



ORIGINAL ARTICLE

Memory Formation and Belief

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In this paper, I deal with the constructive and dynamic nature of memory formation and with the nature of memory belief, whether a memory belief reflects the real past experience or a modified memory representation. That is I grapple with the issue of whether such a belief adheres to the final stage of memory or reflects the whole constructive process of memory. After examining the multiple-trace and reconsolidation theories of memory, I conclude that recent findings in neuroscience fundamentally disturb conventional notions of memory belief, since beliefs do not reflect the reconstructive processes episodic and autobiographical memories go through.

Keywords: memory, belief, episodic memory, autobiographical memory, neurobiology, reconsolidation, multiple-trace theory

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INTRODUCTION

Neuroscientists have recently shown that memory, especially autobiographical memory, is a dynamic entity that perpetually changes. Autobiographical memories are vulnerable to multiple influences and prone to distortions and deceptions; they are never constant and never result in fully accurate representations. At the same time, however, these changes occur without us being aware of them. Even so, we still attribute belief to memories and view them as accurate representations of our past.

In what follows, I examine this puzzle, focusing on the process and formation of episodic and autobiographical memory and the nature of its beliefs. As I focus on the formation of memory belief, I do not deal with belief's propositional dimension. Thus, this discussion will not be embedded in the philosophical framework of propositional attitude, but instead in frameworks conceptualizing how belief relates to processes of constructing and modifying memories. I examine whether belief formation as it appears emerges from the underlying mechanisms of memory formation. If our memories beliefs do indeed depend on the processes of memory formation that perpetually alter these memories, what then is the epistemological status of such beliefs? How is belief sustained? Are be-

liefs modified together with their corresponding memory representations?

Thus, I am interested in whether memory and memory-belief formation are distinct. I work to determine whether memory beliefs go through the same modifications as memory representations, or whether beliefs join memories only in the last stage when memories are already formed. Given that, in most cases, we are not aware of the changes to memories, a further question becomes whether earlier manifestations of a given belief are also expunged as this belief undergoes continual change. Tackling these questions will help determine whether autobiographical memories are inherently joined by the misleading belief that they represent the past as it was, even when these representations have undergone multiple modifications.

Neuroscience has found that memory serves as a generative, reconstructive, and dynamic entity. Memory is not a literal reproduction of the past, but instead an ongoing constructive process. Memories are modified and reconstructed repeatedly. Cognitive psychologists, who deal with memory, investigate how memory is formed, reconstructed and modified, and in what way it conforms to past experiences. These psychologists presume that memory's function is to

adapt and adjust us to new circumstances, and, as a result, tends to fail in reproducing reality. For these reasons, memory often contains errors, inaccuracy, distortions, and gaps. Following the cognitive psychologists' postulation that memory is a constructive process, scholars of neurobiological memory formation theories, which examine the underlying neural mechanisms of memory, support the dynamic and flexible characterization of memory construction at the neurobiological level. Two central theories explain the constructive nature of memory, Multiple-Trace Theory and Reconsolidation Theory.

MULTIPLE-TRACE THEORY (MTT)

Current models assume that separate processes encode an initial experience, and that no single anatomical location contains the entire representation of a specific memory. Instead, the features of a memory are spread out and distributed over many locations. According to these models, components of memory representation are distributed widely across different parts of the brain as mediated by multiple neocortical circuits. Each circuit handles a distinct component of the original experience such as the visual, auditory, taste, tactual, and motor sensations. Researchers assume that the integration of these components takes place within the medial temporal regions. For instance, Schacter (1996, p. 87) writes:

“the medial temporal region contains instructions that specify how to assemble the puzzle; eventually, the instructions are shifted over to cortical regions that contain all the component pieces of the puzzle”

Phenomenologically, remembering appears to the observer as a unified experience — just as perception itself appears unitary — but, in fact, each experience is sustained by multiple neural cognitive systems. Morris Moscovitch, who maintains that the retrieval process is much more crucial than the other phases, clarifies the process of memory recovery with reference to finding a book in the library. Moscovitch (2007, p.19) writes:

“While the whole book is located in a specific place and picking the book is picking all that is included in it, retrieval process is more like assembling the pages of a book which may be scattered in different locations in the library. Finally, unlike a call number which is distinct from the book itself, retrieval cues and processes interact with the engram and

influence the memory which is recovered. Depending on the interaction, some ‘pages’ of the memory may be missing, others may be placed in the wrong sequence, still others may be imported from other books which are related in some way to the cues and the engrams, and some of the cues themselves may be incorporated into the memory that is recovered and change the engram on which it was based”

Retrieval of a past experience involves assembling scattered memory features from different neuronal locations. This assembling, according to neuroscientists, is not a simple process in which all the pertained features obey at the time of retrieval to form an exact representation of past occurrence. Rather, retrieval is a process in which features from the original memory are omitted or lost, and features from other, associated memories are attached to the retrieved memory. The interaction between a cue and a memory representation can add or eliminate information from the encoded engram, import related information from other engrams, change the order of encoded the information, and so on. Thus, according to the MTT, remembering something is not like storing a file on the computer, which remains the same from the moment we closed the computer at night to the next morning when we open it again. Rather, every time we access a memory, we come up with different results.

RECONSOLIDATION THEORY

Memory recovery is not only the integration of a retrieval cue with the dissipated components of a memory trace, but also has additional aspects that determine the subjective recollective experience. As neuroscientists have revised consolidation theory in line with emerging insights, they have come to emphasize the elastic and constructive formation of memory. In the past, researchers claimed that memory consolidation (the process of memory stabilization) takes place only once. According to such accounts, a new memory is initially labile but becomes stabilized over time through the process of consolidation. This process converts an unstable short-term memory into a stable long-term one. These researchers believed that, after consolidation, memories are stable and resilient to disruption. In short, the initial idea among memory researchers was that consolidation stabilizes memories in a reliable way.

However, the theory of memory has been radically changed in the last two decades. Currently, neuroscientists, who study neural processes and mechanisms of memory persistence (e.g. synaptic strength and plasticity), show that consolidation takes place not only after new learning (encoding), but also after every recall (memory retrieval). During retrieval, consolidated memories enter a transient state when they become labile once again, and require another phase of consolidation (known as “reconsolidation”) to persist (Nader et al., 2000; Dudai, 2004). These neuroscientists claim that memories are always in a state of change and constant adjustment, since memories are not permanently stored, but enter a transient and labile state during every retrieval (Dudai, 2002, 2009; see also Alberini, 2011). Thus, memory retrieval behaves like re-encoding: the instability of the encoding process exists again at the time of memory activation (Nadel, 2007). The engram returns to short-term active state when memories are vulnerable to distortions.^a Some neuroscientists who deal with reconsolidation theory also maintain that the act of retrieval can itself cause amnesia since the connections between the synapses underlying the trace become weakened. Thus, retrieval by itself can actually disrupt an established memory trace (Nader, 2003). The susceptibility of memory to modification during reconsolidation depends on various factors, including the age and specificity of the memory, the strength of initial learning, and the strength and number of prior reactivations. For example, when the memory is weak, it is more susceptible to disruptions, and the stronger the reactivation of a memory, the more it becomes labile. Due to these findings, neuroscientists have assumed that when a memory is reactivated, it must undergo additional phase of consolidation (known as “reconsolidation”) to persist. Thus, consolidation takes place not only after new learning (encoding), but also after every recall (memory retrieval).^b The molecular mechanism that stabilizes memory is thus required after every recall (Silva, 2007).

The functional significance of the labile phase of reconsolidation is not fully known. Generally, researchers assume that the reconsolidation process reinforces and sustains the reactivated memories (Sara, 2000), allowing new informa-

tion and learning to become associated with already established and reactivated memories. Indeed, during reconsolidation, memories do not just remain as they were, but change to allow the integration of new information (Alberini, 2005; Tronel et al., 2005). Reconsolidation is thus a manifestation of a larger memory updating mechanism that adapts the reactivated memory to new circumstances. From neurobiological point of view, this adaption mechanism permits new experiences and information to modify existing neuronal connections and networks. This mechanism is possible due to the enhanced plasticity of neuronal circuits that encode all or part of a memory trace. In this way, plasticity refers to inherent ability of the nervous system to adapt as a result of learning and new experiences.

Changes in synapses (the fundamental storage unit in the brain) enable reconsolidation and adaption. While synapses allow for change and modification, they also facilitate storing and stability, since synapses convey and maintain memory information (Rudy, 2008; see also Dudai, 2009). Thus, as John Sutton (2001, p. 1111-1112) has conceived, the neuroscience of memory implies two coexisting but contradictory features: “distinct transient patterns of activity, and composite, enduring, but modifiable dispositional states” (see also Sutton, 1998). Put differently, synaptic flexibility allows for the persistence of lasting impressions on neural circuits, while, on the other hand, also enabling change and modification.^c

Thus, memory recovery is a complex process that is not only composed of collecting disparate memory traces, but involves integrating them with new information and experiences. Memory traces are, with use, modified and reconstructed as memory retrieval involves a process of revision, adjusting past memories with new perceptions and future anticipations (Dudai, 2009). Yadin Dudai (2012, p.234-235) writes:

“Because reactivation of the trace commonly occurs in an altered context, it results in newly encoded hippocampal traces, which, in turn, bind new traces in the neocortex. This results in multiple traces that share some or all the information about the initial episode”

Integrating new components into the activated engram thus forms a new version of the original

episodic memory.

Such changes are part of a natural process where the memory trace undergoes various modifications that we cannot necessarily consider as errors or fabrication, but, rather, stem from normal brain activity. Multiple-trace Theory and Reconsolidation Theory provide a dynamic, constructive, and plastic view of the nervous system and demonstrates that a memory is not a literal reproduction of the past, but instead an ongoing constructive process, an adaptive mechanism that conflates past and present. In turn, this neurobiological characterization of memory provides a new framework for rethinking memory. If it is true that stored memories are continually being revived and revised through normal brain activity, this finding changes traditional concepts of memory representation. It might challenge the notion that memory is a source of factual truth and, as a result, transform the way we understand memory and remembering. Thus, the neuroscience of memory poses new problems and raises several questions.

What is the exact epistemological status of memories?

If our memories are perpetually modified, does this not imply that they are essentially memories of memories and re-remembering of remembering, rather than memories of the original perceived experience?

What about a belief that is attached to a memory? We attribute to memories beliefs and view them as accurate representations of our past. Do these emerging findings undermine apparently justified memory beliefs?

Do memory beliefs mislead us, having us believe that memories accurately represent the past?

MEMORY BELIEF

Neuroscience postulates memory as a mechanism composed of multiple systems, forms, functions, and processes. The reason that cognitive psychologists divide memory to subsystems derives from their inability to arrive at generalizations that explain all the variety of memory types and expressions. Psychologists categorize and classify forms of memory according to types of knowledge they represent, and also by their underlying mechanism, process, function, and mode of acquisition. In short, different kinds of

memory depend on different brain systems and correlate with different neural expression. By identifying multiple memory systems, researchers hold that different brain areas support different memory systems. As a result, they contend that a memory with one feature, such as consciousness, necessarily correlates to specific brain region such as the hippocampus, whereas a memory not associated with awareness relies on another area, the basal ganglia and related brain structures (Willingham and Goedert, 2001).

Out of the multiple kinds of memory, I focus, in what follows, on episodic and especially autobiographical memory, our personal past experiences. Episodic memory formation is relevant to other memory systems because all systems share common processes like encoding, storing, and retrieval. Additionally, different memory systems closely interact. However, there are at least four reasons to concentrate on episodic memory.

First, different kinds of memory behave differently. Brain substrates of procedural memory, the implicit acquisition of non-symbolic skills, remain unchanged and relatively permanent over a life cycle. Conversely, the brain substrates of declarative memory which includes episodic (personal experiences), and semantic memory (factual knowledge about the world, concepts, rules, and language) appear to fluctuate. Episodic memory is even more susceptible to manipulation and to various kinds of errors than semantic memory (Tulving, 1982).

The second reason concerns the relation of memory to veridicality. Memory systems involve different kinds of knowledge. For instance, procedural memory does not require awareness and stems from accumulated practice and experience. Thus, issues of truthfulness are not as relevant to this type of memory. In contrast, episodic and semantic systems are declarative and propositional, as they are kinds of knowledge that can be verified as right or wrong.

Third, episodic memories are the only ones with direct reference to the past. As Tulving (1999, p.15) points out:

“episodic memory is the only form of memory that, at the time of retrieval, is oriented toward the past: retrieval in episodic memory means ‘mental time travel’ through and to one’s past. All other forms of

memory, including semantic, declarative and procedural memory, are, at retrieval oriented to the present”

Moreover, it may appear that procedural memory is only realized in the present, but is also oriented towards the future. We learn skills to exercise them more effectively in the future.

The forth reason relates to differences between episodic and semantic memory. Semantic memory does not refer to the time or context of learning. It does entail truthfulness, but we share this knowledge with others. In contrast, episodic memory is accompanied by the experience of remembering. It identifies the specific time, place, and context in which the experience occurred. As a result, episodic memory is the only type that provides an epistemic authority on our own past. However, we are often not in the position to defend our memory beliefs, since we cannot go back to the past and justify or verify them. Even when we do have supporting evidence, it does not necessarily validate the belief, even if it correlates with our memory. Supporting evidence might seemingly support the current belief, but it is very plausible that this supporting evidence itself has already been integrated into the memory, influencing and constructing a new memory belief that still may fail to represent the real past occurrence (Price et al., 1936). Thus, unconsciously, we integrate apparent supporting evidences from the present into a memory that change due to natural alterations in perspective and interpretations. Overall, then, relying on present perception-justification might verify the modified memory, but not necessarily the original experience. Brian Smith (1966) describes this complex process of how new perceptions are unconsciously integrated into memory. He illustrates how memories have both dynamic and transient states in order to show that memories are in perpetual state of modification that occurs without us noticing these changes or being able to compare memories to the original experience:

“Not only is it impossible to compare our memories with the events of which they are the memories; but because the present is, as it were, always slipping away from us into the past we cannot even compare our memories with what purport to be the effects of the original events (or, more properly, with our inferences from those ‘effects’). For what I am com-

paring must always be, not the memory itself but my memory of that memory. Suppose that today I remember building, a short while ago, a castle in the sand. Tomorrow I go to the beach and there it is. I say ‘Yes just as I remembered it yesterday’. But how do I then *know* it is just as I remembered it yesterday? The sight of the sand castle itself may well influence my memory of my previous remembering”

(Brian Smith, 1966, p.27, italics original)

When current perceptions do not correspond to our previous ones, earlier memories adjust in light of later encounters. As a result, old memories absorb new impressions. Usually, earlier memories adjust so quickly that we are not aware of the adjustment or even that there was an incongruity. Yet even though this adjustment process occurs continually, episodic and autobiographical memories are endowed with subjective state of awareness that engenders a strong belief and a feeling of confidence in the reliability of our memories. However, there is no necessary correlation between this confidence and the reliability of the memory. Often, people can have high confidence not only in distorted memories, but also in memories of events that never happened. Emotional attachment does not indicate the veracity of the memory either, since people can feel strong attachment to inaccurate memories as well (Lynn et al., 1998; see also Loftus, 2003). Moreover, when we recollect, we are not conscious of these memory reconstructions. This reconstruction process is inaccessible for us even if we dwell deeply on the process of recalling, since even reflection does not necessarily lead to a better understanding of the components involved in the process of memory construction. Hence, studying episodic memory can give insight into the complex transformations that occur in it, enabling us to draw clearer connections between recent findings and the nature of memory beliefs.

Neuroscience, then, leads us to the view that memories are misattributed with belief. That is, neuroscience eliminates the opposition between true and false memory beliefs, since all autobiographical memories entail, in sense, false beliefs. Recalling is, in some degree, always falsely believed, for a given recall is never exactly like the original experience and goes through various modifications without our awareness, so

much so that we falsely believe that memories represent events exactly the way we experienced them. Thus, the integration of additional information in autobiographical memories actually causes an unjustified belief to become justified. Conversely, since memory is a dynamic process, no fully justified memory beliefs appear possible, leading to epistemic skepticism regarding most, if not all, episodic memory.

To further examine these distinctions in the following, I discuss the various theories of memory belief and justification, and whether the neuroscience of memory implies that initial justified memory beliefs are no longer justified, since memories are in a perpetual state of adaptation and adjustment. The question that follows, then, is whether belief adheres to the initial experience or to the modified memory. If, as appears to be the case, belief is attached to memories in their modified form, it becomes unclear whether such belief reflects an awareness of ongoing memory modifications, or whether this belief does not, itself adapting to these very modifications.

BELIEF AND JUSTIFICATION

Believing is not necessarily congruent with knowing, since one can believe without knowing whether a state of affairs is true. One can also follow Russell's thought experiment that the world came into being five minutes ago and maintain that a memory belief is independent of past occurrence. According to Russell, in order to account for knowledge of the past, memories are accompanied with a feeling of familiarity and belief. Consequently, we would count both false and true memory beliefs as memories so long as they were accompanied with such feelings. Therefore, according to Russell, an imagination-image accompanied by a feeling of familiarity and belief will be regarded as a memory. In short, according to Russell, memory beliefs do not necessarily entail relying on past experiences.

Likewise, according to the foundationalist theory of memory-belief justification, the reason for regarding a memory as a memory is determined by the justification one had when the belief was originally formed (Schroer, 2008), the justification depending on the initial circumstances.

Therefore, according to this theory, an apparent memory belief is justified (even if it is not actual). Another version of the foundationalist theory — the preservation theory — claims that memory contains a generative capacity for justification that, unlike perception, also functions to preserve these very justifications (Audi, 1995, 1998; Schroer, 2008). Put differently, memory does not generate new justifications for a belief, but merely preserves such justifications. Thus, the initial formation of a memory determines the justification for a memory belief and, from then on, is preserved. That is, a memory belief is not changed during an interval from $t1$ to $t2$, since the belief associated with a memory is sustained from the initial formation to the later recall.

There are several reservations to make regarding both the foundationalist theory and the preservation theory. The foundationalist theory, like Russell's approach, implies that an initial false and unjustified belief will be counted as a justified belief, since an apparent memory is justified as a memory belief regardless of whether this belief is actually justified. Michael Huemer has forwarded a dualistic theory that accommodates to and improves upon the foundational and the preservation theories. The dualistic theory, he claims, avoids the implications of unjustified belief (as in Russell's hypothesis that the world sprang into being five minutes ago). Huemer (1999) maintains that every belief encompasses two degrees of justification: a justification that involves the initial formation or adoption of the belief and a justification that is involved in retention. He claims that the dualistic theory thus succeeds in maintaining both justifications: the initial justification at acquisition and the justification present at the time of recalling. He conceives the "normal functioning of memory" as a state that both constitute and retain an acceptable and rational memory belief. He rules out the possibility that a memory belief constitutes a rational belief on an irrational basis, "since a rational belief, in the full sense, requires both rational acquisition and rational retention" (Huemer, 1999, p.351). However, Huemer's theory also has its shortcomings. First, it fails to explicate the conditions under which an initial irrational belief will not become a rational belief. Second, in

his answer to Russell's five minutes hypothesis, Huemer states that when a mental act appears to us as an act of memory, a memory belief then serves as justified. However, the acquisition, retention, and retrieval of a belief are not identical and static processes. Neuroscience shows that memory can convert unjustified belief to justified belief and conversely justified belief to unjustified belief. In addition, neuroscience casts doubt on memory as both a belief-generating and belief-preservation process, for it shows how processes of memory and belief formation are both dynamic. For example, the theory of episodic memory challenges the preservation theory, since episodic memory and attached beliefs are modified over time. Likewise, according to emerging findings in neuroscience, we might believe one thing at t_1 and different thing at t_2 , as the passage of the time unconsciously transforms a memory and, as a result, beliefs. Beliefs retained from an earlier experience do not necessarily go through the same adaptation process as memories and, if they do, we are not aware of this process.

Thus, these findings challenge foundationalist theories since, even if a belief is justified in the past, this initial belief does not guarantee that the current belief is justified since the memory itself went through a series of unconscious modifications. That is, if the belief is itself adjusted to correspond with memory's current content, this belief no longer represents the original memory, but instead the new modified memory. Put differently, this new belief no longer corresponds with the original memory belief, but with the modified memory, since this belief is itself involved in the same reconstructive process as memory.

Another attempt to justify memory belief is inferential. According to this account, if my expectations about a memory are fulfilled at recall, the related memory is justified. The fulfillment of expectations, according to Huemer (1999), confirms that a given representation was based on memory and that this memory was reliable. However, this inferential account disregards the natural process of incorporating expectations into episodic memories at the time of recalling. Episodic memory is formed, modified, and adjusted according to current circumstances, ex-

pectations, and anticipations. At the time of recalling, episodic memories are changed by internalizing expectations and anticipations regarding the future. Thus, since memories internalize expectations and anticipations, we generally feel that our expectations are fulfilled even if they are not. Fulfillment might come about due to the modification process itself in order to adjust the past to the present and to what we expect in the future. Because we are not aware of the revision process, we falsely perceive during recall that our current mental state is exactly that of past recollections. Therefore, we falsely perceive that our expectations are fulfilled, instead of perceiving that representations of the past are adjusted to current expectations.

The inferential argument thus ignores the revision that takes place unconsciously and leads us to problematically connect the current memory to the past instead of connecting it to more relevant states, especially the present and future. Fulfilled expectations, then, do not necessarily prove that a given set of knowledge has its basis in accurate memories, since such expectations may rely on imaginary functions such as supposition, or on new information integrated into memory. Moreover, there are also cases when our expectations are not fulfilled even when a memory retains a correct picture of a past event. In this way, expectation does not appear to serve as a sufficient criterion of reliability.

Another attempt to justify memory belief is through coherentism. According to coherentism, a given memory belief is justified by other apparent memory beliefs. If a memory belief is consistent with the general belief system, and if the various details of the individual memory cohere with the general sense of belief, then, according to coherentism, this memory is justified. However, this theory, like others, fails to account for the dynamic formation of episodic memories. Memories change perpetually, incorporating other details and accommodating to other changes. The reconstructive process might cause a true memory belief to be modified and become a false memory belief in order to cohere with other inaccurate memory beliefs. Thus, coherentism contains similar shortcomings to other theories attempting to justify memory belief. In

sum, philosophers have often discussed original memory belief, belief maintenance, and belief system conflicts. However, they have largely overlooked the dynamic character of memory, how it undergoes changes every time retrieval occurs and how the very way memory is structured leads to unjustified memory beliefs. As a consequence, recent findings in neuroscience have undermined the epistemological status not only of memories, but also of beliefs that constitute the subjective conviction about the truth of memories. Memory modification itself disqualifies belief from providing sufficient evidence to establish the veridicality of a given memory.

BELIEF REFLECTING THE PRESENT RATHER THAN THE PAST

To understand the misleading dimensions of memories, we also need to understand the processes and functions of beliefs and the relation between memory and belief. A central question is whether a belief does or does not undergo the unconscious process of construction. If yes, the question is whether belief and memory would be linked only at the time of recalling, when a memory attains conscious form. If the fusion of memory and belief takes place only at the time of recall, these two cognitive processes are likely separate, and have distinct epistemological realms. In this case, belief does not reflect the real status of autobiographical memories. However, if belief is also modified like memory, the question becomes whether belief reflects the process of modification or whether it eliminates traces from previous phases. If a memory belief reflects the various modifications of a memory, this modification process may then cause multiple and possibly contradicting representations. If, however, a current belief eliminates its previous phases, it does not matter whether a belief follows the process of change or if it appears only at the last stage after the memory is already formed. In this sense, the ordinal character is not important: whether a given belief is joined at the last conscious phase or whether this belief continually exists (but eliminates previous phases), since it represents only the current state in both cases. Our belief reflects the present memory with all associated information added during

reconstruction, possibly creating a discrepancy between a belief and the past.

The conclusion here is that belief does not have bearing on our real past, but does on the current memory representation. That is, memory representation misleads us when they are accompanied by the belief that knowledge on our own past is as it happened, when, in fact, this knowledge contains many components, only one of which is the past event as experienced. The previous belief is no longer readily available, being replaced by a new belief. We do not track the previous beliefs and relevant modification processes, just as we do not track such factors for specific autobiographical memory. The epistemic problem lies in the discrepancy between memories and their corresponding beliefs. If a set of memories change and applicable beliefs do not reflect this change, an epistemic problem emerges that renders these beliefs as unjustified. If we are not aware of the real states of memory formation and modification, we constitute beliefs from a position of ignorance as the beliefs become false. This raises the question whether such confusion simply stems from the fact that we do not know that memory fails to represent the past (and instead represents the present). If so, memory belief might become justified if we attribute it not to the past but to the present.

MISCONCEPTION OF MEMORY

This leads to further questions about prevailing misconceptions of memory. Although it has been several decades since researchers have uncovered the dynamic character of memory, and the view that memory is reconstructive is not new,⁴ the prevailing idea regarding memories is that they are stored changelessly and permanently and that remembering is accurate. The certainty that we feel regarding our memories does not correspond to the real state of our memories. What causes this discrepancy between the neuroscientific view of the reconstructive nature of memory and the layman's spontaneous conception of memory as an accurate representation of the past? Are we deluded by a wrong concept of memory? If the answer is yes, another question follows — is it the beliefs accompanying our memories that deceive us, or, conversely,

our false concepts of memory which are at fault? Does memory itself play us false, or is our concept of memory what is problematic? If we become aware that remembering is a complex process that involves various components, only one of which is the past event itself, will we experience our memories in a different way?

It seems that being aware of the dynamic nature of memory will not necessarily change the way we experience memory. After all, it may be that memory persistence or readjustment cause this faulty belief. Readjustment takes place without conscious awareness as it reorganizes our memory coherently and leaves us with the feeling that the representation is faithful and accurate. Changes are inaccessible to us unless we take an exact record of our activities as, for example, neuro- and cognitive psychologists do in experiments. Readjustments reorganize our memory coherently and leave us with the feeling that the representation is faithful and accurate. Memory and belief are not separated, but unified in one process. The feeling of unity and coherence is important for maintaining a coherent sense of self, and, conversely, cognitive dissonance may arise when belief and memory of a past event diverge. Hence, it seems that becoming aware of the dynamic nature of memory will not itself change the way we experience memory.

FUNCTIONS: THE PROCESS OF ADJUSTMENT

As stated, neuroscientific theories of memory provide a framework for rethinking memory. This framework suggests that we should shift our attitude of episodic and autobiographical memory away from broadly epistemological towards being functional. The fact that memory involves a constructive process of piecing together fragmentary information (rather than something more akin to a direct replay of the past) raises the hypothesis that a veridical representation of the past is not the optimal functioning of human memory system. This raises further questions about whether memory may have other roles as well. Does memory's flexibility give us benefits at the expense of accuracy and trustfulness? What is the function of memory if it does not store and retrieve exact experiential replicas?

Accuracy is far from the only functional goal of memory. Recollecting meets other needs, such as reconstructing the past in a desirable way, fostering self-consistency, and remembering information so as to give a good impression in social settings. The reconstructive mechanism of episodic memory fulfills such needs. Researchers who grappled with this issue have proposed various reasons why human memory, in contrast to video recorders or computers, does not store and retrieve exact replicas of experience (Schacter, 2001; Squire, 1998). One influential hypothesis suggests, as mentioned above, that episodic and autobiographical memories reconstruct past experiences for present purposes and that memory distortions reflect the operation of adaptive processes. Indeed, neuroscientists do not refer to memory distortions in healthy people as weakness or failures of the system, but as byproducts of a more adaptive evolutionary mechanism. This byproduct reflects a tradeoff between the ability to, on the one hand, accurately represent the past and to, on the other, adapt and adjust memories to new circumstances. We forget and distort our memories in order to adapt and adjust to the changing world. In fact, in a constantly changing environment, literal recall is significantly less important than the need for one's memory system to reorganize, revise, and modify memories to conform to current beliefs, attitudes, and emotional needs (Dudai, 2006).

However, adapting the past to the present is not the only function newly ascribed to memory. Researchers have shown that memory is not only about the past, but is also about the future. Indeed, while memory serves as the ability to recall previous experiences, recall itself is not solely directed toward the past, but is guided by the present for the service of the future. Thus, current hypotheses suggest that constructive processes allow individuals to simulate and imagine future episodes, happenings, and scenarios. Since the future is not an exact repetition of the past, simulation of future episodes requires a complex system that can draw on the past in a manner that flexibly extracts and recombines elements of previous experiences — a constructive rather than a reproductive system. Episodic memory is such a system, allowing for other elements to be

integrated and these complex combinations to emerge. Thomas Suddendorf and Michael Corballis (2007, p. 301-302) write:

“The fact that episodic memory is fragmentary and fragile suggests that its adaptiveness may derive less from its role as an accurate record of personal history than from providing a “vocabulary” from which to construct planned future events (and perhaps to embellish events of the past). It may be part of a more general toolbox that allowed us to escape from the present and develop foresight, and perhaps create a sense of personal identity. Indeed, our ability to revisit the past may be only a design feature of our ability to conceive of the future”

And, more specifically, Conway (2001) maintains that episodic memories preserve information highly relevant to motives, outcomes, evaluations, plan execution, and goal processing. Episodic memories are integrated into autobiographical memory because of their relevance to longer-term goals, and, consequently, to the future (Conway, 2009). Alternatively, the process of forgetting occurs because of the non-rel-

evance of these memories to future goals. Autobiographical memories function to ground and harmonize memories of past experiences with a coherent sense of self.

Also, although representations of traumatic events (such as flashbulb memories) are not wholly immune to error and distortion, evidence suggests that negative and stressful experiences lead to a reduction of the structural plasticity (Markowitch, and Welzer, 2005). This may support the idea that the normal function of memory is to form constructive, plastic memories since, in cases of traumatic memories, the memory system as a whole loses plasticity and is, as a result, far less efficient. If our memories would not be modified according to the present or prospective future, a discrepancy would emerge. If memories were to represent the past exactly, representation of the past would not let us absorb changes. Since the present itself is in perpetual change, the memory of the past must have the same dynamic nature.

Endnotes

a: The state of the trace determines its vulnerability. The premise here is that memories in an inactive state are less vulnerable to disruptions than memories in active state. However, this assumption generates controversy, especially on whether inactive memories truly are less susceptible for intervention and only the active state of the trace is vulnerable.

b: Researchers examined the effects of protein synthesis inhibitors after memory reactivation (Alberini, 2005; Sweatt, 2007).

c: There are disagreements whether the original memory is lost or changed through reactivation, and whether reconsolidation brings about new memory, or only a modification of the original memory (Ledoux, 2007).

d: Bartlett introduces the idea that memory is a reconstructive process (See Bartlett, 1932; Neisser, 1976).

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