Brain Mechanisms Underlying Decision-Making: A Biological Perspective

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Date of Submission: 25th January 2026 Date of Acceptance:5th March 2026 Date of Publication: 15th March 2026

To the Editor,

Decision-making is a very important cognitive activity that it underlines almost every facet of human behavior. The essence of decision-making is biological processes that elaborate neural circuitry and hormonal mechanisms, cognitive processes, and individual dispositions. Choices are influenced or modified by environmental factors but in a secondary manner and through the intervening biological mechanisms.

The PFC is often regarded as the brain's executive organ for the performance of decision-making tasks because it is important for working memory, planning, evaluation of future consequences, and inhibition of responses that are impulsive.[1] According to various neuroimaging studies, the dorsolateral prefrontal cortex shows neural activity when subjects make decisions and weighathe rewards of waiting for a payoff. Contrarily, the ventromedial prefrontal cortex integrates estimation of value.

The PFC works together with the limbic system, including the amygdala and hippocampus, to process feelings and memories. Limbic system and PFC are taught to build two-system models of decision making that stem from the interaction between simple (emotional) and complex (reflective) decision making.

The dual-process theory proposes that human thinkings takes place through two systems; system one and system two which each take a different approach towards problem-solving which is the primary difference. Neuroscientific evidence shows that System 1 is linked to limbic activity and System 2 to prefrontal cortical networks Emotional decisions occur faster than rational decisions. This is partly as a result of biological differences in energy consumption, processing speed and neurotransmission. This biologically grounded contrast shows how more or less innate neural architecture can have genuine influence on decision-making.

In acute stress, adrenaline (epinephrine) is an important part of the neurobiological changes that prepares a living thing for quick action through the fight or flight response. An increase in adrenaline makes you able to make quick decisions without higher-order thinking. Excessive cortisol during prolonged stress; affects decision-making as a type of glucocorticoid hormone. Elevated cortisol levels might contribute to poor working memory performance and blockade of synaptic plasticity in the prefrontal cortex. In this regard, stress appears to be environmental; however, the idea is that stress can only influence the organism after it has caused changes in biology.

Findings from diverse bodies of research indicate that decision-making ability is influenced by genes. A research on twins shows that both risk tolerance and impulsivity are heritable traits.[2] For instance, different polymorphisms in the COMT gene result in dopamine turnover in the prefrontal cortex (PFC), which in turn results in differences in working memory and executive function.[3]

There is further evidence from insights of developmental neuroscience that choice patterns are shaped by biological maturation. The prefrontal cortex develops earlier than the limbic system which implies that emotion regulation becomes more mature than cognitive regulation throughout adolescence.

External factors such as stress, peer pressure, scarcity of resources, and social norms certainly have an impact on choices. However, this impact stems from the biological reactions these external factors provoke. For instance, studies have shown that increased cognitive load decreases PFC activation and increase reliance on heuristic shortcuts.[4] An investigation into the altruistic choice behaviours of monkeys in an identical environment was one such study. Despite a uniformity of contexts, individuals displayed consistent variation between generosity and selfishness. The behavioral variations noticed in these situations indicate that such differences are biological and not environmental.

A person's experience of life is hugely affected by the environment. These factors, however, actually alter the neurobiological substrate of cognition: schooling strengthens neural networks in the prefrontal cortex; trauma damages neural pathways associated with stress, and a culture of repetition uses plasticity to strengthen existing patterns in the brain.

According to decision-making science, your assessment of choices and choice of act are determined by biological factors like brain architecture, genetic predisposition, hormonal regulation and development. Decision-making processes, while mediated by impacts from the environment, merely operate on

Access this article online

Website: https://www.nepjol.info/index.php/NJN

DOI: https://doi.org/10.3126/njn.v23i1.89945

HOW TO CITE
Raza, A., & Nadeem, M. Brain Mechanisms Underlying Decision-Making: A Biological Perspective. NJNS. 2026;23(1):57-58

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ISSN: 1813-1948 (Print), 1813-1956 (Online)

pre-existing biological apparatuses and this has been proven through significant biological evidence.

ACKNOWLEDGEMENT: None

FUNDING: No funding was obtained for the study

DISCLOSURES: Authors have nothing to disclose.

CONFLICT OF INTEREST: None.

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