

A critical review on Neuroeconomics

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The neoclassical economic perspective posits that, provided with sufficient information, humans act as efficient maximizers of self-interest. In contrast, psychological literature often characterizes human behavior as possessing a tendency toward self-destruction. Both fields converge in the discipline known since the late 1990s as Neuroeconomics, which seeks to understand how the complex systems and processes inside the “black box” of the human brain relate to economic choices. (Camerer et al., 2004; Loewenstein et al., 2008)

This emergent interdisciplinary field has played an important role in shifting how behavior is predicted, departing from the notion that solely observable elements influence choices and investigating the biological and cognitive factors that physically alter human decisions. Rather than relying exclusively on subjective methods of self-report preferences, neuroeconomic techniques offer the possibility of measuring feelings and thoughts directly. (Camerer et al., 2004; Konovalov et al., 2019)

In its incipient stages, neuroeconomics was primarily criticized for failing to distinguish between neural mechanisms and their causal effects on behavior. This issue has since been addressed by focusing on specific brain regions or their functional interconnections and the adoption of more sophisticated brain imaging techniques borrowed from Cognitive Psychology. Some of the most popular methods include the Electro-Encephalogram (EEG) to measure external brain activity, Positron Emission Tomography (PET) to analyze blood flow through positron emissions, and functional Magnetic Resonance Imaging (fMRI), which detects changes in blood oxygenation as a proxy for neural activation. These are complemented by other practical

techniques that study patients with pathological conditions or brain damage. (Camerer et al., 2004; Konovalov et al., 2019)

Findings in neural activity have challenged many conventional theoretical assumptions, aligning with the principles of Behavioral Economics and highlighting the role of cognitive and affective systems in decision-making. The so-called “black box” of the human brain is a complex architecture of regions that, although working separately, are interconnected. Relevant to economics are the frontal, parietal, occipital and temporal brain lobes, linked respectively to cognitive integration and planning, motor action, visual processing, and emotional memory recognition. (Camerer et al., 2004)

Neuroeconomics successfully explains economic phenomena through the direct association of physical neural responses. Over the past decade, research in the field has served as a more direct and unbiased predictor of human behavior (Konovalov et al., 2019). Some studies have challenged traditional economic views by finding direct neural associations that violate the rationality principle under risk and uncertainty, identifying context-dependent heuristics that influence decision making, and highlighting intertemporal choice inconsistencies. Conversely, other studies have deliberately focused on the “black box” of the human brain to reinforce existing theories and deepen the understanding of the mechanisms and influential factors governing economic choices.

For example, Sanfey et al. (2003), Kuhnen & Knutson (2005) and Tom et al. (2005) have presented evidence significantly diverging from the assumptions of rationality. Sanfey et al. studied participants who rejected unfair offers in the Ultimatum Game. The results suggested that these individuals displayed higher activation in the bilateral anterior insula than in the dorsolateral prefrontal cortex, which translates to how affective states of anger and disgust override the

cognitive goal of maximizing utility. People were willing to sacrifice potential gains in exchange for punishment. Similarly, Kuhnen & Knutson and Tom et al. found that the activation of the anterior insula is associated with risk-averse behavior. People overweight negative feelings associated with loss and underweight positive emotions from gains. This asymmetry counters the rationality principle in both risk-taking financial models and expected utility theory. These findings shed light on the importance of neuroeconomics, as methods from cognitive and behavioral neuroscience provide unprecedented insight for understanding decision-making.

Together with behavioral economics, neuroeconomics has empirically tested context-dependent theories through brain imaging. De Martino et al. (2006) analyzed the “framing effect”, which contradicts the notion that people judge options solely based on their expected utility, demonstrating instead that people are susceptible to how such options are presented. Chung et al. (2017) studied the “decoy effect”, showing that adding an irrelevant alternative to a set of choices can increase the likelihood of choosing the target, contrary to common assumptions. Additionally, Plasmann et al. (2008), examining the case of wine tasting, showed that consumers’ intrinsic preferences and experienced pleasantness are inconsistent. Perceived value is built not only by the intrinsic properties of the product and the state of the individual but is also influenced by external marketing contingencies such as price.

In all cases, researchers have demonstrated that agents are driven physically by heuristic affections in the emotional system or by cognitive context-dependent biases. De Martino et al. linked the framing effect to high activation in the amygdala; negative emotions led to the risk aversion present when options are framed in the domain of losses. Chung et al. associated the decoy effect with activation in the striatum; the irrelevant option added context to the choice bundle and made the target more desirable. Meanwhile, Plasmann et al. explained that a higher

price correlated with higher activation of the medial orbitofrontal cortex (mOFC), indicating that belief and expectation can physically alter the neural representation of experienced reward.

Furthermore, neuroeconomists have challenged intertemporal choices using fMRI. McClure et al. (2004) supported the quasi-hyperbolic time discounting function, which counters traditional exponential theory. People show temporary inconsistency, as they downweight future gains relative to immediate rewards; this is linked to positive emotions activated by the dopamine system in regions such as the ventral striatum, medial orbitofrontal cortex and medial prefrontal cortex. On the other hand, Berns et al. (2006) highlighted the cost of waiting, concluding that people tend to avoid the anticipation of negative experiences linked to the cortical pain matrix, and thus, expedite undesired experiences sooner.

Past studies have also deepened the understanding of the economic framework by linking theoretical behavior with empirical neural reactions. Levy et al. (2010) found that the brain shares a common mechanism that reacts to both risky and ambiguous choices. Consistently, Knutson et al. (2005) and Schultz et al. (2008) studied expected value theory and identified similar brain activity in both cases, associating the medial prefrontal cortex (mPFC) with both the estimation of probability and risk-seeking behavior. However, they did find a separate brain mechanism to represent the magnitude of the reward itself, associating dopamine structures with large gains, as positive arousal is correlated with brain regions such as the nucleus accumbens (NAcc), the striatum, insula and the orbitofrontal cortex. These findings are a step closer to understanding how the brain is integrated to guide economic and social choices.

Concurrently, other researchers have studied the process behind choice valuation. For example, Kable & Glimcher (2007) tested revealed preference theory across time and found that activity in the ventral striatum, medial prefrontal cortex and posterior cingulate cortex increases

when a reward is either higher or more immediate. Alternatively, Chib et al. (2009) studied the “common currency” hypothesis. In their experiment, they used brain imaging to identify activity when choosing between three types of goods: monetary prizes, trinkets and food. The brain encodes the decision value through the ventromedial prefrontal cortex (vmPFC), assigning a common unit regardless of the category, thereby allowing for the selection of the option that yields maximum utility.

Finally, Neuroeconomic research over the last few decades has succeeded in understanding how cognitive, emotional and physical processes influence decision making. Plasmann et al. (2007) studied the “willingness to pay”, that is, the maximum amount someone would give in exchange for an object, and found that, even before reporting the value, the activity in sensory areas linked to the medial orbitofrontal cortex (mOFC) is consistent with economic valuation. Likewise, Behrens et al. (2007) tested Bayesian updating, finding that the anterior cingulate cortex (ACC) oversees decision updating, but its learning rate adapts to the volatility of the environment, thereby reinforcing the theory of rational learning.

Traditionalists often argue that conventional models predict behavior accurately and therefore, studying biological processes is irrelevant. Contrary to these beliefs, neuroeconomic research over the last decades, as presented, emphasizes the utility of integrating brain imaging techniques like fMRI to identify when traditional models fail and to refine existing theoretical frameworks. These findings offer a more direct and unbiased approach to predicting human behavior. However, as the field matures, it increasingly addresses causality by moving from simple brain region localization toward the analysis of interconnected, complex neural systems.

The field of neuroeconomics has succeeded in transforming the understanding of how cognitive, emotional and physical processes influence decision-making. Studies have shed light

on how, contrary to standard assumptions, emotions can override the principle of rational utility maximization, how preferences are influenced by cognitive or emotional context-dependent heuristics, and may also be inconsistent over time. Neural evidence has also inspected the “black box” of the human brain, researchers have mapped integrations that guide economic and social choices under risk and ambiguity, identifying physical reactions that occur even before a conscious choice is made. Although neuroeconomics may not replace the practicality of standard economic models, it has transformed the discipline from focusing solely on observable outcomes to understanding the underlying processes of human architecture.

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