Basal ganglia play a crucial role in decision making

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Abstract

Many studies have suggested that the striatum, located at the interface of the cortico-basal ganglia-thalamic circuit, consists of separate circuits that serve distinct functions. It plays an important role in motor planning, value processing, and decision making.

Keywords: *striatum; basal ganglia; decision making; reward; dopamine; nucleus accumbens*

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The striatum is a heterogeneous structure located at the interface of the cortico-basal ganglia-thalamic circuit, receiving input from a variety of brain regions (eg, prefrontal cortex, ventral tegmental area) to control motor planning, value processing, and decision making. Many studies have shown that the inputs and outputs of each basal ganglia structure are topographically organized, which suggests that the basal ganglia consist of separate circuits that serve distinct functions. In fact, there are parallel cortico-basal ganglia and cortico-cerebellar circuits. These parallel circuits may underlie voluntary (goal-directed) behavior and automatic skills, enabling animals and humans to adapt to both volatile and stable environments. A chosen action, as it is repeated, becomes more accurate, quicker, and stereotyped, and is eventually carried out automatically. This is called habit or skill. This automatic skill-learning process guides animals to obtain maximum rewards. This is critical for survival because the chosen action can be shortened, after the skill has been learnt.[1]

Learning the consequences of an action and learning the value of those consequences are critical precursors for choosing the best course of action. Impairment in either process, or a failure to integrate them with action selection, leads to aberrant decision making, with detrimental consequences for achieving goals and real-world functioning.[2] Dysfunctional decision making is common across a range of psychiatric disorders, and it has been argued that many psychiatric symptoms are associated with dysfunction in either learning or reward circuitry. Animal models and clinical observations of neurologically impaired patients suffering from impaired decision making are very important. In the same way, modulation of brain activity such as prefrontal cortex and connected regions (eg, striatum), by noninvasive methods such as transcranial magnetic stimulation or transcranial direct stimulation, has improved our understanding of the neural and cognitive substrates of decision making.

Dopamine (DA) is an important neuromodulator as well as a powerful signal for learning-related changes in this system. Across multiple behaviors, the role of DA in the nucleus accumbens (mesolimbic dopaminergic reward system) in motivated action is broadly consistent, signaling predictions (especially reward prediction errors) and expectations about motivationally salient stimuli for the putative purpose of guiding action. However, this general mechanism also reveals subtle but important distinctions across multiple levels such as the valence of the reinforcer, the type of action or learning being undertaken, and decisions being made to acquire those outcomes. Further, at the microcircuitry level of encoding, the nucleus accumbens appears to be comprised anatomically and functionally of subregions capable of encoding discrete but interdependent features of goal-directed action.[3]

In this issue, the involvement of the basal ganglia, especially striatum, in decision making and reward will be addressed from a variety of perspectives. ❑

REFERENCES

1. Kim HF, Hikosaka O. Parallel basal ganglia circuits for voluntary and automatic behavior to reach rewards. *Brain*. 2015; 138:1776-1779.
2. Yager LM, Garcia AF, Wunsch AM, Ferguson SM. The ins and outs of the striatum: role in drug addiction. *Neuroscience*. 2015; 301:529-541.
3. Saddoris MP, Sugam JA, Cacciapaglia F, Carelli RM. Rapid dopamine dynamics in the accumbens core and shell: learning and action. *Front Biosci (Elite Ed).* 2013;5:273–288.