SEARCHING FOR THE "BUY BUTTON" OF THE BRAIN

THE NEUROBIOLOGY OF DECISION-MAKING

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"Proceed to checkout?" or "Delete items in cart?" We face a multitude of decisions every day— while these choices may seem simple, they in fact involve an extensive connectome with coordination of the brain's billions of neurons. Emotions, ethical values, and facts are some of the many variables mediated by this extensive network. Much of what is understood about these mechanisms originated from the idea of three brains.

Three Brains: An Outdated but Compelling Model

The Triune brain model, developed by Paul D. MacLean in the 1960s, proposes that the three regions of the brain concerning higher-order thinking, emotional responses, and instinctive behavior evolved separately.[1] One region deemed the "reptilian brain" is considered the oldest layer of the brain believed to control instinctive behavior in humans1. While this model has been modified due to an emerging understanding of the integrated evolutionary processes of the brain, the concept remains pertinent to the study of the subconscious mind for decision-making.[2]

To Buy or Not to Buy: How this Choice is Made

The neuroscience of decision-making is still ongoing and many cortical regions of the brain have shown to play a role in this process. But, three crucial pathways have been identified: 1) the hippocampus-prefrontal cortex, 2) the amygdala and ventromedial prefrontal cortex, and 3) the mesolimbic tracts.

The Hippocampus and Prefrontal Cortex

One area of extensive study focuses on the functions of the prefrontal cortex (PFC) and the hippocampus, the brain regions involved in reasoning and conversion of short to long-term memory, respectively. A proposed representation for decision-making

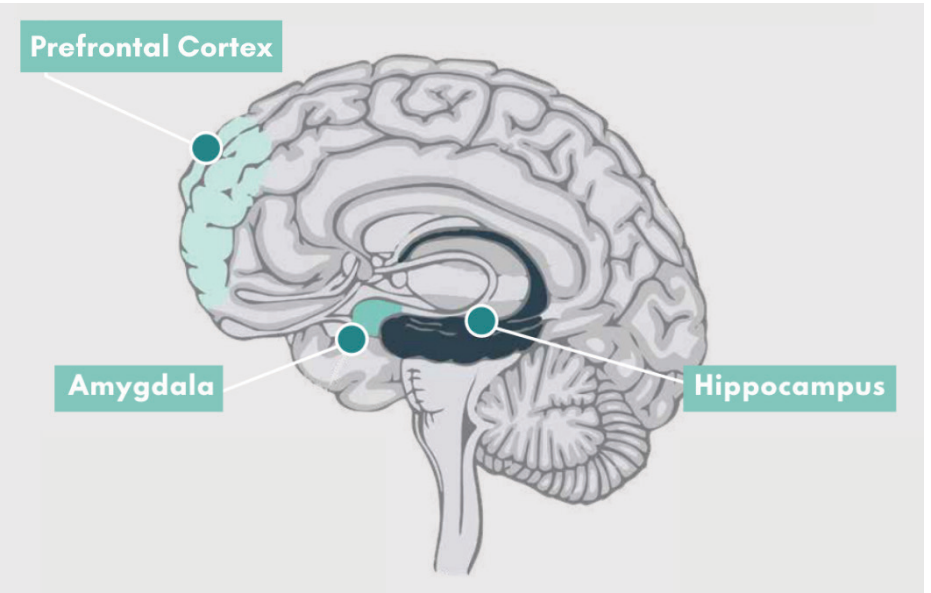

Figure 1: A diagram of the prefrontal cortex, hippocampus and amygdala.

focuses on an algorithmic model with four steps.[3] In the first step, hippocampal neurons are excited by sensory stimuli. Secondary stimulation of the hippocampus then follows with the production of a neural response integrating both sets of stimuli. In the third step, this information is sent to the PFC, where retrieval of additional information from the hippocampus is performed. The retrieval of additional information depends on active feedback from other regions of the brain in which this input is used to determine the necessity of context information.[4] The proposed last step entails a controlling process mediated by the PFC and subcortical brain regions in the production of decisions that reflects preferences.[5] The output of this information flows in this closed-loop system.[3]

The Amygdala

The amygdala is a gray matter brain structure that integrates emotional responses, especially in the fight or flight response. The amygdala is pivotal to decision-making in the brain's "impulsive system," the brain's system involved in associating emotional responses with immediate outcomes. These outcomes are associated with the understood phenomena of "winning" and "losing."[4] Additional studies have shown that the amygdala is an active brain region when choices reflecting winning (enhanced monetary reward) and losing (monetary loss and regret) are made.[5] The idea is that without proper evaluation of stimuli that represent reward (ex. money) by the amygdala, the emotional information that would be gained during proper mental evaluation of these stimuli can't guide decisions in the future. These findings have been corroborated by studies with patients with amygdala lesions in which certain types of decision-making, such as those made under risk, have been impaired.

The amygdala works in conjunction with the ventromedial prefrontal cortex (vmPFC), a highly developed brain region that is crucial for emotional regulation. Specifically, the vmPFC is thought to be involved in

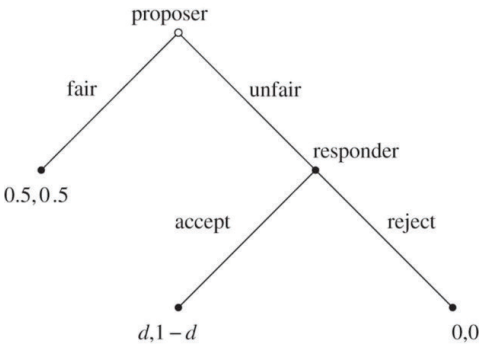

Figure 2: A representation of the ultimatum game. The quantitative values display hypothetical ways of splitting a sum of money.

integration of information, including that from the "impulsive system" of the brain.[4]

Dopamine and the Mesolimbic System

Dopamine is a neurotransmitter, a chemical messenger of the brain, involved in movement control and reward processing. Two major dopaminergic pathways, the mesolimbic and mesocortical pathways, have known critical functions in decision-making.[3]

The mesolimbic pathway is involved in motivational behavior, meaning that it functions to deal with rewards. This pathway begins in the ventral tegmental area (VTA), a dopamine-rich midbrain structure projecting to several brain regions like the nucleus accumbens (NAc). The NAc is where dopamine mediates feelings of pleasure. Thus, dopamine projected in this pathway helps drive behaviors related to pleasurable stimuli through positive reinforcement.[2] Specifically, this form of learning is mediated by the dopamine response, a calculation that the brain uses to assess the difference between the actual reward and the anticipated reward. These calculations help the brain form predictions about certain stimuli, and these predictions influence decision-making.

The mesocortical pathway has dopaminergic projections from the VTA to the medial prefrontal cortex (mPFC), a region critical for executive functioning and goal-directed behaviors.[1] This pathway is crucial for learning and memory and its importance is exhibited through studies examining differential activation due to disorders of the brain such as ADHD and Parkinson's Disease. In these two disorders, executive functioning concerning behaviors such as planning and attention management—both of which are critical to decision-making—are impaired.[1]

Continued Research

A myriad of studies on decision-making in the brain have investigated these processes in particular contexts focused on the neural mechanisms of risk evaluation and reward anticipation and identifying brain regions involved in behaviors concerning calculations, judgements, and perceived loss and reward.[6] For instance, studies focusing on the orbitofrontal cortex, a region of the PFC that is highly developed in primates, suggested that this region represents stimuli during decision-making in a way that combines information both from working and long-term memory.[7] In combining past and current information, the brain appears to make decisions prior to the presentation of novel stimuli. Processes such as these may explain phenomena relating to personal preference.

Hitting the Buy Button: Neuroeconomics

Neuroeconomics is an interdisciplinary field that explains human decision-making through the application of neuroscience tools to economic models. A classic example of neuroeconomics is demonstrated through the ultimatum game where two participants interact anonymously in a "take-it-or-leave-it" negotiation setup.[8] In this experiment, the first player proposes how to divide some money with the second player; if this proposal is rejected by the second player, neither player gets anything. But, if the second player accepts, the money is divided as such.[9] Economic theory suggests that the second player, regardless of the amount of money offered, should take the deal and be satisfied, since it is better to end up with even a small sum of money rather than none. But studies have shown that the brain does not follow these predictions. Building off this model, a University of Arizona study focused on this game and used data from functional magnetic resonance imaging (fMRI) scans that track blood flow to specific brain regions, thus allowing for the examination of regional brain activity. The anterior insula, a part of the brain involved in negative emotions such as disgust, and PFC were examined. The results indicated that as offers in the ultimatum game became increasingly unfair, the activity of the anterior insula increased while the PFC remained active as the situation was being assessed.[10] Studies such as these illuminate how decisions can be largely emotionally-driven despite the notion that humans are viewed as rational creatures.

A subfield of neuroeconomics, neuromarketing, focuses on understanding the brain's decision-making mechanisms to gain insight on customer preferences and motivations. The underlying assumption of neuromarketing is that all human feelings and all aspects of consciousness are products of neural activity. The predominant techniques used in this field of study are brain scanning and physiological tracking, which measure neural activity and eye movement, respectively.[11]

There are many facets of neuromarketing that focus on a variety of topics that range from understanding how to elicit specific emotional responses, the effects of different advertising mediums, and brand design elements.

Results from a 2019 study exploring consumer neuroscience and marketing communications indicate that pathos-oriented messages prompting individuals to "act, share, promise, or challenge" were more effective than those with a logos appeal.[12] Additionally, a 2017 study focused on the relationship between audiovisual advertising–induced emotional responses and memory.[13] Six basic emotions were represented through appropriate audiovisual messages, and cardiac electrical activity responses were recorded. A questionnaire documented disparities in the actual message transmitted and the perceived "suggested memory." The results showed that messages conveying sadness resonated best with participants.[13] Together, these studies represent one focus of neuromarketing research—understanding how to elicit particular emotional responses that influence decision-making at the consumer level.

Due to neuromarketing's focus on human behavior, an ethical concern is the potential for manipulation, especially at the subconscious level. Despite these concerns, many professionals in the field support neuromarketing endeavors since no "buy button" part of the brain has been found. In fact, because there are many factors involved

in decision-making, many researchers posit that human behavior is difficult to predict, let alone manipulate.[14] In other words, insights gained from isolated neuromarketing research do not provide the necessary data to substantially influence consumer decision-making. In spite of these sentiments, it is no secret that companies such as Microsoft and Google use neuromarketing strategies. While the effectiveness of these targeted strategies is difficult to assess, the concern is how far these companies will go to find the "buy button" of the brain.

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IMAGE REFERENCES

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