Cortica
www.revuecortica.net | ISSN : 28131940
Cortica Journal Club
Cortica 2023 *2*(2), 198-202
https://doi.org/10.26034/cortica.2023.4215

THE IMPACT OF SOCIAL NETWORKS ON LEARNING AND MEMORY PROCESSES

Pauline Petit
Master en Neuroscience Cognitive, Psychologie, Université de Fribourg, Suisse

***Auteure correspondante** : Madame Pauline Petit pauline.petit@unifr.ch

Citation : Petit, P. *(2023).* The impact of social networks on learning and memory processes. Cortica 2*(2),*198-202 https://doi.org/https://doi.org/10.26034/cortica.2023.4215

Résumé

Les processus d'apprentissage et de mémorisation dans le cerveau humain sont complexes et dynamiques, influencés par divers facteurs, tels que les structures et systèmes cognitifs et neuronaux, ainsi que les types de mémoire, l'âge et les influences sociales. Le réseau social d'une personne peut avoir un impact sur les réseaux de ses amis et les liens avec la communauté. Cela signifie que les changements dans le réseau neuronal d'un individu peuvent provenir du réseau social de quelqu'un d'autre. Des études ont montré que nos connaissances et nos souvenirs peuvent déclencher des réponses neuronales similaires à celles de nos cercles sociaux, même chez des personnes avec lesquelles nous ne communiquons pas directement. La capacité du cerveau à encoder des réseaux sociaux plus larges affecte les schémas neuronaux des amis et des liens communautaires, et vice versa.

Mots clés : Apprentissage, Mémoire, Cognition, Réseaux Sociaux, Cerveau, Hippocampe, Cortex Préfrontal

Abstract

Learning and memory processes in the human brain are complex and dynamic, influenced by various factors, such as cognitive and neural structures and systems, as well as memory types, age, and social influences. One person's social network can have an impact on the networks of their friends and community ties. This implies that changes in an individual's neural network can originate from someone else's social network. Studies have shown that our knowledge and memories can trigger similar neural responses as those within our social circles, even among individuals with whom we do not directly communicate. The brain's capacity to encode broader social networks affects the neural patterns in friends and community ties, and vice versa..

Keywords: Learning, Memory, Cognition, Social networks, Brain, Hippocampus, Prefrontal cortex

Learning and memory processes in the human brain are complex and dynamic, supported by multiple cognitive and neural systems and structures. The ability to acquire new information or modify existing knowledge and the ability to encode, storage and retrieve that information over time, define respectively learning and memory. Referring to Semon's engram concept presented by Roy and collaborators (2022), the brain structures that support various memory processes differ, depending on the type of information to be retained and how it is encoded and retrieved. Even a given memory is not stored in a single brain area. This highlights the complexity of human brain and the implementation of functional connectivity.

According to the work of Gazzaniga, Ivry and Mangun (2018), the memory system includes the medial temporal lobe which contains the hippocampus and parahippocampal gyrus, which are responsible for encoding information and linking relationships between different types of information. It also includes the parietal cortex, involved in encoding and retrieving episodic or contextual memory, the temporal cortex, which stores episodic and semantic knowledge, and the association sensory cortices for the effects of perceptual priming. However, there are also connections with many other parts of the brain that impact memory, even as brain connectivity changes over time (Tallman et al., 2022).

Memories can be classified into short-term or long-term memories. Short-term memories are mainly used by the working memory, while long-term memories can be declarative, consisting of semantic memory or episodic memory, or nondeclarative, consisting of memories for how to perform actions that we cannot explain, such as biking or brushing our hair, perceptual representation system, classical conditioning, and non-associative learning.

Rasch and Born (2008) proposed the two-store memory model for declarative memory, which suggests that the hippocampus is not necessary for nondeclarative memory acquisition. This model divides declarative memory into a fast-learning store, primarily managed by the hippocampus for encoding information, and a slower store that involves the reorganization of memory in the neocortex. This is consistent with the findings of Tallman and colleagues (2022), who

Cortica Journal Club
Cortica 2023 *2*(2), 198-202
https://doi.org/10.26034/cortica.2023.4215

studied memory consolidation across several periods of time. They found that memories gradually reorganized the neocortex, and a larger network was revealed that contained clusters in the prefrontal cortex, the insula, the medial temporal lobe, the lateral temporal lobe, the posterior cingulate cortex, the parietal cortex, and the occipital cortex. All these regions exhibited decreasing functional connectivity with the hippocampus as the memory aged.

It is important to note that the memory learning system develops not only with age, but also exists in utero. Studies have shown that as early as five months after conception, individuals begin to learn the characteristics of their native language, and there are also indications of earlier learning through the transmission of transgenerational knowledge.

The evolution of neural patterns is impacted by factors such as people's age, the age of memories but also social factors. Lukkes and collaborators (2009) have found that social isolation in rats during a period equivalent to childhood and adolescence in humans can lead to changes in prefrontal cortex function, disrupted synaptic plasticity, and causes social behavioral deficits. Even with subsequent socialization, some of these deficits may persist. Similarly, humans who experience social stress during childhood may have their neuronal and network development of the brain affected, which can contribute to neural degeneration in adulthood and to an increased risk of mental illness later in life. Momennejad (2022) supports the idea that human cognition is shaped by learning and memory in social networks.

The ability of the nervous system to adapt and change its structure, function, or connections in response to internal or external stimuli is known as neuroplasticity. Neuroplasticity plays an important role in trace learning and memories formation, which is strongly influenced by environmental factors and experience. According to Roy and collaborators (2022), the formation and pruning of synapses in response to new information and experiences can alter gene expression and result in the formation of new neural circuits that are behaviorally defined.

Social interaction plays a crucial role in our daily life, and our brain is constantly processing and responding to the information it receives from these interactions. This suggests that our relationships may have a significant impact on our brain's neural patterns. It is reasonable to hypothesize that human brains have evolved to handle the cognitive demands of navigating complex social networks, and vice versa. Dunbar (1992, 1993) has proposed that the maximum number of simultaneous interactions possible is related to the neocortical volume.

The limited number of neocortical neurons in humans, referred to Dunbar's number, is estimated to be 147.8 relationships that an individual can monitor simultaneously. Cognition is social and serves social functions, which is why our own social network is limited. Research by Parkinson, Kleinbaum and Wheatley (2018) demonstrate that people tend to form relationships with others who are similar to them in terms of physical attributes, demographic information, and behavioral tendencies. This phenomenon is known as homophily.

Momennejad (2022) series of fMRI studies studying similarities in brain activation during viewing clips reported that those activation are more similar with people of the same community ties. These results depend on the degree of separation and the geodesic distance between individuals. Parkinson, Kleinbaum and Wheatley (2018) found similar results studying friends and completed that knowledge by the fact that we have similar perception and response to the world, which confirms the homophilic pattern. In this second study, brain areas where response similarity was found to be associated with the attentional allocation network, regions related to bottom-up attentional control, and emotional brain regions were discovered to be linked with proximity in social networks.

Because the human brain is sensitive to the network status of other individuals and is able to track social ties and relationships that are direct or more distant, the social network of an individual can influence the social network of their friends or community ties. This means that changes in an individual's neural network can originate from the social network of someone else.

To conclude, learning and memory processes are complex and dynamic, and depend on many internal and external factors such as the type of memory, age, and even social factors. Studies have found that humans' knowledge and memories tend to have similar neural responses to certain stimuli as those of their friends and community ties, and even with members of their community whom they never directly communicate with. The brain's ability to encode the topology of a larger network impacts the neural patterns of our friends and community ties and vice versa. Understanding the learning process of these social networks and neural patterns may offer theoretical insight and be applied to future or current artificial intelligence machines.

Cortica Journal Club
Cortica 2023 *2*(2), 198-202
https://doi.org/10.26034/cortica.2023.4215

References

Dunbar R. I. M., « Neocortex size as a constraint on group size in primates », *Journal of Human Evolution*, vol. 22, n° 6, juin 1992, p. 469–493 (DOI 10.1016/0047-2484(92)90081-J).

Gazzaniga, M.S., Ivry, R.B., Mangun, G.R (2018). *The Biology of the Mind*, (5th Edition, chap 9-13). WW NORTON.

Lukkes, J. L., Mokin, M. V., Scholl, J. L., & Forster, G. L. (2009). Adult rats exposed to early-life social isolation exhibit increased anxiety and conditioned fear behavior, and altered hormonal stress responses. *Hormones and behavior*, *55*(1), 248-256.

Momennejad I. (2022). Collective minds: social network topology shapes collective cognition. *Philosophical transactions of the Royal Society of London*. Series B, Biological sciences, 377(1843), 20200315. https://doi.org/10.1098/rstb.2020.0315.

Parkinson, C., Kleinbaum, A. M., & Wheatley, T. (2018). Similar neural responses predict friendship. *Nature communications*, *9*(1), 1-14.

Rasch, B., & Born, J. (2008). Reactivation and consolidation of memory during sleep. *Current Directions in Psychological Science*, *17*(3), 188-192.

Roy, D. S., et al. (2022). Brain-wide mapping reveals that engrams for a single memory are distributed across multiple brain regions. *Nature communications*, 13(1), 1799. https://doi.org/10.1038/s41467-022-29384-4

Tallman, C. W., Clark, R. E., & Smith, C. N. (2022). Human brain activity and functional connectivity as memories age from one hour to one month. *Cognitive Neuroscience*, *13*(3-4), 115-133. https://doi.org/10.1080/17588928.2021.2021164