

THE IRRATIONAL ECONOMIST

MAKING DECISIONS IN A DANGEROUS WORLD

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Chapter 10

The Useful Brain: How Neuroeconomics Might Change Our Views on Rationality and a Couple of Other Things

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Humans love *boxes*.

By boxes, I mean anything from a folder to a mental category that is supposed to facilitate our lives.

Think about the hard drive of your computer. Don't you have a bunch of folders for personal items---where you store digital photos of people you love and work-related documents? Or a "to-do list" with an "urgent things to be taken care of" column and a "not so urgent" one next to it?

In addition to the physical (and electronic) ones, there are all these mental boxes we rely on.¹ We use them to categorize and classify our thoughts (important, or not),

¹ Note that by distinguishing between physical and mental boxes I'm providing you with a clear illustration of my own strong tendency to make boxes!

emotions (happiness, sadness), opinions (interesting, boring), and even people we know (relative, friends, colleagues).

Whether we admit it or not, we are box-dependent.

But there is a downside to this habit. Whenever categorization enters the game, the ghost of simplification rears its head and dichotomies that are not supposed to exist are artificially created. And science has always constituted a fertile ground for artificial dichotomies to emerge and persist, sometimes forever.

Think about the rationality versus emotion debate that motivates this book (two quite time-resistant boxes, as discussed in the Introduction). As stimulating and interesting as this debate can be, we have been walking in circles for ages and some fresh insights could definitely come handy.

But what if there were no such things as emotion on the one hand and rationality on the other?

Shaking the (Ir)Rationality Tree: Welcome to “Emo-Rationality”

Given our current state of knowledge in the behavioral and brain sciences, I tend to favor the following proposition, not as an economist but as a neuroscientist:

The dichotomy between *rational* and *affective decision making* may be an *artificial* construction of our minds to help us categorize our choice behavior. From what we know so far, our brain does *not* seem to generate emotions and rationality in an independent fashion. Rather, it might be dealing with a complementary pair, a kind of “emo-rationality.”

This perspective, which has recently gained acceptance in the brain sciences,² still remains bizarre for (too) many economists. If confirmed, however, it could have a major impact on economics, markets, and public policy. This is why, over the past decade, I---and a number of colleagues³---have become increasingly interested in the following question: *How can the joint study of behavior and brain dynamics help economics and other social sciences take a more realistic approach to the understanding decision making processes?*

The Curious Case of Phineas Gage

The emo-rationality idea---although to my knowledge never before formulated this way---has a history.

It might have started in the middle of the nineteenth century, when Phineas Gage, a railroad construction worker, suffered a terrible accident that would change forever not only his life but also our understanding of the way emotions affect social behavior.

On September 13, 1848, somewhere near Cavendish, Vermont, Gage was the leader of a team of men who were blasting rocks with powder in preparation for the Rutland and Burlington Railroad. Suddenly, an uncontrolled explosion sent a three-foot, seven-inch, thirteen-and-a half pound, quarter-inch-diameter iron rod through his forebrain. Literally. The rod not only penetrated the skull under the left cheekbone but went all the way up through his brain before landing some thirty yards away.

² J.A.S. Kelso and D.A. Engstrøm, *The Complementary Nature* (Cambridge, MA: MIT Press, 2006); L. Pessoa, "On the Relationship Between Emotion and Cognition," *Nature Reviews Neuroscience* 9 (2008): 148--158.

³ See, for example, Colin Camerer's chapter in this book.

Phineas Gage survived despite the fact that a large portion of his forebrain was missing (or at least severely damaged)---an injury that would have disrupted the dense reciprocal information exchange between the frontal lobe and deeper areas of his brain. Dr. John Martyn Harlow, a local physician thanks to whom we know so much about the case since he wrote daily reports on Gage's condition,⁴ took good care of him.

Despite the hole in his skull, the survivor returned home ten weeks after the accident. He even tried to resume work less than a year later. But as his co-workers mentioned, something had changed: "Gage was no longer Gage!"

Before the accident, he was a respectful and polite person, in addition to being a dedicated and efficient employee mostly held in high esteem. Afterward, his behavior changed dramatically. He became prone to intemperate outbursts, spiteful to others, and impatient. His inability to hold to a plan for future actions and his overall lack of "emotional control" ended up costing him his job.

Gage's case, later popularized by neurologist Antonio Damasio in his best-selling book *Descartes' Error*,⁵ is one of the first-known demonstrations that the frontal areas of the brain play a key role in rational behavior by "controlling" emotional reactions.⁶ But one can wonder if, reciprocally, emotions participate in rational behavior.

⁴ M. MacMillan, *An Odd Kind of Fame: Stories of Phineas Gage* (Cambridge, MA: MIT Press, 2000).

⁵ A. Damasio, *Descartes' Error: Emotion, Reason, and the Human Brain* (New York: Putnam Publishing, 1994).

⁶ This approach is still used in courts to (attempt to) prove someone's penal (ir)responsibility to the actions he or she committed. See J. Rosen, "The Brain on the Stand," *New York Times*, March 11, 2007.

This is where *neuroeconomics*⁷ comes into play.

What Can We Learn from the Marriage of Economics and Neuroscience?

Today, this multidisciplinary field---which brings together economics, neuroscience, psychology, philosophy, sociology, and physics---is offering new empirical and theoretical insights on how emotions and rationality interdependently sha(r)p(en) our decisions. Among the most striking examples are a couple of neuroscientific studies of a familiar experimental economic setting, the Ultimatum Game (UG). The first of these was conducted by scientists at Princeton University in 2003.⁸ Alan Sanfey, Jonathan Cohen, and colleagues used functional magnetic resonance imaging (fMRI)⁹ in order to estimate the brain activity that occurs when people decide to accept (or not) an unfair share of money in the UG.¹⁰ From a purely rational view, whether a proposition is

⁷ P. W. Glimcher et al., *Neuroeconomics: Decision Making and the Brain* (London: Academic Press, 2008).

⁸ A.G. Sanfey et al., *The Neural Basis of Economic Decision-Making in the Ultimatum Game*, "Science 300, no. 5626 (2003): 1755--1758.

⁹ Functional magnetic resonance imaging is the brain imaging technique that is used to make those beautiful 3D pictures of the brain with color blobs that one often sees in the media. These blobs are supposed to indicate where brain activity is significantly higher when tasks are compared. For readers who are not familiar with this methodology a few things need to be added: fMRI does not measure brain activity directly but, rather, estimates it based on the magnetic properties of oxygen consumption in the brain and the assumption that when a part of the brain is more active than another, its metabolic (oxygen) consumption is higher. Also, the fact that only a couple of areas are colored on a brain image does not necessarily mean that the rest of the brain is inactive. Fortunately for all of us, the entire brain is continuously working!

¹⁰ As depicted in the previous chapter by Colin Camerer, arguably one of the leading lights in neuroeconomics, the first player in a UG, the *proposer*, offers a share of money he owns to another player, the *responder*. If the responder accepts the proposer's offer, both players keep their respective splits. If the responder doesn't, neither receives any money. If both the proposer and the responder were behaving as rational maximizers, the proposer would offer the minimum amount and the responder would

unfair or not should not make any difference to their decision--they would get more money by accepting than by rejecting it. Still, these UG experiments have shown repeatedly that many of us prefer what we consider a "fair" offer that earns us less money over an "unfair" one with a higher outcome. This setting constitutes a good illustration of an "irrational" economic decision.

However, only the evolution of activity in the more "emotional" part of the brain (the insula) allows us to predict whether an unfair offer will be accepted or not. One could therefore be tempted to conclude that the "emotional brain" somewhat prevails over the more "rational brain" when making such decisions. In fact, reality is a bit more complex than this, as a second experiment has revealed.

Neuroscientists are capable of imaging the brain while it thinks, calculates, and decides. But they can also alter brain functioning by simulating lesions.¹¹ Daria Knoch, Ernst Fehr, and their colleagues at the University of Zurich recently investigated whether decisions in the UG would be affected if one of the so-called---or so-believed, I should say---rational parts of the brain (the DLPFC) were "asleep" for a little while.¹² If rationality is temporarily in the "off mode," one would logically expect emotions to take over, irrational behavior to dominate, and---in the UG---unfair proposals to be rejected more often.

accept it, with even a penny being better than nothing. This is rarely the case in the UG.

¹¹ The technique used in this procedure, which is called repeated transcranial magnetic stimulation (rTMS), momentarily disrupts the workings of a targeted brain area.

¹² D. Knoch et al., "Diminishing Reciprocal Fairness by Disrupting the Right Prefrontal Cortex." *Science* 314, no. 5800 (2006): 829--832.

In fact, what the experimenters discovered was precisely the opposite. In this study, recently published by the prestigious magazine *Science*, people actually *accepted* more unfair offers!¹³ In short, when the so-believed rational part of the brain is deactivated, people tend to favor rational choices.¹⁴

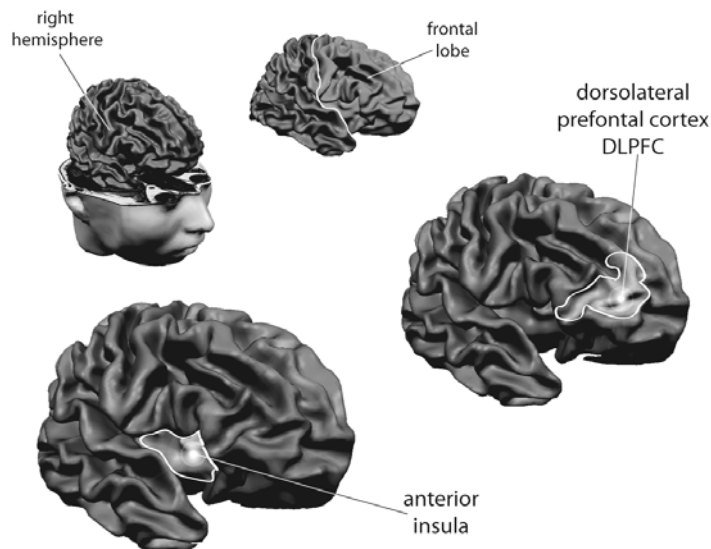


Figure 10.1. Some of the brain areas¹⁵ showing increased activity when refusing an unfair offer in the Ultimatum Game

Functional magnetic resonance imaging reveals a significantly higher brain activity in the dorsolateral prefrontal cortex, or DLPFC (considered one of the “rational” parts of the brain), the anterior insula (considered one of the emotional parts), and the anterior cingulate cortex (a kind of mediator between emotion and cognition) when the decision to *refuse* an *unfair* offer is made, as opposed to accepting it (see Figure

¹³ Even more puzzling was the fact that their ability to judge the offers as unfair remained unchanged.

¹⁴ This study clearly showed that the decision to accept can change while the judgment regarding the (un)fairness of the offer does not, therefore supporting the claim that judgments do not always determine decisions.

¹⁵ Note that these are not actual experimental data but 3D reconstructions generated courtesy of Brain Voyager© for illustrative purposes.

10.1). Thus it appears that both parts of the brain, respectively identified as rational and emotional, are involved in the final decision---corroborating the emo-rational hypothesis.

These results force us to confront our tendency to build artificial boxes and create conceptual dichotomies. This trend is a by-product of our desire to categorize things such that each has a unique and specific function. We may think of emotions and rationality as two separate things, but the brain, a complex dynamical system, seems not to work this way.

Neuroscience can certainly bring us to a better understanding of decision-making processes. The two UG experiments described earlier provide information that could never have been obtained without the union of neuroscience and economics; the former brought the methods, while the latter provided the framework. I also believe that we have embarked on a new scientific path that could lead us to a serious rethinking of the ways we have conceptualized emotion and rationality for decades---a rethinking that could seriously impact our daily lives.

From Laboratory Experiments to Decisions in Everyday Life

One way to ensure the scientific and social development of neuroeconomics is to move from laboratory experiments to field studies of decision making in everyday life. Indeed, most neuroeconomic experiments have thus far been performed in isolation from the real world, where people---usually college students---are stuck in fMRI scanners and have to make very simple decisions. Furthermore, in most of these experiments, they are making decisions about money they cannot lose;

because university rules do not allow students to lose their own money during experiments, the only money they can lose is the amount that we researchers give them to participate in our experiments. Anyone watching our work from outside the scientific perspective might wonder about its practical relevance.

I share this concern to a certain extent because I am aware that, for all neuroscience's usefulness in furthering an understanding of individual human behavior and decision making, the brain, on its own, is rather useless. After all, people are not solely their brains. And their behavior is not just the output of their brains in action. Rather, they are made up of brains encased in bodies that are evolving in a physical environment, interacting with confederates, constrained by their past, and driven by the goals they have set that could become their future, not to mention the more or less explicit social demands they have to cope with¹⁶. Indeed, an individual's personality, behavior, and decisions emerge from countless interactions and coordination patterns occurring at myriad levels ranging from brain cells discharging to people talking to each other. And experiments performed in labs simply cannot account for all these parameters.

Cognizant of these limitations, some scientists are now moving beyond the laboratory to perform exciting new experiments. This has been made possible by the development of alternatives to existing brain imaging techniques, which are very expensive. In fact, the brain has many ways of letting us know how it reacts to or processes a situation. Eye movements,

¹⁶ O. Oullier & F. Basso, "Embodied economics: How bodily information shapes the social coordination dynamics of decision making" *Philosophical Transactions of the Royal Society: B Biological Science*, (2010), Forthcoming.

pupil dilations, heartbeats, skin-conductance data, and facial expressions are among the many “external” signs that can be used to accurately assess brain dynamics as people interact with the environments of their daily lives.

In situ neuroeconomics has actually already happened. In 2007, John Coates, a former Wall Street trader turned neurophysiologist at Cambridge University, ran live experiments on the trading floor of a bank located in London. Analyzing the hormonal levels of traders during their day of work, he determined over a period of several days how these levels fluctuated with the traders’ financial performance and the volatility of the market. Hormones in the blood are a means by which the brain “talks and listens” to distant organs; as such, they represent yet another form of information regarding how the brain is (re)acting in a certain context.

In the London trading floor experiment, the operators were in their “natural” work environment and thus could either make or lose money in what was clearly a real-life situation for them. The study revealed that *testosterone* (a hormone involved not only in sexuality but also in impulsive and risky behaviors) and *cortisol* (a hormone whose level increases under stress) are strongly influenced by the volatility of the market. One major finding was that these two hormones--one favoring impulsivity and the other one accompanying stress---play “hot and cold” in the sense that they have to remain within a certain concentration range in order for a trader to perform well on the market. One can see here a hint that emo-rationality is “in our blood” as well.

Neuroeconomics and Beyond

The aforementioned study poses an additional question to neuroeconomics, inasmuch as economists study more than one individual at a time: *What can we learn from a single brain (or a dozen) that can be generalized so as to advance our understanding of the complexity of markets?* This question of how to scale-up results from the very micro to the very macro is of interest to both neuroscience and economics.¹⁷ Neuroscientists wonder about the parallels between the activity of an individual neuron and the integration of billions of neurons in the brain of any individual. And economists wonder about those between local individual behavior (micro-economics) and national or international aggregate behaviors (macro-economics).¹⁸

As a brain scientist, I am tempted to ask: *Can we make any progress in understanding complex interactions by studying electrical activity or metabolic estimation of a few cubic millimeters of brain matter?* The answer is: It depends. This information will never be sufficient to explain, predict, or decode human behavior and measure economic decision per se. But as we saw in the examples discussed above, neuroeconomics is clearly capable of giving information that other fields might have guessed at but never provided evidence for. And by liberating neuroeconomics from its laboratory constraints, we ensure that the best is certainly to come.

¹⁷ O. Oullier et al., "The Coordination Dynamics of Economic Decision Making: A Multilevel Approach to Social Neuroeconomics," *IEEE Transactions on Neural Systems and Rehabilitation Engineering* 16, no. 6 (2008): 557--571.

¹⁸ If you are interested in this question, see the great book by Nobel Laureate Thomas Schelling: *Micromotives and Macrobehavior* (New York: Norton, 1978).

All in all, whether one is a neuroaficionado, a neuroopportunist, or a neuroskeptic, it can hardly be denied that we are currently witnessing a true paradigm shift whereby neuroscience might help refine, for better or worse, fundamental concepts that we take for granted, such as genuine notions of human behavior, (ir)rationality, conscience, or free will. These advances are already having major implications in our lives. For example, programs have been launched to evaluate how neuroscience might impact public policy.¹⁹ Applications range from justice (*What would happen if one day we found reliable ways to distinguish a true statement from a lie? Can we measure emo-rationality, and could we use those findings to screen or select judges or witnesses?*) to new strategies for informing customers and fighting against addictions and obesity, for example. A better understanding of the decision-making processes of people who suffer from the latter pathologies could save a lot of money being spent on healthcare. It could also save lives.

Clearly emo-rationality is an in-between world that challenges the belief that rationality and emotion are separate. As I have argued in this chapter, they might be united in a more complex interdependent way than that represented by the two simple boxes we are used to. A lot of people are going to be nostalgic for the “good old days” when decision making was either rational or not.

My way of looking at it is to consider ourselves extremely lucky. If our brains were not so complex (structurally and functionally), and our environments so rich

¹⁹ Examples include the Neuroscience and the Law program in the United States and, in France, the Neuroscience and Public Policy program, a unique initiative so far that I am in charge of at the Prime Minister’s Center for Strategic Analysis.

(informationally speaking), we would not be asking ourselves these questions today.

And we would certainly not be able to make those boxes we enjoy so much.

Recommended Reading

Akerlof, G. A., and Shiller R. J. (2009). *Animal Spirits: How Human Psychology Drives the Economy, and Why It Matters for Global Capitalism*. Princeton: Princeton University Press.

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About the author

Olivier Oullier is an associate professor of neuroscience at Aix-Marseille University (France) and a research associate at the Center for Complex Systems and Brain Sciences (Florida Atlantic University). His research at the Cognitive Psychology Laboratory (UMR 6146) of the University of Provence focuses on multi-level social coordination dynamics, embodied cognition and neuroeconomics.

A member of the World Economic Forum's Global Agenda Council on Decision-Making and Incentive Systems, he is a scientific advisor to the French Prime Minister's Center for Strategic Analysis where he heads the "Neuroscience and Public Policy" program –the world's first institutional initiative to specifically evaluate and implement the applications of the newly found knowledge on brain sciences in various aspects of our daily lives including health prevention, risk management, education and justice.

Founder of the first graduate course on neuroeconomics and neuroethics in France, Dr. Oullier serves as an expert on these topics for various institutions including the French Parliament and the European Commission.

His next book (with Alan Kirman and J.A. Scott Kelso), "The state of mind in economics: Neuroeconomics and beyond", is forthcoming from Cambridge University Press.