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MY BRAIN BUT OUR MEMORIES !

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Memory is the bridge between the present and islands of the past. It selectively keeps parts of the past alive, which shape human beings as individuals but also as collectives. Psychological studies of individual human memory processes often work with the more or less conscious underlying assumption that memory can be studied in isolation from culture, class, generation and other social identification processes (Lebow, 2006). Yet, it is becoming more and more clear that "human brains […] are embedded in large social and ecological systems" (Momennejad, 2022, p. 8). Cognition is formed through collective learning and collective remembering. Strikingly, the topology of human social networks directly influences the topology of memory networks in the brain (Momennejad, 2022). But how can the very physical biological basis of memories in the brain be touched by something so unphysical as society? This essay reviews and connects neuropsychological and societal mechanisms and influences in the process of learning and memory.

Are memories physically stored in the brain? Today, the answer to this question seems to be so solid from a neuroscientific standpoint, that it seems weird to even ask it. But only a century ago, it was hotly debated whether memory is something that happens physically in the brain or psychically in the mind (Tonegawa et al., 2015). One of the earliest theorists who advocated for a physical theory of human memory was Richard Semon. He came up with the engram theory, in which he postulated that "all simultaneous excitations (derived from experience) […] form a connected simultaneous complex of excitations which, as such acts engraphically, that is to say leaves behind it a connected and to that extent, separate unified engram-complex" (Semon, 1923). Far from cellular

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and genetic biology, and sophisticated imaging technologies for the analysis of the nervous system, this was very impressive and radical thinking. Probably too radical for most of his colleagues. Semon's contributions were almost completely ignored in mainstream psychology until the early 1980's (Tonegawa et al., 2015). Decades later, Semon's predictions turned out to be quite accurate on a neurobiological level of the brain and the idea of memory engrams is still helpful today to guide research. The definition of memory engrams has over the years been adjusted by advances in research. As of today, memory engrams are the enduring physical and chemical changes that occur in the brain as it learns (Roy et al., 2022). In other words, there is a pattern of cells that gets activated simultaneously and becomes "wired together" (becoming an engram) while making an experience or learning. This same pattern of cells, the memory engram, will be activated when recalling a memory (Roy et al., 2022). Additionally, it is suggested that the storage of a memory does not happen in a single engram but in a connected engram complex. This means the brain "picks" different regions of the brain to store different aspects of a memory. This forms a tightly connected network of engram components, reaching into various different brain regions (Roy et al., 2022; Tonegawa et al., 2015). Today, this is known as the unified engram complex hypothesis.

Recently, Roy et al., (2022) have conducted a study with mice, making use of a combination of very sophisticated neurobiological procedures to map and activate engrams, which provides new and interesting evidence for the unified engram complex hypothesis. On the one hand, the study provided the hitherto most comprehensive set of brain regions involved in a single engram complex. On the other hand, it has shown that activating just one component of an engram, activates other engram components. This supports the hypothesis that there is functional connectivity of engram components across multiple brain regions. Between these conclusions and Semon's engram theory lie about 100 years. This again shows how far ahead of its time the engram theory was.

Systems consolidation theory (Marr, 1971; Squire & Alvarez,1995) also focuses on an understanding of the neurological mechanisms of memory. It is compatible with the unified engram complex hypothesis in that it proposes a variety of brain regions to be involved in storing memories. In contrast to the memory engrams hypothesis, the systems consolidation theory additionally takes into account the dimension of time. Specifically, the systems consolidation focusses on how hippocampal structures are very important for the primary encoding of memories. But as memories age, they are thought to become hippocamupus-independent and are reorganized in the neocortex (Marr, 1971; Squire & Alvarez,1995). In a very recent study, Tallman et al. (2022) identified various patterns of human brain activity and connectivity that changed over four different time points (1 hour, 1 day, 1 week, or 1 month after learning). These findings were in line with the systems consolidation theory. Connecting them back to the engram theory, they also show how the brain regions, which were activated when experiences are made and learning is happening, might not stay the same that get activated during recall across time.

Neuroscience has contributed a lot to the understanding of the biological basis of memory and the mechanisms of how learning and memory happen. Yet, individual biology is not the only factor that shapes memory processes in the brain. The social environment human beings live in have an often overlooked and underestimated importance for learning and memory (Lebow, 2006). Parkinson et al. (2018) conducted a study where participants were watching the same video during an fMRI scan. They found that the neural response of participants was more similar to the neural response of other participants who were close to them in a social network than participants who were more distanced. Connecting these findings with the engram theory, this means that the memories of people who are socially close will have more similarity compared to the memories of socially distant people because memory formation depends on the neuronal activation during the making of an experience (Tonegawa et al., 2015). Momennejad (2022) argues that shared memories are crucial in shaping group identity and facilitating collective action. It is therefore not surprising that human beings have evolved to synchronize the way they learn and remember with those in their social networks.

So far this essay focused on *how* learning and memory happens but not on *what* is actually remembered. Collective memories are the basis for shared beliefs, which function as a filter for what individuals remember (Momennejad, 2022). Lebow (2006) closes the cycle in arguing that individual memory is often in line with and reinforcing collective memories. It therefore seems that collective and individual memories are not exactly the same but they exist in a tight interconnection. Coman et al. (2016) used graph theory and behavioural experiments to test whether the content of memories would be aligned in people to the degree they are separated in a social network. Participants in their study were taking part in arranged virtual communication networks. They first studied content individually and then discussed it in chats with other pre-assigned participants of their network. The results of this experiment confirm the expectation, that the memories of the studied content were most aligned between people who were in direct conversation with each other and least aligned between people who had the furthest geodesic distance. These are findings from an artificially formed network of people who didn't know each other before. Here, conversations seemed to be crucial for the convergence of memories. How does this work for already naturally existing social networks? Vlasceanu and Coman (2020) conducted a study in which they showed that people who were in the same social network had a higher alignment of beliefs, even if they never directly interacted. Returning to the claim of Momennejad (2022) that collective beliefs determine what individuals remember, it could be expected that shared beliefs have a similar function as direct interactions between members of a social network in forming individual memories. In summary, ones belonging to a social network has a significant impact in determining *what* we remember.

Concluding, this paper has reviewed the engram theory (Semon, 1923; Roy et al., 2022; Tonegawa et al., 2015) and systems consolidation hypothesis (Marr, 1971; Squire & Alvarez,1995; Tallman et al., 2022), which are both contributing to an understanding of *how* memories are made on a neuropsychological level. Yet, to answer the question *what* individual memories contain, it is essential to take into account the social context. Various studies (Parkinson et al., 2018; Coman et al., 2016; Vlasceanu & Coman, 2020) have shown that social networks are a driving force in determining the content of memories. Lebow (2006) even argues that individual as well as collective memories are entirely socially constructed. Contemplating this claim is not easy. Even though every human being has their own brain, their own biological and chemical machine, generating and storing memories, it might be that there is very little "my own" in the content we remember.

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