International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 11 Nov 2021, pp: 381-409 www.ijaem.net ISSN: 2395-5252

Philosophical Undercurrentsin Neuro - Organisational Economic Behaviour (Noeb)

Prof Dr Kalpana Sahoo, Col Prof Dr J Satpathy and Prof Dr Sebastian Laza

Faculty, School of HRM, XIM University, PDF Researcher, Srinivas University, India
Faculty, Management, Srinivas University, India & Visiting Professor, Management University of Africa, Nairobi
Faculty, SchoolofNeuroeconomics, National Universityof Cuyo, Mendoza, Argentina

Submitted: 05-11-2021 Revised: 12-11-2021 Accepted: 15-11-2021

INTRODUCTION

In what is usually not mentioned, Psycho - economics started with Psychology (not scientific) in the middle of the XVIII century, hand in hand with the so-called Classics, such as Adam Smith (especially with his Philosophy of Moral Sentiments) and David Hume, among others. To be more rigorous, as the (scientific) psychology still did not exist, those founding fathers of psycho - economics acted in some manner as psychologists, especially through introspection, recognising in their writings the remarkable influence of emotions - just as the reason- in the decision making; that is to say the conjunction of both, not the separated reason acting in isolation to make the best decision.

However, a few decades later, the economists who followed Adam Smith and the like - the neoclassicals - became skeptical about the possibility that our psychological forces could be measured directly, which led to the adoption by the economic science of the useful tautology between unobserved utilities (originated in the black box of the human psyche) and observed (revealed) preferences.

However, at present, the important advances in Cognitive Neuroscience allow (for the first time in the history of science) to approach a more direct measurement of thoughts and feelings, opening said black box -the human mind-, the basal block of all economic interaction. Undoubtedly, this scientific possibility is disruptive for the Economic Sciences, since it allows to face the generation of economic philosophy and its subsequent verification / falsification from other methodological paths. We will return to this topic in a later chapter.

Making a very brief historical synthesis of the traditional micro models of decision making, the Philosophy of Revealed Preferences (in English it was known as WARP) was developed initially in 1930 by the famous economist Paul Samuelson (and later refined, in what it was called GARP), becoming the core of the so-called neoclassical revolution. The philosophy, in its GARP version, proposes that if a consumer, when facing the choice between an apple and an orange, chooses the apple, he is revealing his preference for the apple (without necessarily knowing the neuro mechanisms that led him to that decision -It does not matter to the neoclassicals-). Additionally, if the same consumer reveals preferring oranges over pears, this implies that indirectly is revealing preferences of apples over pears, that is, which (observed) decisions can be used to predict about the relative desirability of many pairs of other goods, although they have never been directly compared by consumers. Thus, what Samuelson and later authors demonstrated mathematically was that even simple assumptions about this kind of binary choices, revealing stable (albeit weak) preferences, could have powerful implications for economic philosophy.

After the WARP and the GARP, but within the same idea, came the theoretical refinements of the so-called Expected Utility Philosophy (von Neumann and Morgenstern) and Subjective Philosophy of Expected Profit (Savage), almanners with the sole purpose of predicting decisions (choices), no matter in the least the internal process in the human black box, your brain. Undoubtedly, and put into context, the contribution of Samuelson and his followers and refiners was truly ingenious; However, today, with neuro advances, it is clearly insufficient to understand the complexity of the economic decision-making process.

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But they do not begin with Neuro - organisational economic behaviour (NOEB) the attacks against the revealed preferences, but they come already from the decade of '50; for example in 1953, the French economist Maurice Allais demonstrated certain failures of that philosophy, which went down in history as the Paradox of Allais. In 1963 the so-called Ellsberg Paradox was added, with dyes similar to that of Allais, in the sense of discovering faults that violated the main axioms of the Philosophy of Revealed Preferences and all its later versions. Subsequently, during the '70 and '80 came the NOEBel prizes Simon, Kahneman and Tversky (mentioned in detail in a previous chapter), with theoretical and empirical contributions that noted that the range of phenomena that was outside the traditional philosophy of Revealed Preferences and Expected Utility was much greater than that implied by the paradoxes of Allais and Ellsberg. Of course, at present, neuroeconomists have joined, with instruments of measurement much more sophisticated than previous critics, and each time discovering more holes in the neoclassical ceiling, more anomalies, which already cause doubts about their true scientific rigor.

Allais's Paradox[i]

In 1952, a few years after the publication of the von Neumann and Morgenstern philosophy, a meeting was held in Paris to discuss risk psycho - economics. Many of the most renowned economists of the time were present. Among the American guests were future NOEBel laureates Paul Samuelson, Kenneth Arrow and Milton Friedman, as well as the illustrious statistician Jimmie Savage.One of the organisers of the Paris meeting was Maurice Allais, who a few years later would correspondingly, receive the NOEBel Prize. Allais set out to show that his guests were susceptible to a certainty effect, and that, therefore, they violated the philosophy of expected utility and the axioms of rational choice in which that philosophy rested.Allais's paradox was later developed by Maurice Allais in his book Le Comportement de L'homme Rationnel Devant le Risque: Critique des Postulats et Axiomes de L'écoleAméricaine, published in 1953. The paradox is generally explained with the following example[ii]: An individual is asked to choose one among the different bets:

- Bet A: 100% probability of receiving 100 million.
- Bet B: 10% chance of receiving 500 million, 89% probability of receiving 100 million, 1% chance of not receiving anything.

And another among the following bets:

- Bet C: 11% probability of receiving 100 million, 89% probability of not receiving anything.
- Bet D: 10% chance of receiving 500 million, 90% chance of not receiving anything.

If the axiomatic of the expected utility were applied, the preference A> B should imply that C> D. However, the experiment shows that more rational individuals would choose A> B, but C <D, although you can easily see that the expected value of each bet is a = 100, b = 139, c = 11 and d = 50.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 philosophy until the moment they were reminded that the meeting was about to conclude. Allais wanted the ad to fall like a bomb: 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 philosophy of the decision, ignored the problem of Allais. As often happens when a philosophy that has been widely accepted and considered useful is challenged, they saw the problem as an anomaly and continued to use the philosophy 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

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who tried to rationalize the violations of the utility philosophy lawyers of confusion, since together with Kahneman they went in a different direction. They maintained the philosophy 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 philosophy that would describe the choices people make regardless of whether they are rational or not. In the perspective philosophy (prospects), the decision values are not identical to the values of the probabilities.

Anomalies

Fortunately, and thanks to all these strong criticisms over the last 50 years, there is now growing curiosity about Neuro - organisational economic behaviour (NOEB), Behavioral Psycho - economics and other rebellious branches towards the neoclassical status quo, although still with uncertain credulity about what can change important aspects of traditional economic philosophy, 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 correspondingly, shown with Behavioral Psycho - 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 Neuro - organisational economic behaviour (NOEB) to solve them. They argue Camerer, Loewestein and Prelec[iii], that in many areas of psycho - economics there are basic or variable constructs that can be usefully thought as neural processes, and in this manner, 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 philosophy, 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 correspondingly, induces effort. But probably, this workers' moral is not sensitive only to salary levels, but correspondingly, depends on the feelings of employees towards their employers, and correspondingly, 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 manner, hand in hand with Neuro - organisational economic behaviour (NOEB).

Correspondingly, within the current theoretical base of psycho - 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 correspondingly, 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 philosophy (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 Behavioral Psycho - economics than on Neuro - organisational economic behaviour (NOEB), but illustrates the current philosophy-practice disparity in psycho - economics with eloquent examples[iv]. For example, let's go back to the field of finance and consider investor overconfidence. In philosophy, rational investors are expected to make periodic contributions and withdrawals from their investment portfolios, which try to keep them balanced in terms of the

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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[v], empirically evaluated the behavior 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 behavior, 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 philosophy 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 correspondingly, 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 philosophy), they decide to hide them, in such a manner 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 philosophy 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 behaviors 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.

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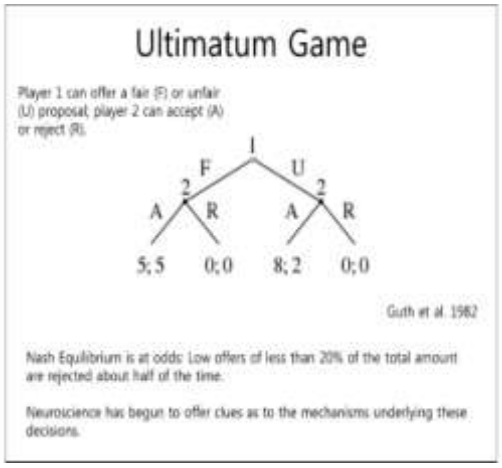
Through all these eloquent examples, we have analyzed only six of the many anomalies that the traditional, hyper-rational philosophy cannot explain today, and that give rise to the fact that Neuro - organisational economic behaviour (NOEB) (and correspondingly, Behavioral Psycho - Economics) can help to overcome them, with results so far promising. Next, we will analyze more in detail specific findings that different research teams in Neuro - organisational economic behaviour (NOEB) are currently obtaining around the world.

NOEB and Ultimatum Game

In a landmark study in Neuro - organisational economic behaviour (NOEB), Sanfey, Rilling, Cohen and others[vi], 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 currency: 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 currency, 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 neuroimages, it was observed that 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 correspondingly, 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 correspondingly, 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.Correspondingly,, 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 scale depending on the degree of injustice of the offer.Finally, Sanfey and other researchers correspondingly, 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 manner, 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 philosophy for suggesting that any sum of currency offered to a person - without any cost or consideration - should be accepted, since net income is maximized. This neuroeconomic study then suggests that the human being does not almanners maximize in his economic decisions, since sometimes, although the

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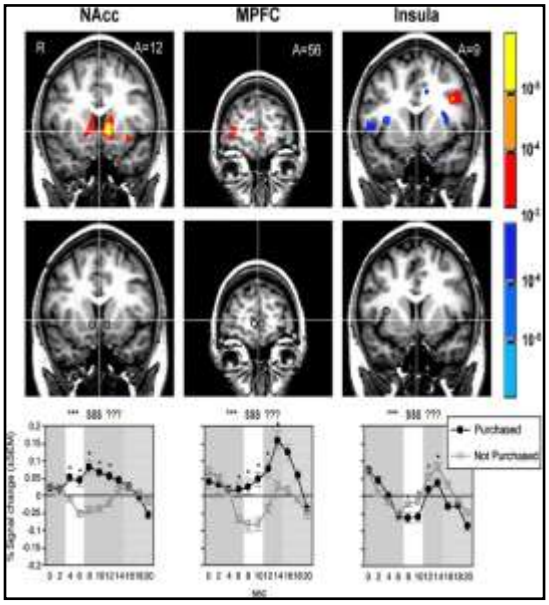
economic calculation advises to accept, the emotional influences, making the decision apparently irrational. But such a decision is not irrational, it is simply ... human.

Neural Purchasing Predictors

Knutson, Loewenstein and others[vii], in one of the first studies that used fMRi (functional magnetic resonance) to examine the consumer's real behavior, shook the board a bit of what had been done in Neuromarketing - or in economic terms, in the study of micro-demand functions, and analyzed by brain images people at a time of purchase in concrete form. Some argue that it is one of the most important Neuromarketing studies published to date.

Twenty-six adults participated in the same, each with $ 20 to spend on certain products, which then would be sent home in case of purchase. And if they chose not to make any purchase, they could keep the currency. The products and their prices appeared on a computer screen that participant could see while their brains were being scanned by magnetic resonance.The researchers found that, as the participants were observing the attributes of each product, a subcortical brain region called nucleus accumbens was activated - this region is usually associated with the anticipation of pleasure or something pleasant, which like-. However, when people were warning about the excessive prices of certain products, two additional things happened: the brain region known as insula (eminently emotional area) was activated and the pre-frontal middle cortex (eminently rational area) was deactivated. We have already mentioned that the insula is a brain area that is activated in situations that the person observes as unfair, or unpleasant; while the pre-frontal cortex is related to the balance of gains and losses, that is, the economic calculation, the eminently rational.



In the upper part of the figure, activation of the nucleus accumbens (NAcc), the middle prefrontal cortex (MPFC) and the insula can be observed. In the middle figure, the geographical location of each of them is observed and in the lower graphs, the changes in the level of activation over time are observed, measured in seconds (product display, price display, decision period) and your confidence intervals. In this manner, by studying which brain regions were activated at the time each person decided to buy, the researchers were able to successfully predict whether the participants would decide to buy or not. Activations of the regions associated with the preference for the product (nucleo accumbens) and the weight of gains and losses (middle pre-frontal cortex) indicated that a person would decide to buy a product. On the contrary, when the region associated with excessive prices (insula) was activated, the participants would choose not to buy said product.

That is to say, a significant aspect of the study is that the brain scan via neuroimaging predicts consumer behavior almost as well as the intentions of the consumers before the experiment, showing that:

- Neuromarketing studies aim to be better than the usual market studies, since they are less biased, although they are more expensive;
- From the econometric point of view, introducing neuro variables allows enriching the demand functions estimated in the traditional manner.

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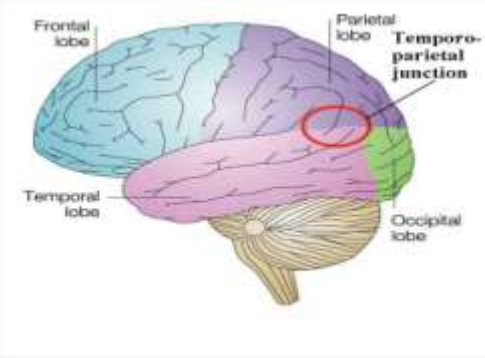
Philosophy of Mind

In this study, Sanfey, Rilling, Cohen and others[viii], 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 philosophy, 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 Philosophy of Mind, i.e. those circuits' brain cells that are activated when trying to predict the behavior of our interlocutors.

The so-called Philosophy 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 philosophy 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 Philosophy 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 correspondingly, 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 currency 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 correspondingly, 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[ix] 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 Philosophy 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 correspondingly, found that were activated that had not been noticed in previous studies -without social interaction-. Thesewere:

- 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

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hippocampus could be related to the activity of decoding behaviors 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 philosophy 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

Oxytocin and Trust

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 organisations 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 behavior 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 correspondingly, that high levels of oxytocin have been strongly associated with reciprocal behaviors of said signals of trust.In this work, Paul Zak and Ahlam Fakhar[x], 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 Normanner for example, 65% of respondents answered that they could trust their fellow citizens, while in Peru only 6% responded in that manner).

Oxytocin (a type of 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.

FIGURE 1

Source: Paul J. Zak.

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 manner, 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 correspondingly, 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-

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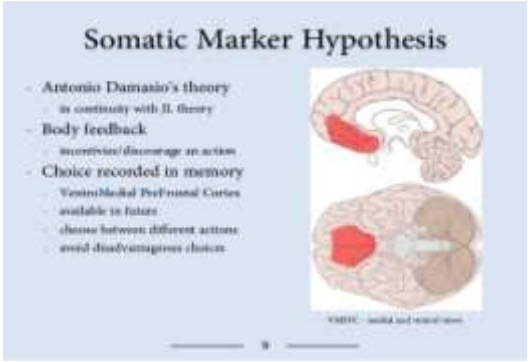
independent of the usual institutional causes-for the problem of confidence differentials observed between countries, indicators directly associated with higher or lower levels of investment and economic development of each country. That is to say, this work tries to show that specific environmental / 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. Correspondingly, the conclusions of this work give a certain rationality towards the maintenance of clean environments and towards the consumption of healthy foods.

Somatic Markers and Decision Making

Based on an interesting work by the Chilean psychologist Claudio Lavin[xi], we now analyze the somatic marker hypothesis, developed by Antonio Damasio in 1998, a philosophy that has been very relevant when understanding the role of emotion in decision making. It is argued that before the consequences of a decision there is a certain emotional reaction that is subjective, that is, it can be experienced, and at the same time somatic, that is, it is translated into muscular, neuroendocrine or neurophysiological reactions. This emotional response in turn can be associated with consequences, whether negative or positive or sets of stimuli that define a situation, that are repeated with certain constancy over time and that provoke such response. This mechanism of association is what produces what Damasio calls somatic marker and that is defined as: a bodily change that reflects an emotional state, either positive or negative, that can influence the decisions made at a certain time. In this manner, it is stated that the emotional reaction goes from being a mere consequence, for example of some negative decision, to influencing the decision making itself, making possible the anticipation of the consequences and guiding the final resolution process.

In this sense, it is affirmed that somatic markers can provide unconscious (or, in general, metaconscious) signals that facilitate and contribute to decision-making, even without the subjects being able to explain the reason for their strategy (for example, when we buy products that clearly would not suit us from the point of view of the cost-quality ratio, or when businessmen manifest, at certain times, an aversion to risk that seems irrational). One manner to study these somatic marker effects is shown by the IGT (Iowa Gambling Task), where the word gambling gives us the idea of tests based on bets / games of chance, in which different people must choose between four heaps of cards, and depending on their choice they receive rewards or symbolic monetary punishments, so that in the long run two heaps will lead the participants to lose while the other two win.



These tests -in their majority- have been carried out through the study of the changes in the electrodermal activity (skin conductance levels and response) produced by the decision-making situation. For example, the works of Bechara - another prominent neuroeconomist nowadays - have shown that normal subjects show greater cutaneous conductance responses when the probable consequences of their choices - gains or losses - are greater. However, the greatest wealth of this research lies in the finding of anticipatory electrodermal responses, that is, they appeared just before the subjects made the choice. The researchers observed that the subjects who chose the heaps of cards with the highest profits showed a greater conductance response before choosing the disadvantageous decks (with lower gains), which has been interpreted as an anticipatory corporal signal that guides the subjects avoid said deck.These conclusions, together with those of other studies carried out in recent years, have placed the pre-frontal cortex, especially the ventromedial orbitofrontal portion, in the key region for decision-making, since it is in this zone where the consequences of long-term actions are evaluated, thanks to the integration of somatic

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states with information specific to the situation and with stored memories of similar situations.

Lavin concludes that these findings have supported the idea that there are anticipatory somatic responses (supported and reinforced by experience) that guide future behavior and the choices made in similar situations, positioning somatic markers as a relevant variable to consider when evaluating decision making and the relationship between it and emotion. This is correspondingly, reinforced by the differences between the electrodermal responses of people who achieve optimal performance in the development of tasks and those who achieve poor results and correspondingly, those who have neurological damage in the brain areas involved in these responses.

Another interesting study related to the subject is one of Natalie Denburg[xii], which analyzes the influence of somatic markers through the different stages in a person's life, especially discriminating between adults under and over 70 years.Her paper analyzes the correlation that exists between decision making and people's psychophysiological responses, where through the use of the (already mentioned) Iowa Gambling task (IGT), it was observed how they intervene in adults greater changes in skin conductance (SCRs) compared to the anticipation generated prior to the behavioral response. It was found that older adults who obtained negative results in the test (that is, low performance in the bets) presented greater discrimination of the changes in the conductance of the skin during the execution of the test (IGT), reason why it was concluded in which decision-making ability is subject to the interpretation of somatic markers, and that the reduction in decision-making capacity in older adults (over 70 years) would be due to an abnormal functioning of the somatic response against the anticipation of future events.

It was observed that decision making is assisted by emotional processes, signs or somatic markers that originate not only in the body but correspondingly, in cortical and subcortical areas, including the ventromedial prefrontal cortex (VMPC), the amygdala and the insular cortex, somatosensory cortex, the basal ganglia and the peripheral nervous system. Needless to say, many of the areas mentioned belong to the so-called limbic system, that is, our emotional, meta-conscious and non-rational brain.

In another very interesting aspect of the study, it was correspondingly, found that, during the game, older adults produced greater amplitude of psychophysiological response to the decks that offered greater reward and that younger adults generated greater amplitude of psychophysiological response to the decks that offered economic disadvantage, which suggests that the pattern of anticipatory discrimination during successful IGT performance differs for older adults and younger adults.This translates into the fact that decision-making effectiveness in older adults is due to the anticipation of the positive, as opposed to the young adults who sustain their decision making in anticipation of negative responses.

Somatic markers can be positive or negative, although in both cases, they are vital for the action. If positive somatic markers prevail in decision-making in older adults, this suggests that positive somatic states promote approaching behaviors and that younger adults use negative somatic markers to evade options that do not suit them.But why this difference between young adults and older adults? Some researchers argue that older adults would have greater attenuation of their emotions by experiencing less negative affect than their younger counterparts, presumably for existential reasons[xiii].

Summarizing then the concept of somatic marker, and beyond the two particular cases analyzed in this section, we can conclude that:

- The somatic marker is learned in past experiences;
- The somatic marker is noted in situations in which certain current events are associated with past emotions;
- When the marker is reactivated, either consciously or metaconsciously, the partial or complete replication of an emotional state associated with the current situation to be resolved is promoted;
- The somatic marker, like memory trace, is recorded in high-order cortical circuits, of which the ventral-medial prefrontal cortex is the most notable example.

In summary, we believe that the hypothesis of the somatic marker, by the hand of Damasio, Bechara and several other researchers in recent years, promises to be of great importance to unite the philosophy of hyper-rational decisions (on which psycho - economics is based on the neoclassical school) with the reality observed in the business world, where very important decisions are made every day, which involve a lot of currency, but where the emotional, the intuitive and the meta conscious sometimes end up giving priority to the final decision, improving the success of it, and not the other manner around.

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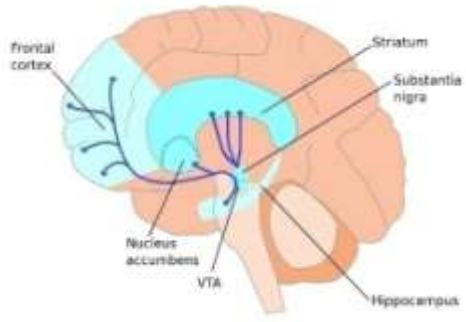
Utility of Currency

Neuroeconomists usually perform, among other field studies, brain scans while people perform activities where they earn or lose currency. The results obtained suggest that the currency activates reward areas similar to those that are activated through the consumption of food and drugs, which would imply that the currency confers direct utility, instead of being valued only by what can be bought with it.

The standard economic model assumes that the utility of currency is indirect, since it is only a means to facilitate the exchange of goods and services, which are those that end up providing utility directly. Thus, the traditional neoclassical psycho - economics conceives the pleasure of food or cocaine, for example, and the pleasure of obtaining currency, as two totally different phenomena. However, neurological evidence[xiv] suggests that the same dopaminergic reward circuits of the brain are activated for a wide variety of rewards, including attractive faces, funny cartoons, cultural objects, sports cars, drugs, and currency). So, according to neuro evidence, it would seem that currency, like the other goods and services mentioned, provides a direct reward.



Therefore, the idea that many types of reward (whether by buying goods and services or simply by having currency in your pocket, even if it is not spent) are processed in a similar manner in the brain, has important implications for psycho - economics, that he assumes that the marginal utility of currency depends on what it can buy; in this manner today it is hypothesized that currency would become what psychologists call a primary reinforcer, which means that people would value currency without carefully calculating what they plan to buy with it. And while, we acknowledge, Neuro - organisational economic behaviour (NOEB) is not advanced enough today to categorically affirm this hypothesis, there is a very high possibility that brain valuation for currency is loosely linked to the utility of consumption.But then, if earning currency directly provides pleasure, the experience of saying goodbye to him will probably be painful. This would be one of the reasons why many consumers tend to accept purchases in installments (medium- and long-term financing) to disguise the payments, and in this manner reduce our pain by getting rid of liquidity.

Deliberative vs Affective

Following a very interesting synthesis made by the Argentine economist Alfredo Navarro[xv], in Animal Spirits: Affective and Deliberative Influences on Economic Behavior, Loewenstein and O'Donoghue[xvi], two eminent North American researchers, maintain that although the neoclassical model supposes an economic agent with a single decision center, the deliberative (the rational part of the brain), this model has worked relatively well to explain the economic behavior, both of the consumer that maximizes its usefulness, and of the businessman who efficiently organises his company, of the offender who faces to the risk of being arrested if he commits a crime, or of the one who makes the decision to marry or have children.

But Neuro - organisational economic behaviour (NOEB), as we have commented until the satiety in this book, confirms that there are two decision systems: the affective and the deliberative. The first corresponds to the internal parts of the brain, that is, the most primitive in the evolutionary stage, and the second is located in the cerebral cortex and appears in more recent stages of the evolutionary process. The affective system is related to emotions that have effects on the motivations of human behavior, with a value component almanners present, either biological (fear, hunger, sexual desire) or social (sympathy, hatred, distrust), and usually operates in meta-conscious form.

Cognitive vs affective processes

Cognitive processes	Affective processes
Concerned with 'yes/no' questions	Concerned with 'go/no go' questions
Work with affective processes to produce action	Work with cognitive processes to produce action
Can control affective processes	Can override cognitive processes

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The deliberative system, on the contrary, acts by evaluating what the affective system perceives, with which it is bound by biunivocal nervous connections, and over which it exerts a certain power by having it will power to correct the behavior that would be followed if it existed only the affective system, as it happens with the most primitive animals. The stimuli can affect the affective part only, or correspondingly, the deliberative part, and depending on the evaluation of both systems, the behavior to be followed will be defined. With these assumptions, which are the basic contributions of Neuro - organisational economic behaviour (NOEB), Loewenstein and O'Donoghue go a step further, to build a mathematical model that allows them to formalize this relationship. They assume that the human being faces a function to be minimized, which is the cost of his behavior. A part of the cost is the difference between what the deliberative system wants and what it ultimately obtains and another part of the cost is the effort that the deliberative system must make to turn the impulse of acting in a certain manner.

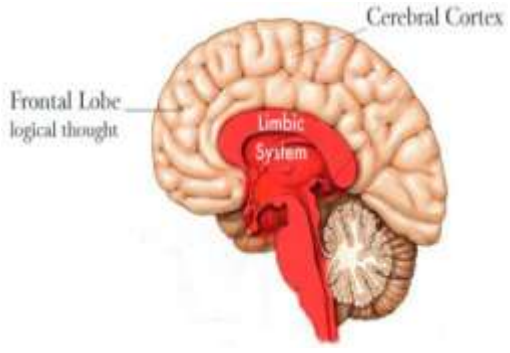
[U (xD, c (s), a (s)) - U (xA, c (s), a (s))] + h (W, σ) [M (aA, a (s) - M (x, a (s))]

Where, U is a utility function, x the chosen course of action, of a set X, the supra-indexes D and A indicate the optimal behaviors for the deliberative and affective systems respectively, s is a vector of stimuli, ya (s) and c (s) are the vectors of affective states of the affective and deliberative systems respectively related to these stimuli, h is the effort necessary to correct the desire that comes from the affective system, function of the power of the will, W and elements that weaken it, σ, and M are the courses of action of the affective system.

This model tells us that the deliberative system is subject to two forces: one from the deliberative system itself and another from the affective system. If the first one totally overrides the second one, the behavior followed would be xD, and if only the affective one prevails the behavior would be xA. However, what usually (but not almanners) happens is that an intermediate point is reached between both extreme positions. Subsequently, the authors apply this model to three different problems: intertemporal preference, risk behavior and altruism. In all three cases, they come to the conclusion that the affective system shares the regulation of behavior with the deliberative system, and that totally rational behaviors, derived from the deliberative system, are not almanners what we find in reality.

Again, following a synthesis made by Alfredo Navarro[xvii], in The Vulcanisation of the Human Brain[xviii], Cohen, renowned American neuroscientist, considers human behavior in terms of its evolution from more primitive forms, in which the cerebral cortex did not yet exist. He considers that the brain is a confederation of mechanisms, which sometimes act together, but at other times they compete with each other (other neuroeconomist, as Paul Glimcher, don't think the same). Cohen describes an experiment in which the behavior of different people is analyzed in the face of the dilemma of avoiding the death of five people by sacrificing a sixth. When the decision must be made at a distance from the facts, we use to accept the suggestion of the cold rationality, avoiding the death of five at the expense of the death of the sixth. But when immersed in the problem, close to the facts, the limbic part of the brain seems to have priority (eminently emotional zone), and we are reluctant to sacrifice that sixth person.

The author, who analyzes the emergence of the human cerebral cortex rationality as something evolutionary, attributes it to the fact that our ancestors did not have the possibility to act at a great distance, due to natural danger the were exposed. The cortex, which would have been the result of a process of vulcanisation of the brain, has generated a technological system that has exceeded our emotional capacity. It is a very complicated task to produce a nuclear device, but it is very simple to press a button to throw it. This could imply that the evolution of the human being has led to a crossroads difficult to solve because the cerebral cortex has developed, capable of enormous progress that perhaps would not have occurred in the limbic brain, and that would mean, in that case, and that evolution has taken a bite of the apple of Eden.



And to finish with the synthesis of neuroeconomic papers made by Alfredo Navarro, let's analyze now the work entitled Damage to the prefrontal cortex increases utilitarian moral judgments, where its authors (Michael Koenings, Liane Young, Ralph Adolphs, Daniel Tranel, Fiery

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Cushman, Marc Hauser and Antonio Damasio[xix]) analyze whether emotions play a causal role in ethical judgments, and how different areas of the brain contribute to that end. They analyze the behavior of six patients who present lesions in the ventromedial prefrontal cortex, (a region of the brain necessary for the control of emotions, and particularly of social emotions), which have an extremely utilitarian behavior when deciding on moral dilemmas. This type of work illustrates the manner in which damage to the brain can be an alternative manner of studying its functioning.

The research described above constitute only a small sample, in order to illustrate the manner in which neuroeconomists work, but there are many other interesting works, which we will not detail in this work for reasons of extension. However, with all those seen in this chapter, we have enough to make a partial assessment of the topic: most of the studies that are being done in Neuro - organisational economic behaviour (NOEB) to date, almost almanners aim to identify the components of rationality and emotionality that are behind of each economic decision, as if trying to tell traditional theorists, linked to the maximizing and hyper-rationalist models currently in force.

In short, Neuro - organisational economic behaviour (NOEB) is unleashing a theoretical discussion that brings them, and that surely will reach high decibels in the coming decades, no doubt.

Risk and Uncertainty

Following with concrete research results, we will mention the conclusions of other influential neuroeconomic papers. In The Neural Basis of Financial Risk Taking, Kuhnen and Knutson[xx] tell us that financial investors systematically deviate from rationality when making their portfolio decisions, and in this manner, 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;
- 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 manner, they conclude that taking into account anticipatory neural mechanisms can add predictive power to the rational decision model of neoclassical psycho - economics, which evidently remains in shame in the face of empirical evidence.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 correspondingly, react - in situations with a certain degree of risk and uncertainty - on an emotional level, and such emotional reactions can greatly affect their behavior.

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 recognises - 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 currency 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 behaviors 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

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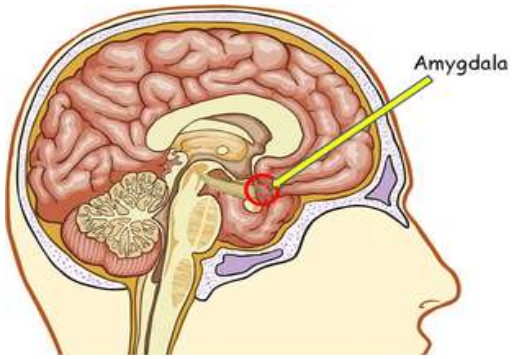
indicate potential threat and responds to inputs from both automatic and controlled processes in our brain. However, the amygdala correspondingly, receives stimuli from the cerebral cortex (the most rational part of the brain), which can moderate or even eliminate the emotional response.



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 almanners 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 correspondingly, 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[xxi] found greater activation of the frontal insula and the amygdala (both eminently emotional zones) when people faced ambiguous choices (uncertainty) compared to risky ones.Once 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 philosophy, argue Camerer, Loewestein and Prelec in his aforementioned paper[xxii]. And they add that, if the current philosophy 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.

Game Philosophyand Neuro - Organisational Economic behaviour (NOEB)

Game philosophy 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 behavior of individuals in games. Apparently different types of interaction may, in fact, present similar incentive structures and, therefore, jointly represent the same game.

While psycho - economics was one of its first applications (especially for oligopolistic markets), game philosophy 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 Neuman and Oskar Morgestern, before and during the Cold War, mainly due to its application to military strategy. Since the seventies, game philosophy has been applied to animal behavior, 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 philosophy has been used in political science, ethics and philosophy. Finally, it has correspondingly, attracted the attention of computer researchers, using artificial intelligence and cybernetics.

But punctually in the field of psycho - economics, Neurosciences in general and Neuro - organisational economic behaviour (NOEB) in particular are already well equipped to explore the main assumptions upon which the predictions of game philosophy 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 correspondingly, knowing how other people think you think, is critical in predicting other people's behavior. Nowadays, many neuroscientists think that in the human brain there is an area specialized in mind reading (correspondingly, called Philosophy of

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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 behaviors for the common people.

McCabe and others[xxiii] 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. Correspondingly, interesting is the research by Tania Singer and others[xxiv], who reported an important link between reward and behavior 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 - correspondingly, 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 Neuro - organisational economic behaviour (NOEB) and Philosophy of Games, the Argentine economist Alfredo Navarro[xxv] tells us that, apart from the importance that Neurosciences have for Psycho - economics -in particular to redefine the rationality hypothesis-, it is correspondingly, important to keep in mind that there is a mechanism to export economic methodologies to neuroscience and biology, giving a new perspective to the philosophy of evolution and allowing analyzing the reciprocal behavior of living beings, where Game Philosophy plays a very important role. That is, according to this vision, there would be a round trip: Neurosciences impacting Psycho - economics, which gives rise to Neuro - organisational economic behaviour (NOEB) (the object of analysis of this work), but correspondingly,, and this is the novelty, Psycho - 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[xxvi], where this round trip between Psycho - economics, Neurosciences and Biology is analyzed.

Paul Glimcher, who comes from the field of medicine, not psycho - economics, in a recent work entitled: Decisions, Uncertainty and the Brain. The Science of Neuro - organisational economic behaviour (NOEB), analyzes the behavior 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 behavior of living beings in general and of humans in particular. Glimcher, after reviewing the ideas about the nature of human behavior of Hippocrates, Galen, Harvey, Bacon and Galileo among others, considers Descartes (1596-1650) as the founder of neuroscience. Divide human behavior 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 behavior could be seen as the product of pure physical interactions in physiological systems.But, the complex behaviors 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 behavior 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 behavior, 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 behavior of living beings with the same purpose of predicting their behavior? 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 behaviors and complex behaviors, not deterministic. Subsequently Pavlov generalized the analysis of reflexes to the totality of

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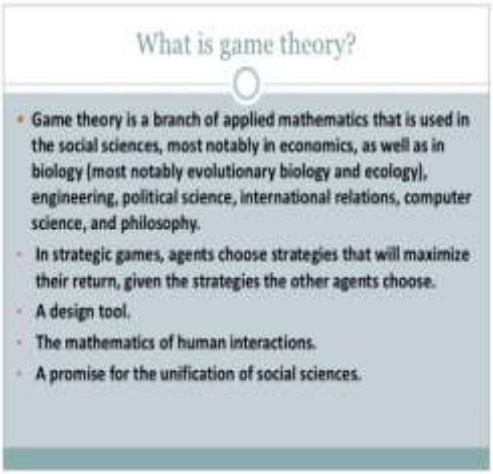
human behavior and therefore correspondingly, generalized determinism to all human behavior.

Several reactions against the Sherrington paradigm took place, especially that of Marr, who in the seventies proposed a different hypothesis: behaviors 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 philosophy of probabilities, since we rarely have a total knowledge of the circumstances around us. Although the philosophy of probabilities was born in the eighteenth century with Pascal and Bayes, three centuries pass until it is incorporated into human behavior, both in psycho - economics and in neurobiology.

In this manner Glimcher, through his historical analysis, presents a manner to analyze the behavior of organisms from two different perspectives: simple behaviors, in the Cartesian division, can be solved by applying classical economic philosophy, 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 behaviors, we must resort to the philosophy of games, to analyze behaviors that are unpredictable, not because epistemologically we do not reach knowledge to explain the causes of behavior, 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 philosophy explains not only human behavior, but the behavior of all beings belonging to the animal kingdom, and not only economic behavior, but all kinds of behavior, 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 behavior and gain an advantage from it.In this manner, following the reasoning of the neurobiologist Glimcher, the analysis of the behavior of living organisms can be understood much more fully if we do so from the perspective of game philosophy, 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 behavior 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 behavior, and another that derives from the need to follow a random behavior.

Suppose a lion is in front of a lamb. You can jump to the right or to the left, trying to guess the behavior of the lamb. Suppose that it can correspondingly, jump to the right or to the left. If it jumps in the same direction as the lion, it is lost, but if it does it in a different direction, it can be saved. If he jumped in the same direction, the lion would know in advance what his behavior would be, and he would be lost. But if he tossed a coin into the air to make his choice, he would be saved, for example, 50% of the time, all on condition that the lion does not know in advance what he is going to do. Therefore, random behavior is essential to pursue what has been defined above as inclusive fitness.



In this manner, the mentioned Glimcher reaches its conclusion[xxvii], in the sense that:

We should begin to employ probabilistically based approaches to understand how the brain takes information from the outside

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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 psycho - economics, biology and neuroscience. The central challenge facing neural scientist is to link behavior and brain…

Psycho - 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. Behavioral ecologist recognises this; their field is focused on the study of how animals approximate economically defined goals with regard to the maximization of inclusive fitness. Experimental psycho - economicsrecognise this; their field is focused on the study of how economic behavior approximate economically defined goals with regard to the maximization of utility. Neurobiologist are correspondingly, beginning to recognise this, and today it seems natural to assume that some form of Neuro - organisational economic behaviour (NOEB) 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 psycho - 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 Philosophy, is a very useful resource to understand the behavior of a large part of living beings, and not only of companies in their economic interactions (such as the philosophy of the oligopoly).

IntertemporalDecisions

Economic analysis defines intertemporal decisions as those with consequences over multiple periods of time, including a wide range of decisions, of varying degrees of complexity and frequency, such as investments in real and financial assets, savings for retirement, purchases with credit cards, purchases of merchandise for the home in advance, etc.

Traditional Philosophy

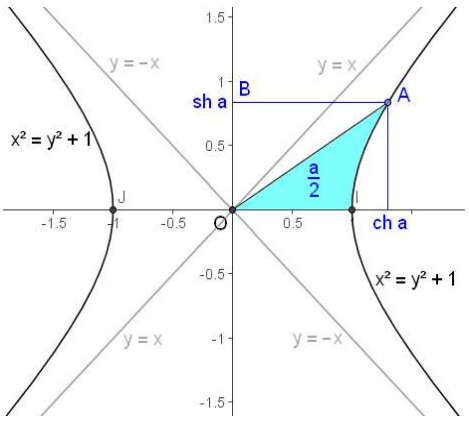
To study and model intertemporal decisions, traditional psycho - economics has generally used the philosophy of discounted utility, based on the idea that economic agents prefer a similar reward more if it is obtained in the present than in the future; and similarly, future costs would be less painful than the costs to be faced.To formulate these theories, models have been generally used based on the assumption that the total utility of a series of rewards and / or costs over time can be decomposed into a weighted sum (or integral) of utility flows in each period of time. .

A particular case is the function of exponential discount, which has as its main characteristic that the discount rate is independent of the passage of time, and consequently, the evaluation of a course of action towards the future (project) is independent of the moment in which the project is analyzed. This property of decisions is called dynamic consistency.However, the problem with this exponential model is that it cannot explain several empirical regularities, that is, it would be incompatible with reality in certain cases. In fact, several field studies show that discount functions decline at a faster rate in the short than in the long term, that is, people are more impatient when they make short-term exchanges (today vs tomorrow), than when they make exchanges in the long term (day 100 vs day 101).

To illustrate, the empirical evidence suggests that if a person is given $ 100 to choose now or $ 110 tomorrow, he may prefer $ 100 now, while the same person may choose $ 100 in two years or $ 110 in two years and one day, he could prefer $ 110 in two years and one day. It seems then that discount rates tend to be higher in the short term than in the long term.

Alternative Approaches

At present, some economists familiar with the neuro have studied alternatives to exponential discount functions. The generalized hyperbolic function has the property of declining at a higher rate in the short term than in the long term, adjusting the cases of inconsistent decisions. Ainslie (1992)[xxviii] and Loewenstein and Prelec (1992)[xxix] have used this type of function in their studies.



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Another highly studied discount function is correspondingly, the quasi-hyperbolic discount function, which correspondingly, captures the property that the short-term discount rate is high and the long-term discount rate is low. The quasi-hyperbolic equation is generally referred to as the function biased to the present and was first proposed to model the planning of the transfer of wealth between generations, and then applied to an individual scale by David Laibson (1997)[xxx] in the model of the golden eggs to study intrapersonal financial decisions.

These models would better capture the dynamic inconsistency of the preferences, that is, the idea that the passage of time changes the preferences of the agents and, consequently, projects that can be positive evaluated with some initial time perspective can be turn negative if they are evaluated from other time perspective.
Correspondingly, models of dynamic inconsistency have been used to study problems of self-control: credit card expenses, drug addictions, etc.

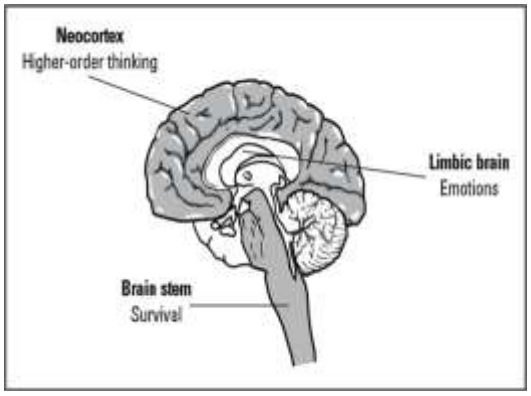
Neuro Fundamentals

As noted above, the quasi-hyperbolic function of discounting time provides a good fit to experimental behavioral data, however few studies have focused their analysis on identifying the causes of this tension between short-term and long-term preferences. Then the following questions arise:

- What is the mechanism behind these intertemporal decisions?
- Do they arise from a single preference mechanism or from multiple systems that interact?

In an attempt to answer these questions, Samuel McLure, David Laibson, George Loewenstein and Jonathan Cohen[xxxi], using functional magnetic resonance imaging (fMRI), examined the neural correlate of time discount while subjects made choices between monetary reward options that varied across time.The experiment consisted of giving the participants a choice between a sum in the short term and another in the long term, the first being less than the second. Both options were separated by a minimum time lag of two weeks, and in some pairs of options, the earliest option was immediately available.The hypothesis was that the behavior pattern of the two parameters (β and δ) arises from the joint influence of different neural processes. The β related to the limbic system and the δ related to the lateral prefrontal cortex and other structures associated with higher cognitive functions (the more rational ones).
What results did the researchers obtain? Basically, there would be two systems involved in such intertemporal decisions:

- Parts of the limbic system (emotional zone of the brain) associated with the dopamine system of the central brain, including the paralimbic cortex, which would be triggered by decisions involving immediately available rewards;
- Regions of the lateral prefrontal cortex and the posterior parietal cortex (eminently rational areas of the brain), uniformly involved in intertemporal decisions independently of the delay in time.



This neuroeconomic finding is consistent with the evidence that consumers act impatient today but prefer to act patients in the future, correspondingly, supporting the hypothesis that different neuronal systems are activated by intertemporal decisions: the impatience of the short term, which is driven by the limbic system (emotional, not deliberative), and that responds preferably to immediate rewards and to a lesser extent to future rewards; and long-term patience, dominated by the lateral prefrontal cortex and associated structures (the most deliberative parts of our brain), which can rationally evaluate exchanges between abstract rewards, including rewards over longer periods.Finally, we believe that future

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research should better assess what kind of discount functions are ideal for predicting real-world economic decisions, and generally improve methods for measuring intertemporal decisions, where Neuro - organisational economic behaviour (NOEB) will undoubtedly play an important role.

Glimcher'sTwoStagesModel

Paul Glimcher, maybe the most important neuroeconomist of the planet at present, from his laboratory at New York University, has made numerous experiments and collected a huge empirical evidence about studies done in other parts of the world, which has allowed him to condense all this material into an interesting theoretical model, published at initial version in 2009[xxxii], then reactualized, where it is hypothesized about the true functioning of the human brain when making decisions. Here is a summary of his model, which in turn is a brief summary of much what it is known in Neuro - organisational economic behaviour (NOEB) so far:

- This model of Glimcher is called two-stage, because on the one hand, the assessment aspect of decision alternatives is analyzed (something similar to the utility that people give to each object or possible action) -THE VALUATION MAP- and on the other, the concrete decision to be taken is analyzed, that is, the reason for the selection of a single one (among several alternatives) and its subsequent execution -TODAY DECISION-;
- To give a simple example, in the ASSESSMENT STAGE, the model describes the neuropsychological circuits through which human beings value the alternatives A, B, C, D and E that we have for a given course of action (for example where to go on vacation next summer), that is, something similar to the utility (the economic concept) that we give to each alternative in the neoclassical model; whereas in the DECISION STAGE, the model describes in what manner (brain circuits that are activated) we end up choosing the supposed best alternative, say A, to go on vacation;

The assessment stage has been studied in more detail and depth in recent times, not so much the decision stage, which in humans is a bit delayed (but not in other mammals, such as monkeys), mainly due to the fact that (in humans) the temporal dynamics of the selection and execution of a given course of action today is difficult to follow via neuroimaging (fMRI);

- In any case, the aforementioned two systems or stages, valoration and decision, would not be watertight behavior, since there is some empirical evidence that some characteristics of our valuation process (our preference function) are intrinsically attributable to mechanical processes linked to the decision stage;
- In another interesting feature, today a high number of studies shows that certain areas of the ventral striatum and the frontal cortex learn and represent valuations (preferences) even when learning is passive, that is, even when the person is not faced with an action or specific object on which he has to decide;
- The values (preferences) assigned to objects and actions would be learned by means of trial and error, where the dopaminergic neurons of our mid-brain would play a fundamental role, through the concept of the reward prediction error (the difference between the expected reward of a given course of action and the one actually achieved), an error that would be narrowing down more and more thanks to the aforementioned learning;
- The decision system involves large portions of our parietal cortex, among others; that in turn receive direct and indirect projections from the areas of the ASSESSMENT SYSTEM, and, once the decision has been made, the process is projected directly towards the MOVEMENT CONTROL AREAS, for the concrete execution of the decision;
- In a fact that is quite limiting for those theorists on welfare issues, in Neurosciences today we know a lot about the neuronal circuits involved in the aspects of evaluation of alternatives, only one little about making concrete decisions, but almost nothing about the neural circuits that act in what is called a person's sense of well-being; since as we all know, not necessarily the fact of consuming (even though there is a sharp process of weighing rewards and punishments, or costs and benefits) leads us safely to a feeling of well-being;
- In something that is very important, in Neuro - organisational economic behaviour (NOEB) the concept of subjective value (VS) is proposed, but in cardinal form, instead of the traditional concept of utility of the traditional philosophy, which is ordinal;
- The VS, in this manner, being cardinal, is measured in terms of the rate of firing of neurons -neuronal firing rates- that occurs in certain areas of the brain before the perception of each object or alternative action to choose (for example the options A, B, C, D and E to go on vacation), where the researchers analyze

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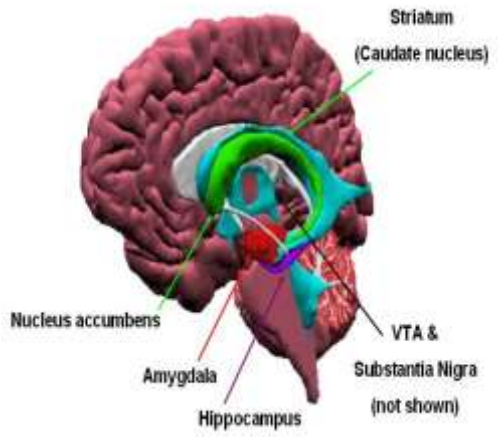
said neuronal ignition from the scan of our brain, via neuroimaging;

- The choice of the final alternative when making a decision (the alternative A to go on vacation), would be given after comparing the relative VS between the different options, after a fouling of the process by noise;
- The reward prediction error -RPE- of a chosen alternative would be given by the difference between the expected VS and the VS obtained when making the decision (for example, alternative A to go on vacation); and through the delimitation of said RPE is how our brain would improve its rating system, in this manner, it is getting less and less wrong;
- The empirical evidence (and working hypotheses) available today suggest that two brain areas seem to contain all the neurons required to extract VS for any object and action: the ventral striatum (member of the limbic-emotional brain) and the middle prefrontal cortex, and in particular the ventral striatum for actions and the middle prefrontal cortex for objects;
- But one thing is the extraction of SV (that is, granting value to options A, B, C, D and E before making the decision) and another one its storage (once the decision to choose A has been made), the purposes of being used in subsequent decisions;



- In this manner, the sv calculated in the areas mentioned in the previous item would be stored in a much wider area than the ventral striatum and the middle prefrontal cortex, which we had seen almost exclusively involved when sv is granted for the first time to an option;
- Which would lead to the conclusion that when an sv (already stored) is represented in our brain (for example, when deciding where to go on vacation next year, not this year), it would reflect activity in areas such as the lower frontal sulcus, the insula, the amygdala, the posterior cingulate, the superior temporal sulcus, the caudate nucleus, the putamen, and the dorsolateral prefrontal cortex, and obviously the ventral striatum and the middle prefrontal cortex; that is, a much wider area than the participant in the initial assessment of the option;
- However, and in what is a current limitation of neuro - organisational economic behaviour (NOEB), the details (i.e. The how, not only the where) of this assessment process -assignment of vs to objects and actions- are just beginning to be understood, since they are difficult to reach via neuroimaging;
- Going to the decision stage, and as we said at the beginning, it is much less studied than the stage of evaluation, almanners speaking of human beings, not of other mammals, like monkeys, where the empirical evidence is much greater;
- In the decision stage, the neurons of the lateral intraparietal area (lip) would seem to play a fundamental role, since they would be responsible for representing the relative vs of each decision alternative (the a, b, c, d and e of our example of holidays);
- Remember that the vs of each alternative comes from the assessment stage, and arose basically from the neuronal activity of two specific areas: the ventral striatum and the middle prefrontal cortex; but in the decision stage, the absolute vs of each alternative decision would be transformed into relative vs, and this would occur first in the posterior parietal cortex and then be represented in the lip area;
- As in the assessment stage, in the decision stage there is correspondingly, internal brain noise, which affects the quality of decision-making;
- At a certain moment, the set of available options (a, b, c, d and e, with their respective absolute and relative vs) converge to a single alternative, the one chosen (alternative a), which would occur when collicular neurons they exceed their trigger threshold;
- In what is a very important current limitation, it should be mentioned that the majority of these studies on the decision stage revolve

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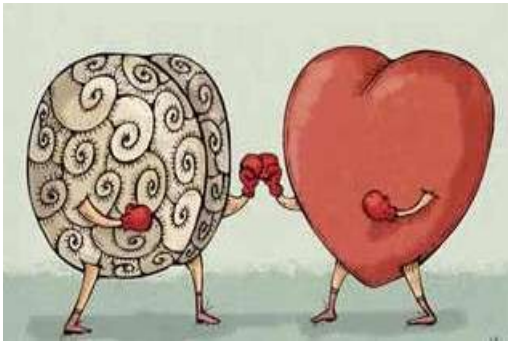
around monkeys, and in particular decisions made through generation of movements through the eye, which is not the only possible alternative to generate movements. However, almanners according to Glimcher, there is some empirical evidence that this type of brain structures would correspondingly, operate for decisions on more abstract objects than those that a monkey can usually choose (and which are more usual in humans); and less evidence that it would correspondingly, operate for structures that generate movements other than the eye, in both monkeys and humans; clarifying that the lesser evidence available is temporarily, especially with the advances that are coming in neuroimaging.

Single or Dual System?

To finish with this impressive model, and as we said at the beginning, Glimcher polemizes with Kahneman and affirms that the output of the assessment stage is not only input of the DECISION STAGE, but correspondingly, the reverse path would be observed, since there would be numerous decision circuits interconnected with important areas of assessment, such as the aforementioned frontal cortex and basal ganglia; that is, the process would not be linear or additive, but rather more complex, but unitary.In fact, Glimcher, at the end of the exhibition of his model, attacked fellow neuroeconomists and behaviorists, such as Nobel Prize winner Kahneman, Laibson or Mc Lure, who proposed the existence of two relatively independent systems that would regulate decision-making, one associated with the emotional (the limbic area) and the other more rational (some of frontal and parietal cortex).

To be more specific, Glimcher criticizes the multiple ego rationality models, which generally describe the area comprised by the basal ganglia and the prefrontal mid cortex as an emotional module, which interacts (additively) with a second system organised around the posterior parietal cortex and the dorsolateral prefrontal cortex, which would form a rational module. The mentioned Glimcher indicates that, for example, it would be relatively proven (in monkeys) that neural activity in the posterior parietal cortex (eminently rational) would predict preferences (supposedly generated in emotional areas), under all the conditions that have been studied (immediate reward, future reward, large and small rewards and rewards of high and low probability).And later Glimcher mentions a lot more empirical evidence, that together, they would be showing a structure globally involved in valuation activities (STAGE OF ASSESSMENT) and not a structure managed exclusively by emotionality;

Of course, concludes Glimcher, the emotions truly influence our decision-making, especially in the assessment stage, but in no manner would there be multiple selves, that is, the emotional on the one hand determining valuations (utilities) of objects and actions, and the rational on the other side, deciding which is the best option and giving the order to execute. Andhere it is convenient to cite the criticism of Kahneman[xxxiii], the Nobel Prize in Behavioral Psycho - economics, who does not believe that the evidence cited by Glimcher is conclusive to invalidate the argument that decision-making emerges from a conflict between emotions and reason; the opposite of the unitary system proposed by Glimcher;



In fact, according to Kahneman, there would be important behavioral evidence (more grounded in psychology than Neurosciences) about the existence of multiple selves in our psyche, and the importance of conflict; however, he concludes that more empirical evidence is needed from Neurosciences to define the winner of this debate; that is to say, it does not attack in definitive form against the Glimcher model, which is logical, since the evidence in Neuroscience is superior to the psychological one;

Finally, Glimcher acknowledges that there are still important aspects to better specify in his model, basically due to lack of empirical evidence, especially in the DECISION STAGE, since we remember that Neuro - organisational economic behaviour (NOEB) is just touching the decade of life and can still be improved a lot plus the instruments available to open our black box.

In summary, the neuropsychological system that sustains our decision making would seem to be a little bit more complex than the simplified version of neoclassical psycho - economics, based on ordinal utility curves, faced with the restriction of the income of each

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consumer, to be able to determine what quantities are consumed of each good and service, deriving from this model the respective demand curves of each of them.

Comparison: Ordinal and cardinal approach

Ordinal Utility	Cardinal Utility
Consumption can't be measured	Consumption can be measured
Utility is used for grading/ranking of the products depending on the preferences of the consumer	Uses utils which help in understanding how much utility is derived from consumption of a product.
Much less compared	Comparative study
Conceptual and practical	Preceded the ordinal approach
Convex function	Concave function
Qualitative measure	Quantitative measure

Undoubtedly this neoclassical model, which is simple and unreal, has been enormously useful for doing science, as we will see in the next chapter, where we analyze whether Neuro - organisational economic behaviour (NOEB) could imply a paradigm shift or not. However, through this model of Glimcher, we have been able to appreciate that today we can measure (via neuroimaging) the true utility that each person obtains from each good or service, the so-called SV (subjective value), which would be observed in our brains depending on the degree of neuronal firing rate, which is generated when we perceive and evaluate said good or service to acquire it or not; and correspondingly, that said utility or VS would be cardinal, not ordinal, and that it learns, that is, it would improve day by day thanks to our neuronal plasticity. That is, before this new empirical evidence, will continue maintaining the old neoclassical models?

Basal Ganglia and Aversion to Change: Criticism to the Extreme Liberal

Is it good to overprotect companies and institutions to endure? According to the renowned economist Nicholas Taleb, overprotection instead of helping to do something stronger, on the contrary, makes it weaker. Like the overprotected children, those organisations that are deprived of elements of stress, in the long run they become weaker. And although the argument seems indisputable, it has an important neuro contradiction, which we develop below.

For Taleb, antifragility goes beyond resilience or robustness. The resilient resists the blows and remains the same, whereas the antifragile becomes better with the blows. Antifragility becomes strong with randomness, uncertainty, the volatile, the unknown, the incomprehensible and the errors. What does not kill me, makes me stronger, would be a good phrase to exemplify Taleb's concept of antifragility.According to Taleb, organisations (private, public, NGOs) should tend towards less interventionist patterns, where the natural takes its course, and especially, randomness. For him, the environment of organisations is much more complex than what our memory or historical account can tell. In addition, the educational system and the scientific apparatus would be designed, in their vision, to organise all events in a linear manner, simplifying too much.

In this manner, although in nature anti-fragility is the norm, the scientific story rejects antifragility, often preventing interferences with things that it does not understand, confusing the unknown with the non-existent. Impossible to disagree with Taleb in that regard, but of course ... scientists are human beings, flesh and blood like everyone else, whose brains seek assurances and regularities, which limit environmental uncertainty. That is the flaw we notice in Taleb's argument, and on that point is where I want to go deeper.

Habits help us in our daily lives, because they allow us not to have to decide each of our actions continuously, and thus reduce the consumption of energy in the brain. Constant routines are thus delimited before we get down to work, which saves us time. In this manner, the natural thing is that the brain tends more towards the routine than towards the disorder and change, which implies that it has to be trained to achieve what Taleb proposes (in fact, many international companies today pay onerous training for this type of programs for its executives).In the human brain there is a region that participates notably in the formation of routines and habits, since acquiring a routine requires considerable effort, the brain stores in its memory the template of the habit, to reactivate it at the slightest sign. These patterns are developed and established in the so-called basal ganglia, whose functions are essential in the acquisition of habits, addictions and learning processes.

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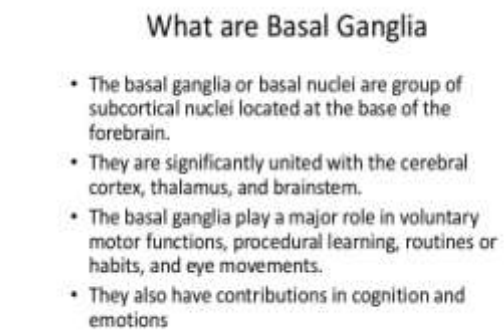

In this manner, habits arise because our brain is trying to save mental effort: these fragments of automatic routines are stored in the basal ganglia, so that when we execute an automatic routine, work the basal ganglia, and the rest of the brain rest, simplifying a little. In other words, the permanent change Taleb poses is unnatural to our brain, unless we train it. The tendency is towards order, rigidity and permanence, and not vice versa; and in the end our institutions are the result of our brain format.Following with his notion of fragile-robust-antifragile, Taleb establishes some comparisons. Curiosity is antifragile, and books have the ability to multiply it. The banking system is fragile, but Silicon Valley, with its permanent innovation, is anti-fragile. Food companies are fragile, restaurants are antifragile. The bureaucrat is fragile, the entrepreneur is antifragile. A person who depends on a salary to live is very dependent on their organisation and very fragile for their level of dependence. An artist is antifragile because of his independence from an employer.

In this manner, Taleb criticizes all types of state interventionism to save sectors and companies in decline, since that undermines the mechanism that generates anti-fragility, necessary for the system to innovate and be increasingly productive. But of course ... the argument collides with a reality: our brains have a natural tendency towards aversion to change, that is, towards what the renowned economist calls fragile. Such a contradiction!

In addition to our natural tendency towards routine and inflexibility, dominated by the basal ganglia in the brain, there is a whole question of errors in our decision-making process, depending on the uncertainty of a complex world (which Taleb describes well), and correspondingly, of our limited ability to analyze all available information (limited rationality of Simon), which enhance the aversion to change of the average human being.In general, Neurosciences seem to indicate that our brain is not designed for outstanding performances in relatively complex decisions, including the brains of people who have studied at the university level. It is known that the human brain has been developing for millions of years, but for most of our history as a civilization it served for people who only covered basic needs: find food, reproduce and defend the territory, not much more than that. It was not until the last 200-300 years that the world became exponentially complex, which has implied the need for refined neural connections for decisions that are increasingly risky and / or uncertain, but correspondingly, a good part of the primitive remnant. Ourbrain'semotionalstate has remainedalmostunchanged.

Paul Glimcher, one of the most reputable neuroeconomists today, argues that the valuations (preferences) we assign to objects and actions would be learned by trial and error, where the dopaminergic neurons of our mid-brain (reward system) would play a fundamental role, through the concept of the reward prediction error (the difference between the expected reward of a given course of action and the one actually achieved), which would be limited by learning. That is, the brain predicts, and is wrong, generating errors, and while they are decreasing with experience, in a world as changing as today, learning is increasingly continuous, and errors too.That is, there are at least two natural tendencies in the opposite direction to Taleb's antifragility: the action of the basal ganglia (our natural tendency to routines and rigidities) and

the computational problems of our brain to predict / decide without mistakes (bounded rationality), in an increasingly complex and changing world.

To conclude, and although we agree with what Taleb raises about the importance of freedom and the search for risks to make robust and anti-fragile people, institutions and psycho - economics as a whole, it is a difficult proposal to apply for mental models' humans have today, and that, in the end, determines our behavior.The question is why people, institutions and society tend to fall into rigidities, routines and interventionism, which hinders the dynamism that Taleb mentions as necessary for success, innovation and productivity. And the answer goes through our brain: the human being seeks assurances, low risks, conventions and other rigidities that reassure him and give him certain equilibria that flexibility and permanent randomness do not give him. In the background, our brain functioning is the result of thousands of years of adaptation of human life to the environment where he lives, with a prominent role to the basal ganglia to build routines and other rigidity that reassure us in the face of so much systemic uncertainty. Adapted brains for permanent change are the minority (and you have to train them), the norm is the routine.

Good book that of Taleb, but with that deep contradiction: it raises certain libertarian conducts as desirable for our modern societies, when our brains, human nature and institutions have adapted to the world doing just the opposite, creating routines and rigidities that moderate the increased environmental uncertainty. The natural tendency of the human being is to seek order, and not disorder; our brains are wired that manner, not other manner round. That is perhaps the main reason why governments gets so much into psycho - economics to temper the changes, our brains seek gradualism, not shock, although that disgusts the most liberal-free traders.

Notions in Neurofinance

In an effort to seek better foundations on financial decision making, and using the current boom of Cognitive Neuroscience, a modern area of study has emerged, the Neurofinances, where the use of magnetic resonance images, with people during real risky investment situations (or bets), is essential.For example, today Neurosciences show that the circumstances that accompany a decision to bet / invest currency are seldom independent of the investment / bet itself. The oscillations of stock markets, or the constant variability of betting games (horses, casino, etc.), have a significant impact on the amount of risk that people are willing to take, increasing it.

In this manner, observations by brain scanner indicate that the increase in risk taking in bets / investments would be correlated with the emotional reaction caused by being an individual immersed in a situation of volatile bets, which makes the reflective-deliberative activity decrease.Additionally, and correspondingly, from Neurosciences, today it is quite clear that the financial choices we make are influenced by our previous experiences, forming what are called somatic markers. The hypothesis of somatic marker, owed to the Portuguese neurologist Antonio Damasio, proposed a manner to explain how emotions affect when making complex decisions (including financial investments).

According to Damasio, our previous experiences make us store in the brain a series of sensations (muscular and hormonal responses) pleasant or unpleasant related to certain stimuli. This relationship between stimulus and emotional state is what is called a somatic marker. Faced with the task of making an investment decision in a context of risk or uncertainty, a stimulus similar to that of previous experiences would trigger in our body the release of a certain somatic marker.

Thus, the options we opt for are those associated with pleasant somatic markers, and we avoid those that the somatic marker associates with adverse results. This process greatly accelerates decision making, being a kind of shortcut for the brain, in order to avoid investing excessive deliberative resources in making decisions that require a rapid response. Needless to say, that in matters of financial decisions in stock markets (or in casinos and places of betting), immediacy is permanent, and these cerebral shortcuts, then, become very useful.

Loss Aversion

An interesting concept, from the hand of NOEBel Laureates Kahneman and Tversky, explains the concept of aversion to loss, i.e. the idea that the losses of an amount x make us proportionally more damage than the happiness produced by the profits of that same amount x. That is, it would be more than proportional the pain for the loss of $ 500, than the happiness for winning $ 500.

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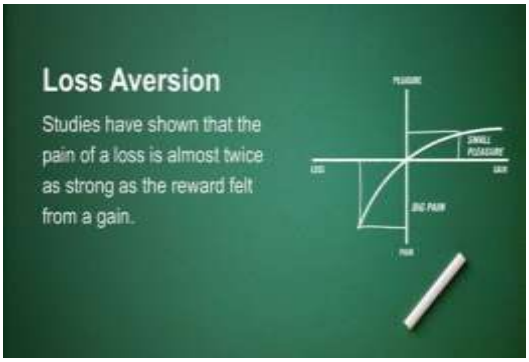


Financial losses are processed in parts of the brain that are responsible for the pain network. One of these areas is the amygdala (the center of fear). For example, patients with this area damaged are proven not to be afraid of losses and often take high financial risks, which normal people do not.

IrrationalInvestors?

There are many aspects of life in which we make mistakes in making decisions, even sometimes very rude. It is proven that, even in areas where we have some experience, we often stumble from time to time, almost inexplicably. According to many economists, in the world of financial betting (stock markets, casinos, etc.), such repetitive errors are usually abundant, which fuels the debate on how rational investors are when designing their portfolios.

In general, Neurosciences seem to indicate that our brain is not suited for outstanding performances in complex financial decisions, including the brains of people who have studied finance at the university level. It is known that human brain has been developing for millions of years, but for most of our history as a civilization, was adapted for people who only covered basic needs: find food, reproduce and defend the territory, not much more than that. It was not until the last 200-300 years that the world became more complex in an exponential manner, arising, among others, financial decisions in securities markets, which has implied the need for refined neural connections for increasingly risky decisions, but correspondingly,, a good part of the primitive remnant of our brain has remained almost unaltered.

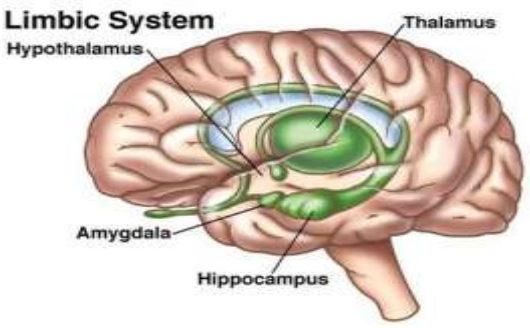
Some think that if some investors are too optimistic and others are too pessimistic at the same time, the market should be able to find its middle ground, compensating, and tending towards rationality on average. However, the empirical evidence in Finance seems to show that individual investment errors tend to move in the same direction and correspondingly, occur more or less at the same time, that is, it is not that irrational investors would be losing currency against arbitrageurs more rational, but that the errors, in certain situations, would be generalized (remember the financial panics, with herd behavior, which so often does not rationally justify similar market collapses, or similar bubbles).

That is, it would not be that investors are irrational because they do not know how to calculate future costs and benefits (the most deliberative part of the brain) in controlled situations (a university exam, for example), but that such calculations would cloud, in practice, in environments that are too volatile and risky, generating excessive herd and panic behavior among investors, caused, to a large extent, by brains overly dominated by their more primitive roots (the most emotional parts).

BrainPredicts

It has correspondingly, been discovered that the brain works with predictions, contrary to the previously accepted philosophy, that it reacts to sensations it picks up from the outside world. In this manner, human reactions would be just the adaptation of the body to the predictions that the brain makes, based on the state of our body the last time it was in a similar situation (somatic markers).

In this manner, the brain tries to find out what a certain sensation means and what is causing it (for example, a strong downturn in the stock market), to then define what to do with it, and thus build thoughts, feelings, perceptions and decisions, that arrive just when it is necessary, and not a second later, but of course, with errors of prediction and biases, which make such decisions may be unsuccessful several times, until the learning improves the perception, and the subsequent action.



And in this process, it is the limbic tissue (the emotional one) that would dominate, and then direct those predictions to the cortex (the most rational part of the brain). For example, when a

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 11 Nov 2021, pp: 381-409 www.ijaem.net ISSN: 2395-5252

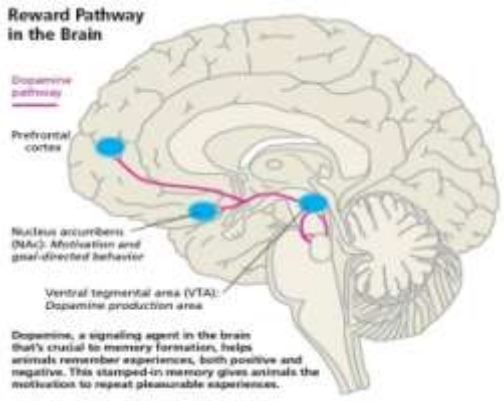
person is told to imagine a red apple in their mind, limbic areas of the brain send predictions to visual neurons and cause them to interconnect and fire in different patterns so that the person can actually see that apple red The reader can change in this example to red apples for papers that are quoted in the stock market, the conclusions are the same.

In this manner, the investors of the market are the architects of their own experiences (somatic markers), which start from the emotional brain, since the limbic regions of the brain send but do not receive predictions. Therefore, our brain would be built so that things work in the reverse of popular knowledge: it is not seeing to believe, but the other manner around, believing to see. That is, the perceived risk of certain private securities (corporate risk), or of certain countries (sovereign risk), would be mental constructions that arise mainly from the emotional part of the brains of market investors (that is, their limbic parts), explaining in large part the reason for so many financial panics, bubbles, overreactions and mistakes in general, so common in modern stock markets.

RewardPrediction Error

Related to the above, Paul Glimcher argues that, in principle, errors arise from an inadequate evaluation of the information available and, in addition, imaginary constructions that do not correspond fully with reality (the predictions we talked about above), overestimating the real possibilities of gambling, or risky financial investments.

Following the aforementioned Glimcher, and as I mentioned in a previous section, in the human brain coexist two systems or stages, one of VALUATION (where alternatives are compared) and another of DECISION (which chooses an alternative over others), that work related, since some characteristics of the valuation process (our function of preferences -utility-) would be attributable to mechanical processes intrinsically linked to the decision stage.Within this context, a high number of studies shows that certain areas of the ventral striatum and the frontal cortex learn and represent valuations (preferences) even when learning is passive, that is, even when the person is not before an action or specific item on which you have to decide.



And finally, the valuations (preferences) assigned to objects and actions (for example the portfolios to be inverted) would be learned by means of trial and error, where the dopaminergic neurons of our average brain (reward system) would play a fundamental role, through the concept of reward prediction error (the difference between the expected reward of a given course of action and the one actually achieved), an error that would be limited more and more thanks to the aforementioned learning.

In short, given the relentless pursuit of improvement in financial decision-making, the emergence of Neurofinance are very welcome, since tools are needed to help understand errors, biases and other usual irrationalities in the formation of expectations that then determine the prices of the assets listed on the stock exchange.In any case, these experiments in controlled environments, with observations via neuroimaging and other analysis tools, only help to begin to understand better the underlying brain mechanisms, although not necessarily to correct them, since it is mainly part of the adaptation from our brain to the complexity of the world that surrounds it, and that is achieved little by little, in a process of permanent trial and error.

CONCLUDING

The results of the studies commented throughout this chapter are only some of the many that have been published in recent years, on the actual functioning of human decision-making processes, both in psycho - economics and in management, marketing and other disciplines framed within the so-called economic sciences; and it is our main intention to refer them -beyond the specific knowledge they have contributed- to show how this tool works, that we have available since a relatively short time, and which promises advances that we cannot predict yet, but we believe could

become important and disruptive to what has traditionally been done in Psycho - economics.

As Colin Camerer says[xxxiv], in some aspects the contributions will be incremental, in other radicals, with Neuro - organisational economic behaviour (NOEB) advancing at an accelerated pace, continuing the knocking down of the postulates of Jevons 200 years ago:I hesitate to say that men will ever have the means of measuring directly the feelings of the human heart.

We must get out of the Friedmanian comfort of the irrelevance of assumptions and go to challenge everything we have been saying so far, where some postulates will remain almost unchanged, and others will change, but what is certain is that many economists, in the next few years, are going to study how the brain and our rationality really works, until convince themselves that the maximizing models that we have been using up to now are extremely limited, in light of the new empirical evidence provided by Cognitive Neurosciences.

[i] Http://Racionalidadltda.Wordpress.Com/2013/05/26/La-Paradoja-De-Allais/

[ii] Excerpted From: Http://Policonomics.Com/En/Paradoja-Allais/

[iii] Camerer, Loewestein And Prelec (2005); Neuropsycho - Economics: How Neuroscience Can Inform Psycho - Economics; Journal Of Psycho - Economics Literature, Vol. XLIII, N°1.

[iv] López, Ernesto, We All Have Our Quarter Of An Hour: Behavioral Psycho - Economics, Neuropsycho - Economics And Its Implications For Consumer Protection, Mimeo, Year 2005, INDECOPI, P. 114-116.

[v] BARBER, B. And T. ODEAN (2001). Boys Will Be Boys: Gender, Overconfidence And Common Stock Investment, The Quarterly Journal Of Psycho - Economics.

[vi] Sanfey, Rilling, Cohen And Others, The Neural Basis Of Economic Decision Making In The Ultimatum Game, In Science Magazine, June 2003.

[vii] Knutson, Loewenstein And Others, Neural Predictors Of Purchases, In Revista Neuron, January 2007.

[viii] Sanfey, Rilling, Cohen And Others, The Neural Correlates Of Theory Of Mind Within Interpersonal Interactions, In Science Direct Magazine, 2004.

[ix] Sanfey Et Al, The Neural Basis Of Economic Decision Making In The Ultimatum Game, In Science Magazine, June 2003.

[x] Zak And Fakhar, Neuroactive Hormones And Interpersonal Trust: International Evidence, Elsevier, 2006.

[xi] Lavín, Claudio, Emotions And Decision: Somatic Markers, Year 2008, Published In The Blog Www.Neuroeconomia.Cl

[xii] Denburg, Natalie L., Psychophysiological Anticipation Of Positive Outcomes Promotes Advantageous Decision-Making In Normal Older Persons, Elsevier, 2006.

[xiii] Carstensen, L.L., Issacowitz, D.M., Charles, S.T., 1999, Taking Time Seriously: A Theory Of Socioemotional Selectivity, American Psychologist 54, 165-181.

[xiv] Aharon, Itzhak, Nancy Etcoff, Dan Ariely, Chris F. Chabris, Ethan O'Connor, And Hans C. Breiter. 2001. Beautiful Faces Have A Variable Reward Value: Fmri And Behavioral Evidence. Neuron, 32 (3): 537-51. Mobbs, Dean, Michael D. Greicius, Eiman Abdel-Azim, Vinod Menon, And Allan L. Reiss. 2003. Humor Modulates The Mesolimbic Reward Centers. Neuron. Erk, Suzanne, Manfred Spitzer, Arthur P. Wunderlich, Lars Galley, And Henrik Walter. 2002. Cultural Objects Modulate Reverse Circuitry. Neuroreport. Schultz, Wolfram. 2002. Getting Formal With Dopamine And Reward. Neuron. Breiter, Hans C., I. Aharon, Daniel Kahneman, A. Dale, And Peter Shizgal. 2001. Functional Imaging Of Neural Responses To Expectancy And Experience Of Monetary Gains And Losses. Neuron. Knutson, Brian And Richard Peterson. In Press. Neurally

Reconstructing Expected Utility. Games And Economic Behavior. Delgado, Mauricio R., Leigh E. Nystrom, C. Fissell, D. C. Noll, And Julie A. Fiez. 2000. Tracking The Hemodynamic Responses To Reward And Punishment In The Striatum. Journal Of Neurophysiology.

[xv]Navarro, Alfredo Martín, De Schant, Fermín And Martín, Jorge Marcelo, NEUROECONOMY AND METHODOLOGY: SOME INITIAL REFLECTIONS, Mimeo, Year 2007, P. 23-25.

[xvi] Loewenstein, G. And O'Donoghue, T. (2004). Animal Spirits: Affective And Deliberative Influences On Economic Behavior. Working Paper.

[xvii] Navarro, Alfredo Martín, De Schant, Fermín And Martín, Jorge Marcelo, NEUROECONOMY AND METHODOLOGY: SOME INITIAL REFLECTIONS, Mimeo, 2007.

[xviii] Cohen, J. (2005), The Vulcanization Of The Human Brain, Journal Of Economic Perspectives, Vol 19. No. 4.

[xix] Koenigs, M., Young, L., Adolph, R., Tranel, D., Cushman, F., Hauser, M., Damasio, A. (2007) Damage To The Prefrontal Cortex Increases Utilitarian Moral Judgemets. Nature, Vol 446.

[xx] Kuhnen, C. And Knutson, B. (2005), The Neural Basis Of Financial Risk Taking, Neuron. September.

[xxi] Hsu, Ming; Camerer, Colin And Others; 2005, Ambiguity Aversion In The Brain: FMRI And Lesion Patient Evidence., Caltech Working Paper.

[xxii] Camerer, C., Loewenstein, G. And Prelec, D. (2005), Neuropsycho - Economics: How Neuroscience Can Inform Psycho - Economics, Journal Of Economic Literature. Vol. XLIII. N° 1.

[xxiii] Mccabe, K., Houser, D., Ryan, L., Smith, V. And Trouard, T. (2001) A Functional Imaging Study Of Cooperation In Two Person Reciprocal Exchange. Proceedings Of The National Academy Of Sciences Of The United States Of America, Www.Pnas.Org/Cgi/Doi/10.1073/Pnas211415698

[xxiv] Singer, Tania, Kiebel, Stefan And Others, 2004, Brain Responses To The Acquired Moral Status Of Faces, Neuron, 41 (4): 653-62.

[xxv] Alfredo Navarro, Neuropsycho - Economics And Game Theory. Methodological Implications, Mimeo (2007). The Author Is A Full Member Of The National Academy Of Economic Sciences.

[xxvi] Glimcher, P. (2003), Decisions, Uncertainty And The Brain. The Science Of Neuropsycho - Economics, Cambridge, Mass.: The MIT Press.

[xxvii] Glimcher (2003), Decisions, Uncertainty And The Brain. The Science Of Neuropsycho - Economics, Cambridge, Massachussets: The MIT Press, P. 321.

[xxviii] Anslie, G. (1992), Psychopsycho - Economics, New York: Cambrigde University Press.

[xxix] Loewestein G. And Prelec D. (1992) Anomalies In Intertemporal Choice: Evidence And An Interpretation. Quaterly Journal Of Econnomics, 107, 573-957.

[xxx]Laibson. D. (1997), Golden Eggs And Hyperbolic Discounting. Quaterly Journal Of Psycho - Economics, 112, 443-477.

[xxxi]Mc Lure, Samuel, David Laibson, George Loewenstein And Jonathan Cohen, Separate Neural System Value Immediate And Delayed Monetary Rewards, Science, October 2004

[xxxii]Glimcher P., Choice: Towards To Standard Back Pocket Model, Included In Neuropsycho - Economics, Decision Making And The Brain, Elsevier, 2009.

[xxxiii]Kahneman D., Remarks On Neuropsycho - Economics, Included In Neuropsycho - Economics, Decision Making And The Brain, Elsevier, 2009.

[xxxiv] Camerer, C., Loewenstein, G. And Prelec, D. (2005), Neuropsycho - Economics: How Neuroscience Can Inform Psycho - Economics, Journal Of Economic Literature. Vol. XLIII. No. 1