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The Adaptive Nature of Memory and Its Illusions

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Abstract

In this article I discuss how false memories do not always have to be associated with negative outcomes. Indeed, under some circumstances, memory illusions, like other illusions more generally, can have positive consequences. I discuss these consequences in the context of the adaptive function of memory, including how false memories can have fitness-relevant benefits for subsequent behavior and problem solving. My hope is that this article changes how illusions are conceptualized, especially those arising from memory. Rather than being a "demon" that vexes our theories of memory, illusions can be thought of as sometimes having positive consequences much in the same way as many of the other outputs of a very powerful, adaptive memory system.

Keywords

adaptive memory, memory illusions, false beliefs

False memories, or memories for part or all of an experience that did not actually occur, are one consequence of a powerful and adaptive memory system that is reconstructive. Although much of today's research on memory illusions focuses on their negative consequences (e.g., such as those seen in the forensic arena), some recent research has convincingly demonstrated that false memories can have positive consequences. These more positive consequences occur not only in terms of other cognitive processes (reasoning, problem solving; e.g., Howe, Garner, Charlesworth, & Knott, 2011) but also influence future behavior (Chen, Zeltzer, Craske, & Katz, 1999), as well as guide planning for future actions, perhaps the quintessential adaptive function associated with memory (e.g., Atance & O'Neill, 2005; Hassabis & Maguire, 2007). In this article, the adaptive nature of memory, both true and false, is articulated using a variety of recent studies including those showing that processing information for its relevance to survival can lead to improvements in remembering, both in adults (for a review, see Nairne, 2010) and in children (Otgaar & Smeets, 2010). Surprisingly, such processing also leads to increased false-memory rates, resulting in a net decrease in overall accuracy (Howe & Derbish, 2010). It is this latter discovery that has led to a new, adaptive perspective on memory illusions, one that parallels other discoveries concerning the adaptive value of perceptual and cognitive illusions more generally (McKay & Dennett, 2009).

Adaptive Memory

It is, perhaps, self-evident that memory is one adaptive system that has emerged out of a variety of evolutionary pressures. It is not known exactly when, or under what adaptive pressures, individual memory became an essential evolutionary adaptation. Speculation suggests that it may have emerged some 500 million years ago (Ginsburg & Jablonka, 2010). This "Cambrian explosion" and its attendant advance in memory marked a critical change in the number and variety of fitness-relevant behaviors available to organisms. These advances included memory for locations where survival-essential resources (e.g., food and water) could be found, shaped the manner in which organisms searched for mating partners, and helped them recognize and avoid predators (Ginsburg & Jablonka, 2010). Memory is essential to many survival-relevant behaviors, especially learning associations between significant objects (e.g., predators) and signs of their presence (e.g., odors, rustling grass). The evolution of memory, particularly associative memory in which past experiences can be retained, opened up hitherto unseen mechanisms for adaptive change, including the ability to mentally simulate possible future states when deciding the best course of action given multiple alternatives (Hassabis & Maguire, 2007).

Research has shown that the neural mechanisms underlying recall of past episodes also underlie imagining future behaviors, although the source of this similarity remains unclear (Hassabis & Maguire, 2007). Recent evidence has shown the important role that dopamine plays in remembering previous experiences, linking current information to those memories,

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and utilizing these associations in the service of future, adaptive behaviors. That is, "when individuals encounter new information that evokes old associations, this associative novelty can promote not only preferential encoding but also the organization of memory to facilitate its later use—processes that could be catalyzed by dopamine" (Shohamy & Adcock, 2010, p. 468). Thus, there is compelling behavioral and neuroscientific evidence supporting the idea that memory has been shaped by evolution with adaptation in mind.

Additional behavioral evidence comes from two distinct lines of research concerning how evolution may have affected memory. First, memory may have become specialized to perform very particular functions, including recognition of trustworthiness, which may enhance survival by helping individuals avoid others who are deceptive (e.g., Mehl & Buchner, 2008). Others suggest that memory was shaped by gender differences in the division of labor, in which spatial-memory requirements were different for men who hunted mobile prey than for women who gathered food from fixed and immobile locations (Pacheco-Cobos, Rosetti, Cuatianquiz, & Hudson, 2010).

Second, research has examined whether memory is specialized to retain fitness-relevant survival information (Nairne, 2010). Here, participants are given an ancestrally relevant (e.g., surviving in the grasslands) or irrelevant (e.g., surviving in a city) scenario and are asked to evaluate the importance of a list of words in the context of these environments. Concepts rated for ancestrally relevant survival are remembered better on a surprise memory test.

Although there is disagreement concerning the importance of an evolutionary interpretation of these findings, another problem has emerged: Not only are there more true memories generated in this adaptive-memory procedure, but also more false memories. Using lists of highly associated concepts that were survival relevant, negatively valenced, or neutral, both true and false memories were more abundant when items were rated for survival. Independent of processing, survival-relevant concepts also evinced higher rates of true and false recollection (Howe & Derbish, 2010).

Together, these results raise several concerns, not the least of which is that "adaptive memory" results in reduced, not enhanced, accuracy. Because false memories increase at a rate commensurate with true memories for survival materials and survival processing, overall recollective accuracy necessarily decreases relative to other types of materials and processing. Therefore, we can ask why correlated increases in both true and false memories are adaptive and, moreover, what possible adaptive significance there would be for constructing memories that are either entirely, or even just partially, false. It is important to answer these questions because, depending on their context, false memories may have negative consequences (e.g., the conviction of innocent people) rather than positive ones (e.g., evading predators). Before getting to this, I turn to a more general problem—namely, what is the adaptive value of illusions more generally?

Do Some Illusions Have Adaptive Consequences?

Illusions of various origins occur more frequently than we think. Indeed, research in the visual sciences has shown that much of what we "see" is actually a type of "intelligent" hallucination (Gregory, 1968). In fact, perceptual illusions are critical to adaptation, because in many natural environments, the type and amount of sensory information available can vary over time and across space. For example, "it is important to be able to perceive surfaces independently of their varying light intensity (and vice versa) in order to forage or predate successfully" (Corney & Lotto, 2007, p. 1790). That illusions occur is a simple consequence of the constructive nature of perception; "every instrument has measurement errors and the human visual system is no exception. So *every* percept will have an error associated with it, be it large or small" (Corney & Lotto, 2007, p. 1797).

Magicians have long exploited frailties of our visual system by creating optical illusions involving mirrors, lighting, and variations in object perspective. Cognitive illusions also abound and are similarly manipulated by magicians who use sleight of hand. The key here is to create a false action (e.g., pretending to move an object from one hand to another) that makes the audience think they are seeing a real action. Indeed, audiences frequently report seeing and remembering the "real" event even though it never happened (for a review, see Kuhn, Amlani, & Rensink, 2008). Although these illusions are not necessarily adaptive (unless you are attempting to survive by being a magician), they are based on principles derived from basic mechanisms that are quite adaptive.

Although the systems that create illusions are themselves shaped by evolution, whether the illusions themselves are adaptive depends on the nature of the illusion and the context in which it occurs. Indeed, as already noted in the case of memory illusions, not all errors have adaptive consequences. Although not all cognitive errors are adaptive (e.g., the Cotard delusion, in which an individual comes to believe he or she is dead), there are many that have fitness relevance (McKay & Dennett, 2009). For example, positive yet illusion-like self-appraisals can lead to a sense of confidence, leading to better chances of success in future tasks. Moreover, illusion-like beliefs can affect health. For example, individuals may believe that the medicine they are taking can cure what is ailing them, and then it does, despite the fact that the "medicine" is a placebo.

Do Some Memory Illusions Have Adaptive Consequences?

Little doubt exists that memory is a powerful and flexible system that is essential to an organism's ability to adapt and survive. Representational flexibility is key to an organism's ability to restructure and update what is in memory, a critical

feature of memory that is linked to an organism's survival. The processes involved in that flexibility include the combining, rewriting, and blending of incoming information with information already stored in memory. However, because memory is so malleable, remembering is a process that, like the other perceptual and cognitive processes, is prone to error and, under some circumstances, can go inexorably wrong.

Just how wrong can remembering be? At one end of the spectrum, we may make memory errors concerning less consequential aspects of our experiences, perhaps confusing two similar experiences (e.g., whether we wore a black or blue suit to work yesterday) or by inferring that events occurred because they are consistent with world knowledge (e.g., inferring, but not explicitly remembering, that we locked the door before leaving for work). At the other end of the spectrum, people falsely remember entire events occurring when no such event has taken place (e.g., being abducted by a UFO; Spanos, 1996).

Although we know a considerable amount about the "darker" side of memory illusions (as when people falsely remember being sexually abused), we know much less about the positive and potentially adaptive functions associated with memory illusions. Recently, we (Howe & Derbish, 2010; Howe et al., 2011) have argued that false memories, like false beliefs, can (depending on their content and context) have an adaptive consequence. For example, one adaptive value of false autobiographical recollection is the tendency toward positive biasing of one's past self. These "misrememberings" involve false memories about the self rather than the event, and they allow revision of the past that facilitates self-enhancement, permits a more positive self-evaluation of one's current self, and helps maintain effective social relations (Ross & Wilson, 2003). This positivity has also been linked to enhanced emotional regulation (Mather & Cartensen, 2005) that, in turn, has been interpreted as being an extremely adaptive function of memory—or more accurately, of false remembering (Newman & Lindsay, 2009). This is because such recollections can directly benefit one's current self-image and influence future behaviors and motivations. Indeed, because many functions of autobiographical memory are arguably social, false memories of our past may (a) be quite adaptive inasmuch as they serve to enhance social relationships and (b) serve to enhance intimacy in relationships, a goal more important than keeping an accurate record of one's past.

False memories may have other adaptive uses, including aiding the solution to problems in a survival-related context, something that may be a crucial evolutionary trait. An increase in false memories for survival information may not necessarily be maladaptive if they can prime solutions to complex problems in a manner similar to true memories. As Howe and Derbish (2010) pointed out, that the byproduct of memory activation can be a false recollection may be a small price to pay if such false memories, like true memories, can aid the solution of more complex, survival-relevant problems.

As a first approximation to the study of false memories and problem solving, Howe et al. (2011) presented children and adults with lists of associated words that gave rise to false memories. These false memories were also the solution to compound remote-associate problems—that is, problems that were presented after participants studied the word lists. For those participants who generated a false memory following list presentation, subsequent problem solving was not only easier (higher success rates) but was also faster. Thus, false memories generated by participants primed solutions in a later problem-solving task, much in the same way true memories prime solutions on other, related tasks.

Conclusions and Future Directions

Perception, cognition, and memory are all powerful adaptive systems that are prone to errors (illusions) given their (re)constructive nature. Illusions are not always detrimental, and many have more positive, fitness-relevant consequences. Indeed, false memories not only allow us to (mis)remember a past that facilitates the present (e.g., maintain intimate relationships) but also helps us predict the future (e.g., avoid predators).

As intriguing as these ideas may be, it is only by testing specific experimental predictions about the fitness-relevant consequences of remembering that our understanding of the adaptive function of memory (both true and false) will grow (see Nairne, 2010). Indeed, some researchers have tested exact predictions concerning the adaptive value of false remembering, including specific behavioral consequences that are linked to developing false memories. For example, children who came to falsely remember prior lumbar punctures as less painful than they actually were experienced less distress during subsequent lumbar punctures (Chen et al., 1999). Therefore, reframing memories of the past can have fitness-relevant consequences that include making life-saving treatments not only more bearable but also more likely to continue. Additional research might focus on how episodic-memory errors (and accuracies) contribute to the emergence and development of future thinking (Atance & O'Neill, 2005), including how memory for experiences and solutions to past problems are used to alter future behaviors and solutions to new problems (Suddendorf, Nielson, & von Gehlen, 2011).

Although considerable research remains ahead of us, false memories can have positive consequences, not just negative ones. Determining the adaptive benefits of false memories, like those for true memories, requires innovative experimental design, the measurement of behavioral changes, and the assessment of the fitness-relevant consequences of such memory illusions, immediately as well as in the future. In this article, I have attempted to demonstrate that false—like accurate—remembering does influence current as well as later behaviors and may even influence the construction of plans for the future. This is critical because it illustrates the powerful influence memory has on behavior, regardless of memory's truth value. Whether a behavior's consequences are positive (e.g., potentially increasing the likelihood of life-saving medical treatment) or negative

(e.g., false accusations of sexual abuse leading to imprisonment of innocent people) depends on both the content of those memories as well as the context in which that remembering occurs. The point here is simply that while we know much about the negative consequences of memory illusions, future research should also focus on the positive consequences of misremembering our past.

Recommended Reading

Howe, M.L. (2011). *The nature of early memory: An adaptive theory of the genesis and development of memory*. New York, NY: Oxford University Press. Outlines an adaptive theory of memory and its development, including false memories.

Kuhn, G., Amlani, A.A., & Rensink, R.A. (2008). (See References). Goes into greater depth concerning how magicians exploit the frailties of the human visual system to create illusions.

McKay, R.T., & Dennett, D.C. (2009). (See References). Goes into greater depth concerning the nature of cognitive illusions, or false beliefs.

Paivio, A. (2007). *Mind and its evolution: A dual coding approach*. Mahwah, NJ: Erlbaum. Provides a more detailed analysis of the evolution of cognitive processes.

Roediger, H.L., III. (1996). Memory illusions. *Journal of Memory and Language, 35*, 76–100. Provides an in-depth look at memory illusions and grounds the study of these illusions in terms of illusions commonly found in perception.

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