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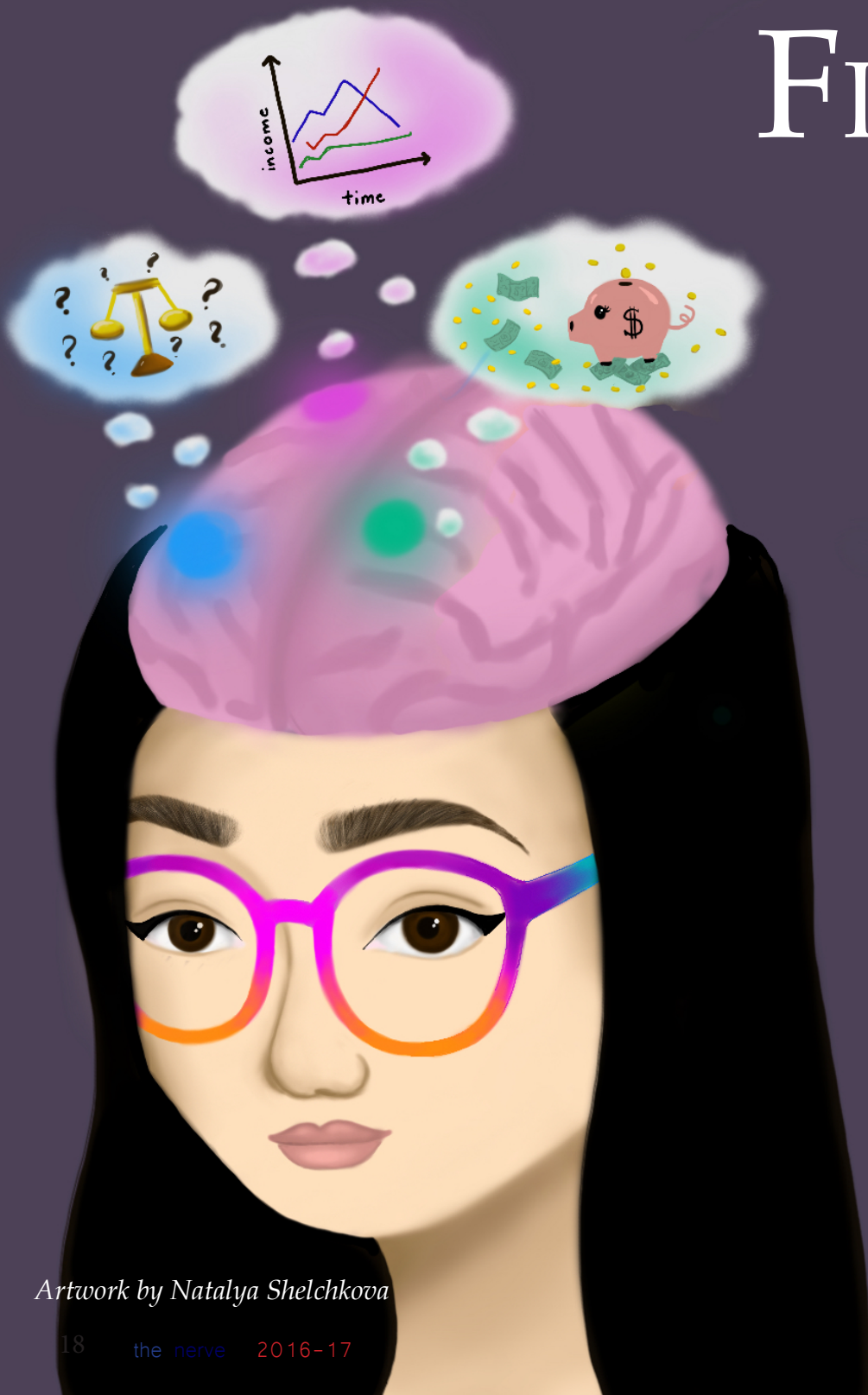
Neuroeconomics: an emerging field of study

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NEUROECONOMICS: AN EMERGING FIELD OF STUDY

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When we hear the word “economics,” we instinctively think of banking, finance, and investment. This limited perspective makes us believe that the field of economics doesn’t extend beyond money and the stock market. It is undeniable that money and businesses are vital to the world we live in, however, we as human beings drive all these financial activities. So, if we want to understand how the world runs, we need to start by understanding one of the most fundamental human activities that exist in our day to day life: decision-making. Economics can be defined in many different ways. One definition is the study of understanding how people take advantage of resources and make decisions. To achieve this, we must first understand how our brain, the CPU (Central Processing Unit) of our system, runs all the algorithms when making decisions with financial consequences.

The concept of “Homo Economicus” in traditional economics describes people as rational actors who make optimal decisions without the influence of emotion.¹ Based on this assumption, the outcomes of our decisions should always be predictable. Nonetheless, traditional economics has a lot of limitations in terms of explaining our confusion, indecisiveness and impulsivity when it comes to decision-making. Many behavioral experiments emerged in the late 1960s as Game Theory slowly became part of the mainstream microeconomics discussion.² As the majority of these experimental results challenge the predictions associated with traditional economics, more people are beginning to understand the significance of what economists call bounded rationality, in decision making. Bounded rationality is the idea that our brain does not function as a computer, but instead our decisions can be affected by our emotions and cognitive abilities.

Neuroscientists have already started seeking to understand the neural and behavioral basis of our economic behaviors. This incipient field of interdisciplinary study, Neuroeconomics, combines neuroscience, economics, and psychology. Scientists studying in this field apply knowledge about brain mechanisms and use a variety of tools and technologies to ask questions about the mysteries of human decision-making.

Decision scientists divided decisions into four categories according to their complexity.³ The first category is intuitive decisions which represent the most basic level of decision-making. We usually apply familiarity, existing preferences, and common sense when making this type of decision. The second type is empirical decisions. These are the decisions we make based on trial and error, experience, and estimation. Heuristic decision is the third category. We make these decisions based on scientific theories, rules of thumb, and beliefs. Rational decision is the most complex category and we perform this type of decision making based on minimizing costs while maximizing benefits.

A growing consensus in behavioral neuroscience suggests that we always assign a value in the brain to all the options we have first and then compare these values when making simple choices.⁴⁻⁶ Professor Antonio Rangel’s neuroeconomics lab at the California Institute of Technology has conducted many interesting studies about our simple economic decisions. One of their research studies was a search for a region in the brain that computes representations for the decision values of dissimilar goods. They conducted an experiment by scanning the participant’s brain with functional magnetic imaging (fMRI) while the participants make purchasing decisions among goods from different categories.⁷ They discovered that a single area in the ventromedial prefrontal cortex (vmPFC) was correlated with encoding values for all categories of goods.⁷ This result suggests that the brain has a “common currency” by default that allows us to evaluate all of our options when we make purchasing decisions.

A widely applied concept in economics is the idea of opportunity cost. Interestingly, this concept is naturally encoded in the human brain as a willingness-to-pay (WTP) computation.⁸ WTP allows buyers to calculate the maximum amount of resources they are willing to give up in exchange for the object being sold, and is an essential component of all economic transactions in every marketplace.⁸ Professor Rangel’s lab studied the neural basis of this type of computation by scanning hungry participants’ brains with fMRI while they made bids on 50 kinds of junk foods.⁹ Their study showed that WTP is encoded in the orbitofrontal cortex (OFC)

and dorsolateral prefrontal cortex (dlPFC).⁹

The results of another study in Professor Rangel's lab revealed that when making purchasing decisions, attention has an influence on choices. They presented their participants with a video of the images of two types of chips blinking one after another repeatedly. Each image shows up on the screen for a few seconds each time and one of them has an unnoticeable longer total time of appearance. After the video they asked the participants to make a decision of which type of chips they would like to purchase and the result was that the majority of participants picked the one that was shown for a longer time.¹⁰ This experiment suggests a role of visual fixations in the process of economic decision-making. They also found through fMRI that vmPFC encodes values responding to the signals that are attention modulated.¹⁰ These results also have the real life implication that smart marketing strategies should be able to manipulate how long the consumers' eyes can fixate on a product.

These are just a very few interesting studies in neuroeconomics on our purchasing behaviors. There are also many other social and behavioral experiments in the field that explore the brain mechanisms behind people's mysterious decisions.

In 2002, Nobel Prize winner Professor Daniel Kahneman presented the theory of loss aversion, which refers to the idea that people always prefer avoiding losses over obtaining equivalent gains.¹¹ This phenomenon was first observed by one of the most influential modern economists, Paul Samuelson, in 1948. He proposed in his book that the effect of a 100 dollar raise in salary is weaker than the effect of a 100 dollar cut.¹² Professor Kahneman also suggested that under computable situations, people's estimation for loss is approximately twice as much as the gains with the same real values.¹³ The study of neuroeconomics found that the brain has different processes for gain and loss under a connected pathway. fMRI scanning showed that the brain region correlated with economic awards overlaps with the region correlated with our basic survival behaviors like foraging. The reward pathway in our brains is shown to be more sensitive to losing money.³ This can be explained by evaluating the contrast before and after

having the idea of losing money. When we think about losing money, our fear and anxiety will deactivate or suppress the activities of the originally activated brain regions.³ When we introduce this concept into real life economic context, we can suggest that consumers are faced with the joy of shopping (gain) and the expense of money (loss). So we can explain the popularity of credit cards: the effect of losing real money is discounted temporarily which allow consumers to experience purely the joy of owning new goods and services.

Another famous economic experiment that allows neuroscientists to study the fairness values encoded in the brain is the Ultimatum Game. In this game, the first player receives a sum of money and decides how to split it up. This split is then offered to the second player, who has the choice to accept or reject the offer. Neither player gets any money if the second player rejects the offer made by the first player.¹⁴ The rational decision for the second player in this game is to always accept the offer, even if it is unfair, since gaining some money is always better than gaining nothing. A study done in 2006 tested whether a lesion to certain brain areas would affect a player's ability to take an unfair, but still beneficial offer.¹⁵ In their version of the Ultimatum Game, the split is always unfair. The first player had to keep more of the money than he offered to the second player. For example, if \$100 was allocated to the first player, they might split it up 80/20, offering the second player \$20, or less than half of the total amount. The second player, when offered an unfair split, theoretically should often reject the offer because it is perceived as unfair. The study suggested that participants with lesion to the right dlPFC have a higher tendency to accept the so-called unfair, but still beneficial offer.¹⁵ So this particular area of the brain seems to encode a sense of fairness, that is, patients with dlPFC lesions are more likely to accept unfair offers.

Scientists have also discovered that human beings are not the only ones that have encoded values in the brain for fairness, losses and gains, and reward values. These computational models can also be applied to primates who behave as if they understand the concepts. In fact, animal models allow scientists to conduct

more detailed experiments for a better understanding of the neuronal circuits involved in decision-making. A research article published in 2003 described how capuchins are able to detect unequal pay and reject the inferior reward.¹⁶ In 2005, Padoa-Schioppa and Assad published a study in which they asked monkeys to choose between two unequal food rewards by looking left or right on a screen.¹⁷ By recording the monkeys' eye movement, they found that certain neurons in the OFC fire faster in response to a better reward which suggests that they encode economic values. More recent research has also shown that OFC plays an important role in learning from unexpected outcomes and helping us alter our economic behaviors when decisions go wrong.¹⁸

All this information just scratches the surface of neuroeconomics and what scientists have been able to learn about decision-making throughout the years. It is remarkable how one of our most common and seemingly easy activities is so complicated to explain and so difficult to comprehend. Hopefully with our wisdom and the help of advanced technology, we can eventually solve this riddle of our own nature.

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