Dual Process Theory: How Does the Brain Decide?

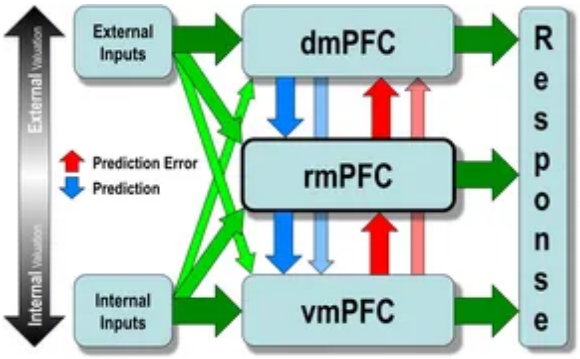

Figure 1. The hierarchical allostatic regulation model of medial prefrontal cortex (mPFC) function for social valuation

Note. From "Stability or plasticity? – A hierarchical allostatic regulation model of medial prefrontal cortex function for social valuation," by H. Kim, 2020, Frontiers in Neuroscience, 14, Article 281. Copyright 2020 by H. Kim.

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INTRODUCTION

Humans make decisions every day, every minute, and every second. But how? According to the book Thinking, Fast and Slow by Daniel Kahneman (2011), there are two systems that are involved in decision-making: System 1 and System 2. While System 1 is responsible for unconscious, autonomic, and intuitive decisions, such as recognizing a friend's face in a crowd, System 2 is in charge of deliberate, slow, and analytical decisions, such as writing an essay. However, how does the brain decide which system to use? The answer to the question is not yet fully known, although there are some reference models that help us to hypothesize the underlying mechanisms. Here, the hierarchical allostatic regulation model of the medial prefrontal cortex will be introduced to better understand the core system behind the process (Kim, 2020).

ALLOSTASIS

As suggested by the name of the model, it heavily relies on the body system of allostasis. Allostasis is a physiological process of the body anticipating environmental change and adapting to it by changing internal bodily state to maintain stability, which can be determined via heart rate variability (Kim, 2020). To achieve this, the medial prefrontal cortex (mPFC) plays a crucial role.

Inside mPFC, there are three core subregions: ventromedial prefrontal cortex (vmPFC), dorsomedial prefrontal cortex (dmPFC), and rostromedial prefrontal cortex (rmPFC). vmPFC is responsible for emotional regulation, decision making, and goal-directed actions. In terms of social

valuation, it represents internally driven value, that is, focusing on interoception or homeostatic signals when deciding which is more important. Therefore, it manages intuitive and internalized valuation, which could be either prosocial or altruistic. dmPFC is in charge of detecting or resolving conflicts, looking for new methods, and integrating external sensory inputs. In regard to social valuation, it is often engaged in high conflicts such as guiding behaviors after negative outcomes. Thus, it supports mentalization, perspective-taking, and strategic prosociality when it brings benefits. In short, it integrates multiple sources and allocates them to meet each demand. rmPFC is in control of default-mode processing, long-term planning, and cognitive branching. It specializes in self-referential and enhancement. In contrast to vmPFC, it deals with context-sensitive prosocial valuation, meaning its decisions are influenced by competitions, social observations, and reputation concerns, which are also linked to metacognition (Kim, 2020).

MODEL

The model represents these three regions as internal valuation, external valuation, and integrator, respectively. Internal valuation refers to intuitive and familiar responses, while conflicts could be escalated to external valuation and update mappings as well as reinternalizing through repetition. Basically, easy decisions that would be handled by system 1 would be processed in vmPFC and vice versa. In between, rmPFC monitors and resolves internal conflicts (Kim, 2020).

What about shifting between systems 1 and 2? The model suggests the thalamic reticular nucleus (TRN) switches between them by modulating internal and external thalamo-cortical loops. It is further divided into anterior and posterior TRN, which focus on internal and external stimuli, respectively. As it detects conflicts, it suppresses unnecessary signals, which enable flexible shifting between valuation modes. As a result, internal valuation is prioritized, but can be altered when a huge mismatch with the environment is presented (Kim, 2020).

OTHER FACTORS

Other than the model itself, there are other factors that affect the decision of the brain. One of the most strong elements is neuromodulators. For example, cholinergic amplifies sensitivity to conflict and lowers mismatch tolerance, which promotes external valuation. In addition, dopamine signals reward prediction errors, and noradrenaline interrupts ongoing activity and promotes reorganization. As a whole, they regulate the dilemma of becoming extremely stable or plastic (Kim, 2020).

CONCLUSION

Overall, the model provides an important framework for exploring the mechanism behind selecting system 1 and 2 (Kahneman, 2011; Kim, 2020). While it serves as only one hypothesis, further research may hopefully reveal more detailed insights into the neural system.

REFERENCE

1. Kahneman, D. (2011). Thinking, fast and slow. Farrar, Straus and Giroux.
2. Kim, H. (2020). Stability or plasticity? – A hierarchical allostatic regulation model of medial prefrontal cortex function for social valuation. Frontiers in Neuroscience, 14, Article 281. https://doi.org/10.3389/fnins.2020.00281