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HOW HUMAN BRAINS ENCODE THEIR OWN LEARNING AND MEMORY PROCESSES AND HOW THE TOPOLOGY OF ONE'S LARGER SOCIAL NETWORK SHOW SIMILAR NEURAL PATTERNS TO NEURAL PATTERNS OF OUR FRIENDS AND COMMUNITY TIES?

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HOW HUMAN BRAINS ENCODE THEIR OWN LEARNING AND MEMORY PROCESSES? Neurons receive sensory input from the environment which refers to the process of *encoding* (Cadar et al., 2018; Deng et al., 2010). Encoding is the initial process of learning whereby the information is processed to the memory system (Cadar et al., 2018). The term *memory* refers to the faculty of encoding, storing as well as the retrieval of information (Tyng et al., 2017). Information obtained by the environment will be encoded through the structures in the medial temporal lobe (MTL) including the brain structures hippocampus and para-hippocampal regions (Argyropoulos et al., 2021; Deng et al.,2010; Tallman et al., 2022).

Encoding is the first process that occurs within the faculty of memory (Cadar et al., 2018). This allows humans to understand the world and encode memories (Cadar et al., 2018; Tallman et al., 2022). The memory is then reorganized through the bidirectional connection into the neocortex (Tallman et al., 2022). This allows that the memory can be retrieved without the MTL (Tallman et al., 2022; Tyng et al., 2017). Humans organize the information into their already existing concepts or make a connection to new concepts (Tallman et al., 2022; Tyng et al., 2017). This process occurs because learning processes

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are translated into memories to obtain it long-term through the AMPA-type glutamate proteins which strengthen the memories (Hardt et al., 2014).

Therefore, memories become part of the encoding synapses (Deng et al.,2010; Hardt et al., 2014). The midbrain has been identified as responsible for establishing as well as maintaining memory (Tallman et al., 2022). The prefrontal cortex (PFC) is responsible for learning new information (Tallman et al., 2022). Therefore, damage to the PFC affects the process of acquiring new leaning information and thus also encoding (Tallman et al., 2022). The hippocampus is responsible for establishing, connecting, and maintaining memories (Tallman et al., 2022). The important role of the hippocampus is that it allows memories to be remembered (Tallman et al., 2022). Without the hippocampus or with damage to the hippocampus amnesia would occur (Tallman et al., 2022). Also, the amygdala plays an important role in how humans encode memory (Roy et al., 2022). This is because the amygdala is involved in the process of which memory to store, depending on the emotional response of an event (Hermans et al., 2014; Roy et al., 2022).

It is worthy to state that negative events are more strongly remembered (Tyng et al., 2017). Stress has also been identified as key factor in the way of how humans encode information which will in turn affect how we remember the memory (Schwabe & Wolf, 2013). *Learning* is viewed as the process of acquiring new or modifying knowledge, behaviors, preferences as well as skills which starts already in the womb (Tyng et al., 2017). During the process of learning engram cells, which are chemical changes that occur in the brain structure are activated and become reactivated during recall (Roy et al., 2022). Furthermore, through aging humans, develop complex cognitive abilities (Roy et al., 2022). Additionally, motivation plays a key role in learning because it is associated with the reward-based learning and thus the release of the neurotransmitter dopamine (Stelly et al., 2020).

The time of learning and the association with memory plays a key role too, as accuracy as well as confidence of a memory decreases as time goes by (Tallman et al., 2022). Studies of fMRI and measures of the functional hippocampal connectivity showed decreases as the memory aged (Tallman et al., 2022). Therefore, as humans age, memory ages and become weaker and accuracy decreases (Tallman et al., 2022). It is worthy to note that humans do not store their memories as they were first encoded rather that memories get reorganized due to the process of memory consolidation (Tallman et al., 2022). This leads to the fact that stabilizing long-term memory is dependent on memory consolidation (Tallman et al., 2022).

Conclusively, learning which is the initial process of encoding starts already in the womb and continues throughout life (Tyng et al., 2017). Encoding is the first process of the memory faculty and occurs in the medial temporal lobe regions (Cadar et al., 2018). Therefore, damage to these regions can have negative outcomes such as amnesia (Tallman et al., 2022). Additionally, various factors including stress, motivation, negative events, and age have an influence on learning and encoding and therefore, also how and if memories are stored and remembered (Schwabe & Wolf, 2013; Tallman et al., 2022).

Answering the second question is a bit complicated yet very interesting: HOW THE TOPOLOGY OF ONE'S LARGER SOCIAL NETWORK SHOW SIMILAR NEURAL PATTERNS TO NEURAL PATTERNS OF OUR FRIENDS AND COMMUNITY TIES? Human cognition such as the acquisition of language, tool use, beliefs about the world, social norms are shaped through learning, memory as well as social networks (Li et al., 2018; Momennejad, 2021). Social networks are comprised of diverse social structures which can be weak or strong clustered as well as hierarchically which serve different roles (Momennejad, 2021). Furthermore, the diverse social structures differentiate humans from animals such as herds and swarms (Momennejad, 2021). Humans pass and share information through social networks to synchronize knowledge, beliefs, and collective memories which in turn shape collective cognition (Momennejad, 2021).

The term *collective memory* refers to the merging of memories amongst members of a social cohort (Momennejad, 2021). Collectively shared memories which were acquired through social networks such as friendships, communities, and family members are likely to shape group identity which in return facilitates collective behavior and thus collective cognition (Momennejad, 2021; Parkinson & Wheatley, 2016). Additionally, collective memories are likely to form the foundations of shared belief systems such as religion, health, and political choices which leads to how humans remember these belief systems as well as how they are likely to behave collectively (Momennejad, 2021).

Already given the above information you and I shouldn’t be too surprised as to why we hold similar belief systems, engage in the same health choices, or vote for the same political party as our friends and other individuals in our social network. Have you wondered how our beliefs spread amongst our social networks? It has been suggested that collective beliefs are synchronized accordingly to a social network’s topology (Momennejad, 2021).

A study conducted by Vlasceanu and his colleague Coman (2022), revealed that the topology of social networks has an impact on beliefs alignment (Momennejad, 2021). Their study implicated that the belief alignment is even present amongst members who have never had any direct contact with one another (Momennejad, 2021).

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Additionally, an association between network topology and collective behavior has been established through the fact that individuals tend to adopt health behaviors more if the reinforcement of that health behavior came from many close relationships within the larger network (Momennejad, 2021). This suggests that the topology of communication networks shapes behavior (Momennejad, 2021). Furthermore, this provides also evidence the health behaviors spread more amongst close network topologies than random one's. Further studies of the role of network topology also identified that influential members have more power to change collective beliefs and social norms amongst their cohort (Momennejad, 2021).

As I have stated before, our beliefs and memories are alike to the one's of our family members, friends, and community. Furthermore, the similarity is depending on the shortest distance or furthest distance to another community, social network (Momennejad, 2021). This is part of the reason why you and I share similar cognition and thus collective behavior with our close ties (Momennejad, 2021). Given the fact of cognitive and behavioral similarities it can be assumed humans within their social network share similar neural patterns (Momennejad, 2021). In fact, several fmri studies investigated whether social network topology have similar brain signals of community members (Momennejad, 2021).

Results of a study revealedneural responses of individuals who were asked to participate in an audiovisual video were more alike to the neural responses measured by their close community members (Momennejad, 2021). Furthermore, it was also revealed that the closer the geodesic distance between friends, the more similar were their brain responses (Momennejad, 2021). Whereas members within the same social network but a greater geodesic distance showed less similar responses (Momennejad, 2021). This provides biological evidence that you and I also share collective cognition and behavior with our close ties since we show similar neural patterns. Interestingly, also in the studies of fmri, highly influential members played a greater role (Momennejad, 2021). The study revealed that brain activities of community members became more like the influential group members (Momennejad, 2021). Furthermore, human brains have evolved to navigate cognitive demands and being able to track closer, further away, and multiple steps away relationships to understand the broader social network topology (Momennejad, 2021).

Conclusively, collective cognition, beliefs, memories, behavior, and neural similarities can be seen as reasons as to why we are like our friends, family members and community. This is since social network topology shapes collective cognition despite the diverse structures (Momennejad, 2021). Furthermore, it has also been revealed that a shorter geodesic distance and the influence of a powerful ingroup member plays a key role similar neural pattern (Momennejad, 2021).

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