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Brain, Mind And Neuroeconomics

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Has economics an unconscious base? Sigmund Freud was one of the greatest intellectual figures of the 20th century, an Austrian neurological doctor of Jewish origin. Much of his work remains, to this day, highly controversial, where some point to his as a genius, while others highlight his alleged lack of scientific seriousness. Freud tries to give an explanation to the way mind operates, proposing a structure divided into three parts: the id, the ego and the superego. The Freudian theory covers several aspects of human psychic functioning, with a high preponderance the Austrian doctor gave to two points: the unconscious and the sensation of pleasure, repressed or not, in the interpretation of human comportment. Let's rescue the following paragraphs of Freud: The ID represents the primal impulses and constitutes the engine of human thought and comportment, motivation and our most primitive gratification desires. The SUPEREGO is the part that counteracts the id, representing moral and ethical thoughts. The EGO remains between them, and acts mediating between our primitive needs and our ethical and moral beliefs.

Keywords: economics, superego. Desires, ethical moral belief

Introduction

'The unconscious is the largest circle that includes within itself the smallest circle of the conscious, all conscious has its preliminary passage in the unconscious, while the unconscious can stop with this step and still claim full value as a psychic activity. The unconscious of a human being can react to that of another without going through the conscious.'

Consumer Neuroscience today teaches (via neuro imaging techniques not available in Freud's time) that we do not know at all why we choose what we buy. The decision would be taken, to a large extent, below the threshold of consciousness, where our most instinctive biology and our most emotional parts, the Freud's ID, sharpen. The ID would elucidate the interest in the product, the intention to purchase and the

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loyalty to the brand. These elements correspond to the construction, induced by the promotional campaigns, of desires and brand loyalty. Undoubtedly, the Freud's postulates 100 years ago are not at all far from these modern findings. The mechanism would work, at the ID, in the following way: certain sensory stimuli (induced by large corporations) activate deep areas of our brain. The reward system (limbic and subconscious), especially the nucleus accumbens and ventral striatum, are put into action and drives to seek food, sex and safety, the three basic pillars of human survival.

Brands, creations of large corporations to induce, seek to activate brain areas that regulate the sense of belonging, making us part of a group, a tribe, a community. All this, together with the natural tendency to imitate and / or empathize with everything that surrounds us (mirror neurons), leads us to consume much less rationally than we believe, pulling down the dogma of free choice, the sovereignty of the consumer. Therefore, the Marketing of Emotions tries to strongly exploit the Freudian concept of the ID - the most primitive and hidden instincts of the human being, to create value and, ultimately, benefits. Today it seems as a strong resurrection of Freud's ideas, at least under the Consumer Neuroscience field

Dopamine and Consumer Pleasure Center

Dopamine area is considered as ‘pleasure center’, since it regulates motivation and desire and causes us to repeat comportments that provide us with benefits or pleasure. It is released with both pleasant and unpleasant stimuli, causing us to demand more of something, or to avoid them if the result is unpleasant. It is very studied also in the case of addictions. That is, we live clearly today in a world where, thanks to Neuromarketing, corporations are learning to find product mixes that give maximum sensory enjoyment to the consumer (visual, tactile, auditory enjoyment, etc.), generating a true Freudian Economy, in the sense of enjoyment and pleasure, not repressed this time. The cerebral reward system, around the ventral striatum and the nucleus accumbens (limbic system), where the neurotransmitter king is dopamine, is key in this process. It turns out that this neurotransmitter influences the sensation of pleasure in the brain, and therefore, shapes the tastes and preferences of consumers. Its secretion increases during pleasant situations and stimulates one to look for that activity, occupation or pleasant goods and services.

Its objective is clear: to make us want to repeat one or more comportments, as a way to assure existence. For example, the pleasant sensation we feel when having sex or eating something delicious, make us want to repeat the action, ensuring the survival of the species through the reproduction and / or consumption of food. That is to say, for Economics, dopamine is of vital importance, being one of the

main responsible for modeling the consumer's preference curves, and the whole valuation-pricing system of the economy. Neuroeconomics shows today that the unconscious basis of comportment, highlighted by Freud, connected to the dopamine centers of pleasure or cerebral reward, are not far from the economic reality, and today large corporations are designing real experiences of pleasure for its consumers, generating a truly Freudian paradise of high added value for companies, which at some point will lead governments to assess how much danger they represent in terms of purchase addictions, but that today represent great profits for companies.

Some Anomalies

In 1952, a few years after the publication of the Von Neumann and Morgenstern expected utility theory, a meeting was held in Paris to discuss risk economics. Many of the most renowned economists of the time were present. Among the American guests were futures Nobel laureates Paul Samuelson, Kenneth Arrow and Milton Friedman, as well as the illustrious statistician Jimmie Savage. One of the organizers of the Paris meeting was Maurice Allais, who a few years later would also receive the Nobel Prize. Allais set out to show that his guests were susceptible to a 'certainty effect', and that, therefore, they violated the theory of expected utility and the axioms of rational choice in which that theory rested. Allais's paradox was later developed by Maurice Allais in his *book 'Le Comportement de L'hommeRationnelDevant le Risque: Critique des PostulatsetAxiomes de L'écoleAméricaine',* published in 1953.

In the first bet the least risky option is preferable to a higher expected utility, while in the second bet a higher profit is preferable to a less risky option. That ends up being the paradox, based on the fact that in financial risk or betting choices, although people generally prefer certainty to uncertainty, if the bet is presented differently, they will prefer the uncertainty that was previously rejected. As Allais had anticipated, the well-educated participants in the meeting did not notice that their preferences violated utility theory until the moment they were reminded that the meeting was about to conclude. Allais demonstrated that the most outstanding decision theorists around the world had preferences that were inconsistent with their own concept of rationality. Apparently, he believed that his audience, persuaded, would abandon the approach that he somewhat disdainfully labeled 'American school' and adopt its alternative logic of the election he had developed.

However, Allais was going to suffer great disappointment. The majority of economists, little fans to the theory of the decision, ignored the problem of Allais. As often happens when a theory that has been widely accepted and considered useful is challenged, they saw the problem as an anomaly and continued to use the theory of expected utility as if nothing had happened. On the other hand, the decision theorists (a group we can find statisticians, economists, philosophers and psychologists) took Allais' challenge very seriously. When Amos Tversky and Daniel Kahneman began their work, one of our first goals was to find a satisfactory psychological explanation of Allais' paradox.

Most decision theorists maintained their belief in human rationality and tried to twist the rules of rational choice to allow this pattern. For years there have been multiple attempts to find a plausible justification for the effect of certainty, but none has been convincing. Amos Tversky was little patient with these efforts; he called on theorists who tried to rationalize the violations of the utility theory 'lawyers of confusion', since together with Kahneman they went in a different direction. They maintained the theory of utility as a logic of rational choice, but abandoned the idea that humans are perfectly rational in their choices. They set out to develop a psychological theory that would describe the choices people make regardless of whether they are rational or not. In the perspective theory (prospects), the decision values are not identical to the values of the probabilities.

Fortunately, and thanks to all these strong criticisms over the last 50 years, there is now growing curiosity about Neuroeconomics, Comportmental Economics and other 'rebellious' branches towards the neoclassical status quo, although still with uncertain credulity about what can change important aspects of traditional economic theory, the neoclassical. It happens that the tradition in economic science of ignoring neuropsychological regularities in making assumptions, both in the micro and macro models, is so strongly rooted-and in fact has proven to be, to some extent, successful, that to know more about the brain and of its underlying neuropsychology seems to be unnecessary for a few colleagues. And it is likely that economists continue a few years more hesitant to give importance to the new neuro findings, beyond the curiosity that they show today, and that they have also shown with Comportmental Economics; but nevertheless, it is difficult to believe that certain neuroscientific regularities are going to be ignored for a long time, especially those that help explain better certain anomalies that have been discussed for years in our discipline.

Mention some of these anomalies, for example, in order to illustrate possible contributions of Neuroeconomics to solve them. They argue Camerer, Loewestein and Prelec[20], that in many areas of economics there are basic or variable constructs that can be usefully thought as neural processes, and in this way, studied using Neuroimaging, Trasncranean Magnetic Stimulation and other related tools (these tools have already been mentioned in a previous chapter). For example, let's take the field of finance, where millions of daily stochastic observations are made in markets, but despite such statistical access, and after decades of arduous academic research, there is still little agreement on basic issues such as why prices of financial stocks are usually so volatile, based on changing risk perceptions. Perhaps knowing a little more about the neural mechanisms that underlie the assessment of risks by human beings, biases and other human 'fragilities' can help explain these theoretical riddles better.

Continuing with the enumeration of anomalies in economic theory, let us now turn to labor markets, where a major question is still why wages are rigid to the downside. It is generally said that companies are afraid of such casualties because they want to keep high the 'morale of the workers'; and that paying a high salary also induces effort. But probably, this 'workers' moral' is not sensitive only to salary levels, but also depends on the feelings of employees towards their employers, and also can be very sensitive to recent experience, to the opinion of other workers, whether the salary cuts are procedurally fair, among others. And there are no reasons why these aspects cannot be described as neural processes and studied in this way, hand in hand with Neuroeconomics.

Also, within the current theoretical base of economics, there would be an important series of anomalies in terms of intertemporal choices. In the United States, Camerer, Loewestein and Prelec mention, debt with credit cards is quite high at present (about US $ 5,000 average per family) and, as a consequence, a large number of personal bankruptcies are declared annually. There is also the case of low-calorie food, which is cheap and easier to obtain than ever before, but spending on diets and treatments for obesity (no cheap at all) is growing more and more. Surely, understanding how brain mechanisms process reward for what we consume, or how they produce compulsion (shopping, food, etc.), could help explain these facts and shape effective policies on the subject, since analysis based on traditional economic theory (hyper-rationalist) do not fit too much.

But the empirical findings of alleged anomalies crop up everywhere. Let's see additional examples, in this case from the work of the Peruvian economist Ernesto López, which is more based on Comportmental Economics than on Neuroeconomics, but illustrates the current theory-practice disparity in economics with eloquent examples[21]. For example, let's go back to the field of finance and consider investor overconfidence. In theory, rational investors are expected to make periodic contributions and withdrawals from their investment portfolios, which try to keep them balanced in terms of the profitability-risk ratio and carry out some transactions for tax purposes. However, it is difficult that these legitimate needs of the rational investor can justify the high volumes of transactions registered in stock exchanges throughout the world. In a very interesting work, Barber and Odean[22], empirically evaluated the comportment of a sample of 35,000 investors from the United States and came to the conclusion that:

- The volume of transactions was excessive compared to what was recommended and,
- As a consequence of this comportment, agents that carried out the most transactions, in general, obtained worse results than the market average.

Something else: in the same study, investors were classified by sex and it was found that males (who, moreover, are overrepresented in the financial sector worldwide) made 45% more transactions than women and obtained lower net profits by approximately one percentage point, a statistically significant margin. What explanation can be given to these results? In these cases we speak of overconfidence, which consists of the conviction of an agent, that the accuracy of his knowledge about the value of an action is superior to that of the market and that is reflected in the current price.

In agreement with the empirical findings, psychological studies show an excess of confidence in men with greater intensity than women, especially in what refers to tasks that are perceived as 'masculine' -among which finance is counted- and in those situations in which the feedback information is non-existent or ambiguous (again, this is the case of finance). So, even when both men and women show signs of overconfidence, the excess of confidence of the 'macho' in an activity that assumes as 'his domain' leads him to invest in excess and to obtain worse results than women. That is, again, the neoclassical maximizing cost-benefit calculation seems to fail, and what is worse, we are talking about a large sample of investors, not isolated cases.

Another interesting example is related to household savings. In effect, the theory of the life cycle, widely accepted in the traditional academic world, predicts that people will save during the most productive periods of their lives and will get into debt or consume their savings during the years of lower income. Clearly, this prediction is not supported empirically. On the contrary, it is appreciated that the consumption of people is very closely related to their income and that, in many cases, the consumption of individuals falls drastically when they go to retirement, simply because they do not have enough savings to 'soften' their consuming patterns. An analysis conducted for the United States shows that many middle and lower income families simply do not have the capacity to save and, therefore, do not save. And if this happens in the United States, surely similar studies in Latin American countries would lead to results, similar or probably worse.

We can also give as an example the case of those markets characterized by the use of veiled information (hidden): it is verified that there are several markets where companies choose to hide information from consumers. Take as an example bank, which spend large amounts on advertising to express the virtues of their services, but do not sufficiently highlight the various costs that the consumer must assume, such as commissions and expenses of various kinds. In this case, although banks could compete based on these charges (as indicated by conventional economic theory), they decide to hide them, in such a way that most consumers take a long time to understand the cost structure of services associated with their bank accounts. And similarly, in the printer market manufacturers compete intensively for the cost of printing equipment, but they do not compete with respect to the main cost associated with having a printer, namely, ink cartridges only compatible with one type of equipment, that can end up costing ten times the value of the equipment throughout its useful life. As already mentioned, in these cases, conventional theory would imply that this concealment of information would end up affecting the agent responsible for it, since the veiled information - which is probably not favorable to consumers - would lead to the 'rational consumers' discover the information or, at least, establish the conjecture that hidden prices must be high prices and, consequently, be directed towards those suppliers that do not hide information. In balance, all suppliers would reveal the full information relevant to consumers.

However, the results of the analysis show that the existence of 'myopic' consumers leads to the emergence and permanence of information hiding comportments by suppliers, a situation that would configure a market equilibrium in which a part of the information is veiled. These results are consistent

with other research that show that consumers give more weight to the sale price of an electrical device than to the cost of the associated electricity consumption during the product's useful life, or that reveal that, in the case of purchases over the Internet, the consumers pay more attention to direct costs than to shipping costs. Through all these eloquent examples, we have analyzed just a few of all the anomalies that the traditional, hyper-rational theory, cannot explain today, and that 'give rise' to the fact that Neuroeconomics (and also Comportmental Economics) can help to overcome them, with results so far promising. Next, we will analyze more in detail specific findings that different research teams in Neuroeconomics are currently obtaining around the world

Economic Brain: Risk and Uncertainty

In a classic neuroeconomic papers, *The Neural Basis of Financial Risk Taking*, Kuhnen and Knutson[23] tell us that financial investors systematically deviate from rationality when making their portfolio decisions, and in this way, in their study, they try to identify neural mechanisms responsible for such anomalies. Using fMRI (neuroimaging), the authors examined whether, by anticipating investors' neural activity (i.e. by seeing what goes on inside their brain during decision making), optimal and suboptimal financial decisions can be predicted. They characterized two types of deviations with respect to the optimal investment decision (neoclassical):

- Risk search errors, and
- Risk aversion errors.

As for the concrete results, it was found that activation of the nucleus accumbens (eminently emotional area of the brain, activated when the person has a marked preference for something) preceded both risky choices and risk-seeking errors, while activation of the anterior insula (part of the emotional brain, center of disgust-displeasure) preceded choices without risk and risk aversion errors. These findings suggest that:

- Different neural circuits, linked to anticipatory effects, promote different types of financial decisions, and
- That excessive activation of these circuits can lead to investment errors (risk and search aversion).

In this way, they conclude that taking into account anticipatory neural mechanisms can add predictive power to the rational decision model of neoclassical economics, which evidently 'remains in shame' in the face of empirical evidence.

Risk and Neuroeconomics

People react to risks at two different levels. On the one hand, people try to assess the objective level of risk that different scenarios have. But on the other hand, people also react - in situations with a certain degree of risk and uncertainty - on an emotional level, and such emotional reactions can greatly affect their comportment. The existence in human beings of separate systems for the cognitive and the affective, which respond differently to the risks, is more noticeable when the two systems collide. People often seem to be 'two minds' (one deliberative and one more visceral) when facing situations with risk: for example when we have to invite someone to leave, or speak before a certain number of people, or take an important examination, our deliberative mind uses various tactics to propel us to take risks, which perhaps our visceral (emotional, non-deliberative) mind would prefer to avoid. Perhaps the most dramatic illustration of the separation of visceral reactions and cognitive / rational evaluations is found in the various degrees of phobias that people suffer: what distinguishes a phobia is the impossibility of facing a risk that one recognizes -objectively- be little dangerous (move by elevator, by an escalator, to name some of the most scandalous). Moreover, the fact that we humans spend some money on drugs and / or therapies to overcome our phobias is a clear sign that our deliberative and visceral systems are not in mutual peace usually.

However, today there is much that is known about the neural processes underlying the emotional / affective responses to risks. Most of the risk-averse comportments are caused by fear responses / fear of risks, where this fear seems to originate in the region called the amygdala (the center of fear, located in the emotional part of our brain). The amygdala constantly monitors new stimuli that indicate potential threat and responds to inputs from both automatic and controlled processes in our brain. However, the amygdala also receives stimuli from the cerebral cortex (the most rational part of the brain), which can moderate or even eliminate the emotional response.

The decision making under risk and uncertainty, as for example the case of intertemporal elections, adequately illustrate both the collaboration and the competition between the emotional and rational systems that exist within us. The case of the difference in risk taking between people with brain damage

in the pre-frontal zone (which produces a disconnection between the emotional and rational systems) and normal people is much cited; the former always tend to make decisions that are much riskier than the latter. And while clearly, having pre-frontal damage to the brain in general decreases the quality of our decision-making, there are particular situations in which people with brain damage such as the above can make higher decisions than normal people, for example before very risky scenarios where normal people are usually paralyzed.

The evidence from Neurosciences also substantiates the distinction between risk (known probability) and Knigthian uncertainty (ambiguity). Different studies with neuroimaging show that different degrees of risk and uncertainty activate different areas of the brain. For example Ming Hsu and others[24] found greater activation of the frontal insula and the amygdala (both eminently emotional zones) when people faced ambiguous choices (uncertainty) compared to risky ones. Again, it can be seen that Neurosciences, and specifically, a consideration of emotional and automatic processes - both long forgotten by economists in dominant economic models- could potentially lead an important line of research and theory, argue Camerer, Loewestein and Prelec in his aforementioned paper[25]. And they add that, if the current theory continues failing to incorporate the affective dimensions of risk, it will be unable to shed light on such important phenomena as the ups and downs in the stock markets, the betting markets and the vicissitudes of public responses to threats as diverse as terrorism and global warming, to name just a few important issues.

Neuroeconomics and Game's Theory

Game theory is an area of applied mathematics that uses models to study interactions in formalized incentive structures (so-called games) and carry out decision processes. Their researchers study the optimal strategies as well as the predicted and observed comportment of individuals in games. Apparently different types of interaction may; in fact, present similar incentive structures and, therefore, jointly represent the same game.

While economics was one of its first applications (especially for oligopolistic markets), game theory today is used in many fields, from biology to philosophy. It experienced a substantial growth and was formalized for the first time from the works of John von Neumann and Oskar Morgestern, before and

during the Cold War, mainly due to its application to military strategy. Since the seventies, game theory has been applied to animal comportment, including the development of species by natural selection. In the wake of games like the Prisoner's Dilemma, in which widespread egoism hurts the players, game theory has been used in political science, ethics and philosophy. Finally, it has also attracted the attention of computer researchers, using artificial intelligence and cybernetics. But punctually in the field of economics, Neurosciences in general and Neuroeconomics in particular are already well equipped to explore the main assumptions upon which the predictions of game theory rest. These assumptions are:

- Players have appropriate beliefs about what others are going to do,
- Have no emotions or concerns about what others earn,
- Plan forward,
- Learn from experience.

In strategic interactions (games), knowing how other people think, and also knowing how other people think you think, is critical in predicting other people's comportment. Nowadays, many neuroscientists think that in the human brain there is an area specialized in 'mind reading' (also called Theory of Mind), probably in the pre-frontal zone of our brain, known as area 10 of Brodmann, which generates reasoning about what people who interact with us probably think and then do. In fact, autism is believed to imply a deficit in this area and related circuits. People with autism often have problems imagining what other people think and believe, and therefore are driven to have abnormal comportments for the common people.

McCabe and others[26] used neuroimaging to measure brain activity when different people played games involving trust, cooperation, rewards and punishments. They found that those players who cooperated showed significant activation in the aforementioned Brodmann area 10 and in the thalamus. On the contrary, those who cooperated little did not show systematic activation in those areas.

Also, interesting is the research by Tania Singer and others[27], who reported an important link between reward and comportment in certain games. These researchers played the participants of their study, repeated games of the type 'prisoner's dilemma', where some players, while they were scanned, faced a series of opponents. First, only the scanned participants were informed that some of their opponents

would cooperate intentionally while others would cooperate, but unintentionally. Subsequently - also only the scanned ones - they were shown the faces of those against whom they had played. The faces of the intentional cooperators activated the insula, the amygdala and areas of the ventral striatum, among others. And since striatum is a brain area related to rewards, activations in this region meant that simply seeing the face of people who intentionally cooperated with one is retributive.

In an interesting work on the relationship between Neuroeconomics and Theory of Games, the Argentine economist Alfredo Navarro[28] tells us that, apart from the importance that Neurosciences have for Economics -in particular to redefine the rationality hypothesis-, it is also important to keep in mind that there is a mechanism to export economic methodologies to neuroscience and biology, giving a new perspective to the theory of evolution and allowing analyzing the reciprocal comportment of living beings, where Game Theory plays a very important role. That is, according to this vision, there would be a round trip: Neurosciences impacting Economics, which gives rise to Neuroeconomics (the object of analysis of this work), but also, and this is the novelty, Economics impacting on Neurosciences That is, a soft science impacting a hard science. Let's see how this is. In what follows of this section we will make a review of the work of the aforementioned Navarro, which in turn is based on the very interesting work of the neurobiologist Paul Glimcher[29], where this round trip between Economics, Neurosciences and Biology is analyzed.

Paul Glimcher, who comes from the field of medicine, not economics, in a recent work entitled: Decisions, Uncertainty and the Brain. The Science of Neuroeconomics, analyzes the comportment of living beings based on their effect on other living beings and of these on the first, trying to establish a new paradigm for a better interpretation of the comportment of living beings in general and of humans in particular. Glimcher, after reviewing the ideas about the nature of human comportment of Hippocrates, Galen, Harvey, Bacon and Galileo among others, considers Descartes (1596-1650) as the founder of neuroscience. Divide human comportment into two types, the simple and the complex. The first corresponds to the responses to the impulses of the environment, where there is no free will, as when we perceive the heat of a flame near one hand and quickly remove it. This was revolutionary, because no one before had seriously argued that a phenomenon as complex as comportment could be seen as the product of pure physical interactions in physiological systems. But, the complex comportments have as

characteristic that they are at the mercy of the soul, which supposed lodged in the pineal gland, and that can decide freely according to the circumstances. While the first type of comportment is determined, as is the movement of the planets, whose trajectory we can foresee exactly, it does not occur as well as the second, where free will retains all its validity.

The idea that human comportment, at least that which we call simple, was perfectly predictable took more force at the end of the 18th century with the development of the mathematics of Leibnitz, Newton, Lagrange and Laplace, which allow to predict the future position of the planets every time with better precision. Why then not analyze the comportment of living beings with the same purpose of predicting their comportment? Charles Scott Sherrington, an Oxford neurophysiologist, at the beginning of the last century laid the foundations for the physiological study of reflexes, through a neat description of the processes, but still maintaining the Cartesian distinction between simple, deterministic comportments and complex comportments, not deterministic. Subsequently Pavlov generalized the analysis of reflexes to the totality of human comportment and therefore also generalized determinism to all human comportment.

Several reactions against the Sherrington paradigm took place, especially that of Marr, who in the seventies proposed a different hypothesis: comportments should be analyzed in terms of the organism's objective, which is basically to maximize their 'inclusive fitness', meaning that rate at which genes are propagated. But to this must be added the fact that living organisms do not have a full knowledge of the world that surrounds them, for which reason they find themselves in a situation of relative uncertainty. The deterministic mathematics, which was the basis of the theories of reflexes, become insufficient, and it is necessary to resort to the mathematics of the uncertain, that is, to the theory of probabilities, since we rarely have a total knowledge of the circumstances around us. Although the theory of probabilities was born in the eighteenth century with Pascal and Bayes, three centuries pass until it is incorporated into human comportment, both in economics and in neurobiology.

In this way Glimcher, through his historical analysis, presents a way to analyze the comportment of organisms from two different perspectives: simple comportments, in the Cartesian division, can be solved by applying classical economic theory, because either there is nothing random, or the uncertain is due to our lack of knowledge, so we must use the calculation of probabilities. But in other circumstances -complex comportments-, we must resort to the theory of games, to analyze comportments that are

unpredictable, not because epistemologically we do not reach knowledge to explain the causes of comportment, as Pavlov maintained, but because they are, necessarily, intrinsically random.

This is a very striking statement for two reasons, firstly because it implies accepting that economic theory explains not only human comportment, but the comportment of all beings belonging to the animal kingdom, and not only economic comportment, but all kinds of comportment, and in second term because, to this affirmation, it is not made by an economist, but by a neurobiologist. According to Pavlov and Laplace, the uncertainty comes from the lack of knowledge of who decides, while what Glimcher says is that the uncertainty comes from outside, from the outside world to who decides, and that the latter must necessarily make a random decision if you do not want your opponent to predict your comportment and gain an advantage from it. In this way, following the reasoning of the neurobiologist Glimcher, the analysis of the comportment of living organisms can be understood much more fully if we do so from the perspective of game theory, which we remember begins to be applied to the analysis of economic problems with the appearance of the developments of von Neumann and Morgenstern, in 1944, where non-cooperative zero-sum games are analyzed, but more especially after the Nash developments, which analyzes the determination of equilibrium in more generalized situations, such as games cooperatives and non-zero sum. The analysis of the comportment of organisms that have brains allows Glimcher to argue that there are two types of uncertainty: one that we can call epistemological, which is originated in the lack of information and knowledge of the agent, and that could allow a mechanistic interpretation of the comportment, and another that derives from the need to follow a random comportment.

Glimcher reaches its conclusion[30], in the sense that:

We should begin to employ probabilistically based approaches to understand how the brain takes information from the outside world and uses that information in concert with stored representations of the structure of the world to achieve defined computational goals. It has been my central thesis that this goal can be best achieved through the synthesis of economics, biology and neuroscience. The central challenge facing neural scientist is to link comportment and brain. Economics was designed to be just that, a mathematical corpus which attempts to describe how any goal should be achieved in an uncertain world like the one we inhabit. Comportmental ecologist recognizes this; their field is focused on the study of how animals approximate economically defined goals with regard to the maximization of

inclusive fitness. Experimental economics recognize this; their field is focused on the study of how economic comportment approximate economically defined goals with regard to the maximization of utility. Neurobiologist are also beginning to recognize this, and today it seems natural to assume that some form of Neuroeconomics will play a critical role in explaining how the brain of humans and other animals actually solve the maximization problems this two other disciplines have identified.

In short, Alfredo Navarro, in his great review on the work of Glimcher, illustrates us about something that should fill us with pride to who we come from a soft science such as economics: we are in a position to export analytical tools to tougher sciences such as neurobiology, since it has been discovered that, for example, Game Theory, is a very useful resource to understand the comportment of a large part of living beings, and not only of companies in their economic interactions (such as the theory of the oligopoly).

Economic Mind of Others

In a truly leading study, Sanfey, Rilling, Cohen and others[31], tried to determine in two different games (Prisoner's Dilemma and Ultimatum), if people who interact socially, receiving feedbacks from other human beings, and intuiting how these feedbacks could be used to infer how our brain works, could predict what others think. Recall that in game theory, one of the most important tasks for participants is to act strategically from what others do or plan to do, and this implies a key role of the so-called Theory of Mind, i.e. those circuits' brain cells that are activated when trying to predict the comportment of our interlocutors.

The so-called 'Theory of Mind' studies our social brain. One of the distinctive attributes of human social cognition is our propensity to build models of other minds, that is, to make inferences about the mental states of others. This human capacity has become known in Neurosciences as a theory of the mind and many neuroimaging studies have attempted to elucidate the neural substrates of this natural human ability. Previous studies to the here detailed have already shown the main activable cerebral areas (some more rational, others more emotional) in this type of action.

The brains of the participants in this experiment (led by the aforementioned Sanfey) were scanned using fMRi (functional magnetic resonance) while playing two different games: Ultimatum Game (UG) and Prisoner's Dilemma (PDG), both in front of other humans and in front of computer screens. Comparing both games, a striking degree of coincidence was observed between the brain areas that were

activated, including both areas already accepted as specific to the Theory of Mind (mentioned above), as well as several other brain areas that had not been previously reported, and that may be related to the immersion of participants in real social interactions. And while the interactions of humans with computers also achieved activation in some of the same areas activated by games between only humans, in the latter case these activations were more notorious and defined.

In both games, the participants witnessed a decision on the part of their partners, in the UG they observed an offer of money that another made them, either fair or unfair, and on which they had to react and in the PDG they observe an election what another did, whether cooperative or selfish, and about which they also had to respond. That is, before deciding the answer to take, in both cases, they witnessed something that revealed the partner's intentions. What brain areas would be activated in both cases? That was the central core of the study.

If in the previous study the activated brain areas were analyzed when responding to a fair or unfair offer, in this new study[32] the previous moment was analyzed, that is to say, the activable brain areas when a proposal was recently known, just or unjust, and it is deliberating what to do, and at the same time, inferring what the other person is like and his true intentions. Going to the concrete results of the study, for both games (UG and PDG), activation was detected in two of the four classic areas of the Theory of Mind: anterior paracingular cortex and posterior superior temporal sulcus (STS later). Both areas were activated in interactions with both humans and computers, but showed stronger responses to human partners in both games, that is, respondent participants rejected unfair offers from humans to a greater extent than from computers in the UG and cooperated more often with humans than with computers in the PDG.

Following with the results of the study -where we remember there is social immersion of the participants-, brain areas were also found that were activated that had not been noticed in previous studies -without social interaction. These are:

- Precuneus
- Upper temporal sulcus (sts) medium
- An area that includes hypothalamus, middle brain and thalamus
- Left hippocampus

Both the activation of the posterior cingulate and the hypothalamus can be related to emotional issues when receiving responses from humans, who obviously have less presence when doing studies without human interaction. The activation of the average STS, normally attributable to the biographical memory, may be related to the fact that the participants are learning new information about other people -the ones who make the offers-. Finally, the activation of the hippocampus could be related to the activity of decoding comportments and intentions of others: are they just or unjust? Are they cooperative or non-cooperative?

In summary, and taking into account that the paper leaves perhaps more questions than answers, the brain areas that can be activated with respect to the theory of the mind (many of them more emotional than rational, without a doubt), would be at least:

- The Anterior Paracingular Cortex
- Upper Posterior Temporal Sulcus (Posterior Sts)
- The Posterior Cingulate / Precuneus
- The Average Sts
- An Area That Includes Hypothalamus, Middle Brain And Thalamus
- The left hippocampus

In other landmark study in Neuroeconomics, Sanfey, Rilling, Cohen and others[33], applied fMRi (functional magnetic resonance) about nineteen players of the Ultimatum Game, to investigate the neuro fundamentals of the cognitive and emotional processes put into play when making economic decisions. The aforementioned Ultimatum Game (in this case a single shot -one shot game-) consists of two people trying to share a certain sum of money: one player proposes a division and the other can accept it or not.

Brain images were taken only of the players responding to the proposals (not those who formulated them), where such formulated proposals were sometimes fair and sometimes unfair. The offers considered fair (50/50 distribution of money, or half for each) were all accepted, while unfair offers (all those involving a distribution below 50/50 for the respondent) were more rejected as that increased their degree of injustice (60/40 is not the same as 80/20). And through the neuro images, it was observed that

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these unfair offers activated brain areas related to both the emotional (anterior insula) and the cognitive (dorsal-lateral pre-frontal cortex). And in another data that is interesting, it was also observed that the degrees of rejection of unfair offers were greater when the bidder was a human being than when it was simply the computer (who were also used in this experiment as formulators of proposals), illustrating that human beings have a superior emotional reaction to unfair offers from other humans than to the same formulated via some impersonal mechanism (computers in this case).

Another interesting finding of this work was given that, in the face of unfair offers that were later rejected, greater activation of the insula than pre-frontal cortex was observed, while the accepted offers showed the opposite, greater activation of the prefrontal cortex than insula. This situation would be reaffirming what is already known in Neurosciences: the rational / cognitive tendency of the pre-frontal cortex and the eminently emotional nature of the insula. But beware... it is not a competition in our brain between the rational and the emotional separately, but it is a performance of both together, related and complementing. Also, in another interesting finding, it was observed that the activation of the pre-frontal cortex remained constant before less or more unfair offers, perhaps representing how stable the mental representation of a monetary maximization is, while the activation of the insula scales depending on the degree of injustice of the offer.

Finally, Sanfey and other researchers also observed, in the case of unfair offers, an activation of the anterior cingulate, a cerebral area bordering the pre-frontal cortex, normally activated in situations of conflict between the emotional and the cognitive, such as this one experiment. In this way, we can conclude that the observed activation in the anterior insula (eminently emotional area of the brain) before unfair treatment or offerings, indicates a very important role of emotions in human decision-making processes, despite the attempt of the standard economic theory for suggesting that any sum of money offered to a person - without any cost or consideration - should be accepted, since net income is maximized. In general, all these neuroeconomic papers, combined with game's theory, suggests that the human being does not always maximize in his economic decisions, since sometimes, although the economic calculation advises one clear path, the emotional influences, making the decision apparently irrational, taking other way. But such decisions are not irrational, are just human.

Oxytocin, Trust and Market Economies

No one can argue, surely, that trust between people is essential to strengthen human societies. Trust is necessary to make friends, form partners, families and organizations and of course play an essential role in economic exchanges and politics. In the absence of trust between people and companies, market transactions are cut, and in the absence of trust in the institutions and leaders of a country, political legitimacy is lost. Recent empirical evidence in humans has identified the role of neuroactive hormones, especially oxytocin, as a facilitator of pro-social comportment based on trust. Recent neuroeconomic experiments with humans have shown that the reception of a signal of confidence from a stranger is associated with an endogenous release of oxytocin by the brain and also that high levels of oxytocin have been strongly associated with reciprocal comportments of said signals of trust. In this work, Paul Zak and AhlamFakhar[34], test whether the endocrinological bases of trust between humans (in small groups, that is, at the micro level) can be scaled at the country level (macro level), especially taking into account the statistics on confidence at the national level show substantial disparities (in Norway for example, 65% of respondents answered that they could trust their fellow citizens, while in Peru only 6% responded in that way).

Oxytocin (a type of neuroactive hormone we said), whom Zak calls the 'molecule of morality', is synthesized in the hypothalamus (belonging to the limbic system - eminently emotional zone of the brain) and then released into the circulatory system. In humans, certain areas of the brain associated with memory (the diagonal band of Broca and the basal nucleus of Meynert) and areas associated with emotions (hypothalamus and amygdala) present an important accumulation of oxytocin receptors, although there are receptors of oxytocin distributed throughout the brain. This distribution of oxytocin receptors in limbic areas suggests that the decision to trust others has an important emotional component, and therefore a high component of speed and low introspection when deciding.And, as both studies with animals and humans, indicate that estrogen is highly related to oxytocin levels, the authors of this work used estrogen as a proxy for oxytocin. The hypothesis to be demonstrated in this study was that people who live in societies settled in environments with high levels of oxytocin and / or estrogen are more likely to affirm that their fellow citizens are reliable, that is, to have more confidence in their peers.

Analyzing in detail the work, thirty-one variables were taken (between biological, social and environmental) associated with interpersonal trust for a sample of forty-one countries, where the authors found that two groups of variables are related to trust interpersonal at the country level: the consumption by its inhabitants of plants based on estrogens (phytoestrogens) and the existence of environmental conditions that include the presence of molecules of the estrogen type. In this way, these results provide preliminary evidence that levels of confidence at the country level may be related to the intake of neuroactive hormones by its inhabitants, via food or via the environment, mainly.They also comment Zak and Fakhar that there are more than 300 plants in the world that have been identified as phytoestrogenic. For example, phytoestrogens are found in foods such as soybeans and derivatives, rye and derivatives, rice, beans, beef and tea / mate, among others.

In summary, this paper shows that endocrinological effects can be a new explanation-independent of the usual institutional causes-for the problem of confidence differentials observed between countries, indicators directly associated with higher or lower levels of investment and economic development of each country. That is to say, this work tries to show that specific environmental / food conditions in some countries, which impact the oxytocin levels of its inhabitants, can lead to higher levels of confidence. Specifically, nations that have high per capita incomes, clean environments and consume more food with phytoestrogens have a good chance of showing high levels of generalized trust among their inhabitants, which facilitates economic transactions in general and investment levels in particular.This information, Zak and Fakhar conclude, should be useful for politicians, if they are interested in raising the levels of trust among their governed, and therefore the quality of their market systems, especially in developing countries. Also the conclusions of this work give certain rationality towards the maintenance of clean environments and towards the consumption of healthy foods.

Libertarian Paternalism

The term ‘libertarian paternalism’ was coined by the aforementioned comportmental economist Richard Thaler and the jurist Cass Sunstein, in a 2003 article in the American Economic Review. The authors developed their ideas in a more extensive article at the University of Chicago Law Review that same year.

Why are there so many people who smoke a lot or are addicted to different types of drugs? Why do so many people eat junk food in excess? And more generally ... why do so many people voluntarily decide

to do things that they know hurt them in the long term?Richard Thaler, the last Nobel Prize in Economics, and solid member of the 'Economics of Comportment' School, argues that the problem originates in the limited rationality of human beings. In their mental processes, argues the academic, people separate the immediate effects of an action from the aggregate and long-term effects of it, valuing them in different ways (usually more value to the present than to the future), and behaving systematically in a contrary to their own benefit.In this way, Thaler justifies the state intervention, 'libertarian paternalism' he calls, to remedy the incorrectness of people with an exacerbated 'limited rationality', giving them a nudge in the right direction. It is, without a doubt, a form of interventionism that liberal libertarians will blaspheme forever.

In any case, the intervention suggested by Thaler is much less 'interventionist' than those we are accustomed to seeing in the real policies of the day-to-day governments. Thaler argues that, given the imperfect and limited rationality of many people, small changes in the rules of initiation could encourage people to behave in the 'socially desirable' way, reducing long-term interventionism. For example, the basic rule, for him, should be the donation of organs after death; if someone did not want to donate, they could opt for it. The junk food must be in the most hidden places of the supermarkets, so that the effort of buying it is greater. If someone does not manifest their willingness to have a pension fund, it must be considered that they do want one.

In the aforementioned article, they propose that, both from the private sector and from the government, it is about influencing the comportment of people to make their life longer, healthier and better. They continue that, in proven findings of the social sciences, it has been shown that, in many cases, individuals make very bad decisions, decisions that they would not have made if they had paid attention and had had all the information, unlimited cognitive abilities and absolute self-control.And while it is paternalistic / interventionist, they justify that it is liberal / libertarian in the sense that its goal is to ensure that people are freed from many of their biases of limited rationality, to disassociate from disadvantageous agreements, if they prefer. According to them, libertarian paternalists want to facilitate people to follow their own path; they do not want to put obstacles in the way of those who wish to exercise their freedom.

Remarks

Thaler's critics say that his 'libertarian paternalism' is just a modern justification for state interventionism, which starts from considering people are irrational because they do not make the

decisions that a certain group of people find desirable.And critics add: if people are really irrational, as Thaler says, what makes sure that those who design the rules are not? What assures us that their 'pushes', far from helping us to be better, enslave us to their tastes and appreciations, depriving us of our tastes and our appreciations?

Libertarian paternalism is a relatively weak and soft type of paternalism that does not involve interference, because the options are not blocked or eliminated, nor are they taxed in a significant way. If someone wants to smoke, eat a lot of candy, subscribe to unfavorable medical insurance or not save for retirement, libertarian paternalists do not force him to act differently, they only induce him with incentives.

Thaler and Sunstein argue that government and private companies often become 'architects of choice', because our perceptions often depend on how we organize the different options that are presented to us. The world is full of these 'architects' - parents, religious leaders, professors, doctors, etc. - who influence our choices and have the responsibility to give them shape through 'nudges', which do not limit us but can compensate for human error, if we use them correctly.

State interventionism based on 'socially desirable patterns' is not new, although the term 'libertarian paternalism' can be. The idea of inducing through 'incentives' (fiscal, or otherwise) certain economic comportments, which do not arise spontaneously, by limited rationality or for whatever reason, is the guide of modern economic policy for a century at least, although now it is better grounded in neuropsychological terms.

Therefore, new labels for old uses and customs of economic policy, although this time with a bias towards a more limited, more intelligent interventionism, since it is based on a deeper knowledge of human rationality, backed in Neurosciences, and not in mere philosophical speculations about the human psyche, quite deficient in many cases.

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