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MANUFACTURED MEMORIES

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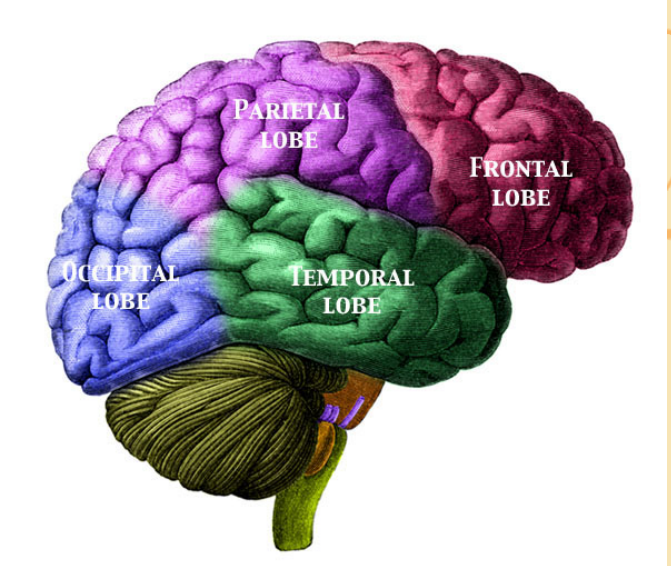
The brain is continually awash in information. Most people would prefer to believe that--even if they are unable to retain all the information that they encounter over the course of their lives-- the information and events that they are able to recall are an accurate reflection of their experiences. However, this is not always the case. The processes of classifying, conceptualizing, and consolidating the continuous streams of data that constitute our mental and sensory experiences are complex, and it seems inevitable that occasional errors should occur. These types of errors result in the creation of false memories--recollections of events or details that never took place. The process of false memory creation is complex, involving several regions of the brain and a wide variety of mental activities. When these false memories are mistaken for true recollections, the consequences can be profound: false witness testimony can result in wrongful conviction; allegations of childhood sexual abuse made on the basis of supposedly recovered memories can throw lives into tumult. However, false memories seem to be an unavoidable consequence of the brain's attempts to strike a balance between information intake, management, and recovery.

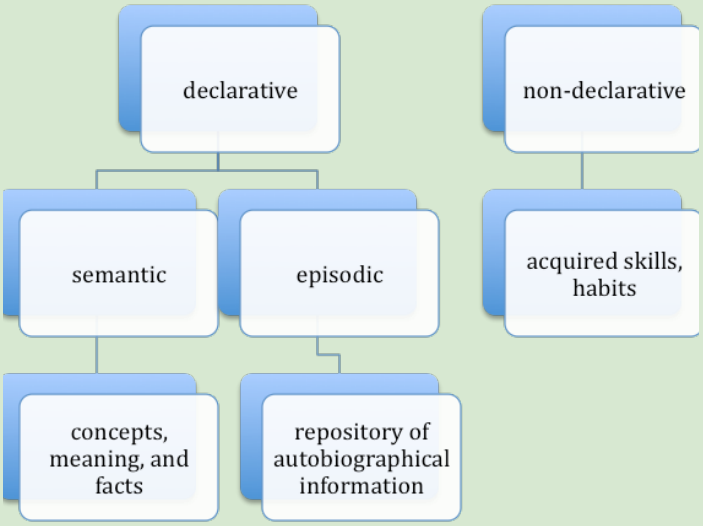
Memories can be broadly differentiated into one of two types—declarative and non-declarative (Byrne, n.d.). Declarative memory consists of information that can be consciously recalled—such as facts, dates, and concrete knowledge. Declarative memory can in turn be subdivided into semantic memory—context-dependent memory of concepts, meaning, and facts about the world—and episodic memory—the repository of autobiographical information (Straube, 2012; Tulving, 1972). The capacity to re-experience autobiographical events in their original context is a consequence of episodic memory (Straube, 2012). In contrast, non-declarative memory manages memories that are not formed or accessed consciously, such as acquired skills, habits, and simple forms of associative learning (Byrne, n.d.). These two types of memories are formed, stored, and accessed by different neural structures (Payne et al., 2009). Declarative memory is studied more frequently in the context of memory distortion.

> *"creation of false memories is itself an active—if unconscious—process that occurs during encoding"*

The formation of memories can be divided into three stages: encoding (memory formation), consolidation (the strengthening of memory traces), and retrieval (the active recollection of memories) (Roediger & McDermott, 1995), each of which involves sev-



Location of key brain regions.



Different types of memories.

eral brain regions. Semantic encoding is carried out by the medial temporal lobe, which consists of the hippocampus, amygdala, and related tissues (Kim & Cabeza, 2006). The hippocampus plays a pivotal role in the formation of accurate declarative memory (Johnson, Raye, Mitchell & Ankudowich, 2012); however, its ability to integrate and recombine information from numerous sources has implicated it in false memory formation (Straube, 2012). The hippocampus also helps stabilize memories to enable their long-term storage and is hypothesized to be engaged in memory retrieval (Carr, Jadhav & Frank, 2011). The frontal cortex is also involved in the processing of semantic memory and helps the brain determine the relative importance of information while creating and retrieving memories, a function that is important for assessing the plausibility of memories and comparing alternative recollections (Johnson et al., 2012; Kim & Cabeza, 2006). This ability to distinguish plausible memories complements the function of the perithinal cortex, whose activation is associated with the subjective sense of 'remembering,' even in the absence of a readily-accessible memory (Johnson et al., 2012). The amygdala—the center of emotional processing in the brain—can also contribute to this subjective sense of remembrance, and furnishes memories with an emotional depth that can contribute to their sense of plausibility (Byrne, n.d.; Johnson et al., 2012).

The formation of episodic memory is more complex and involves activation of several brain regions not associated with semantic memory. The involvement of several different neural regions is believed to make episodic memory more prone to error than the semantic memory, as memories are compiled from a wider variety of sources and are composed of a more diverse set of data (Straube, 2012).

Recent work at M.I.T. has shown that false memories can be created during memory retrieval, which may occur when a previously formed memory becomes closely associated with a particularly evocative external stimulus (Ramirez et al., 2013). False memories, however, are not merely the result of mechanical errors in the encoding and storage processes, but may also result from the brain's efforts to extract as much meaning from information as efficiently as possible (Gallo, 2010). This view of false memory formation was given credence by the word-list recall experiments conducted by Deese in the 1950's and Roediger and McDermott in the 1990's, which provide a powerful illustration of the malleable nature of recollection. The structure of Deese, Roediger, and McDermott's experiments—now referred to as the DRM task—is simple. In the first stage, the subject is presented with a list of thematically related words (e.g. bed, night, and dream) and asked to study them. After the study period, the subject is then asked to recall the words presented in the previous part of the experiment. Results from experiments which adhere to this general structure reveal that subjects often falsely remember having studied non-presented critical lures that are thematically consistent with the words from the list (e.g. sleep) (Gallo, 2010; Raymaekers, Peters, Smeets, Abidi & Merckelbach, 2011; Roediger & McDermott, 1995). While these types of memory tests have limitations—autobiographical memories are significantly more complex than word lists—studies of brain processes involved in the DRM task have revealed much about both how true and false memories are formed, retrieved, and assessed.

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The DRM task engages both components of declarative memory: the memory of events controlled by the episodic system, and the processing of underlying concepts and themes that is the hallmark of semantic memory (Payne et al., 2009). Work by Kim and Cabeza (2006) revealed that during completion of the DRM task, regions of the brain associated with semantic memory were activated during both true and

false memory formation, suggesting that the creation of false memories is itself an active—if unconscious—process that occurs during encoding (Kim & Cabeza, 2006; Straube, 2012). Specifically, Kim and Cabeza found that activation of the left ventrolateral prefrontal cortex promotes not only the creation of true memories of presented words, but that of false memories of closely associated but non-presented semantic associates (Kim & Cabeza, 2006; Straube, 2012).

Kim and Cabeza's observations may be the result of semantic elaboration—the integration of incoming information with pre-existing semantic knowledge—a process that has the potential to both promote the formation of true memories and contribute to creation of false ones (Kim & Cabeza, 2006). There are several schematic theories regarding how this process may work. According to the fuzzy trace view, studying a list of closely associated words leads to the formation of two types of mental traces—verbatim and gist. Verbatim traces contain item-specific information, whereas gist traces contain the essence of the presented information—such as the underlying theme of a list of associated words. (Brainerd & Reyna, 2002; Kim & Cabeza, 2006; Straube, 2012). It is theorized that gist traces are more robust to the passage of time than verbatim traces, meaning that recovered memories are more likely to reflect the overall essence of an experience rather than its concrete details (Brainerd & Reyna, 2005).

The spreading activation view posits that, within a semantic memory network, mental activation spreads from presented words to closely related words. This secondary activation is later attributed to memory (Kim & Cabeza, 2006; Roediger & McDermott, 1995; Straube, 2012).

While activation may promote the formation of false memories, monitoring—the editing and decision process that helps determine the origin of activated information—helps prevent their proliferation (Gallo, 2010). The source monitoring framework theorizes that mental experiences consist of several attributes, such as recollections of sensory details or a sense of remembrance, which can help qualify their origin and accuracy (Johnson et al., 2012). There are several different types of monitoring processes. Diagnostic monitoring is the process by which memories are dismissed as false because they fail to elicit strong feelings of recollection (e.g. "I didn't take a helicopter to work today because helicopter rides are distinctive and I would have remembered doing that"). In contrast, disqualifying monitoring relies on corroborative evidence to disentangle true and false recollections. When a questionable memory elicits recollections that are inconsistent with prior information, the memory is dismissed as false (e.g. "I didn't drive to work today because I remember taking the bus instead") (Gallo, 2010). The monitoring process, however, is not infallible. Monitoring can be affected by the presence of prior knowledge and the social and cultural context in which experiences occur and judgments regarding adequate evidence of remembrance are made—both of which can lead to memory misclassifications (Johnson et al., 2012).

While results from DRM-based experiments have shown that false memory creation occurs during the encoding process, memories can be distorted and fabricated during consolidation as well. Consolidation primarily takes place during sleep and involves an intensive reorganization and reintegration of information gathered and memories generated over the course of the day. New memory traces are strengthened, promoting the formation of strong, accurate memories. However, information from these new memories can also be integrated with pre-existing memories (Straube, 2012). Thus, sleep promotes the formation of both true and false memories. Sleep deprivation, in contrast, decisively favors the creation of false recollections. This effect is likely due to the reduction in monitoring that occurs as a result of sleep deprivation, making it more difficult to correctly identify the source of mental activation (Straube, 2012).

As the studies of memory consolidation during sleep illustrate, memory building is a dynamic process and memories often retain the capacity to be updated by incoming information and integrated with recent experiences. This plasticity of memory can introduce ambiguity into legal proceedings, where accurate memories of oftentimes violent and traumatic events are necessary to determine culpability. Unfortunately, such unadulterated memories are difficult to obtain. High levels of the stress hormone cortisol have been shown to impair the retrieval of autobiographical memory, resulting in vague, disjointed eyewitness testimony that often strikes jurors as less credible (Lacy & Stark, 2013). In addition, the retention and retrieval of memories can be very vulnerable to the kind of suggestive questioning, presentation of misinformation, and positive feedback responses that play a prominent role in witness questioning (Lacy & Stark, 2013). Reliance on inaccurate recollections can have chilling consequences: incorrect eyewitness identification has been implicated in the wrongful conviction of 75% percent of individuals who were later exonerated on the basis of DNA evidence (Lacy & Stark, 2013).

The effect of memory distortions reach beyond eyewitness testimony. The general public, including jurors and judges, retains several misconceptions about how memories are formed and maintained (Lacy

& Stark, 2013). The types of suggestive questioning used during eyewitness testimony can induce memory distortion in jurors as well: jurors often confound information presented by lawyers and witnesses (Lacy & Stark, 2013). Jurors also tend to place more faith in testimony when witnesses themselves believe that their memories are accurate, despite the evidence that outside of laboratory settings the connection between perceived and genuine memory accuracy is tenuous (Lacy & Stark, 2013). A particularly contentious confluence of memory retention and the justice system is the use of suggestive therapy to retrieve supposedly repressed memories of childhood sexual abuse (CSA), which has in some cases led to accusations of malpractice.

"The general public, including jurors and judges, retains several misconceptions about how memories are formed and maintained"

One such example is that of Beth Rutherford, who sought out therapy in 1992 at the age of 19 while suffering from work-related stress. Prior to beginning therapy, Beth believed that she had enjoyed a happy childhood and with warm and loving parents. Beth was thus initially surprised to be informed that her symptoms were consistent with those of sexual abuse victims. Beth's therapy sessions focused heavily on themes of sexual abuse and she was encouraged by her therapist to re-interpret her childhood memories and experiences in ways that were consistent with the theory that she had repressed memories of being sexually abused by her father. As the emphasis on sexual abuse and memory recovery in Beth's therapy sessions increased, she began to have dreams of being assaulted by her father, and was informed that these dreams were in fact heavily repressed memories. After two and half years in therapy, Beth claimed to have recovered highly specific memories of childhood sexual abuse at the hands of her father which had resulted in two pregnancies and forced abortions. Beth's revelations reduced her to a state of physical and mental deterioration: her weight dropped to 90 pounds, she became estranged from her parents, and began taking mood-controlling medications. However, there was reason to doubt the veracity of Beth's recollections: her father had undergone a vasectomy when Beth was four years old, rendering him incapable of causing the pregnancies that Beth so vividly remembered (Brainerd & Reyna, 2005).

Unfortunately, both the nature of the kind of suggestive therapy used with Beth and that of those who seek it out may contribute to false memory formation. Studies have shown that those who claim to have recovered memories of CSA during suggestive therapy sessions are more likely to make misattributions during DRM exams (Association for Psychological Science, 2009; Brewin, 2012; Raymaekers et al., 2011), suggesting that these people may be more vulnerable to false memory formation in general. In addition, individuals undergoing therapy are encouraged to maintain an attitude of openness and discovery, possibly causing them to confirm the veracity of events that may never have occurred but are consistent with the overall essence of their experience or that appear to be plausible explanations for their behavior. This effect is exaggerated by the often significant passage of time between when the memory is claimed to have taken place and its recovery in therapy (Brainerd & Reyna, 2005).

Beth's story illustrates the power of suggestion on the process of memory formation and attribution, and the impact that memory--or what is perceived as memory--can have on one's sense of self. Given the profound effect that Beth's false memory recovery had one her physical and mental health, one must wonder how the mind can be so vulnerable to external influences. Beth's experiences, while traumatic, may be the result of an evolutionary advantage process: the ability to integrate suggestions from respected sources and vague emotional sensations into highly convincing recollections of seemingly plausible events that can explain confusing or troubling events and behaviors. Such is the power of false memories: when abused or misapplied they can have significant negative effects; but false memories can also be a learning tool, a way of consolidating information and integrating life experiences in a way that obscures details but maintains their underlying truth.

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