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1)Does the hypothalamus play a primary role in learning?

2)are hypothalamic effects on learning secondary to changes in brain state such as attention/motivation?

The documented control by hypothalamus-unique transmitters, such as orexin and MCH of synaptic strength in isolated brain slice preparations implies a primary role for the hypothalamus in synaptic weight updating.

the lateral hypothalamus is also critical for updating many types of associative and non-associative memories.

memory : a behavioural or cellular/molecular state created by an experience.

memory updating : experience-dependent memory modification

associative learning : memorizing cues/contexts temporally associated with punishments or rewards

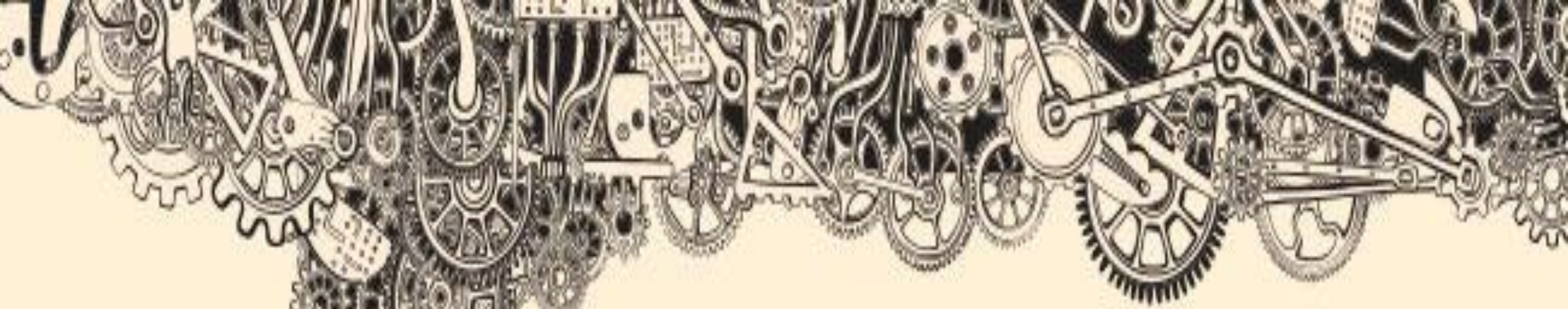
non-associative learning: learning without explicit punishments or rewards

The hypothalamus is a portion of the brain that contains a number of small nuclei with a variety of functions. One of the most important functions of the hypothalamus is to link the nervous system to the endocrine system via the pituitary gland. The hypothalamus is located below the thalamus and is part of the limbic system

The hypothalamus controls body temperature, hunger, important aspects of parenting and attachment behaviours, thirst, fatigue, sleep, and circadian rhythms.

More recent work suggested that the hypothalamus might act as an interface for various types of cognitive functions, such as learning and memory .

However, the precise mechanisms and circuitry of how the hypothalamus may be involved in memory and learning processes are largely unknown. Recent methodological developments utilizing chemogenetic and optogenetic approaches have enabled specificity in studying distinct neurons and their pathways in behaving animals. These studies unravelled new insights regarding the structure and function of the hypothalamus as related to learning and memory processes, especially the lateral hypothalamus.



Hypothalamus as a region critical for learning and memory:

The involvement of the hypothalamus in learning and memory is implied by numerous studies in both humans and animal models.

Anatomical lesions of thelateral hypothalamus, or more selective ablation or silencing of specific lateral hypothalamic neurons, can compromise key behavioural and cellular correlates of learning and memory, while lateral hypothalamic electrical stimulation can improve memory.

For example, the decision to eat involves an evaluation of the internal metabolic information and the external environmental conditions over a certain period of time. This is evident when a subject is deciding which type of food to eat. Depending on which type of nutrients the organism (animals as well as humans) needs, it will decide which food to consume. However, how the internal nutritional state of an organism dictates the selection of a specific food in this decision making is still unknown.

Hypothalamic representation of variables that govern learning:

Important forms of learning depend on rapidly-changing variables such as rewards (e.g. taste), punishments (e.g. electric shock), "neutral" context (e.g. novelty), and slowly-changing variables such as internal body state (e.g. nutrient levels, which can also be considered as a form of reward feedback).

Causal roles of specific hypothalamic neurons in updating associative and non-associative memories

Associative learning involves a change in behavioural and neural responses to a neutral stimulus (e.g. a tone), after repeated temporal pairing of such stimulus/cue with a punishment or a reward. The simplest form of associative learning is Pavlovian conditioning, which has been typically studied in animal models in the context of fear conditioning, where fear behavioural responses to punishments or threats .

Through which mechanisms does the lateral hypothalamus modulate learning and memory

Arousal and motivation are important prerequisites for updating many types of memories. Experience-dependent memory updating often requires motivation to perform certain actions (e.g. to explore a novel object). It also requires sensory awareness, since without wakefulness and arousal, the experiences that shape memory may not be translated into changes in brain activity patterns. The lateral hypothalamic cell types described above, the orexin and MCH neurons, have both been implicated in setting the animals' level of arousal, motivation, as well as stress/anxiety .

Conclusions

The studies reviewed above indicate that hypothalamic signals can directly control multiple forms of memory, through mechanisms that are not explained by traditional hypothalamic roles such as energy homeostasis, motivation, and arousal. When and why should the hypothalamus be involved in memory formation?

Another key question is whether the hypothalamic neurons act as general controllers for all kinds of experience-dependent synaptic plasticity, or whether they are selective controllers of specific kinds of memory?

THE END

THANKS FOR YOUR ATTENTION