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MEMORY: IN MY BRAIN AND BEYOND

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ABSTRACT

The brain is a complex organ of which we still do not know everything. Without any external stimulus, the brain can internally generate feelings, emotions, and thoughts itself, just by remembering (consciously or not). But it can also erase feelings, and thoughts to protect itself. Brain can create and destroy, which is quite powerful. Regarding memory, the same applies: our brain can create false memories, a big issue in testimony in court, and it can delate memories, when too traumatic or simply not relevant anymore. In this work, I will talk about memory in general, beginning with information on how the encoding process works in standard situations. I will continue by presenting what are the engrams and how a single memory is globally distributed in the whole brain. I will further present what is collective mind and how it shapes our own cognition. I will end with interesting philosophical questions (at least, for me) raised by these studies.

KEYWORDS: memory, memory engram, collective mind.

RÉSUMÉ

Le cerveau est un organe complexe dont nous ne savons pas encore tout. Sans aucun stimulus externe, le cerveau peut générer lui-même des sentiments, des émotions et des pensées, simplement en se souvenant (consciemment ou non). Mais il peut aussi effacer des sentiments et des pensées pour se protéger. Le cerveau peut créer et détruire, ce qui est assez puissant. En ce qui concerne la mémoire, la même chose s'applique : notre cerveau peut créer de faux souvenirs, un problème important dans les témoignages au tribunal, et il peut effacer des souvenirs, lorsqu'ils sont trop traumatisants ou simplement plus pertinents. Dans ce travail, je parlerai de la mémoire en général, en

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commençant par des informations sur le fonctionnement du processus d'encodage dans des situations standard. Je continuerai en présentant ce que sont les engrammes et comment un seul souvenir est globalement distribué dans l'ensemble du cerveau. Je présenterai ensuite ce qu'est l'esprit collectif et comment il façonne notre propre cognition. Je terminerai par des questions philosophiques intéressantes (du moins, pour moi) soulevées par ces études.

MOTS-CLÉS : mémoire, engramme mémoriel, esprit collectif.

HOW DO HUMAN BRAINS ENCODE THEIR OWN LEARNING AND MEMORY PROCESSES?

Every time we live something, from feeling the wind on our skin to studying foreign language vocabulary, we encode. However, sensory memory lasts a few seconds and is automatic whereas semantic memory (part of long-term memory) needs consciousness and motivation to be held for a longer time. So, many experiences we live, from simple sensations to complex learning, firstly goes into the prefrontal cortex (PFC) when it involves consciousness (i.e., only sensory information we are aware of goes into the PFC). If the PFC judges something to be important enough, it will send the signal to the hippocampus, so that the experience will become long-term memory. As in this example the feeling of the wind on the skin is a sensory short-term memory, it will not be transferred to the hippocampus. The prefrontal cortex has two main roles in memory processes: it is the gate for experiences to enter more complex loops in the brain and it exerts a top-down inhibitory control over the hippocampus so that redundant information is not encoded as long-term memory. It is important to note that not all types of memories require the hippocampus to be encoded: declarative memories (that is, explicit memories that “we know we know”) are consciously learnt and require hippocampus to become long-term memories whereas non-declarative memories (or procedural, implicit memories) are unconsciously learnt and don’t require hippocampus. However, for declarative memory, is the hippocampus always useful to store and retrieve a memory? Tallman and colleagues (2022) demonstrated that activity and connectivity change when aging. In fact, when a memory ages, connectivity between cortical regions and hippocampus changes, which is consistent with system consolidation theory that posits that, with time, the system consolidate so that hippocampus is no longer needed for a memory to be stored and retrieved (Tallman et al., 2022).

So, what precedes is the general process, but how does our brain encode, on chemical and biological levels? Learning a new thing is in fact encoding and memory is the ability to store and retrieve information that have previously been encoded (consciously or not). When our brain encodes something new, it changes pre-existing connections between neurons and/or create new ones: it is a kind of

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plasticity. Retrieving a memory reactivates the same connections, the same changes as when it has been encoded (Semon, 1904; Tonegawa et al., 2015).

Where do those changes happen? Where is a single memory stored in the brain? In 1904, Semon invented the term “engram” which is defined as the physical substrates of a memory. An engram cell is a neuron that is activated by learning, leading to cellular changes and whose reactivation leads to memory recall (Tonegawa et al., 2015). Many engram cells form together what we call engram cell ensemble. Those ensembles are localized in specific brain regions and the engram cell ensembles associated to a unique memory are distributed across the brain and are connected to each other (Semon, 1904). In 2022, Roy and colleagues have been able to identify brain regions that contain engram cells for a contextual fear conditioning memory in mice and have also been able to show that those ensembles were connected, so that the activation of one ensemble activate other engram ensembles (Roy et al., 2022). Those results support the unified engram complex hypothesis proposed by Semon (1904). To simplify a bit, a memory is not a solid block localized in a specific region of the brain, it is made of many little features that connect to permit the retrieving of it. A global memory is, indeed, composed of many distinct aspects of that memory.

Thus, memory is nowadays no longer seen as something mechanical, fixed in a specific region of the brain, and relating only to what we can individually remember. According to the extended definition, memory is the capacity to store and retrieve information, in general, which includes DNA memory (Zlotnik & Vansintjan, 2019). It is a dynamic, fluid process that changes connections between neurons. Therefore, in accordance with this extended definition, memory is also outside our own brain which lead us to the collective mind theory and collective memories.

HOW THE TOPOLOGY OF ONE'S LARGER SOCIAL NETWORK SHOW SIMILAR NEURAL PATTERNS TO NEURAL PATTERNS OF OUR FRIENDS AND COMMUNITY TIES?

Collective memory is defined as the convergence of memories among the members of a social network or community. It is a fundamental capacity in order to have common beliefs and norms in increasingly complex human communities (Coman et al., 2016). According to Coman and colleagues (2016), collective memories (or mnemonic convergence) form from interindividual discussions. For example, speaking with someone about a past event change the configuration of individual memories that ultimately align together. Interestingly, they show that mnemonic convergence is dependent on individual cognitive mechanisms (i.e., strengthening of discussed features and weakening of non-discussed ones) and on the social network topology (Coman et al., 2016). The findings about

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collective mind and social network topology have been summarized in the review of Momennejad (2022) and they conclude that cognition is shaped not only by what we experience as individuals but also by the characteristics of our social networks. Regarding the "social network topology", it is defined as the structure of communication networks and it is quite clear that a non-clustered network structure (i.e., a single large cluster) enables memories to align more compared to a clustered network structure (i.e., two or more subclusters that communicate little between each other). This result is explained by a greater distance between the most distant members in the clustered group (see Figure 3. in Momennejad, 2022 for a good visual explanation).

Now we know that memories are shared among group members, but is this phenomenon observable at the neuronal level? Are there similarities in the brain among group members and if so, are my brain activations more similar to those of my friends compared to those of my larger social network? Research done by Parkinson, Kleinbaum and Wheatley (2018) focuses on this topic. Their main conclusion is that neural responses when viewing a movie are exceptionally similar among friends and that the further we are from someone, the less these similarities will appear. So, closeness predicts neuronal activity and, in return, similarities in brain activations can predict friendship. Indeed, they could predict how close two subjects were from each other by viewing at how much their neural responses overlapped. Being attracted by individuals that resemble us is called homophily and could be defined with the commonly used metaphor: birds of a feather flock together.

CONCLUSION

Knowing that memory is, in addition to being distributed in the whole brain, also beyond our own brain is a powerful finding that questions our own will and personal identity: if choosing my friends depend on how similar are our neuronal responses, can I still think I am free to select them? Can I still base my identity on my memories, knowing that they are certainly shared by many people and prone to malleability when discussed? Those questions, although vertiginous, remember us that we are much more similar than what we think and that we are connected to each other in a way we aren't always aware of. Maybe those findings on collective mind will put forward Jung's controversial theory on collective unconscious: he thought that there exists a kind of collective and inherited psychic system that is shared among all humans and that connect all of us together, unconsciously (Jung, 1936). His theory, although a little mystical or occult, seems more relevant as it could have been thought, if we think of collective mind theory as a larger process that also includes our ancestors' memories. Are our memories stored even beyond our own existence and contain inherited aspects of distant ancestors? According to Jung, there is no doubt and, in the words of Zlotnik &

Vansintjan (2019), memory seems to exist everywhere.

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