects of autobiographical memory and anxiety. For example, Burke and Mathews (1992) found that people with generalized anxiety disorder (GAD) recalled more personal memories when given a word that cued an anxiety evoking memory, compared to those without GAD. There has also been research that has shown that those experiencing more anxiety *about* an event (state anxiety as opposed to generalized trait anxiety) were more consistent in remembering flashbulb-type news event detail, such as 9/11 (Conway, Skitka, Hemmerich, & Kershaw, 2009; see also Er, 2003). From the studies above we might predict that HSAM individuals will have higher anxiety scores than controls and undergraduates, and that we will find a positive correlation between anxiety and autobiographical ability. Specifically, we might predict that somatic trait anxiety might be associated with superior memory if we were to assume that somatic experience of anxiety involves excitatory hormone (e.g., epinephrine) release and possibly enhanced encoding. One important caveat of this prediction is that it may be that *constant* high levels of anxiety (i.e. a trait in anxiety) may not lead to better autobiographical encoding in HSAM because each event may not stand out as *distinctive* from others.

Empathy. The relationship between emotion and enhancement of autobiographical memory could lead one to wonder if people who have deeper emotional experiences towards

others (empathy) might encode encounters with others better. Since much of autobiographical memory involves how others impact the self (e.g. weddings, family births and deaths, nationally important news events), it is possible that those high on empathy might remember such other-related memories better than those lower on empathy. One could imagine, for example, those people who empathize more with people who died in a plane crash on 9/11 might be more emotionally affected by it and subsequently remember the details more accurately later. Indeed, Robinson and Swanson (1990) wrote that the central function of autobiographical memory is to maintain and extend relationships, an ability that is also necessary for developing empathy.

To investigate this theoretical relationship empirically, Pohl, Bender, and Lachmann (2005) measured participants empathy (using the Interpersonal Reactivity Index; Davis, 1983) and utilized an autobiographical memory measure that asked whether and how well they remembered each of 8 personal events (e.g. 18th birthday) and 3 important news events (e.g. Chernobyl disaster). They found that autobiographical memory performance and empathy were positively related, r = .34. There was stronger relationship between autobiographical memory and empathy in women, compared to men. However, further research is warranted because there is some uncertainty whether the autobiographical memory reports that were scored in Pohl et al. were actually true—they were not verified. For the most part the autobiographic memory details were simply confirming whether the participants thought they remembered the event, and how well they remembered the event—very little of which could be verified. Nevertheless, this suggests a link between autobiographical memory and empathy that could be explored further with verifiable event details. Given the theoretical and limited empirical data one could tentatively hypothesize that we might find a difference in empathy between HSAM and control

participants, and perhaps even a positive correlation between empathy and autobiographical memory.

Emotional Detachment. As discussed above, there is a link between emotion and memory, and perhaps empathy and autobiographical memory. High empathy and low emotional detachment are similar, in that empathy is related to feeling for others and low detachment can also mean an emotional desire for others. However, they differ in that detachment can also mean how detached one feels towards life in general and/or events (rather than people). It seems possible that being detached from the meaningful events could impede the development and maintenance of autobiographical memory. The mechanisms for this could be a combination of a lack of an epinephrine surge during and after the personal event, and a lack of subsequent rehearsal of the subjectively meaningless event in detached individuals. Related to this hypothesis, Addis, Moscovitch, Crawley, and McAndrews (2004) used an emotionality scale that ranged from "detachment; no emotional experiences" to "intense emotional experiences," and found that those participants that scored lower on the scale (detached) had lower autobiographical memory detail ratings than those high on the scale (r = .54). Even though the amount of detail was self-reported and the details were not independently verified to have actually happened by the researchers, the study does, when combined with the other findings reported above, give reason to explore this relationship further.

High Arousal Emotions. In keeping with the literature discussed above on the relationship between emotional arousal and enhanced encoding of memory, it is possible that those people who react most strongly to an event on measures of high arousal emotions (e.g. those that report feeling stress, tension, and jumpiness) might develop better autobiographical memory for those events. Indeed, Talarico, LaBar, and Rubin (2004) found that emotional

intensity was their largest correlate of autobiographical memory measures. Emotional intensity was associated with higher self-reported recollections, vividness, and rehearsal of autobiographical memory. Although these autobiographical measures were not verified, research in the area of flashbulb events (where some of the news events are verifiable) reinforce the idea that emotion can enhance encoding strength (Brown & Kulik, 1977; Conway et al.,1994; Finkenauer et al., 1998; Luminet et al., 2004). However, it should be noted that even such flashbulb events are nevertheless subject to memory errors.

It is possible that if we compare people's emotional reaction on high arousal emotions *towards the same event* (for example 9/11) then the variation from person to person may partly reflect their tendency to emotionally react to semi-autobiographical events. Those with high emotional arousal could be more likely to consolidate a stronger memory trace of the event. It is also possible that they may also respond similarly to other autobiographical events with high arousal, and therefore have stronger autobiographical memory in general. HSAM individuals may have such strong memory because of a tendency to have high arousal emotions triggered on a daily basis. If emotion is one of the causal factors of strong consolidation in HSAM, we might predict that HSAM individuals will be higher on high arousal emotions.

The Sleep Consolidation Hypothesis

One final hypothesis is that sleep quantity or quality could be a partial explanation of HSAM. It is known that encoding and consolidation processes of memory can occur during sleep, and that sleep is helpful and necessary for the maintenance of normal memory (Stickgold, 2005; Stickgold & Walker, 2005; Walker & Stickgold, 2004). There are clues that sleep can improve memory recall, and that sleep deprivation can reduce memory accuracy. For example, participants taking a nap after the event stage of a procedural memory task had improved

memory accuracy after the nap (e.g. Mednick, Nakayama, & Stickgold, 2003). This is true not only with procedural memory, but also with declarative and episodic memory: several studies have found effects of sleep on memory accuracy (e.g., Dumay & Gaskell, 2007; Frenda, Patihis, Loftus, Lewis, & Fenn, 2014). Given these results, it seems likely that consistently getting enough quality sleep may lead to better memory for personal events. However, relatively few studies have investigated sleep and autobiographical memory specifically.

Murre, Kristo, and Janssen (2013) is one of the few studies to investigate the relationship between autobiographical memory accuracy and self-reported naturally occurring sleep quantity and quality. Participants were initially asked questions about an autobiographical event that had happened recently, and then at a later date they were tested on memory for those details. The initial reports, taken less than 6 days from the event, were taken as being the more accurate of the two reports, and deviations at the later time points were taken to be inaccuracies. They found that sleep *quality* was associated with autobiographical memory performance at longer intervals (4–6 weeks) but not at shorter retention intervals (less than 2 weeks). Sleep *quantity* was not associated with memory performance. The quality of sleep may therefore help the deep consolidation of autobiographical memory over a period of many weeks. This is interesting because HSAM individuals outperform people with average memory much more on tasks involving longer term memory than shorter term memory (see LePort et al., 2012).

This consolidation process therefore is important in forming lasting autobiographical memories, but it remains to be seen whether sleep quantity of quality is a pathway through which HSAM individuals gain their enhanced memory ability. It is possible that HSAM individuals sleep more on average; and that would help explain, at least in part, their enhanced memory. However, the other possible pathways to greater memory, many of which are discussed in this

dissertation, could explain the phenomena without sleep differences. For example, it may be that emotion arousal or rehearsal are causal factors in HSAM, and sleep consolidation will turn out to be not a causal pathway. In this study, we investigate whether measures of sleep vary between HSAM individuals and controls, and whether sleep is associated with autobiographical memory ability within the HSAM group. We will not only look at sleep quantity, but look at variables that may indicate sleep quality, such as the number of awakenings during the night.

Intelligence and Rationality

Given their superior cognitive ability in one domain (autobiographical memory), it would be interesting to see if HSAMs are comparable to controls on other cognitive ability measures such as intelligence and rationality measures (e.g., critical thinking & flexible thinking). Rationality measures, such as critical thinking and flexible thinking are designed to measure cognitive abilities that are sometimes missed by intelligence tests (see Stanovich, 2009). Critical thinking refers to an unbiased evaluation of evidence and arguments through reasoning, whereas flexible thinking refers to actively open-minded thinking with little impulsivity, avoidance of confirmation bias, and the willingness to change one's beliefs in the face of disconfirming evidence (Stanovich & West, 1997). If HSAM individuals have strictly domain-specific enhanced memory ability, they may have similar scores to control participants on intelligence, critical thinking, and flexible thinking. There is a possibility that their enhanced cognitive ability comes at a cost at some other mental ability. This is possible because in some past cases of superior memory, for example in autistic savants (Peek & Hanson, 2008), enhanced memory in one domain comes with deficits in other cognitive abilities. However, in some savant cases they performed excellent in another domain, such as mathematical calculation. Other people with high memory ability, such as some mnemonists, seem to have no such deficit in cognitive ability, and

in some domains they had high ability. For example Hunter (1977) described a superior memory individual who was also highly intelligent and good at mathematical calculation. Indeed, even the HSAM-like case reported by Henkle's (1871) was reported to be able to perform extraordinarily at mathematical calculation. If there are any severe cognitive deficits or advantages in other cognitive domains in HSAM individuals, none have yet been identified (LePort et al., 2012).

General intelligence (psychometric *g*) is strongly associated with working memory (e.g., Kane et al., 2004), and SAT scores (Frey & Detterman, 2004). Working memory could be peripherally important during the encoding stage of autobiographical memory, but it unclear from this whether intelligence and autobiographical memory ability would be linked. However, Williams, Williams, and Ghadiali (1998) found that those with higher intelligence produced higher autobiographical memory specificity. They used the Autobiographical Memory Test (Williams & Broadbent, 1986) which shows participants positive and negative words that act as cues for recall of autobiographical memory, and those reports are then coded for the number of specific memories produced. Since HSAM individuals also report higher specific autobiographical details than average, we might find that they too have higher than average intelligence.

It will be also interesting if HSAM individuals are higher or lower on other cognitive skills that are tangentially linked to intelligence. Although there appears to be little direct research on rational thinking and autobiographical memory accuracy, similar arguments to those given about for intelligence may also apply. Rationality measures such as critical thinking (West, Toplak, & Stanovich, 2009) and flexible thinking (Stanovich & West, 1997) could possibly reflect an ability to manipulate information using higher processes that are also used in memory.

Indirect clues the literature include the observation that memory impaired individuals had deficits in flexible thinking (Korsakoff, 1889/1996) and alcoholics had deficits in both critical thinking and memory (Khudik, 1984). Fletcher, Marks, and Hine (2011) found that working memory was reliably related to rationality. Though working memory is different than autobiographical memory, these findings could generate a tentative hypothesis that those with superior memory might have better flexible and critical thinking.

Summary. There are a number of possible pathways that could be associated with HSAM. These possible explanations include emotional arousal in experiences as they happen, deep absorption in new experiences, post-event fantasizing, heightened arousal in the consolidation period after the event, and greater consolidation during sleep. Ahead of time it is difficult to predict which of these might explain enhanced autobiographical memory, simply because HSAM may be a phenomenon that has more than one cause. In this article I search for clues for correlates with HSAM ability, by examining how individual difference measures vary between HSAM and control participants, and if they do how these measures vary with autobiographical ability within the HSAM group.

Method

Participants

Twenty HSAM individuals and 38 age- and gender-matched controls from the general public (± 4 years of age) participated (as described in more detail in Chapter 2).

Materials

Identification of HSAM. The identification of HSAM in the participants of this study was performed prior to the present study's data collection, and is described in Chapters 1 and 2. In the current chapter, the 10 Dates Quiz score is taken to be the best measure of HSAM ability,

as compared to the Public Events Quiz, for a number of reasons. One reason for this is the 10 Dates Quiz gives the participant the freedom to recall a public event they actually experienced within a month of a randomly chosen date. In the Public Events Quiz the potential confound is that the participant's did not hear about or experience the news story that the researchers ask about. In the Public Events Quiz the date is not randomly generated, rather it is prescribed by major new events in five categories. Whereas the 10 Date Quiz did not restrict news event categories, the Public Events Quiz did—and could partially reflect specific ability in one or more of the five categories, e.g. sports events. In contrast to the Public Events Quiz that involved only news events, the 10 Dates Quiz also measured participants' ability to produce a personal autobiographical event from a randomly selected date. For these reasons, in this study the 10 Dates Quiz is used in analyses as a measure of HSAM ability.

A brief summary of individual differences measures that may not be self-explanatory is given here. The Appendices provide further detail.

Absorption. The Tellegen Absorption Scale (Tellegen & Atkinson, 1974) was the scale used in our study to measure the disposition to become absorbed into new experiences. The 34 items on this scale are shown in Table 5.1 (see also Appendix J). Participants were asked to state how often various experiences happened to them, on a four point scale that ranged from *1 = never* to *4 = always*. Each of the 34 questions were summed to give the overall absorption score.

Fantasy Proneness. The Creative Experiences Questionnaire (Appendix K) consisted of 25 items related to the fantasy proneness construct. Participants answered "yes" (coded 1) or "no" (coded 0). The overall fantasy proneness measure was obtained by summing the yes responses together.

Synesthesia Subscale. The items used in a synesthesia subscale (from the Tellegen Absorption Scale; see Table 5.1) were: item 10 “Textures -- such as wool, sand, wood -- sometimes remind me of colors or music”; item 27 “Some music reminds me of pictures or changing color patterns; and item 33 “I find that different odors have different colors.”

Anxiety and Emotional Detachment Traits. The Swedish Universities Scale of Personality (SSP; Gustavsson et al., 2000; see Appendix F) was used to measure the subscale traits of psychic trait anxiety, somatic trait anxiety, and trait emotional detachment. Psychic trait anxiety is characterized by “worrying, anticipating, lacking self-confidence,” whereas somatic trait anxiety involves “autonomic disturbances, restless, tense” (Gustavsson et al., 2000; p. 219). Trait detachment is described as “avoiding involvement in others, withdrawn” (p. 219).

Empathy. The Basic Empathy Scale (BES; Jolliffe & Farrington, 2006; Appendix L) is a 20 item measure used to measure both cognitive empathy (“the capacity to *comprehend* the emotions of another”) and affective empathy (“the capacity to *experience* the emotions of another”; p. 589). Participants rated how much they agreed to various empathy-related questions on a 5 point Likert scale from *1 = strongly disagree* to *5 = strongly agree*. These scores were summed into sub-scores for cognitive and affective empathy.

High Arousal Emotions. In Session 1, participants rated how often they felt on each of the following high-arousal emotions: “Stressed”, “Tense,” and “Jumpy” in the week following the September 11th, 2001 terrorist attacks. The Likert-type scale ranged from *1 = never* to *10 = all the time*. These three items were summed to produce the overall score for high-arousal emotions.

Sleep Diaries. The sleep diary was a self-reported measure filled in every morning for one week. Items included the time participants went to bed and got up, the time it took to fall asleep, night-time awakenings, how long they slept, and daytime naps (see Appendix I).

SAT Scores. SAT scores were taken as a proxy measure of intelligence because they correlate highly with the psychometric measure for general intelligence *g* (Frey & Detterman, 2004; $r = .82$). It was a convenient and relatively cohort consistent measure to use because each subscale of the SAT test for all the participants had been normed around an average of 500 from 1972 to 2012 (College Board, 2014).The SAT total score was attained by adding the Math and Reading Subscales. A new writing subscale was introduced to the SAT in 2005 (College Board, 2014) so to keep scores comparable across age cohorts this subscale was not used when calculating the SAT total score.

Critical Thinking. Nine items that measure various aspects of critical thinking ability were compiled using West, Toplak, and Stanovich, (2009) as a guide. See Appendix G for the items and for further citations. These items involved multiple choice answers, and were scored 1 if correct, 0 if incorrect. The critical thinking score was the sum of those nine items.

Flexible Thinking. The Flexible Thinking Scale (FTS; Stanovich & West, 1997) was used as a measure to determine the degree to which participants have flexible and "actively open-minded thinking" (p. 342). The 10 items in this scale were rated on a scale from *1 = disagree strongly* to *6 = agree strongly*. Various items capture different aspects of flexible thinking, tapping into the following dispositions: reflectivity (4 items), willingness to consider evidence contradictory to beliefs (1 item), willingness to consider alternative opinions and explanations (2 items), and a tolerance for ambiguity and postponing closure (3 items). Appendix G documents the questions used in this scale.

Beliefs about Memory. Appendix H shows the items used to ask participants about how they think memory works (as used in Patihis et al., 2014).

Procedure

Subjects participated remotely at a place of their choosing (usually at their home on their own computer), with a research assistant connected to them via Skype video-chat or phone for the entirety of both Session 1 and 2. Participants were instructed to have the computer on a desk, and themselves be sitting on a chair. Researchers advised the participants before the study commenced on how to avoid distractions and interruptions. Individual differences measures were filled out in Session 1, and in Session 2. Sleep diaries were completed every morning for seven days in the week between Session 2. In Session 2 they also completed some memory distortion tasks as reported in Chapters 2, 3, and 4.

Results

In this exploratory analysis, how HSAM individuals differed from controls on a variety of measures was examined. Measures that showed significant or marginal differences on that first analysis were examined to see how they vary with HSAM ability (10 Dates Quiz).

Testing the Imaginative Absorption Hypothesis

Absorption. HSAM individuals had an average score of 90.4 on the Tellegen Absorption Scale compared to the control groups' mean of 72.6 (HSAM: *SD* = 19.9, 95% CI [81.7, 99.1]; Control: *SD* = 16.9, 95% CI [67.2, 78.0]). This difference was statistically significant, $t(56) = 3.57$, $p = .001$, Cohen's $d = .96$. This comparison is shown in Figure 5.1 below.

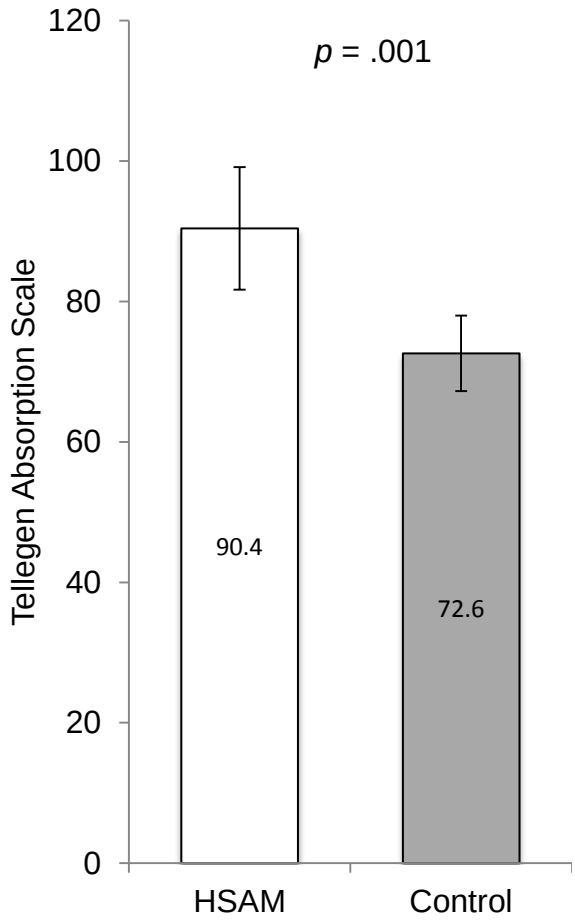

Figure 5.1. Mean scores on the Tellegen Absorption Scale in HSAM and control groups. The mean of the summed scores for absorption in HSAM participants was statistically significantly higher than control participants. Error bars represent 95% confidence intervals.

Finding this group difference prompted an analysis of the relationship between absorption and HSAM ability (as measured by the 10 Date Quiz) within HSAM participants. That relationship is shown in Figure 5.2 below.

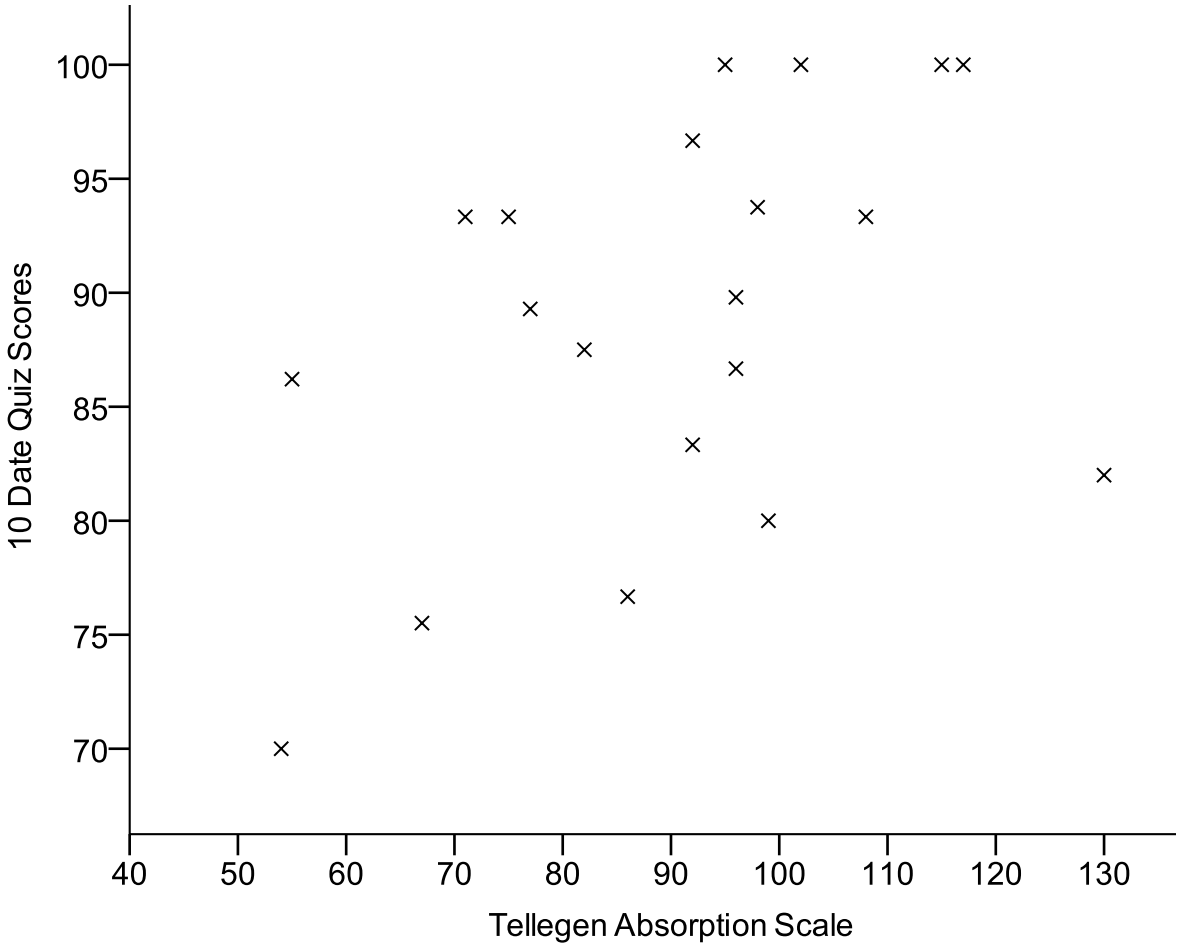

Figure 5.2. Within HSAM individuals: The statistically significant association between absorption and HSAM ability (10 Dates Quiz), Pearson r = .45, p = .047.

Fantasy Proneness. As shown in Figure 5.3 below, HSAM individuals scored higher on the creative experiences questionnaire (M = 11.25, SD = 4.85, 95% CI [9.13, 13.37]) compared to controls (M = 8.08, SD = 4.53, 95% CI [6.64, 9.52]), $t(56) = 2.42$, p = .019, d = .65.

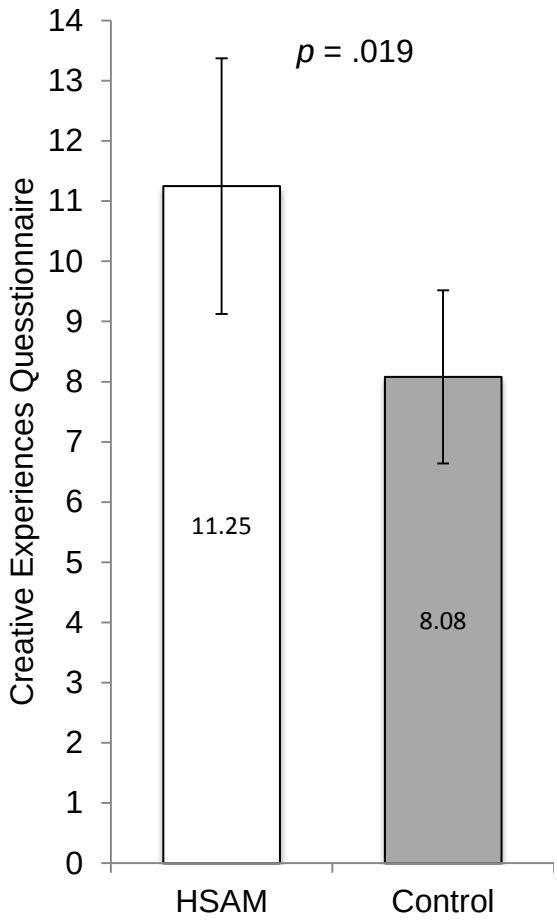

Figure 5.3. Mean scores on the creative experiences (aka fantasy proneness) in HSAM and control groups. The mean of the summed scores for fantasy proneness in HSAM participants was statistically significantly higher than control participants. Error bars represent 95% confidence intervals.

Finding this group difference prompted a further analysis of the relationship between fantasy proneness and HSAM ability within HSAM participants (see Figure 5.4 below). We found a statistically significant positive correlation between fantasy proneness and HSAM ability.

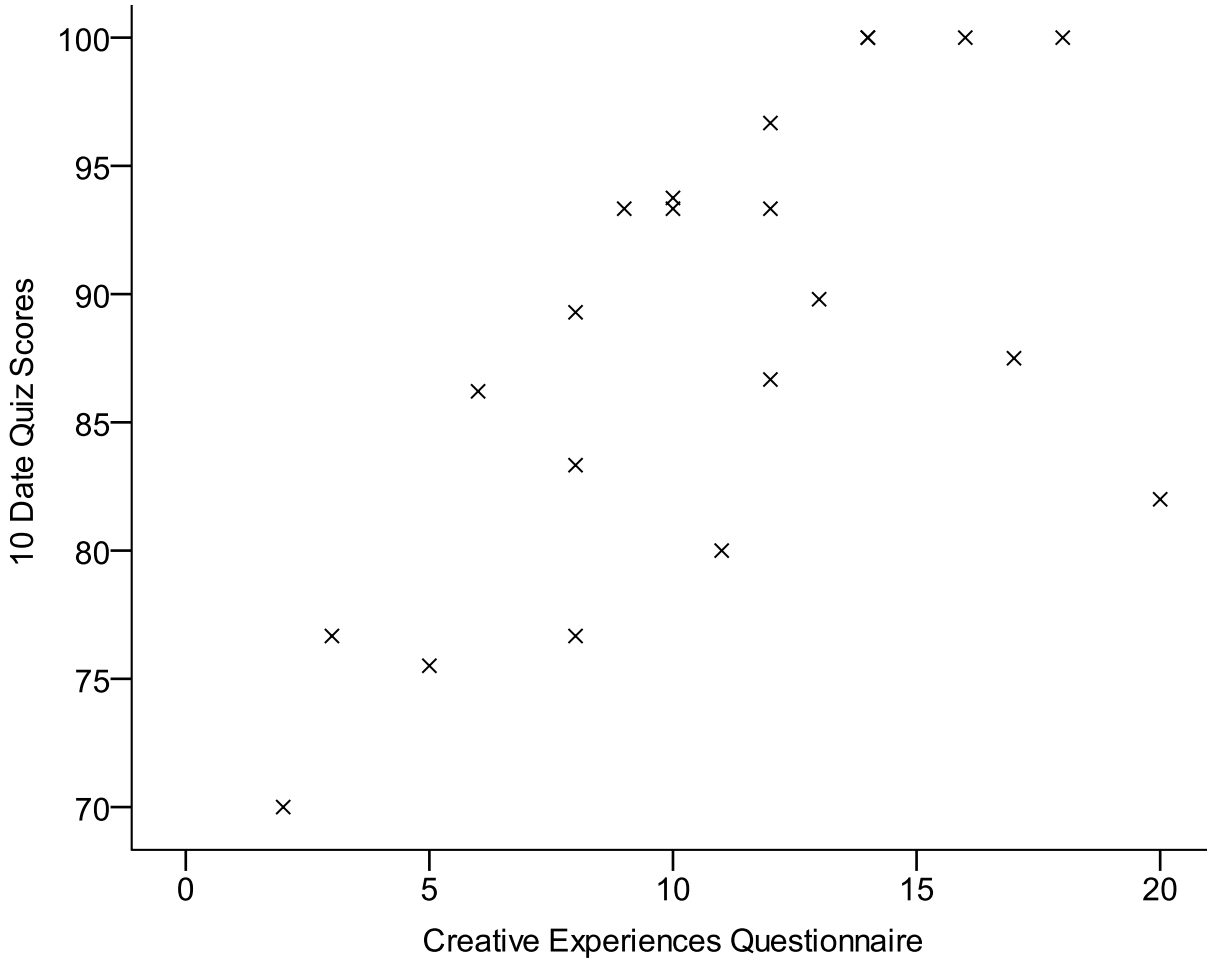

Figure 5.4. Within HSAM individuals: The statistically significant association between fantasy proneness (CEQ) and HSAM ability (10 Dates Quiz), $r = .58$, $p = .008$.

Comparing Absorption to Fantasy Proneness. Absorption was highly related to the fantasy proneness, $r = .82$, $p < .001$. This high association means that the two scales are capturing something similar about participants, namely the tendency to be imaginative and get absorbed in new experiences. They differ a little because absorption captures the tendency to get absorbed in new experiences, whereas fantasy proneness is more about the tendency to imagine, day dream, and fantasize. Due to the high correlation between predictors, we found collinearity to be too high to put absorption and fantasy proneness into a meaningful regression model. Indeed when this was attempted both coefficients became not statistically significant associated

with the 10 Date Quiz (CEQ β = .64, p = .09; absorption β = -.08, p = .83), indicating the standard error had inflated due to the high correlation between predictors. Therefore the bivariate relationships are used in this dissertation chapter for the purpose of discussing the results.

To summarize these bivariate results, both absorption and fantasy proneness were reliably associated with HSAM. Absorption had a larger Cohen's *d* than fantasy proneness when comparing HSAM to control groups, whereas fantasy proneness had a higher bivariate correlation with HSAM ability (10 Date Quiz score) within HSAM individuals.

Item By Item Analysis: Absorption and Fantasy Proneness

Due to the remarkable relationships found between absorption / fantasy proneness and HSAM, an item by item analysis is given in Tables 5.1 and 5.2, below. This was done for two reasons, the first being to check that the items were not all related to autobiographical memory in a way that might explain the difference. The second reason being to see whether specific aspects of the scales might be most associated with HSAM ability.

Table 5.1. *Tellegen Absorption Scale: Each Item's Effect Sizes (*r*) Indicating How HSAM and Controls Differ—Plus Associations with HSAM ability (10 Date Quiz).*

	HSAM vs Control	HSAM 10 Date Quiz
1. Sometimes I feel and experience things as I did when I was a child.	.572***	-.169
2. I can be greatly moved by eloquent or poetic language.	.343**	-.060
3. While watching a movie, a TV show, or a play, I may become so involved that I may forget about myself and my surroundings and experience the story as if it were real and as if I were taking part in it.	.114	.472*
4. If I stare at a picture and then look away from it, I can sometimes "see" an image of the picture almost as if I were still looking at it.	.285*	.062
5. Sometimes I feel as if my mind could envelop the whole world.	.395**	.375
6. I like to watch cloud shapes change in the sky.	.034	.231
7. If I wish I can imagine (or daydream) some things so vividly that they hold my attention as a good movie or story does.	.363**	.192
8. I think I really know what some people mean when they talk about mystical experiences.	.345**	.228
9. I sometimes "step outside" my usual self and experience an entirely different state of being.	.313*	.323
10. Textures -- such as wool, sand, wood -- sometimes remind me of colors or music.	.289*	.217
11. Sometimes I experience things as if they were doubly real.	.242	.119
12. When I listen to music I can get so caught up in it that I don't notice anything else.	.229	.503*
13. If I wish I can imagine that my body is so heavy that I could not move it if I wanted to.	-.058	.354
14. I can often somehow sense the presence of another person before I actually see or hear her/him.	.317*	.087
15. The crackle and flames of a wood fire stimulate my imagination.	.030	.420
16. It is sometimes possible for me to be completely immersed in nature or in art and to feel as if my whole state of consciousness has somehow been temporarily altered.	.159	.502*
17. Different colors have distinctive and special meanings for me.	.347**	**.545***
18. I am able to wander off into my thoughts while doing a routine task and actually forget that I am doing the task, and then find a few minutes later that I have completed it.	.087	.318
19. ***I can sometimes recollect certain past experiences in my life with such clarity and vividness that it is like living them again or almost so.***[1]	**.652*****	.289
20. Things that might seem meaningless to others often make sense to me.	.594***	.182
21. While acting in a play I think I could really feel the emotions of the character and "become" her/him for the time being, forgetting both myself and the audience.	.318*	.324
22. My thoughts often don't occur as words but as visual images.	.289*	.068
23. I often take delight in small things (like the five-pointed star shape that appears when you cut an apple across the core or the colors in soap bubbles).	.143	.313
24. When listening to organ music or other powerful music I sometimes feel as if I am being lifted into the air.	.297*	.261
25. Sometimes I can change noise into music by the way I listen to it.	.132	.238
26. *Some of my most vivid memories are called up by scents and smells.*	.099	.232
27. Some music reminds me of pictures or changing color patterns.	.164	.289
28. I often know what someone is going to say before he or she says it.	.416**	.272
29. I often have "physical memories"; for example, after I have been swimming I may still feel as if I am in the water.	.286*	.295
30. The sound of a voice can be so fascinating to me that I can just go on listening to it.	.233	.403
31. At times I somehow feel the presence of someone who is not physically there.	.263*	.398
32. Sometimes thoughts and images come to me without the slightest effort on my part.	.329*	.415
33. I find that different odors have different colors.	.251	.225
34. I can be deeply moved by a sunset.	.237	.445*

Notes. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. $N = 58$ in HSAM vs Control column, & $N = 20$ for 10 Date Quiz column. Items (19, 26) involving episodic memory are *italicized*. [1]***Metacognitive:*** self-assessment of own memory. Participants indicated the percentage of the time they had the experience (when not under the influence of alcohol or drugs), on a scale from *0% = never* to *100% = always*. Largest effect size in column shown in **boldface**.

Table 5.2. *Fantasy Proneness (Creative Experiences Questionnaire): Each Item's Effect Sizes (*r*) Indicating How HSAM and Controls Differ and Associations with HSAM ability (10 Date Quiz).*

	HSAM vs Control	HSAM 10 Date Quiz
1. As a child, I thought that the dolls, teddy bears, and stuffed animals that I played with were living creatures.	-.008	-.115
2. As a child, I strongly believed in the existence of dwarfs, elves, and other fairy rale figures.	-.166	.429
3. As a child, I had my own make believe friend or animal.	.248	.222
4. As a child, I could very easily identify with the main character of a story and/or movie.	-.065	.276
5. As a child, I sometimes had the feeling that I was someone else (e.g. a princess, an orphan, etc).	.011	.220
6. As a child, I was encouraged by adults (parents, grandparents, brothers, sisters) to fully indulge myself in my fantasies and daydreams.	-.020	.487*
7. As a child, I often felt lonely.	.228	.147
8. As a child, I devoted my time to playing a musical instrument, dancing, acting, and/or drawing.	.011	-.117
9. I spend more than half the day (daytime) fantasizing or daydreaming.	.170	.145
10. Many of my friends and/or relatives do not know I have such detailed fantasies.	.268*	**.525****
11. Many of my fantasies have a realistic intensity.	.341**	.521*
12. Many of my fantasies are often just as lively as a good movie.	.243	.411
13. I often confuse fantasies with real memories.	.089	-.159
14. I am never bored because I start fantasizing when things get boring.	.106	.451*
15. Sometimes I act as if I am somebody else and I completely identify myself with that role.	.077	-.020
16. ***When I recall my childhood, I have very vivid and lively memories.***[1]	.290*	NV
17. *I can recall many occurences before the age of three.*	-.016	.422
18. When I perceive violence on television, I get so into it that I get really upset.	.132	.298
19. When I think of something cold, I actually get cold.	.015	.057
20. When I imagine I have eaten rotten food, I really get nauseous,	-.044	.241
21. I often have the feeling that I can predict things that are bound to happen in the future.	.302*	.264
22. I often have the experience of thinking of someone and soon afterwards that particular person calls or shows up.	**.461*****	.241
23. I sometimes feel that I have had an out of body experience.	.062	.087
24. When I sing or write something, I sometimes have the feeling that someone or something outside myself directs me.	.256	.322
25. During my life, I have had intense religious experiences which influenced me in a very strong manner.	.228	.131

Notes. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. $N = 58$ in the HSAM vs Control column, and $N = 20$ for the 10 Date Quiz column. Items (16,17) involving autobiographical memory are *italicized*. [1]***Metacognitive question***: self-assessment of own autobiographical memory. NV = no variance. Participants answered "Yes" or "No" to the questions. Largest effect size in column shown in **boldface**.

Metacognition about Own Autobiographical Memory Ability

One item in the Tellegen Absorption Scale is of particular interest for understanding individuals' metacognition and self-awareness of HSAM ability. Item 19 reads: "I can sometimes recollect certain past experiences in my life with such clarity and vividness that it is like living them again or almost so." HSAM individuals (M = 3.80, SD = .410) rated this item significantly higher than controls (M = 2.53, SD = .830), $t(55.9) = 7.82$, $p < .001$, $d = 1.72$. Caution is warranted when interpreting the association with the 10 Dates Quiz, (r = .29, p = .287) because was little variance within HSAM participants on the Likert scale (all of them chose 3 or 4 on the scale).

Similarly, one item on the Creative Experiences Questionnaire: "When I recall my childhood, I have very vivid and lively memories" also serves as a self-assessment of their autobiographical memory ability (item 16). On this item HSAM participants (100% "yes") were significantly different than controls (79% "yes"), $\chi^2(1) = 4.88$, exact $p = .041$, $\varphi = .29$. Due to zero variation within HSAM participants it was impossible to analyze how this item was related to the 10 Dates Quiz.

Possible Construct Confounds with HSAM in Absorption and Fantasy Proneness.

A couple of items in both the Tellegen Absorption Scale (items 19 and 26; see Table S1) and the Creative Experiences Questionnaire (items 16 and 17; see Table S2) refer to memory. This raises the question as to whether it is these items that are driving the relationship between these constructs and HSAM. To examine this, in a secondary analysis these questions were excluded from the summed score for both the scales, and the relationship with HSAM re-examined.

Excluding the two memory questions from the Tellegen Absorption Scale, the summed score was significantly higher in HSAM vs. control participants, $t(56) = 3.42$, $p = .001$, $d = .92$ ($r = .416$); and was significantly associated with HSAM ability (10DQ) within the 20 HSAM individuals, $r = .44$, $p = .048$. As way of comparison, as already reported the effect sizes for absorption with those two memory questions *included* were $d = .96$ for HSAM vs controls, and $r = .45$ for the correlation with HSAM ability.

Similarly, excluding the two memory-related questions from the Creative Experiences Questionnaire, the summed score was still significantly higher in HSAM individuals compared to controls, $t(56) = 2.37$, $p = .021$, $d = .63$ ($r = .302$); and still was significantly associated with HSAM ability with the 20 HSAM individuals, $r = .54$, $p = .013$. As described earlier, effect sizes for this scale with those two memory questions *included* were $d = .65$ for HSAM vs controls, and $r = .58$ for the correlation with HSAM ability. Even when excluding questions relating to memory, the core constructs of absorption and fantasy proneness still seem to differ in HSAMs compared to control participants, and to correlate with HSAM ability.

Further item by item analysis shown in Table S2 confirmed that items in the CEQ directly conveying the tendency to fantasize (e.g. items 10 & 11) were significantly higher in HSAM compared to control individuals, *and* did associate with HSAM ability also.

Synesthesia-Related Items. Items 10, 27, and 33 in the Tellegen Absorption Scale (see Table 5.1) all captured synesthesia: which is the triggering of one sense by other senses. The items captured the triggering of color/music by texture, color by music, and color by odor. Summing these 3 items gave a synesthesia total score. On this synesthesia variable, HSAM participants were marginally higher ($M = 6.00$, $SD = 3.13$) than controls ($M = 4.63$, $SD = 1.85$),

unequal variances test $t(26.2) = 1.80$, $p = .084$, $d = .56$. Synesthesia did not significantly associate with 10 Date Quiz scores within HSAM participants ($r = .25$, $p = .280$).

A stronger associate than synesthesia was a related but different question on the TAS. The item "different colors have distinctive and special meanings for me" captured the tendency to find meaning in color. On this item HSAM participants ($M = 2.90$, $SD = .97$) were significantly higher than controls ($M = 2.16$, $SD = .97$), $t(56) = 2.77$, $p = .008$, $d = .74$. This item also was associated with 10 Date Quiz scores within HSAM participants, $r = .55$, $p = .013$.

Testing the Emotional Arousal Hypothesis

Anxiety. Psychic trait anxiety (SSP personality scale subscale) was higher in HSAM individuals ($M = 2.52$, $SD = .53$) compared to controls ($M = 2.17$, $SD = .52$), $t(56) = 2.40$, $p = .020$, $d = .64$. However, somatic trait anxiety did not significantly differ between HSAM individuals ($M = 2.20$, $SD = .50$) and controls ($M = 2.04$, $SD = .57$), $t(56) = 1.04$, $p = .301$, $d = .26$. Neither psychic ($r = .19$, $p = .42$) nor somatic anxiety ($r = .33$, $p = .15$) was significant associated with 10 Date Quiz scores within the HSAM group.

Empathy. Affective empathy (BES) did not differ significantly between HSAM ($M = 39.15$, $SD = 8.13$) and control participants ($M = 37.29$, $SD = 6.25$), $t(56) = 0.97$, $p = .336$, $d = .26$. Similarly cognitive empathy was not statistically significantly higher in HSAM individuals ($M = 36.9$, $SD = 4.40$) compared to control participants ($M = 35.74$, $SD = 3.76$), $t(56) = 1.05$, $p = .296$, $d = .28$.

Emotional Detachment. HSAM participants had significantly lower emotional detachment scores ($M = 2.00$, $SD = .50$) compared to controls ($M = 2.34$, $SD = .46$), $t(56) = 2.63$, $p = .011$, $d = .70$, ($r = .332$).

High Arousal Emotions. On a composite of high arousal emotions (Stressed, Tense, Jumpy), HSAM participants (M = 4.15, SD = 2.46) did not report feeling high arousal emotions more often than control participants (M = 4.03, SD = 2.50) in the week after 9/11, $t(56) = 0.18$, $p = .858$, $d = .05$. However, within the HSAM group higher reports of emotional arousal was a marginal correlate of scores on the 10 Dates Quiz, $r = .41$, $p = .070$.

Testing the Sleep Hypothesis

Over the seven day observation period cumulative sleep scores were calculated for each participant. All 20 HSAM participants filled in their sleep diaries and returned them, and 35 of the 38 controls did so.

Quantity. On the cumulative amount of sleep over the week, HSAM participants (M = 2994 minutes, SD = 348) were not statistically different from age matched controls (M = 3040, SD = 303), $t(53) = 1.19$, $p = .240$, $d = .33$.

Quality. HSAM participants reported feeling well rested when they awoke on marginally more days (M = 5.10 days out of seven, SD = 1.37) during the week than controls (M = 4.26 days, SD = 1.96), $t(53) = 1.70$, $p = .096$, $d = .47$. Because of this marginal p value the correlation within the 20 HSAM participants between the number of well rested reports and 10 Date Quiz scores was examined, but was not significant ($r = .05$, $p = .573$).

Daytime Naps. HSAM participants (M = 1.05 per week, SD = 1.39) were not statistically different from controls (M = 1.20, SD = 1.61) on the number of daytime naps they had during the week, $t(53) = 0.35$, $p = .728$. Likewise, the number of minutes slept during daytime naps did not vary between HSAM individuals (M = 72.4 minutes per week, SD = 117) and controls (M = 73.9, SD = 104), $t(53) = 0.05$, $p = 960$.

Intelligence and Rationality

SAT scores. There were no significant differences on total self-reported SAT scores between HSAM individuals (M = 1170, SD = 182; n = 16) and age match controls (M = 1241, SD = 151; n =18), $t(32) = 1.23$, $p = .227$, $d = .42$. No statistically differences were found on the SAT Math section between HSAM individuals (M = 614, SD = 84.5) and controls (M = 632, SD = 95.3), $t(24) = .51$, $p = .613$, $d = .20$. Similarly on the SAT Reading subsection, HSAM individuals (M = 578, SD = 64.7) were statistically no different from controls (M = 628, SD = 119.8), $t(25) = 1.37$, $p = .183$, $d = .52$.

Critical Thinking. On the composite of 9 questions testing various aspects of critical thinking, HSAM individuals (M = 3.55, SD = 2.06) did not score significantly different from controls (M = 4.24, SD = 2.43), $t(56) = 1.08$, $p = .287$, $d = .31$.

Flexible Thinking. On the total flexible thinking score HSAM individuals (M = 43.9, SD = 4.42) were significantly lower than controls (M = 46.9, SD = 4.92), $t(56) = 2.28$, $p = .027$, $d = .61$ ($r = .291$). Of the four subscales that make up the flexible thinking scale, one: "Tolerance for Ambiguity" was significant different between groups: HSAM individuals (M = 4.15, SD = .56) were significantly lower than controls (M = 4.76, SD = .92) on Tolerance for Ambiguity, $t(54.8) = 2.84$, $p = .006$, $d = .66$ ($r = .311$).

Beliefs about Memory. Table 5.3 shows the percentage agreement with a number of statements about how memory works, while Table 5.4 shows the mean scores on those items with comparisons between HSAM and control participants, and between HSAM and memory and cognition experts from SARMAC (doctorate holding members of the Society for Applied Research in Memory and Cognition). Table 5.4 demonstrates that on many questions, HSAM and age matched control participants have similar beliefs about how memory works: for example most agree that memory is repressed and that some people have photographic memories.

However, HSAM participants tend to disagree more with statements suggesting that memory is unreliable and reconstructed (compared to controls). Tables 5.3 and 5.4 also show that there are large differences between HSAM individuals and memory experts (SARMAC) in their beliefs about memory. There are significant differences between HSAM and SARMAC groups on every single question, with effect sizes ranging from Cohen's d = 1.11 to 2.00. HSAM participants do not reflect the consensus of general skepticism among psychology researchers about the general reliability of memory and the idea that memory can be repressed (Patihis et al., 2014).

Table 5.3

Percentage of Participants Agreeing to Some Degree[a] with Various Statements about Memory and Repression

Participant Group	Traumatic memories are often repressed.	Repressed memories can be retrieved in therapy accurately.	Memory can be unreliable.	Hypnosis can accurately retrieve memories that previously were not known to the person.	Memory is constantly being reconstructed and changed every time we remember something.	Memory of everything experienced is stored permanently in brains, even if can't access all.	Some people have true "photographic memories."	With effort, we can remember events back to birth.
HSAM (n = 20)	85.0	85.0	60.0	55.0	65.0	85.0	90.0	20.0
Control (age, sex matched; n = 38)	73.7	71.1	89.5	50.0	92.1	63.2	86.8	31.6
SARMAC (PhD; n = 51)	23.5	15.7	98.0	11.8	98.0	25.5	29.4	2.0

Note. Likert scale had the following 6 anchors: *strongly disagree, disagree, slightly disagree, slightly agree, agree,* and *strongly agree*. [a]Agreeing to some degree means participants chose *slightly agree, agree,* or *strongly agree* to the statements. SARMAC = Society for Applied Research in Memory and Cognition who are also doctorate (PhD) holders. SARMAC data are from same dataset as Patihis *et al*. (2014), after removing those without doctorates.

Table 5.4

Comparing HSAM Individuals' Beliefs about Memory to Experts in Memory and Cognition: M, (SD), *and* n *given for comparisons.*

Participant group	*n*	(1)[a] Recovered CSA Plausible	(2)[b] Traumatic memories are often repressed	(3) Repressed memories can be retrieved in therapy	(4) Memory can be unreliable	(5) Hypnosis accurately retrieves memories	(6) Memory is reconstructed	(7) Memory of everything is stored	(8) Photographic memories	(9) Can remember back to birth
HSAM	20	2.75 (0.639)	4.50 (0.946)	4.00 (1.124)	3.60 (1.465)	3.35 (1.182)	3.70 (1.174)	4.50 (1.192)	5.00 (1.376)	2.55 (1.099)
Age sex-matched Control	38	2.74 (0.724)	4.03 (1.150)	3.79 (1.119)	4.95 (1.138)	3.55 (1.155)	4.68 (0.933)	3.76 (1.478)	4.71 (1.250)	2.68 (1.435)
t test between HSAM and Control		$t(56) = 0.07$ $p = .946$ $d = .01$	$t(56) = 1.58$ $p = .120$ $d = .45$	$t(56) = 0.68$ $p = .499$ $d = .19$	**$t(56) = 3.88$** **$p < .001$** **$d = 1.03$**	$t(56) = 0.63$ $p = .531$ $d = .17$	**$t(56) = 3.49$** **$p = .001$** $d = .92$	$t(56) = 1.92$ $p = .060$ $d = .55$	$t(56) = 0.81$ $p = .289$ $d = .22$	$t(56) = 0.37$ $p = .716$ $d = .10$
Experts Memory & Cogn. (SARMAC; PhD)	51	2.02 (0.678)	2.18 (1.396)	1.94 (1.139)	5.80 (0.530)	1.88 (0.993)	5.55 (0.673)	2.28 (1.429)	2.65 (1.547)	1.20 (0.566)
t test between HSAM and SARMAC		**$t(69) = 4.09$** **$p < .001$** **$d = 1.11$**	**$t(69) = 6.83$** **$p < .001$** **$d = 1.95$**	**$t(69) = 6.88$** **$p < .001$** **$d = 1.82$**	**$t(69) = 9.35$** **$p < .001$** **$d = 2.00$**	**$t(69) = 5.31$** **$p < .001$** **$d = 1.35$**	**$t(69) = 8.33$** **$p < .001$** **$d = 1.93$**	**$t(69) = 6.15$** **$p < .001$** **$d = 1.69$**	**$t(69) = 5.93$** **$p < .001$** **$d = 1.61$**	**$t(69) = 6.81$** **$p < .001$** **$d = 1.54$**

Note. Significant differences highlighted in **boldface**. Mean ratings given with standard deviations in parenthesis. [a]Question (1) Likert scale: 1 = *very implausible*; 2 = *implausible*; 3 = *plausible*; 4 = *very plausible*. [b]Questions (2) through (9) Likert scale: 1 = *strongly disagree*; 2 = *disagree*; 3 = *slightly disagree*; 4 = *slightly agree*; 5 = *agree*; 6 = *disagree.* SARMAC = Society for Applied Research in Memory and Cognition who also have a PhD.

Discussion

By assessing how HSAM individuals differ on various measures, and how these measures vary with HSAM ability, the results demonstrate some support for the imaginative-absorption hypothesis, and relatively weaker evidence for the emotional arousal and sleep hypotheses. Regarding the *imaginative-absorption hypothesis*, absorption and fantasy proneness both were reliably higher in HSAM participants compared to controls. This initial result suggested that tendencies to become absorbed into new experiences and to be prone to vividly imaginative episodes could perhaps have a beneficial effect on one type memory. This suggestion is further supported by the associations shown in Figures 5.1 and 5.2 between absorption and fantasy proneness and the measure of HSAM ability, the 10 Dates Quiz. This lends some preliminary support to the hypothesis that certain dispositions may partially explain HSAM.

This raises the question as to how could absorption and fantasy proneness be affecting HSAM. Figure 5.5 illustrates speculative possible pathways that might explain the relationship. This speculation is offered because the reader might be initially puzzled as to why a construct such as fantasy proneness would be associated positively with autobiographical memory. By breaking down aspects of the construct, such as “total attention” and “vivid visual imagery” it becomes clearer why there may be a relationship. It should be stressed, though, that at this stage these pathways are hypothetical, could be bidirectional, and that further research could confirm or rule them out.

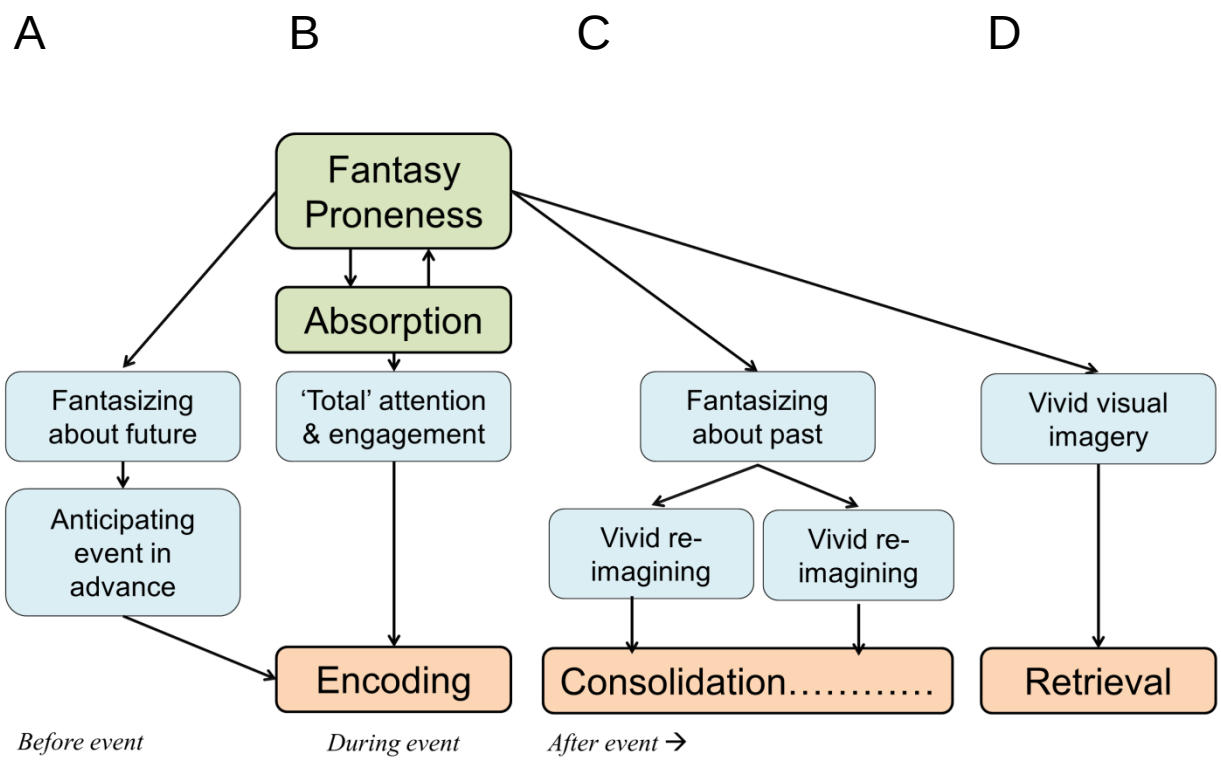

Figure 5.5. Speculative pathways through which dispositions towards fantasy proneness and absorption could explain the association with HSAM. (A) Before the autobiographical event, a tendency to fantasize about upcoming life events could lead to anticipation that aids encoding at the time of the event. (B) During the event, absorption, the "disposition for having episodes of 'total' attention that fully engage" could strengthen encoding of significant life events. (C) After an important event, fantasizing about the event at later dates could bring the event back to mind multiple times, and aid in consolidating a memory. (D) At retrieval, a tendency for strong visual imagery, an aspect of fantasy proneness, could result in memory reports that are rich in detail.

Chapter 3 reported data showing the finding that HSAM individuals had higher false memories than controls on a misinformation task, and that that was mediated by absorption and fantasy proneness. Therefore, the very same tendencies could explain both a deeper attention to misinformation narratives and autobiographical events. In the absence of misinformation, the personal events in which HSAM individuals become absorbed in and fantasize about later will likely lead to accurate memory. Misleading post-event information, though, can produce errors if the HSAM individuals become imaginatively absorbed into the misinformation narrative.

One possible limitation to these findings is a potential selection bias: HSAM participants, though matched on age and gender to controls, were not matched on other variables. Therefore, HSAM individuals might be higher on absorption or fantasy proneness due to something else other than HSAM ability (e.g. profession). This is also a possible limitation of individual differences found in previous studies (e.g. structural brain differences and obsessive tendencies in LePort et al., 2013). However, this does not explain the correlations between absorption/fantasizing and HSAM ability within superior memory individuals.

HSAM may be a multi-causal phenomenon and indeed other factors are needed to fully explain it. For example, not all highly fantasy prone people have HSAM. It may be that HSAM individuals have a very specific *type* of fantasy proneness that involves fantasizing about real autobiographical events. As well as these dispositions, HSAM development could require the structural brain capacity to remember so many autobiographical details (cf. LePort et al., 2012). These factors may interact in a system. For example, dispositions that drive a person to fantasize about past events could lead to the frequent use of memory systems that result in brain changes over time. Likewise brain systems allowing for rich visual imagination may result in people more prone to fantasize.

Less support was found for the *emotional arousal hypothesis.* Although statistically significant results for psychic trait anxiety and emotional detachment were found, they did not associate with HSAM ability. Empathy and high arousal emotions after 9/11 were not significant correlates with HSAM (by group or within HSAM). These findings do not completely rule out the emotional arousal hypothesis, and further research is warranted, perhaps measuring epinephrine levels directly. However, it appears that emotional arousal may be a lesser correlate

of HSAM than the tendencies to become absorbed in and fantasize about autobiographical events.

The *sleep consolidation hypothesis* was not supported with regards to sleep quantity, but further research may be fruitful in investigating sleep quality. Nevertheless, sleep quality did not show the double associative qualities (group comparison and 10 Date Quiz Scores) of absorption and fantasy proneness variables.

This study identified certain types of dispositions as a plausible partial explanation of HSAM. The dispositions of absorption and fantasy proneness, specifically if directed towards personal events, have logical theoretical pathways through which they might operate (Figure 5.5). Combined with the empirical evidence that these are higher in HSAM participants is relatively tentative evidence for this. However, this is reinforced by the correlations between these dispositions and HSAM ability (Figures 5.2 & 5.4), and by the mediating effect of these variables on the misinformation effect shown in Chapter 3. Stable tendencies that produce the memory-related behaviors that consolidate and maintain autobiographical memory may operate over a period of decades, consistently every day, in order to demonstrate HSAM in the present.

Chapter 6: General Discussion

The first chapters of the dissertation outlined the history of the study of superior memory, and described the results of three studies: the DRM word list task, the classic misinformation task, and news-related semi-autobiographical distortion tasks. Chapter 5 then examined how HSAM and control participants vary on individual differences, and how relevant measures correlated with HSAM ability. The general findings were that memory distortion susceptibility was for the most part similar in HSAM and control participants, and that both groups were similar on many individual differences measures except those relating to visual imagery and absorptive ability. These results help rule out some possible explanations as to what may be going on in HSAM, and raise further questions.

Chapter 1 established that superior memory comes in different forms. Superior autobiographical memory, the subject of this dissertation, is unique in that it appears to be the only type that involves autobiographical memory and does not involve the use of mnemonics. HSAM is also one of the most difficult to explain with the current scientific understanding of memory. The two other major types of superior memory include memory athletes and autistic savants. Memory athletes typically employ practice and mnemonic devices to learn long lists of words, numbers, or playing cards. As some memory athletes attest (see Roediger & Dellis, 2014) these skills can be learned by people of average memory by practicing techniques that involve the elaboration of typically meaningless stimuli, such as a string of numbers, into meaningful associations with richer stimuli. This type of superior memory does not contradict any existing theories on memory. Another type of superior memory involves a minority of autistic savants

that have elevated memory ability, typically in one narrow area, and these savants typically have a deficit in some other area of cognition, typically social cognition and/or general intelligence. The fact that these autistic savants exhibit extraordinary ability to remember things like zip codes might be explained by their narrow attention, obsession, and practice with such tasks, and their lack of attention to other potentially distracting complex stimuli, such as social relationships, that ordinary people attend to. These other forms of superior memory are important to discuss and compare because they highlight the uniqueness of the HSAM phenomena. Previous to this dissertation research, it was unclear whether HSAM individual's incredible ability to remember almost every day was due to such individuals having memories that were invulnerable to distortion. It was unclear too what is different about HSAM individuals that make them consistently pay attention to daily events, encode daily events, and consolidate daily events. This dissertation makes some inroads in ruling out some possible explanations, and introduces possible explanations that take a small step forward in clarifying the mystery. It is acknowledged that this dissertation does not provide definitive answers, and serves to complement the excellent work done by others (e.g. LePort et al., 2012; McGaugh & LePort, 2014).

Chapter 2 described the first use of the DRM procedure on people with superior memory. This study assessed whether the memory mechanisms involved in associative memory errors (those measured in the DRM task) coincided with the memory mechanisms involved in HSAM, such as associating life events together to aid recall. It was possible that HSAM individuals would be better able to distinguish between related episodic events that did and didn't happen, and this in some partial way could be an additional explanation for HSAM ability. Even though the experiment involved non-personal lab stimuli, it was still possible that we would capture some basic differences in memory ability or processing. Our experiment, however, ruled out this

hypothesis as being a sizable partial explanation. The small advantage we found in HSAM individuals on discrimination scores in a signal detection analysis could be a clue worthy of further research, although that difference seemed to be due to moderately better presented word recognition, and not due to lower false memory scores. Apart from ruling out the possibility that HSAM individuals have associative and source monitoring ability that is highly different than people without HSAM, these results leaves other plausible explanations unanswered. Another limitation is the type of stimuli: memory for words in a list is different from personal memories. Despite these limitations, these findings are an incremental addition to HSAM research.

Chapter 3 reported results obtained with materials more akin to what you might encounter in real world situations. Participants saw two photographic slideshows of simulated crimes, one involving a purse-theft, and the other involving a break-in and theft from a car. Later, they read a narrative that introduced a few pieces of misleading information, and finally, they were asked to remember what they saw in the original slideshow. This three stage procedure mimics what might be experienced by a witness to a crime who inadvertently reads or hears something misleading about the case, perhaps from another witness or the interviewer. The stimuli is relatively rich and meaningful, relative to words lists, but still of less personal meaning than autobiographical events. In this procedure, it would have been reasonable to assume that due to their strong memory, HSAM individuals would be less susceptible to misinformation. However, the misinformation effect involves a potentially complex interaction between two encoding events, as well as being dependent on source monitoring ability. What we found surprised us initially: HSAM individuals were more susceptible to the classic misinformation effect, although that difference shrank moderately after a source test. This finding made at least some sense when we found that absorption and fantasy proneness had a

mediating effect on the relationship between participant group and false memory. Thus, a partial explanation could be that HSAM individuals, being high on the absorption measure, were more 'totally attentive' (part of the definition of absorption, see Tellegen & Atkinson, 1974) during the narrative that contained the misinformation. This could have strongly encoded misinformation that then interfered with the original memory for the photographs. Because autobiographical memory is narrative in its nature, it could be that tendencies such as absorption could also have a *beneficial* effect on encoding such memory. Chapter 5 explored that possibility.

Chapter 4 described the memory distortion tasks most closely related to HSAM ability, that of semi-autobiographical memory for major news events. 9/11 represented to most Americans an event so important that many have woven the events of that day, and the aftermath, into their autobiographical narrative. For others, it may be less important, semi-autobiographical perhaps, but nevertheless still remembered if they were of sufficient age at the time of the event. Because HSAM participants are extraordinarily better at remembering news events than people with ordinary memory, a reasonable hypothesis was that they would have zero susceptibility to induced memory errors about news events. Quite surprisingly, we found about equal susceptibility to suggestion about remembering non-existent footage of the plane crash of United 93 on 9/11. There were non-significant patterns, though, with HSAM individuals being slightly lower on the Yes/No initial question, but slightly more forthcoming than controls with false details in the questions that followed. These patterns could be consistent with the idea that HSAMs, though having strong memory traces for news events, are also capable of imaginative production of visual images, and that ability can create false details in the presence of misinformation. It could be that the relatively normal proportions of autobiographical induced memory errors in HSAM comes about by an antagonistic relationship

between strong source memory and strong ability to visually imagine misleading information. The errors that might come along with HSAM ability, then, would ordinarily be very low if the participants are given no misinformation or misleading guided imagery tasks. It could be that they do indeed create stronger memory traces for autobiographical events, but HSAM individuals may be relatively average at source monitoring. Further research is needed to test these hypotheses.

Chapter 5 documented a whole host of individual differences measures, and how they vary between HSAM and non-HSAM individuals. Chapter 5 also specifically addressed the hypothesis generated in Chapter 3, that absorption and/or fantasy proneness may be a factor in HSAM. Other hypotheses focused in on differences in measures that capture some aspect emotional arousal, and measures that capture sleep quality and quantity, though these hypotheses were not fully supported. Quite unexpectedly, absorption and fantasy proneness correlated with a measure of HSAM ability, the 10 Date Quiz. The correlations were quite high, despite the low sample size, and were visibly apparent in the scatterplots. While this is only a correlation, and not established as a causal relationship, it prompts speculation about whether personality tendencies could produce the daily memory-related behavior needed to be able to exhibit HSAM a decade or more later. Without such daily encoding and consolidation of personal memory, the person trying to recall random dates would demonstrate hits and misses, and likely not meet criteria as a HSAM. The memory behavior needed to consolidate autobiographical memory, such as being attentive (e.g. absorption) and reimagining visual images later (e.g. fantasizing), may be associated with stable personality traits that ensure the memory-related-behavior is consistently done every day. If this is true, we might speculate that one cause of HSAM is related to a personality configuration including obsessiveness (see LePort et al., 2012), absorption, and

fantasizing about personal events, which produce the attention, encoding, and consolidation needed every day over a period of years. Other causes could be speculated to be enhanced biological memory capacity given by differing sizes of key brain structures (see LePort et al., 2012), and other causes that of yet to be fully investigated: such as an enhanced and persistent *motivation* to remember autobiographical events.

There are several limitations to this dissertation research. The sample size is relatively small, which leads to uncertainty when non-significant results nevertheless have more than negligible effect sizes. In addition, in searching for clues as to the origins of HSAM, this correlational research cannot confidently establish cause, a problem shared with past research (e.g. Ally et al., 2013; LePort et al., 2012; Parker et al., 2006). Also, some of our memory measures did not address personal autobiographical memory. And finally, we only matched participants on age and gender, and broader matching, perhaps on profession and SES, could have been beneficial.

Future Research Directions

Future research could look into functional differences in neuronal activity in HSAM participants, compared to people of average memory. This could help establish whether brain activity varies between groups in certain brain regions. In addition, a longitudinal design could be employed to investigate the accuracy of verified autobiographical events recorded by researchers over time. The decay curves of this memory in HSAM individuals could then be compared to controls. In addition, memory serves an important function in helping organisms forecast and predict the future For this reason, it would be interesting to see how HSAM individuals perform in tasks involving future thinking (see Szpunar, Spreng, & Schacter, 2014).

Conclusion

This dissertation incrementally increases our existing knowledge of the puzzling new phenomenon called HSAM. As part of this new knowledge, some hypotheses seem to have been ruled out, though not completely. HSAM individuals do not seem to have associative, source monitoring, or reconstructive memory mechanisms that are especially different than non-HSAM individuals. Specifically they associate words together in the same way so as to produce memory errors of related words not actually presented. HSAM individuals also incorporate new information into memory as much as anybody else does, so that cannot explain why their memory of decades-old autobiographical memory is so accurate. In addition, enhanced consolidation in HSAM individuals during sleep found little or no support via measures of sleep quantity, with only a slight hint of better sleep quality. Measures related to emotional arousal to personal events and relationships were not found to fully explain HSAM individuals' memory enhancement. Measures related to becoming absorbed in new information and fantasizing were associated with HSAM. These offer a speculative guess as to what kinds of personality traits might be involved in producing the persistent memory behaviors needed to produce HSAM.

These conclusions, combined with earlier research on HSAM (Parker et al, 2006; LePort et al., 2012), point to a speculative explanation of HSAM that might go as follows. HSAM individuals first need their brains, language, and narrative ability to develop sufficiently during childhood in order to start a relatively consistent and full autobiographical memory. This explains why most HSAM individuals can remember accurately from about mid-childhood onwards. These HSAMs may also have personalities that are related to obsessiveness, fantasizing about events related to the self, and becoming absorbed in new experiences. This underlying personality may help them sustain a daily consolidation of a few items of autobiographical memory, such as the date, the day of the week, a news event, and a personal event. Enhanced

brain capacity for autobiographical memory could also exist, whether from practice or genetics, whereby they can encode and consolidate personally meaningful events with more ease than the average person. Whatever the causes of HSAM, what is clear are that there are many questions unanswered. It may be that the study of people with superior memory could be as important to our general theories of memory as was the study of those with deficient memories, such as H.M. (Milner, 1972; Scoville & Milner, 1957).

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Appendix A: DRM false memory word list task materials (from Roediger et al., 2001)

Word List Presentation Set 1

These 10 word lists are presented on screen for 2000ms per word, in order from top to bottom – with 3000ms between the end of one list and the start of the next.

Instructions: Pay careful attention to each word and try to remember them as well as you can.

Light	Garbage	Fast	Want	Shoe	Door	Hard	Table	Water	Hot
Shade	Waste	Lethargic	Dream	Hand	Glass	Light	Sit	Stream	Heat
Table	Can	Stop	Desire	Toe	Pane	Pillow	Legs	Lake	Pipe
Bulb	Refuse	Listless	Hope	Kick	Shade	Plush	Seat	Mississippi	Cook
Post	Sewage	Snail	Well	Sandals	Ledge	Loud	Couch	Boat	Warm
Black	Bag	Cautious	Think	Soccer	Sill	Cotton	Desk	Tide	Fire
Cord	Junk	Delay	Star	Yard	House	Fur	Recliner	Swim	Oven
Desk	Rubbish	Traffic	Bone	Walk	Open	Touch	Sofa	Flow	Wood
Bright	Sweep	Turtle	Ring	Ankle	Curtain	Fluffy	Wood	Run	Kitchen
Lighter	Scraps	Hesitant	Wash	Arm	Frame	Feather	Cushion	Barge	Lid
Read	Pile	Speed	Thought	Boot	View	Furry	Swivel	Creek	Coal
On	Dump	Quick	Get	Inch	Breeze	Downy	Stool	Brook	Gas
Bed	Landfill	Sluggish	True	Sock	Sash	Kitten	Sitting	Fish	Iron
Burn	Debris	Wait	For	Smell	Screen	Skin	Rocking	Bridge	Range
Stand	Litter	Molasses	Money	Mouth	Shutter	Tender	Bench	Winding	Furnace

Recognition Test 1

These words are presented in a randomized order.

Instructions: Below is a list of words, some of which you just saw and others that were not shown. Please check ***OLD*** next to every word which you believe was shown a few minutes ago. Check ***NEW*** if the word was not presented before now.

Lamp	Trash	Slow	Wish	Foot	Window	Soft	Chair	River	Stove
Light	Garbage	Fast	Want	Shoe	Door	Hard	Table	Water	Hot
Desk	Rubbish	Traffic	Bone	Walk	Open	Touch	Sofa	Flow	Wood
Stand	Litter	Molasses	Money	Mouth	Shutter	Tender	Bench	Winding	Furnace
Butterfly	Flag	King	Beautiful	Car	Cabbage	Citizen	Long	Pen	Whiskey
Moth	Banner	Queen	Ugly	Truck	Head	United States	Short	Pencil	Drink
Flower	Wave	Throne	Picture	Ford	Leaf	Vote	Island	Scribble	Rye
Worm	Pendant	Reign	Gorgeous	Taxi	Soup	Member	Rope	Letter	Scotch

Color coding: Critical Lures; Presented Words; Words Not Presented (taken from Roediger et al., 2001 lists not used in our study; usually from positions 1, 8, and 15).

Word List Presentation Set 2

These 10 word lists are presented on screen for 2000ms, in order from top to bottom – with 3000 ms between the end of one list and the start of the next.

Instructions: Pay careful attention to each word and try to remember them as well as you can.

Mad	Peace	Town	Smooth	Hill	Note	Steal	Nurse	Hot	Thread
Fear	Law	Crowded	Bumpy	Valley	Sound	Robber	Sick	Snow	Pin
Hate	Courts	State	Road	Climb	Piano	Crook	Lawyer	Warm	Eye
Rage	Judge	Capital	Tough	Summit	Sing	Burglar	Medicine	Winter	Sewing
Temper	Right	Streets	Sandpaper	Top	Radio	Money	Health	Ice	Sharp
Fury	Liberty	Subway	Jagged	Molehill	Band	Cop	Hospital	Wet	Point
Ire	Government	Country	Ready	Peak	Melody	Bad	Dentist	Frigid	Prick
Wrath	Jury	New York	Coarse	Plain	Horn	Rob	Physician	Chilly	Thimble
Happy	Truth	Village	Uneven	Glacier	Concert	Jail	Ill	Heat	Haystack
Fight	Blind	Metropolis	Riders	Goat	Instrument	Gun	Patient	Weather	Thorn
Hatred	Fair	Big	Rugged	Bike	Symphony	Villain	Office	Freeze	Hurt
Mean	Supreme	Chicago	Sand	Climber	Jazz	Crime	Stethoscope	Air	Injection
Calm	Crime	Suburb	Boards	Range	Orchestra	Bank	Surgeon	Shiver	Syringe
Emotion	Department	County	Ground	Steep	Art	Bandit	Clinic	Arctic	Cloth
Enrage	Trial	Urban	Gravel	Ski	Rhythm	Criminal	Cure	Frost	Knitting

Recognition Test 2

These words are presented in a randomized order

Instructions: Below is a list of words, some of which you just saw and others that were not shown. Please check ***OLD*** next to every word which you believe was shown a few minutes ago. Check ***NEW*** if the word was not presented before now.

Anger	Justice	City	Rough	Mountain	Music	Thief	Doctor	Cold	Needle
Mad	Peace	Town	Smooth	Hill	Note	Steal	Nurse	Hot	Thread
Wrath	Jury	New York	Coarse	Plain	Horn	Rob	Physician	Chilly	Thimble
Enrage	Trial	Urban	Gravel	Ski	Rhythm	Criminal	Cure	Frost	Knitting
Girl	Army	Spider	Lion	Bitter	Carpet	Fruit	Mutton	Shirt	Bread
Boy	Navy	Web	Tiger	Sweet	Floor	Apple	Lamb	Blouse	Butter
Niece	Marines	Tarantula	Mane	Lemon	Tack	Banana	Veal	Polo	Flour
Sister	Combat	Small	Pride	Grape	Wool	Cocktail	Steak	Cuffs	Toast

Color coding: Critical Lures; Presented Words; Words Not Presented (taken from Roediger et al., 2001 lists not used in our study; usually from positions 1, 8, and 15).

Appendix A-1: DRM Critical Lures Rated for Emotional Arousal

Critical Lure	False Recog. Rates	Presentation Set	Valence	Arousal	Random Order of Presentation	Emotional Rank (by arousal)	BAS
Chair	.74	1	5.08	3.15	8	1	.303
Foot	.62	1	5.02	3.27	5	2	.177
Slow	.69	1	3.93	3.39	3	3	.172
Lamp	.63	1	5.41	3.80	1	4	.006
Window	.84	1	5.91	3.97	6	5	.184
Trash	.78	1	2.67	4.16	2	6	.140
River	.67	1	6.85	4.51	9	7	.035
Stove	.70	1	4.98	4.51	10	8	.147
Soft	.81	1	7.12	4.63	7	9	.179
Wish	.80	1	7.09	5.16	4	10	.012
Cold	.84	2	4.02	5.19	19	11	.353
City	.64	2	6.03	5.24	13	12	.185
Music	.69	2	8.13	5.32	16	13	.227
Rough	.83	2	4.74	5.33	14	14	.122
Needle	.68	2	3.82	5.36	20	15	.203
Justice	.76	2	7.78	5.47	12	16	.026
Mountain	.69	2	6.59	5.49	15	17	.154
Doctor	.71	2	5.20	5.86	18	18	.245
Thief	.70	2	2.13	6.89	17	19	.100
Anger	.79	2	2.34	7.63	11	20	.157

Note. BAS = Backward Associative Strength. Valence and arousal data from Bradley & Lang (1999); and false recognition and BAS data from Roediger et al. (2001).

Appendix B: Misinformation Materials (from Okado & Stark, 2005)

Photographic Slideshow 1

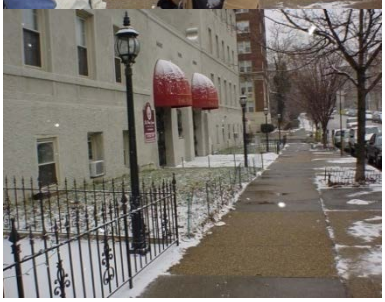
[Each of the following photographic slides were presented on screen for 3500ms]

Instructions to participants: We will now show you a slideshow of photographs depicting a story of a main character who we will call Jane. We will later ask you some questions about it. This slideshow will last about 3 minutes.


Now
Serving


Gordon Florist



Charles Village Pub


Photographic Slideshow 2

We will now show you a slideshow of photographs depicting a story of a man.
We will later ask you some questions about it.
This slideshow will last about 3 minutes.





Narrative 1 (includes misinformation)

[Presented approximately 40 minutes after the photographic slideshows. Both Group A and Group B received narratives that differed only on 6 items. *Italic type indicates misleading information,* whereas regular type is not misleading**.** This key was not visible to participants]

Narrations

Instructions to participants: A police detective looked at the photographic slides of the crime of the woman Jane having her purse stolen – the slideshow you saw earlier. The detective carefully viewed the slideshow several times, and then wrote a narrative about what he saw. On the next page, you will be shown the detective's narrative of the crime.

Please read each sentence carefully as it appears. You will have a few seconds on each sentence before the next one appears. This description will last about 5 minutes.

Please stay focused on reading and following the story for the whole time.

[Each of the following sentences were then presented on screen for 5500ms]

1. Jane was walking down Main Street in Baltimore.
2. She was window shopping and continued walking.
3. Jane stopped to look at a video store after passing a hair salon.
4. She went inside.
5. Jane bought something inside, and left the video store.
6. On her way up the stairs from the store, she saw a friend.
7. Jane waved hello, and he smiled.
8. The two friends hugged.
9. They chatted for a little while.
10. Jane indicated that she had bought something from the video store.
11. *Group A: She showed her friend the new Simpsons DVD.*
    Group B: She showed her friend the new DVD.
12. Her friend did not approve of her selection.
13. They continued to talk.
14. They then hugged goodbye.
15. They walked in opposite directions.
16. Jane continued down Main Street, passing by a woman on a cell phone.
17. A man was walking across the street towards Jane.
18. The man was headed directly towards the girl, who was oblivious to him.
19. The man bumped into Jane from behind.
20. This bump caused her bag to fall to the ground.
21. Her new DVD, sunglasses, mirror and other things fell out of the bag.
22. After he bumped into her, she felt sore and rubbed her arm.
23. The man apologized for running into her.
24. She was angry because all of her items were wet and on the ground.
25. Both of them stooped to the ground to pick up the items.

26. He placed her mirror back in the plastic bag, while she picked up her tape dispenser.
27. The girl stood up and turned around to make sure nothing else had fallen out.
28. Group A: While her back was turned, the man reached with his hand into her pocketbook.
    Group B: While her back was turned, the man reached with his right hand into her pocketbook.
29. *Group A: He took her wallet and hid it in his pants pocket.*
    Group B: He took her wallet and hid it in a pocket.
30. He helped her with her plastic bag that had a yellow smiley face on it.
31. They put the plastic bag back inside her other bag.
32. Jane shook his hand to thank him for helping her out.
33. The man headed back towards the street, first watching a man who was getting something out of his car trunk.
34. The man crossed the street.
35. As Jane continued down the street, the woman talking on her cell phone was finishing her conversation.
36. Group A: Jane took out her cell phone.
    Group B: Jane took out her blue cell phone.
37. Suddenly Jane realized that her wallet was missing.
38. She searched frantically in her bag for her wallet.
39. The woman who had been on the cell phone called out to Jane.
40. *Group A: The woman had a green backpack on.*
    Group B: The woman had a backpack on.
41. The woman explained what she had seen the man do and pointed towards the direction the man headed.
42. Jane looked across the street to see if he was there.
43. Unfortunately, the man had already disappeared.
44. Jane turned back to the woman with a disappointed look.
45. Jane shrugged her shoulders, realizing that she would not be able to catch up with him now.
46. Jane thanked the woman for trying to help her.
47. The two headed in opposite directions.
48. Jane turned a corner and disappeared.
49. The other side of the street still looked empty.
50. Group A: The man, who had been watching them, came out from his hiding place.
    Group B: The man, who had been watching them, came out from behind a tree.

Narrative 2

Narrations

Instructions to participants: A police detective looked at the photographic slides of the crime of the man breaking into the car – the slideshow you saw earlier. The detective carefully viewed the slideshow several times, and then wrote a narrative about what he saw. On the next page, you will be shown the detective's narrative of the crime.

Please read each sentence carefully as it appears, you will have a few seconds on each sentence before the next one appears.

This narrative will last about 5 minutes.

Please stay focused on reading and following the story for the whole time.

[Each of the following sentences were then presented on screen for 5500ms]

1. On a cloudy afternoon, a young man walked down a residential street.
2. He noticed a light purple car across the street.
3. He crossed the street and walked towards the car.
4. He looked into the car, which had a Johns Hopkins University sticker on the rear window.
5. He tried to open the driver-side door.
6. He looked around suspiciously to see if anyone noticed him by the car.
7. *Group A: He used a clothes hanger to open the car door.*

   Group B: He used an object to open the car door.
8. The door opened.
9. The young man pulled the driver's seat back so he could get in.
10. He then opened the change compartment.
11. He saw several bills and a few pennies in the compartment.
12. Group A: He examined the bills.

    Group B: He examined the $10 bills.
13. He put the money into his pocket.
14. He then looked into the back seat of the car.
15. He saw a purse and picked it up.
16. He found a purse and rummaged through it with his right hand.
17. Finding nothing in it, he threw down the purse in frustration.
18. Angry, the young man wondered what to do next.
19. The young man pulled the trunk lever to open it.
20. He got out of the car.
21. He left the front door open as he headed towards the trunk.
22. He approached the trunk to see if the lever worked.
23. He saw that the trunk had opened.
24. He opened the trunk all the way.
25. The young man was pleased with what he saw in the trunk.

26. He suddenly heard a sound nearby.
27. He suspiciously looked across the street and saw nobody there.
28. He turned his attention back to the trunk.
29. He pulled out a bag of cocaine.
30. *Group A: He also found a few rings.*

Group B: He also found a few pieces of jewelry

31. He put all of the items in his pocket.
32. He then closed the trunk door.
33. Group A: He accidentally slammed the trunk on his hand.

Group B: He accidentally slammed the trunk on his right hand.

34. Furious and in pain, he hit the car.
35. With a pained look on his face and holding his hands together, he walked towards the passenger-side door.
36. He approached the door.
37. He opened the door and got in.
38. He opened the glove compartment.
39. He rummaged through the compartment.
40. He closed the glove box.
41. *Group A: He then pulled down the sunshade and found a white parking permit.*

Group B: He then pulled down the sunshade and found a parking permit.

42. Not interested in it, he closed the sunshade.
43. The young man then got out of the car.
44. He closed the door.
45. Group A: He noticed that his shoe was untied and bent down to tie it.

Group B: He noticed that his right shoe was untied and bent down to tie it.

46. He stood up and wondered if there was anywhere else to look in the car.
47. Suddenly, he heard police sirens in the distance
48. He looked around to see in which direction it was coming from.
49. He then began to run in the opposite direction.
50. As he ran away, his hat fell off.

Test (misinformation paradigm materials continued)

[Occurred about one hour after the original slideshows, i.e. 20 minutes after the narratives. Note the **correct answers are in bold,** *misleading information answers are in italic,* and the foil answers are in regular type. This key was not visible to participants]

Memory Test for Picture Slideshow

For each of the following questions, select the answer that you yourself remember seeing in the original slideshows of photographs.
First consider the first slideshow of photographs, which involved a woman named Jane interacting with several people.

1. What is the name of the video store that Jane entered?
   a. Video Internationale
   b. Video Starrz
   c. **Video Americain**
2. After Jane leaves the video store, how does she greet her friend?
   a. She hugs him
   b. They shake hands
   c. They give each other a high five
3. Which DVD does Jane show her friend?
   a. The X-Files
   b. South Park
   c. The Simpsons (Condition A received this misinformation)
4. How does her friend react to her DVD selection?
   a. He seems pleased
   b. He seems displeased
   c. He seems neutral
5. Which hand did the man use to take Jane's wallet out of her bag?
   a. **Left**
   b. *Right* (Condition B received this misinformation)
   c. He did not use any hand to take her wallet from her bag.
6. After he takes her wallet out of her purse, where does he hide it?
   a. In his pants pocket (Condition A received this misinformation)
   b. In his sleeve
   c. In his jacket pocket
7. What color is the cell phone Jane takes out of her purse?
   a. Blue (Condition B received this misinformation)
   b. White
   c. Red
8. What color backpack did the other woman have on?
   a. **Red**
   b. Green (Condition A received this misinformation)
   c. Blue
9. Where does the man come out from after the girl is gone?

a. Inside a car
b. Behind a tree (Condition B received this misinformation)
c. **Behind a doorway**

Now consider the second slideshow of photographs of the man and the car.

10. What object did the young man use to break into the car?
    a. Screwdriver
    b. Clothes hanger (Condition A received this misinformation)
    c. Credit card
11. What type of bills did the man find in the car's change compartment?
    a. $1 bills
    b. $10 bills (Condition B received this misinformation)
    c. $20 bills
12. Where did the man put the money he found?
    a. Back pocket of his pants
    b. Front pocket of his pants
    c. Under his hat
13. While the man was looking in the trunk, what did he see across the street?
    a. A man walking a dog
    b. Nobody
    c. A couple holding hands
14. In addition to drugs, what did the man find in the trunk?
    a. A few rings (Condition A received this misinformation)
    b. Some diamond earrings
    c. A few necklaces
15. What happened when he closed the trunk?
    a. He slammed the trunk on his left hand
    b. He slammed the trunk on his right hand (Condition B received this misinformation)
    c. He was not hurt by the trunk
16. What did the man take out of the glove compartment?
    a. A cassette tape
    b. Sunglasses
    c. Nothing
17. When the man pulled down the sunshade, what did he find?
    a. A purple parking ticket
    b. *A white parking ticket (Condition A received this misinformation)*
    c. A key
18. After the man got out of the car, which shoe did he bend down to tie?
    a. He did not tie any shoe
    b. Left
    c. Right (Condition B received this misinformation)

Source Test

Memory Source Test

For each of the following questions (which are the same questions from the previous page), please choose the option that best describes how you arrived at the answer you gave.

First consider the first slideshow, which involved a woman named Jane interacting with several people.

1. What is the name of the video store that Jane entered?
    (a) I saw it in the picture only
    (b) I read it in the narrations only
    (c) I saw it in both and they were the same
    (d) I saw it in both and they conflicted with each other
    (e) I guessed

[Note that the same answer choices shown in Question 1 also followed every question listed here]

2. After Jane leaves the video store, how does she greet her friend?
3. Which DVD does Jane show her friend?
4. How does her friend react to her DVD selection?
5. Which hand did the man use to take Jane's wallet out of her bag?
6. After he takes her wallet out of her purse, where does he hide it?
7. What color is the cell phone Jane takes out of her purse?
8. What color backpack did the other woman have on?
9. Where does the man come out from after the girl is gone?

Now consider the second slideshow, which involved the man and the car.

10. What object did the young man use to break into the car?
11. What type of bills did the man find in the car's change compartment?
12. Where did the man put the money he found?
13. While the man was looking in the trunk, what did he see across the street?
14. In addition to drugs, what did the man find in the trunk?
15. What happened when he closed the trunk?
16. What did the man take out of the glove compartment?
17. When the man pulled down the sunshade, what did he find?
18. After the man got out of the car, which shoe did he bend down to tie?

Appendix C: News Footage Questionnaire Materials

Memories of News Events

Now we would like to gather some information about how well you remember news events. Please answer each of the following questions to the best of your ability.

1. As you may know, on September 11, 2001, United Airlines Flight 93 crashed in a field near Shanksville, Pennsylvania, killing all 44 people on board. Video footage of the plane crashing, taken by one of the witnesses on the ground, has been well publicized both by the news media and on the internet. Have you seen the video? (Check one)

Yes No

2. How well can you remember having seen the video?

1 2 3 4 5 6 7 8 9 10

(no memory at all) (very clear memory)

Please answer the following questions about your memory of the video footage of the United 93 crash.

3. The plane
   (a) came down vertically, nose down and almost without forward speed
   (b) slid into the ground almost horizontally and at considerable speed
   (c) I can't remember

4. After the impact
   (a) parts of the plane were visible in the wreckage
   (b) the plane's body disintegrated
   (c) the fire and smoke made it impossible to tell
   (d) I can't remember

5. The video footage was
   (a) very clear, you can see and hear exactly what is happening
   (b) fuzzy, it is difficult to tell what is happening
   (c) I can't remember

6. The footage was
   (a) less than 60 seconds long
   (b) between 1 and 2 minutes long
   (c) longer than 2 minutes
   (d) I can't remember.

7. My memory for the footage is

1 2 3 4 5 6 7 I can't remember

(dim) (sharp/clear)

8. My memory for the footage involves visual detail

1 2 3 4 5 6 7 I can't remember
(little or none) (a lot)

9. My memory for the footage involves sound
1 2 3 4 5 6 7 I can't remember
(little or none) (a lot)

10. Overall vividness of my memory of the footage is
1 2 3 4 5 6 7 I can't remember
(vague) (very vivid)

11. My memory for the location where the footage takes place is
1 2 3 4 5 6 7 I can't remember
(vague) (very vivid)

12. The video footage seems
1 2 3 4 5 6 7 I can't remember
(short) (long)

13. The overall tone of my memory for the video footage is
1 2 3 4 5 6 7 I can't remember
(extremely negative) (extremely positive)

14. I remember how I felt at the time I first saw the footage
1 2 3 4 5 6 7
(not at all) (definitely)

15. Feelings at the time that I first saw the video were
1 2 3 4 5 6 7 I can't remember
(extremely negative) (extremely positive)

16. Feelings at the time that I first saw the video were
1 2 3 4 5 6 7 I can't remember
(not intense) (very intense)

17. As I am remembering the footage now, my feelings are
1 2 3 4 5 6 7 I can't remember
(not intense) (very intense)

18. Since I saw the footage, I have thought about it
1 2 3 4 5 6 7
(not at all) (many times)

19. Since I saw the footage, I have talked about it
1 2 3 4 5 6 7
(not at all) (many times)

Appendix D: News Footage Interview Script

Interview Script

The last thing is a 5 minute recorded interview that is anonymous and confidential, so we will just use your participant number during the interview, and not your name. Please speak as freely as possible and answer all of questions with as much detail as you can. We are looking for what you really remember, there are no right or wrong answers, and it is okay if there is anything you cannot remember.

[AT THE BEGINNING OF EACH INTERVIEW START THE RECORDING WITH THE FOLLOWING WORDS]

"This is participant number _ _ _ _"

I want to ask you a few questions about how well you remember news events. As you might recall, on September 11, 2001, two planes were flown into the world trade center in New York City, one plane was flown into the Pentagon in Washington DC, and another plane, United 93 crashed into a field in rural Pennsylvania. The plane crash in Pennsylvania is the event we are interested in asking you about.

The other crashes on 9/11 have already been studied, so we are focusing only on United 93, the one that crashed in a field in Pennsylvania.

Are you familiar with this event?

Can you tell me what you remember about the event?

[LISTEN TO CHECK THEY UNDERSTAND IT IS ABOUT THE CRASH INTO THE FIELD]

As you might know, a witness on the ground in Pennsylvania took some video of the plane crashing and it has been widely shown on TV news and the Internet in the months and years since the attack.

Do you remember seeing that footage?

[IF YES]

Can you tell me what you remember about the footage?

[FREE RESPONSE]

Can you describe how the plane moved in the footage?

Do you remember how the plane crashed in the video?

How did you feel when you saw the footage of United 93 crash in Pennsylvania?

How vivid is your memory of that footage of the crash?

Do you remember how long the video is?

Do you remember if the video had sound?

If you did see the footage, where did you see it first? (Was it on the internet or TV, if so which channel)

Can you remember any additional details? Take a moment to think if you like.

Okay, now I'd like you to tell me how well you can remember having seen the video on a scale from 1 to 10 , where 1 means no memory at all and 10 means a very clear memory. **[END OF INTERVIEW]**

[IF NO]

Sometimes memories fade so we can't remember them, especially ones that are unpleasant or traumatic. However, we can use techniques that can help us find those memories.

[TALK SLOWLY, RAPPORT] If you don't mind, I'd like for you to close your eyes for a few moments. I would like you to use your imagination and try to picture what the footage may have looked like. Imagine you are watching it on your television or your computer screen. You are watching a video of the plane crashing, taken by a witness who is standing in a grassy field near the crash site. Just take a few moments and let any images or sounds come into your head.

[LET MORE THAN 30 SECONDS PASS DURING THIS EXERCISE, INCLUDING 10 SECONDS OF SILENCE AFTER THE LAST SENTENCE]

Keeping your eyes closed, can you describe to me what you are seeing in your mind's eye?

[PARTICIPANT RESPONDS - WAIT FOR THEM TO STOP TALKING AND WAIT A FEW SECONDS BEFORE MOVING ON]

Can you describe how the plane moves?

Describe how the plane crashes in the video?

What does the aftermath look like?

What about the people filming the video, do you hear them talking?

(You can now open your eyes).

Actually, several of the details you are giving me are exactly consistent with the video. So that's really good. Do you feel like you might be remembering the footage?

Do you remember how long the video is?

Where would you have been when you first saw it, right after 9/11?

Do you remember how you felt after seeing it?

Can you remember any additional details? Take a moment to think, if you like.

Okay, now I'd like you to tell me how well you can remember having seen the video on a scale from 1 to 10 , where 1 means no memory at all and 10 means a very clear memory.

Okay, now that the interview is over, I would like to ask you just one last question - Did you indicate that you had seen the United 93 footage in the computer questionnaire?

[If Yes]: Can you tell me why your answer changed from yes to no between the computer questionnaire and this interview? **[END OF INTERVIEW]**

Appendix E - Memory for Emotion Materials

[These questions were asked first in Session 1, and then one week later in Session 2.]

Questions on 9/11

Sometimes after tragic events like the terrorist attacks of September 11, 2001, people feel negative emotions.

1. In the week following the terrorist attacks of September 11, 2001, how often did you feel the following emotions?

Upset	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Distressed	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Scared	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Sad	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Confused	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Grief	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Angry	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Anxious	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Stressed	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Helpless	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Traumatized	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Frustrated	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Tense	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Jumpy	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)

Appendix F: Swedish Universities Personality Scale (SSP; Gustavsson, Bergman, Edman, Ekselius, von Knorring, & Linder, 2000).

INSTRUCTION

Below you will find a number of statements dealing with your habits, your opinions, your way of reacting and how you **usually** feel. There are four possible response alternatives to each statement: ”Does not apply at all”, ”Does not apply very well”, ”Applies pretty much”, and ”Applies completely.”

Your task is to choose the alternative that corresponds to your general way of acting or feeling, i.e. not how you are feeling right now, but rather how you usually feel.

The questions are given in the form of statements. Let’s begin with an example:

	Does not apply at all	Does not apply well	Applies very pretty much	Applies completely
I like outdoor activities.	☐	☐	☐	☐

Mark with an X the square that corresponds to the answer that best applies to you.

Work fast and don’t hesitate too long before answering. It is your spontaneous reaction that is important.

Please, don’t skip any questions!

SSP version 1.0

	Does not apply at all	Does not apply well	Applies very pretty much	Applies completely
1. I rather often find myself clenching my teeth for no reason.	☐	☐	☐	☐
2. I don't have much self-confidence.	☐	☐	☐	☐
3. I get tired and hurried too easily.	☐	☐	☐	☐
4. I find it hard to object if I'm treated badly at a restaurant.	☐	☐	☐	☐
5. I have a tendency to act on the spur of the moment without really thinking ahead.	☐	☐	☐	☐
6. I'm always keen on trying new things.	☐	☐	☐	☐
7. It is easy for me to get close to people.	☐	☐	☐	☐
8. I'm always polite and self-controlled, regardless of whom I talk to.	☐	☐	☐	☐
9. I have had my fair share of troubles in life.	☐	☐	☐	☐
10. Sometimes I get annoyed just by having people around me.	☐	☐	☐	☐
11. I get suspicious if somebody is particularly kind to me.	☐	☐	☐	☐
12. I often get into arguments with people who disagree with me.	☐	☐	☐	☐
13. Anyone who offends me or those near to me can count on trouble.	☐	☐	☐	☐
14. I often feel restless, as if I wanted something without knowing what.	☐	☐	☐	☐
15. I'm probably the kind of person who is excessively sensitive and easily hurt.	☐	☐	☐	☐
16. I don't mind being interrupted when I'm working with something.	☐	☐	☐	☐
17. Even if I know I'm right, I often have great difficulty being firm.	☐	☐	☐	☐
18. I often get so excited about new ideas and suggestions that I forget to check if there are any disadvantages.	☐	☐	☐	☐
19. I prefer people who do exciting and unexpected things.	☐	☐	☐	☐
20. I avoid people who are interested in my personal life.	☐	☐	☐	☐

	Does not apply at all	Does not apply well	Applies very pretty much	Applies completely
21. I'm always a good listener, regardless of whom I talk to.	☐	☐	☐	☐
22. I never seem to be able to avoid getting into trouble.	☐	☐	☐	☐
23. I'm easily annoyed with people.	☐	☐	☐	☐
24. I tend to be on my guard with people who are friendlier than I expected.	☐	☐	☐	☐
25. When people yell at me, I yell back.	☐	☐	☐	☐
26. If I caught someone stealing from me, I wouldn't hesitate to resort to violence.	☐	☐	☐	☐
27. My body often feels stiff and tense.	☐	☐	☐	☐
28. I seldom dare to express myself in a discussion because I have the feeling that people think my views are not worth anything.	☐	☐	☐	☐
29. In order to get something done I have to spend more energy than most others do.	☐	☐	☐	☐
30. When someone jumps the queue in front of me, I usually object.	☐	☐	☐	☐
31. I often embark on things too hastily.	☐	☐	☐	☐
32. I probably have an unusually great need for change.	☐	☐	☐	☐
33. I feel uncomfortable when people take me into their confidence.	☐	☐	☐	☐
34. I always help out when someone needs me.	☐	☐	☐	☐
35. I have often got into trouble even when it was not my fault.	☐	☐	☐	☐
36. I get impatient easily.	☐	☐	☐	☐
37. I don't believe that people tell me the whole truth.	☐	☐	☐	☐
38. I have never deliberately said something to hurt someone.	☐	☐	☐	☐
39. I always give back if someone hits me.	☐	☐	☐	☐
40. Sometimes my heart pounds hard or irregularly for no apparent reason.	☐	☐	☐	☐
41. It probably takes me an unusually long time to get over unpleasant events.	☐	☐	☐	☐
42. I can usually concentrate on what I'm doing even if the environment is distracting.	☐	☐	☐	☐

	Does not apply at all	Does not apply well	Applies very pretty much	Applies completely
43. I feel embarrassed about complaining when I get too little change back.	☐	☐	☐	☐
44. I'm the sort of person who takes things as they come.	☐	☐	☐	☐
45. I prefer to seek out places where exciting things take place.	☐	☐	☐	☐
46. I feel best when I keep people at a certain distance.	☐	☐	☐	☐
47. I never mind if people ask me a favor.	☐	☐	☐	☐
48. It looks as if I will never get the chance to get	☐	☐	☐	☐
49. I'm not a very patient person.	☐	☐	☐	☐
50. It's hard for me to trust other people.	☐	☐	☐	☐
51. I can't help being a bit snooty with people I don't like.	☐	☐	☐	☐
52. I wouldn't hesitate to resort to violence to defend my rights.	☐	☐	☐	☐
53. Sometimes I suddenly start sweating for no particular reason.	☐	☐	☐	☐
54. I often feel uneasy when I meet people I don't know too well.	☐	☐	☐	☐
55. I easily feel pressure when told to speed up my work.	☐	☐	☐	☐
56. When someone is teasing me, I never find a good answer until later.	☐	☐	☐	☐
57. I usually "talk before I think".	☐	☐	☐	☐
58. I almost always feel a need for more action.	☐	☐	☐	☐
59. I prefer not to get involved in other people's problems.	☐	☐	☐	☐
60. If I have made a mistake I'm always willing to admit it.	☐	☐	☐	☐
61. I seem to do things that I regret more often than other people do.	☐	☐	☐	☐
62. I often feel impatient when I have to stand in a queue.	☐	☐	☐	☐
63. Generally I don't trust people to tell the truth.	☐	☐	☐	☐

	Does not apply at all	Does not apply well	Applies very pretty much	Applies completely
64. When I get angry, I often express myself ironically or sarcastically.	☐	☐	☐	☐
65. If somebody hits me, I hit back.	☐	☐	☐	☐
66. An unexpected noise makes me jump.	☐	☐	☐	☐
67. I often worry about things that other people look upon as trifles.	☐	☐	☐	☐
68. I feel calm and secure even when I'm facing new tasks.	☐	☐	☐	☐
69. I sometimes wish that I could speak frankly when I dislike something.	☐	☐	☐	☐
70. When I make a decision I usually make it quickly.	☐	☐	☐	☐
71. Sometimes I like doing things just for the thrill of it.	☐	☐	☐	☐
72. I'm probably reserved and a little cold rather than kind and warm.	☐	☐	☐	☐
73. I'm always polite, even to unpleasant people.	☐	☐	☐	☐
74. There have been times when I was jealous of the good fortune of others.	☐	☐	☐	☐
75. I get irritated waiting for long-winded people.	☐	☐	☐	☐
76. I try to be on my guard to avoid being used by people.	☐	☐	☐	☐
77. If someone criticizes me, I'm not afraid of giving sharp and sarcastic answers.	☐	☐	☐	☐
78. I sometimes get so angry that people around me think I'll start to fight.	☐	☐	☐	☐
79. I sometimes have a feeling that I don't get enough air to breathe.	☐	☐	☐	☐
80. I worry far in advance when I'm going to get started on something.	☐	☐	☐	☐
81. I think I have less energy than most people I know.	☐	☐	☐	☐
82. I find it difficult to assert my opinions.	☐	☐	☐	☐
83. I consider myself an impulsive person.	☐	☐	☐	☐
84. To be on the move, travelling, change and excitement—that's the kind of life I like.	☐	☐	☐	☐

	Does not apply at all	Does not apply well	Applies very pretty much	Applies completely
85. People often come to me with their troubles.	☐	☐	☐	☐
86. I have been known to lie to get out of something I did not want to do.	☐	☐	☐	☐
87. I often feel as though I have done something wrong or unfair.	☐	☐	☐	☐
88. I often get irritated when I get delayed due to other people's mistakes.	☐	☐	☐	☐
89. I often have a feeling that certain people try to avoid me.	☐	☐	☐	☐
90. I'm good at making sarcastic commentaries.	☐	☐	☐	☐
91. If someone is treated badly by someone else, I think he or she should treat them the same way.	☐	☐	☐	☐

Please check that you have responded to all statements!

SSP Scales and Scoring
Scales:

SSP scale labels	Abbreviations
Somatic Trait Anxiety	STA
Psychic Trait Anxiety	PsTA
Stress Susceptibility	SS
Lack of Assertiveness	LA
Impulsiveness	I
Adventure Seeking	AS
Detachment	D
Social Desirability	SD
Embitterment	E
Trait Irritability	TI
Mistrust	M
Verbal Trait Aggression	VTA
Physical Trait Aggression	PhTA

In the next table, the seven items included in each scale are presented. The scoring ranges from 1 to 4; a score of 1 is given for the alternative ”Does not apply at all” and 4 for the alternative ”Applies completely.”

Scoring:

STA	PsTA	SS	LA	I	AS	D	SD	E	TI	M	VTA	PhTA
1	2	3	4	5	6	-7	8	9	10	11	12	13
14	15	-16	17	18	19	20	21	22	23	24	25	26
27	28	29	-30	31	32	33	34	35	36	37	-38	39
40	41	-42	43	44	45	46	47	48	49	50	51	52
53	54	55	56	57	58	59	60	61	62	63	64	65
66	67	-68	69	70	71	72	73	74	75	76	77	78
79	80	81	82	83	84	-85	-86	87	88	89	90	91

A minus sign in front of an item number indicates reversed scoring (items 7, 16, 30, 38, 42, 68, 85 and 86). Consequently, “Does not apply at all” scores 4 and “Applies completely” scores 1. Scale scores are obtained by summing the item scores and then dividing by the number of items included (i.e. 7).

Appendix G - Critical and Flexible Thinking Scales

[Critical Thinking Questions; composite compiled from West, Toplak, & Stanovich, 2009; but also see Kirkpatrick & Epstein, 1992; Levesque, 1986, 1989; Tversky & Kahneman, 1974; Stanovich, 2009]

Directions: Please read the following questions carefully and choose the best answer.

1. It is known that 1 dollar out of every 10,000 is counterfeit. Imagine a money-changing machine that rejects real dollar bills 5 out of every 100 times it changes money. However, it always rejects bills when they are counterfeit. If this machine rejects your dollar bill, what is the probability (expressed as a percentage ranging from 0% to 100%) that your bill is counterfeit? Choose the best answer.
(a) Less than 1%
(b) About 5%
(c) About 50%
(d) About 95%
(e) More than 95%

2. When playing slot machines, people win something about 1 in every 10 times. Lori, however, has just won on her first three plays. What are her chances of winning the next time she plays? Choose the best answer.
(a) She has better than 1 chance in 10 of winning on her next play
(b) She has less than 1 chance in 10 of winning on her next play
(c) She has a 1 chance in 10 that she will win on her next play.

3. A doctor had been working on a cure for a mysterious disease. Finally, he created a drug that he thought would cure people of the disease. Before he could begin to use it regularly, he had to test the drug. He selected 400 people at random who had the disease. Of the 400, he randomly assigned 300 to the treatment group and gave them the drug to see what happened. He randomly assigned 100 people to the no-treatment group and gave them a placebo (a sugar pill manufactured to look like the treatment drug) to see what happened. Table 1below indicates the outcome:

	Group	
Drug condition	Cured	Not cured
Received	200	100
Did not receive	75	25

Table 1.

Choose the statement that best summarized the results shown in the table from among the following statements:
(a) The evidence indicates that the drug was effective
(b) The evidence is inconclusive
(c) The evidence indicates that the drug was not effective

4. Assume that you are presented with two trays of black and white marbles: a large tray that contains 100 marbles and a small tray that contains 10 marbles. The marbles are spread in a single layer on each tray. You must draw out 1 marble (without peeking, of course) from either tray. If you draw a black marble, you win $2.
Consider a condition in which the small tray contains 1 black marble and 9 white marbles, and the large tray contains 8 black marbles and 92 white marbles.
From which tray would you prefer to select a marble in a real situation?
(a) small tray

(b) large tray

5. There are 3 blocks in a stack, where each of the blocks is either new or old. The top block is new, and the bottom one is old. The middle block is either new or old. Is there a new block directly on top of an old block?
(a) Yes,
(b) No
(c) Cannot be determined.

6. A certain town is served by two hospitals. In the larger hospital, about 45 babies are born each day, and in the smaller hospital, about 15 babies are born each day. As you know, about 50 percent of all babies are boys. However, the exact percentage varies from day to day. Sometimes it is higher than 50 percent, sometimes lower. For a period of one year, each hospital recorded the days on which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?
(a) The larger hospital
(b) The smaller hospital
(c) About the same

16. Imagine an urn filled with balls, two-thirds of which are of one color and one-third of which are of another. Tom has drawn 5 balls from the urn and found that 4 are red and 1 is white. Ben has drawn 20 balls and found that 12 are red and 8 are white. Which of the two individuals should feel more confident that the urn contains two-thirds red balls and one-third white balls, rather than vice versa?
(a) Tom
(b) Ben

17. Jack is looking at Anne but Anne is looking at George. Jack is married but George is not. Is a married person looking at an unmarried person?
(a) Yes
(b) No
(c) Cannot be determined

18. A bat and ball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost?

_____cents

Flexible Thinking Scale; Stanovich & West, 1997

Directions: For the next group of questions indicate by choosing the number that corresponds to the degree to which you disagree or agree with each statement:

1. If I think longer about a problem I will be more likely to solve it

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

2. Difficulties can usually be overcome by thinking about the problem, rather than through waiting for good fortune

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

3. Intuition is the best guide in making decisions

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

4. Coming to decisions quickly is a sign of wisdom

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

5. People should always take into consideration evidence that goes against their beliefs

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

6. A person should always consider new possibilities

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

7. Considering too many different opinions often leads to bad decisions

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

8. There is nothing wrong with being undecided about many issues

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

9. Changing your mind is a sign of weakness

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

10. Basically, I know everything I need to know about the important things in life

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

Appendix H: Memory Belief Questions

Wording used in questionnaire	Source
(1) In this question, we are interested in whether sexual abuse experienced in childhood may influence the person's adult life. There are no correct or incorrect answers. It is your personal opinion that is important. Imagine a person with longstanding emotional problems and a need for psychotherapy. How plausible do you think it is that this person is a victim of childhood sexual abuse, even though the person is unable to remember the abuse?[a]	Rubin & Berntsen (2007)
Instructions: To what extent do you disagree or agree with the following statements: [b]	
(2) Traumatic memories are often repressed (which means the person cannot remember the traumatic event due to a defense against painful content).	new
(3) Repressed memories can be retrieved in therapy accurately.	new
(4) Memory can be unreliable.	new
(5) Hypnosis can accurately retrieve memories that previously were not known to the person.	new
(6) Memory is constantly being reconstructed and changed every time we remember something.	new
(7) The memory of everything we've experienced is stored permanently in our brains, even if we can't access all of it	Lilienfeld et al. (2010)[c]
(8) Some people have true "photographic memories."	Lilienfeld et al. (2010)
(9) With effort, we can remember events back to birth.	Lilienfeld et al. (2010)

Note. [a]Question (1) Likert scale: 1 = *very implausible*; 2 = *implausible*; 3 = *plausible*; 4 = *very plausible*. [b]Questions (2) through (9) Likert scale: 1 = *strongly disagree*; 2 = *disagree*; 3 = *slightly disagree*; 4 = *slightly agree*; 5 = *agree*; 6 = *disagree*. [c]Lilienfeld, Lynn, Ruscio, & Beyerstein (2010).

Appendix I: Sleep Log Material

Evening of:

1. Time you went to bed:_____
2. Approximately how long did it take you to fall asleep? _____
3. Time that you got out of bed in the morning: _____
4. Did you feel well-rested when you awoke? Yes No
5. Approximately how many times did you awake last night? _____
    a) What was the total amount of time that you were awake (approximately)? _____
6. What is the total amount of time that you slept? _____
7. Did you nap at all during the day (following this evening)? Yes No
    a) What is the total amount of time that you slept during this nap? _____

[Note participants had seven of these logs to fill in, and they usually did so by editing the Word document file, by email, or in some cases on paper.]

Appendix J: Absorption (Tellegen Absorption Scale; Tellegen & Atkinson, 1974)

Personal Attitudes and Experiences

Directions: This questionnaire consists of questions about experiences that you may have had in your life. We are interested in how often you have these experiences. It is important, however, that your answers show how often these experiences happen to you when you **are not** under the influence of alcohol or drugs. To answer the questions, please determine to what degree the experience described in the question applies to you and choose the option to show how much of the time you have the experience.

1. Sometimes I feel and experience things as I did when I was a child.

□ □ □ □
Never Always

2. I can be greatly moved by eloquent or poetic language.

□ □ □ □
Never Always

3. While watching a movie, a TV show, or a play, I may become so involved that I may forget about myself and my surroundings and experience the story as if it were real and as if I were taking part in it.

□ □ □ □
Never Always

4. If I stare at a picture and then look away from it, I can sometimes "see" an image of the picture almost as if I were still looking at it.

□ □ □ □
Never Always

5. Sometimes I feel as if my mind could envelop the whole world.

□ □ □ □
Never Always

6. I like to watch cloud shapes change in the sky.

□ □ □ □
Never Always

7. If I wish I can imagine (or daydream) some things so vividly that they hold my attention as a good movie or story does.

□ □ □ □
Never Always

8. I think I really know what some people mean when they talk about mystical experiences.

□ □ □ □
Never Always

9. I sometimes "step outside" my usual self and experience an entirely different state of being.

□ □ □ □
Never Always

10. Textures -- such as wool, sand, wood -- sometimes remind me of colors or music.

□ □ □ □
Never Always

11. Sometimes I experience things as if they were doubly real.

□ □ □ □
Never Always

12. When I listen to music I can get so caught up in it that I don't notice anything else.

□ □ □ □

Never Always

13. If I wish I can imagine that my body is so heavy that I could not move it if I wanted to.

□ □ □ □

Never Always

14. I can often somehow sense the presence of another person before I actually see or hear her/him.

□ □ □ □

Never Always

15. The crackle and flames of a wood fire stimulate my imagination.

□ □ □ □

Never Always

16. It is sometimes possible for me to be completely immersed in nature or in art and to feel as if my whole state of consciousness has somehow been temporarily altered.

□ □ □ □

Never Always

17. Different colors have distinctive and special meanings for me.

□ □ □ □

Never Always

18. I am able to wander off into my thoughts while doing a routine task and actually forget that I am doing the task, and then find a few minutes later that I have completed it.

□ □ □ □

Never Always

19. I can sometimes recollect certain past experiences in my life with such clarity and vividness that it is like living them again or almost so.

□ □ □ □

Never Always

20. Things that might seem meaningless to others often make sense to me.

□ □ □ □

Never Always

21. While acting in a play I think I could really feel the emotions of the character and "become" her/him for the time being, forgetting both myself and the audience.

□ □ □ □

Never Always

22. My thoughts often don't occur as words but as visual images.

□ □ □ □

Never Always

23. I often take delight in small things (like the five-pointed star shape that appears when you cut an apple across the core or the colors in soap bubbles).

□ □ □ □

Never Always

24. When listening to organ music or other powerful music I sometimes feel as if I am being lifted into the air.

□ □ □ □

Never Always

25. Sometimes I can change noise into music by the way I listen to it.

□ □ □ □

Never Always

26. Some of my most vivid memories are called up by scents and smells.

□ □ □ □

Never Always

27. Some music reminds me of pictures or changing color patterns.

□ □ □ □

Never Always

28. I often know what someone is going to say before he or she says it.

□ □ □ □

Never Always

29. I often have "physical memories"; for example, after I have been swimming I may still feel as if I am in the water.

□ □ □ □

Never Always

30. The sound of a voice can be so fascinating to me that I can just go on listening to it.

□ □ □ □

Never Always

31. At times I somehow feel the presence of someone who is not physically there.

□ □ □ □

Never Always

32. Sometimes thoughts and images come to me without the slightest effort on my part.

□ □ □ □

Never Always

33. I find that different odors have different colors.

□ □ □ □

Never Always

34. I can be deeply moved by a sunset.

□ □ □ □

Never Always

Appendix K: Creative Experiences Questionnaire (CEQ; fantasy proneness)

(Merckelbach, Muris, & Rassin, 1999; Merckelbach, Horselenberg, & Muris 2001)

1. As a child, I thought that the dolls, teddy bears, and stuffed animals that I played with were living creatures.
2. As a child, I strongly believed in the existence of dwarfs, elves, and other fairy rale figures.
3. As a child, I had my own make believe friend or animal.
4. As a child, I could very easily identify with the main character of a story and/or movie.
5. As a child, I sometimes had the feeling that I was someone else (e.g. a princess, an orphan, etc).
6. As a child, I was encouraged by adults (parents, grandparents, brothers, sisters) to fully indulge myself in my fantasies and daydreams.
7. As a child, I often felt lonely.
8. As a child, I devoted my time to playing a musical instrument, dancing, acting, and/or drawing.
9. I spend more than half the day (daytime) fantasizing or daydreaming.
10. Many of my friends and/or relatives do not know I have such detailed fantasies.
11. Many of my fantasies have a realistic intensity.
12. Many of my fantasies are often just as lively as a good movie.
13. I often confuse fantasies with real memories.
14. I am never bored because I start fantasizing when things get boring.
15. Sometimes I act as if I am somebody else and I completely identify myself with that role.
16. When I recall my childhood, I have very vivid and lively memories.
17. I can recall many occurences before the age of three.
18. When I perceive violence on television, I get so into it that I get really upset.
19. When I think of something cold, I actually get cold.
20. When I imagine I have eaten rotten food, I really get nauseous,
21. I often have the feeling that I can predict things that are bound to happen in the future.
22. I often have the experience of thinking of someone and soon afterwards that particular person calls or shows up.
23. I sometimes feel that I have had an out of body experience.
24. When I sing or write something, I sometimes have the feeling that someone or something outside myself directs me.
25. During my life, I have had intense religious experiences which influenced me in a very strong manner.

Scoring: Yes answers are summed for a score in the range 0 to 25

Appendix L: Empathy: Basic Empathy Scale (Joliffe & Farrington, 2006)

The following are characteristics that may or may not apply to you. Please tick one answer for each statement to indicate how much you agree or disagree with each statement. Please answer as honestly as you can.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. My friend's emotions don't affect me much.	☐	☐	☐	☐	☐
2. After being with a friend who is sad about something, I usually feel sad.	☐	☐	☐	☐	☐
3. I can understand my friend's happiness when she/he does well at something.	☐	☐	☐	☐	☐
4. I get frightened when I watch characters in a good scary movie.	☐	☐	☐	☐	☐
5. I get caught up in other people's feelings easily.	☐	☐	☐	☐	☐
6. I find it hard to know when my friends are frightened.	☐	☐	☐	☐	☐
7. I don't become sad when I see other people crying.	☐	☐	☐	☐	☐
8. Other people's feelings don't bother me at all.	☐	☐	☐	☐	☐
9. When someone is feeling 'down' I can usually understand how they feel.	☐	☐	☐	☐	☐
10. I can usually work out when my friends are scared.	☐	☐	☐	☐	☐
11. I often become sad when watching sad things on TV or in films.	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
12. I can often understand how people are feeling even before they tell me.	☐	☐	☐	☐	☐
13. Seeing a person who has been angered has no effect on my feelings.	☐	☐	☐	☐	☐
14. I can usually work out when people are cheerful	☐	☐	☐	☐	☐
15. I tend to feel scared when I am with friends who are afraid.	☐	☐	☐	☐	☐
16. I can usually realize quickly when a friend is angry.	☐	☐	☐	☐	☐
17. I often get swept up in my friend's feelings.	☐	☐	☐	☐	☐
18. My friend's unhappiness doesn't make me feel anything.	☐	☐	☐	☐	☐
19. I am not usually aware of my friend's feelings	☐	☐	☐	☐	☐
20. I have trouble figuring out when my friends are happy.	☐	☐	☐	☐	☐

Appendix M: Sample Nonexistent News Footage Interview Transcript Excerpts

Excerpts from a HSAM Participant's Interview Showing False Memory

Interviewer: As you might recall, on September 11 2001, two planes were flown into the World Trade Center in New York City, one plane was flow into the Pentagon in Washington DC, and another plane, United 93 crashed in a field in rural Pennsylvania. The plane crash in Pennsylvania is the event we are interested in asking you about. The other crashes on 9/11 have already been studied, so we focusing only on united 93, the one that crashed in a field in Pennsylvania. Are you familiar with this event?

HSAM (subject number 2): Oh yes.

Interviewer: Can you tell me what you remember about the event?

HSAM: Um, What I can remember from the event that I went home. Uh, I went home that afternoon, uh, saw it on the news. Basically, what I remember is that there was a field that had; a plane that had crashed in a field that day. The stories alleged that it was headed to the White House although nobody really knew for sure. Uh, it was later determined that uh, the passengers uh, overpowered the hijackers, and caused it to uh, caused it to, uh, to end up in Pennsylvania. I think it was something like. I am not sure about this but I think it was a flight out of Cleveland that was headed for I don't remember. And I'm not, I think it was headed out of Cleveland but I can't say with certainty. Uh, and a couple of days later I saw the footage of the video.

Interviewer: Okay well, as you mentioned and as you might know, a witness on the ground in Pennsylvania took some video of the plane crashing and it has been widely shown on TV news and the internet in the months and years since the attack. Do you remember seeing that footage?

HSAM: Yes, but a couple of days later.

Interviewer: OK, Can you tell me what you remember about the footage?

HSAM: Uh, I saw it going down. I didn't see all of it. I saw, uh a lot of it going down uh, on air.

…

Interviewer: Ok, do you remember how long the video is?

HSAM: Just a few seconds. It wasn't long. It just seemed like something was falling out of the sky. It was probably was really fast, but I was just, you know, kind of stunned by watching it you know, go down.

…

Interviewer: Ok, so now is the last question, I would like for you tell me how well you can remember having seen the video on the scale from 1 to 10 where 1 means no memory at all and 10 means a very clear memory?

HSAM: I'd say about 7.

Excerpts from a Control Participant's (without HSAM) Interview Showing False Memory

Interviewer: As you might recall, on September 11, 2001, two planes were flown into the World Trade Center in New York City, one plane was flow into the Pentagon in Washington DC, and another plane, United 93 crashed in a field in rural Pennsylvania. The plane crash in Pennsylvania is the event we are interested in asking you about. The other crashes on 9/11 have already been studied, so we focusing only on united 93, the one that crashed in a field in Pennsylvania. Are you familiar with this event?

Non-HSAM (subject number 130168): Yes a little bit.

Interviewer: Can you tell me what you remember about the event?

Non-HSAM: I don't remember so much of that one because a lot of the attention was on the two planes that hit the buildings, but I did hear that another landed somewhere else, and I think there was some kind of uprising—something happened during it and we don't exactly where it was headed but where it landed wasn't the intended destination, and that is about as familiar I am with it.

Interviewer: As you might know, a witness on the ground in Pennsylvania took some video of the plane crashing and it has been widely shown on TV news and the internet in the months and years since the attack. Do you remember seeing that footage?

Non-HSAM: Very vaguely, I think it was kind of blurry the noise was kind of sharp in some places. It wasn't high resolution by any means but the resolution was okay considering its time. I don't remember the specific details of the video-how long it was or what was in the context of it, but I vaguely remember seeing it.

…

Interviewer: Can you describe how the plane moved in the footage?

Non-HSAM: I think what I am remembering is that it was a little rocky but I don't think the camera was very steady but it didn't look very stable as it was moving across the screen.

Interviewer: Do you remember how the plane crashed in the video?

Non-HSAM: I don't think it was a hard crash, but it wasn't a soft one by any means I think there was definitely impact and definitely injuries I think, or if I had been there I imagine I would have been injured, so definitely looked impromptu and not planned at all.

…

Interviewer: Ok, now, I would like for you tell me how well you can remember having seen the video on the scale from 1 to 10 where 1 means no memory at all and 10 means a very clear memory?...

Non-HSAM: …I would say about a 7.

Appendix N: Example of a HSAM Individual's Response that Demonstrated Detailed Autobiographical Memory Ability

Interviewer: Can you tell me what you remember about the event?

HSAM (subject number 4): Sure, what I remember about Shanksville… Pennsylvania was that I heard about it of course after the other three attacks, and it was almost like an aftermath event because September 10th, excuse me, September 11th was a very patriotic day and I remember that Tuesday of course, everything you saw on the news was about the World Trade Center.

In fact just to backtrack a bit in order to explain what I remember about Shanksville, is that I remember seeing of course the World Trade Center on TV, I had had to, I usually had my Tuesday morning yoga class, I would study in the library before yoga, and then right before yoga I would come to eat lunch in my dorm room because I didn't have time for cafeteria lunch, and so as my roommate Lisa is getting ready and as we're watching the TV, we hadn't turned on the TV all day and so we finally turned it on and we're trying to see the Maury show, because it usually came on in the morning in New York, and all we saw was just purple smoke in New York City, and Tom Brokaw speaking, and so we thought okay, a special report, maybe there's a plane crash or something in the area, and then she turns to go to the mirror to do her hair, she was blow drying her hair, and I'm sitting on this, this chair eating my easy mac macaroni and cheese and, that's when they showed the recap of the second tower falling and I remember screaming like it was a horror movie because someone just blew up the World Trade Center, and so, again it was a lot of chaos, and shortly afterwards we found out that classes were canceled, we were a Catholic women's school so there was a memorial service in the chapel, people trying to find out if their loved ones were okay, I had my aunt and uncle working in lower Manhattan, and you know, trying to find out if they made it home okay, which they eventually did.

My best friend Sara, she, I remember hugging her and crying and we stayed in her dorm room the whole time pretty much after mass. And I remember one of the memories also about that day, and again trying to relate this to Shanksville is that, we had an emergency meeting in the dorms, and again a very black day, but Sara and I always joke about it because of the way the [job title redacted] handled himself. The [job title redacted] was trying to get this meeting together of all the women to explain what was going on, and it was a very hot day, and he assembled us all on the porch of the dorm, and it's like eighty something degrees in Westchester County New York, and so all he was saying all I remember him saying was "I am [Name Redacted] I am [Name Redacted], there are no planes flying today I am [Name Redacted]." And that was the whole extent of his meeting, and that's why me and Sara just made fun of the fact that he's really ineffective in being a leader in emergencies.

And so, as things are coming together, as I'm watching the news, because the whole day pretty much just stayed in her dorm room, and I think we just went out to dinner at the cafeteria, and that was about it, just stayed in her room the whole day watching the TV and in the aftermath that's when we heard about Shanksville. To my memory, and you know I didn't see any video of the plane going down in Shanksville , not like I saw with the recaps of the World Trade Center, or even with the burst of fire that you saw from the distance of the Pentagon. I just remember seeing footage of the plane being down. I remember like it looked like a crumpled up ball of metal, like you could see the nose, I think you could see wings, some windows, and just a little bit of smoke, it was kind of like a greyish picture in this field in Shanksville. And, that's all

I remember about it and they were later connecting it, or figured out that this was the fourth plane.

I remember very much, of course, the story about Todd Beamer and how he supposedly said "Let's roll." I remember very much the fact that his wife was pregnant, I think they found out that they were having a boy, and that boy should be about ten years old today, so definitely I remember the Todd Beamer story and thinking how sad it was for his, not so much for his, I didn't think about the baby losing the father but my sympathies most with the wife that here's your husband who's supposed to be your best friend and he's died and you're left to raise this child alone. So that was what really stood out to me.

Note. Personal (not news-related) names were changed in this excerpt. Minor redactions were made to protect anonymity. "Um" and "uh"s removed for ease of read.