Western Undergraduate Psychology Journal

Volume 1 | Issue 1 Article 6

1-3-2014

How Much do We Really Remember About 9/11? A Critical Analysis of the Neuroscience Behind Flashbulb Memories

Michael Salna
UWO

How Much do We *Really* Remember About 9/11? A Critical Analysis of the Neuroscience Behind Flashbulb Memories

Michael Salna*

"I remember it like it was yesterday" is a phrase often heard in relation to an emotional and vivid memory of some episode. Brown and Kulik (1977) defined these memories in the context of momentous public events as "flashbulb memories." Many remember where they were or who they were with when they heard of the terrorist attacks on September 11th, 2001. However, an emerging body of literature suggests that the defining characteristic of these flashbulb memories is the confidence in their accurate recall, rather than their true accuracy. This paper examines the issues of confidence and memory as they relate to 9/11 and whether stress at the time of encoding merely improves the confidence of recall.

Do you recall where you were when you first heard about the September 11th events? Who first told you? How they described it? Flashbulb memories (FBMs) are long-lasting and exceptionally vivid autobiographical memories of emotional events. Brown and Kulik coined the term "flashbulb memories" in 1977 and described these memories as if the mind had taken "snapshots" of the circumstances in which the memory took place (Brown & Kulik, 1977). FBMs are considered episodic memories (memories of past experiences) rather than event memories (more factual and semantically-based; Tulving, 1972) because of the large role an individual's emotional involvement in the original experience plays (Curci et al., 2006). Vivid, flashbulb-like memories have been reported in the assassinations of President John F. Kennedy and Martin Luther King, Jr., the Challenger explosion, and most recently, the terrorist attacks of September 11th, 2001 (Talarico & Rubin, 2003).

Cognitive neuroscientists study FBMs because they can illustrate the influence of emotions, particularly stress, on episodic memory recall confidence and accuracy. Considerable work has been done on how stress modulates memory. After task-learning, stress facilitates memory retention in rodents (McGaugh, Cahill, & Roozendaal, 1996). Similarly, amygdalar arousal in humans has been found to enhance retrieval for emotional episodic memories (Hamann, Ely, Grafton, & Kilts, 1999). The intense shock and negative valence of FBM events is believed to account for the vivid, detailed recollection and confidence individuals have in these memories. However, an emerging body of evidence suggests that it is the "feeling of remembering," rather than accurate factual recall (declarative memory), that is augmented with highly emotional memories (Rimmele et al., 2011; Sharot et al., 2004). Due to the infrequency of events such as 9/11, little work has been done to examine the accuracy and underlying neuroscience of FBMs. This report will explore two papers that speak to these parameters and analyze the discrepancies in arousal, confidence, and recall within the context of 9/11 FBMs.

Sharot et al. (2007) explored the mechanisms underlying FBMs using neuroimaging techniques on 24 New York City residents who were in Manhattan during the September 11th attacks. Structural MRI scans of subjects' brains were performed and followed by three fMRI scans. During the fMRI scans, participants were shown 20 pairs of words, each consisting of a "cue" word and a "trial" word. The cue words came from a list of 60 words designed to elicit subjective memories (eg. "building," "radio," and "photograph") and the trial words put the cue words into context using either "September" (suggesting the 9/11 attacks) or "summer" (referring to events experienced

*Initially submitted for Psychology 3224A at the University of Western Ontario. For inquiries regarding the article, please email the author at *msalna@uwo.ca*.

during the summer). After scanning, participants rated their memories on six factors selected to characterize their recollective experiences: arousal, vividness, reliving, remember/know, confidence, and valence. They completed the study by writing narratives of their 9/11 and summer memories.

Proximity to the World Trade Center (WTC) at the time of the attack proved to be the most significant factor in recollective experience measures. Those participants who were Downtown, and thus closer to the WTC, not only recalled 9/11 memories with more coherent and vivid narratives than those who were Midtown, but also reported higher levels of negative valence related to the 9/11 attacks relative to summer events. Within the Downtown group, 41% mentioned a direct personal threat from the attacks, such as avoiding falling debris, while none of the Midtown group participants mentioned any threats. Moreover, the entire Downtown group reported seeing or hearing the buildings collapse with only 60% of the Midtown group mentioning similar experiences. No differences were found between the Downtown and Midtown groups for summer memories, though Downtown participants were more confident in their recalls and provided greater detail of 9/11 memories than the Midtown group.

The aforementioned memory recollection differences illustrate that the quantity and quality of recollected 9/11 memories were enhanced in participants closer to the danger. Therefore, fMRI scans were expected to show increased activation of neural circuits related to the recollection of emotional memories in Downtown participants. The amygdala, a limbic structure that generates stress responses and modulates emotional memory, proved to be significantly more active in the Downtown group than the Midtown group during recall of 9/11 memories relative to summer memories. The differences in memory recollection and the increased activation of the amygdala suggest that memories of these emotional evens are more vivid, however, not necessarily more accurate.

Sharot and her colleagues (2007) also found a decrease in parahippocampal cortex (PHC) activity during the retrieval of 9/11 memories from the Downtown group relative to the Midtown group. The PHC is believed to have a role in the processing and recognition of scene details in episodic memory (Kohler, Crane, & Milner, 2002). During arousal, attention may be focused on the central arousing aspects of the event (for example, falling debris or the collapse of the towers) rather than peripheral details of the environment. This would result in a failure to encode such details. Though not addressed by Sharot et al., studies on false memories have revealed correlations between decreased parahippocampal activity and false memory recall (Cabeza et al., 2001). These data suggest that the decreased PHC activity observed during 9/11 memory retrieval may correspond with false memory recollection for specific environmental details.

Sharot et al. (2007) acknowledged the practical constraints in measuring memory accuracy due to their study taking place three years after 9/11. This confounding variable could have been compensated for by examining relative hippocampal activation between 9/11 and summer memories in their Downtown and Midtown groups. The hippocampus has long been known to be involved in the encoding and long-term storage of episodic memories, and increased hippocampal activation has been reported when information is correctly recollected (Eldridge, Knowlton, Furmanski, Bookheimer, & Engel, 2000). Therefore, analyzing hippocampal activation would have afforded some inferences of recall accuracy despite the long time period separating encoding and recall.

Jennifer Talarico and David Rubin (2003) challenged the accuracy of 9/11 FBMs by probing the memories of 54 Duke University students on September 12, 2001, one day after the terrorist attacks. These students completed open-ended questionnaires designed to probe both their memories of the circumstances surrounding their first hearing of the 9/11 terrorist attacks and memories of a recent every

day event. They also completed the Autobiographical Memory Questionnaire, a rating-scale that assesses different properties of autobiographical memories. Measurements included scales of "recollection" (how much you "feel as if you are reliving the experience"), "belief" (belief that the event in your memory occurred the way you remember it), and a rating of how much participants could "see, hear, and feel the setting where [the memory] occurred" (Talarico & Brown, 2003). As emotion is an important characteristic for FBMs, the students rated their emotional intensity, valence, and visceral responses to the 9/11 and every day event memories.

After the initial questionnaires, participants were randomly assigned to one of three follow-up groups (n=18 for each group). The same questions were asked again on either day seven, 42, or 242 following the initial questioning in order to measure the memory consistency. During the second session, the every-day event recall was cued with a description participants provided in the initial session and the flashbulb event (9/11) was cued with a question identical to that of the first session: "how you first heard about the news of the attacks on America on Tuesday, September 11, 2001" (Talarico & Brown, 2003). Using cues that did not provide any novel information ensured that there was no preferential memory retrieval from suggestive questioning when probing participants' memories. The recall data were scored by two independent raters. Memory details were judged as consistent if participants used the same or similar words to describe the memories in both sessions.

The results elaborate on those of Sharot et al. (2007). While FBMs demonstrated higher emotional intensity, detail and negative valence, they were not immune to being forgotten. In fact, both FBMs and memories of everyday events decayed at the same rate, with no statistical difference between the reduction in consistent details and increase in inconsistent details over time. In contrast to Brown and Kulik's (1977) emphasis on the retention of irrelevant details in FBMs, Talarico and Brown (2003) found that 42% of the inconsistencies in 9/11 memories were for distinctive details such as the time, place, and participants' activities upon first hearing the news. Interestingly, despite this decline in accuracy, the participants' reported levels of recollection and vividness remained high and constant for FBMs while those for everyday memories progressively declined over time. Furthermore, the 9/11 memories were narrated more coherently and were less fragmented than everyday memories across all of the sessions. Together, these results suggest that participants believed their 9/11 memories were more accurate than everyday memories. Talarico and Rubin (2003) conclude that it is this vividness and exaggerated confidence in FBMs that, while unrelated to consistency, lead to participants' convictions of a flashbulb's accuracy.

It must be noted that the young age of Sharot et al. (2007) and Talarico and Rubin's (2003) subjects, 20 to 33 and 20 to 25 years of age respectively, may limit how representative the retrieval and memory data is of broader demographics. However, Wolters and Goudsmit (2007) arrived at the same set of conclusions using college students (M = 24.8 years of age) and healthy elderly subjects (M = 70.5 years of age) in their ability to remember 9/11 memories.

The findings of these two studies provide a complementary understanding of the mechanisms and characteristics underlying FBMs. Both papers speak to the highly emotional and detailed content of FBMs relative to everyday episodic memories. FBMs have been referenced as a preferential type of episodic memory – one with extremely confident recollection of details (Conway et al., 1994). While both Sharot et al. (2007) and Talarico and Rubin's (2003) results cite the correlation between confident recollection and arousal, Talarico and Rubin directly illustrate that this arousal does not translate into accurate recollection (Talarico & Rubin, 2003). Sharot et al.'s finding of decreased PHC activity in conjunction with increased amygdalar arousal may empirically support this finding, given previous reports outlining the correlation

between decreased PHC activity and the retention of false or distorted memories (Cabeza et al., 2001). The two papers reviewed in this report are now part of a growing body of evidence that suggests the amygdala merely enhances the confidence of recollected memories rather than their consistency. Specifically, amygdalar arousal during encoding increases the vividness and subsequent confidence in flash bulb memory accuracy. However, Sharot et al. and Talarico and Rubin demonstrate that this confidence is unjustified by exposing the startling inaccuracies for details of FBMs and the apparent disconnect between confidence and accuracy in FBM recall.

As a potential explanation, the amygdala's influence in episodic memory may follow the Yerkes-Dodson Law, an empirical bell-shaped relationship between arousal and performance. Performance increases with increased arousal but eventually declines as arousal gets too high. Both Sharot et al.'s Downtown group, who witnessed the death and falling debris firsthand, and Talarico's Duke students, who had witnessed the unfolding of the attacks a mere day before the study, likely had very stressful memories of 9/11 during questioning (however, this was not measured). While studies suggest that the amygdala modulates hippocampal declarative memory by enhancing retention, extreme stress has been shown to impair hippocampal memory (Sapolsky et al., 1990). Moreover, cortisol administration during encoding in humans has been found to impair hippocampal-mediated autobiographical memory in subsequent retrieval trials (Buss, Wolf, Witt, & Hellhammer, 2004). In addition, experimental arousal, even by cortisol administration, cannot mimic the stress levels felt in the life-threatening situations Sharot et al.'s Downtown group found themselves in. If extreme stress and intense amygdalar arousal interfere with a memory's encoding its retrieval will be inaccurate. Speculatively, this may have had adaptive significance as fight-or-flight responses to a threat (for example, a predator), mediated by the amygdala, necessitated that resources be spent attending to threats, rather than encoding peripheral details. Thus, the studies reviewed in this paper may broaden neuroscience's present understanding of a potential Yerkes-Dodson-like relationship between amygdala activation and true memory recall after extreme stress.

The enhanced understanding of stress-affected memory recall may explain the mechanisms underlying other psychological phenomena. Specifically, extreme stress in the context of flashbulb memories has serious implications for eyewitness reports. Eyewitness testimony is some of the most compelling evidence presented in court and largely relies on memory. In 1972, the U.S. Supreme Court stated that the confidence of a witness should be considered an indicator of accuracy (Neil vs. Biggers). However, the results of Sharot et al. and Talarico and Rubin strongly suggest that confidence is not, in fact, a reliable indication of recall accuracy. The memories of witnesses in perceived life-threatening situations, where the perpetrator has a weapon, have been found to be impaired by a phenomenon known as "The Weapon Focus Effect." This is explained by witnesses giving great attention to a perpetrator's weapon, rather than the perpetrator themselves, during a crime. This decreases encoding and subsequent recall of peripheral details, such as the culprit's facial features or identifying tattoos. Meta-analyses have confirmed this effect and cite its potentially damaging repercussions during unintentional errors in eyewitness identification (Steblay et al., 1992). The neurological basis for the Weapon Focus Effect and whether these memories, uniquely distorted by stress, are influenced by the PHC and amygdalar mechanisms found by Sharot et al. in stressful 9/11 memories remains to be determined.

The results of Sharot et al. (2007) and Talarico and Rubin (2003) have several implications for the cognitive neuroscience of memory. First, converging evidence in these studies indicates that intense amygdalar arousal during encoding merely results in vividly remembered memories translating into FBMs being confidently, albeit inaccurately, recalled.

The increased amygdala activation and accompanying decline in parahippocampal activation found when Sharot's Downtown group were retrieving 9/11 memories provides a neurological basis for this. These papers enhance cognitive neuroscience's understanding of excessive arousal and the resultant impoverished memory. This suggests a Yerkes-Dodson-like relationship between memory and arousal, whereby extreme arousal, such as in a life-threatening situation, may impair the accuracy of memories despite a greater confidence in recall. Furthermore, unwarranted confidence in memory recall has concerning implications in eyewitness testimony, where confident witnesses could mean the difference between a sentence and an acquittal. In conclusion, the papers by Sharot et al. (2007) and Talarico and Rubin (2003) shed light on the neurological mechanisms underlying FBMs and the disparities between arousal, confidence, and recall accuracy.

First Received: 1/12/2013

Final Revision Received: 3/17/2013

ISBN: 978-0-7714-3044-2

References

Akirav, I., & Richter-Levin, G. (2006). Factors that determine the non-linear amygdala influence on hippocampus-dependent memory. *Dose-Response, 4*(1), 22-37.

Boals, A., & Rubin, D. (2008). Memory and coping with stress: the relationship between cognitive-emotional distinctiveness, memory valence, and distress. *Memory, 16* (6), 637-657.

Brown, R., & Kulik, J. (1977). Flashbulb memories. *Cognition*, *5*, 73–99.

Buss, C., Wolf, O. T., Witt, J., & Hellhammer, D. H. (2004). Autobiographic memory impairment following acute cortisol administration. *Psychoneuroendocrinology*, *29*(8), 1093-1096.

Cabeza, R., Rao, S. M., Wagner, A. D. *et al.* (2001). Can medial temporal lobe regions distinguish true from false? An event-related functional MRI study of veridical and illusory recognition memory. *Proceedings of the National Academy of Sciences of the United States of America, 98*(8), 4805-4810.

Conway, M. A., Anderson, S. J., Larsen, S. F. *et al.* (1994). The formation of flashbulb memories. *Memory & Cognition, 22*(3), 326-343.

Curci, A., & Luminet, O. (2006). Follow-up of a cross-national comparison on flashbulb and event memory for the September 11th attacks. *Memory, 14*(3), 329-344.

Diamond, D. M., Campbell, A. M., Park, C. R. *et al.* (2007). The temporal dynamics model of emotional memory processing: A synthesis on the neurobiological basis of stress-induced amnesia, flashbulb and traumatic memories, and the Yerkes-Dodson law. *Neural Plasticity,* 2007, 60803.

Eldridge, L. L., Knowlton, B. J., Furmanski, C. S., Bookheimer, S. Y., & Engel, S. A. (2000). Remembering episodes: A selective role for the hippocampus during retrieval. *Nature Neuroscience, 3*(11), 1149-1152.