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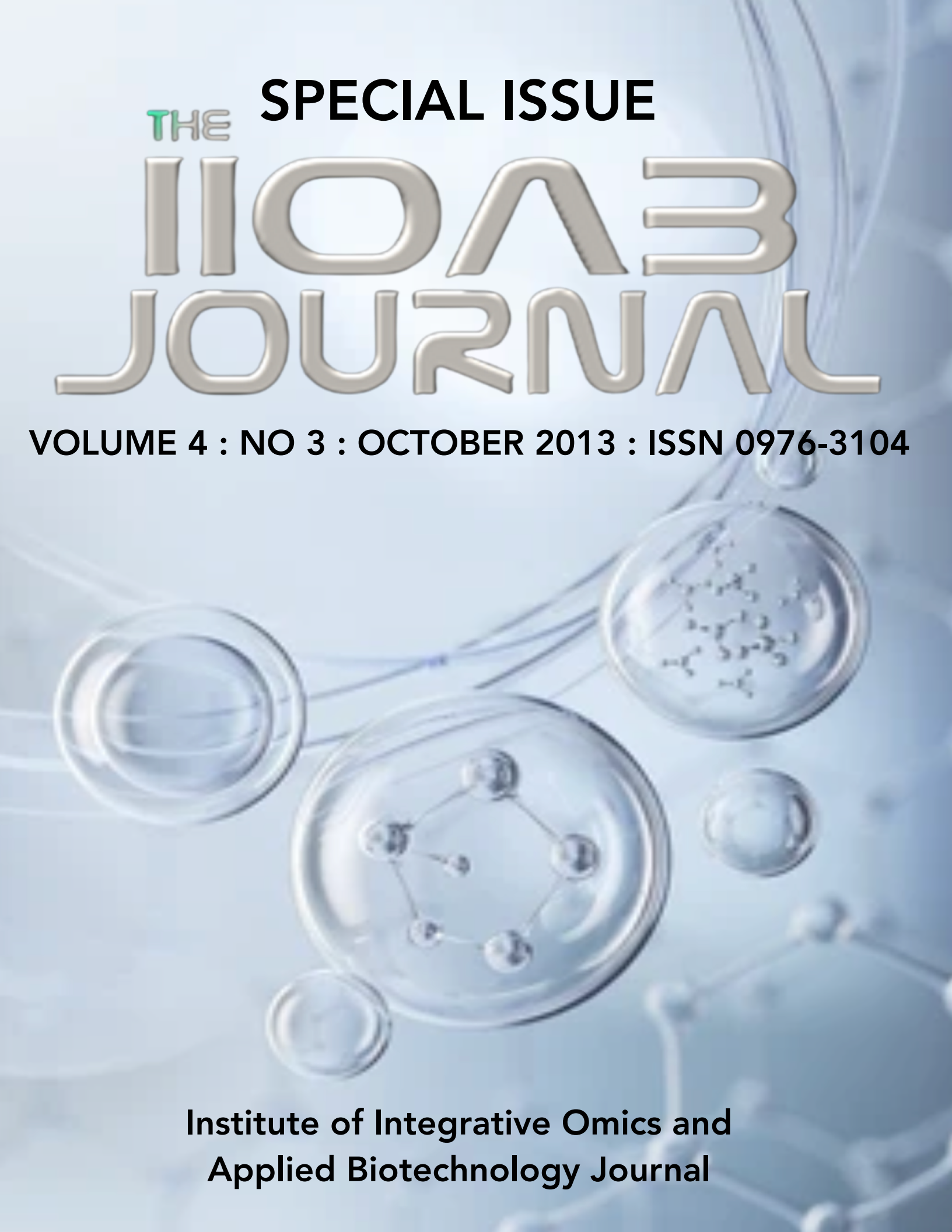

Institute of Integrative Omics and
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Dear Readers,

It is with great pleasure and enthusiasm that I extend a warm welcome to each of you to the distinguished realm of our scientific journal focusing on the intersection of neuroscience and economic decision-making.

As the Editor of this esteemed journal, I am honored to witness the groundbreaking strides being made in understanding the intricate connections between the human brain and the choices we make in economic contexts. Our journal serves as a conduit for the dissemination of cutting-edge research, innovative theories, and empirical studies that illuminate the fascinating interplay between neuroscience and economic decision-making processes.

Your dedication to unraveling the complexities of how neural mechanisms influence economic behaviors is invaluable. Your expertise and contributions are pivotal in advancing our collective understanding of how cognitive processes shape our financial choices, preferences, and judgments.

We, as a community, stand on the threshold of remarkable discoveries that will not only enhance our comprehension of decision-making processes but also have profound implications for numerous fields, from economics and psychology to public policy and business strategies.

I encourage each of you to continue your scholarly pursuits, submit your groundbreaking research, and engage in vibrant discussions within our journal's pages. Together, let us foster an environment where ideas flourish, collaborations thrive, and knowledge expands.

Thank you for being an essential part of our scientific endeavor. I eagerly anticipate the wealth of knowledge and insights that will emerge from your contributions.

Warm regards,
Prof. José António Filipe

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EDITORIAL | OPEN ACCESS

A GENERAL VIEW OVER THE NEUROSCIENCE IN BUSINESS AND ECONOMIC DECISION MAKING

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EDITORIAL

In this special issue, several works have been presented in the area of neuroscience in business and economic decision making. Neuroeconomics is studied according to several different approaches, all of them permitting to understand it as an interdisciplinary field that seeks to explain human decision making. Neuroeconomics combines research methods from different fields as neuroscience, experimental and behavioral economics, cognitive and social psychology, among many others. Nowadays, neuroscience and neuroeconomics are seen as an open door to a new stage of knowledge and to a more profound cognition about human being and human behavior. In this issue, the works of several scientists are presented, showing the progresses are several areas of application.

Behavioral sciences, especially cognitive and social psychology, neurosciences and behavioral economics, and philosophy have recognized the difficulty of choice as a pervasive feature of human decision making (Costa, "Images of Difficulty", on this issue). In this paper, "Images of Difficulty", Ana Costa shows not only that individuals spontaneously operate a distinction between non-moral and moral dilemmas, but also that the neural patterns observed during actual decision-making processes are different and dependent on the non-moral or moral coloring of the choice situation. Moreover, this research shows that neural patterns vary across different sorts of moral dilemmas. Her paper further argues that those advances are putting under pressure the neoclassical economics' rational choice model.

In the paper "A Self-Organizing Map of the Elections in Portugal", Caleiro shows that as most of neural networks, self-organizing maps are trained through a learning process. By the use of a neighborhood function in this learning process, self-organizing maps (SOMs) thus allow to visualize which (and how) democratic elections were more similar/distinct. For Portugal the SOM identifies two clusters of elections: one made of those corresponding to a re-election of the incumbent, i.e. in 1987, 1995, 1999 and 2009; and another made of elections that led to a change in the party in power, i.e. 1991, 2002, 2005 and 2011.

By its turn, in the paper "Neuroprobability – the Janus Probability Third Face in Court", Andrade et al, show that usually the probability theory is approached from a purely mathematical viewpoint or, not entirely in alternative, from a philosophical perspective. In their paper it is intended to present an approach based on the concepts that are typical of Neuroeconomics, that go beyond the rationality either quantitative or qualitative. This may be described simply by the word "Neuroprobability". The epistemological approach is supported following the subjective notion of probability, but not entirely denying that in certain phenomena another ones may be adopted. And often some decisions about random events are taken in the form of pure reactions, not supported for any kind of reason, as it happens for example in Neuroeconomics, giving rise to what we may call a different concept of probability, the Neuroprobability.

In the paper "Measuring Store Emotional Experience through Facial Electromyography and Skin Conductance", Ângelo et al show how, applied in a hypermarket of a retail company, it is possible to develop a Neuromarketing study, where the main goal is to analyze the emotional impact that basic experiential simulation, associated to variables identified on the in-store environment, has on potential customers.

In the paper "The Homo Neuroeconomicus – A Window for the Future", by their side, Silva et al, analyze the validity of the rationality postulate on the moments of decision-making by the economic agent, like it is promoted by the economic and financial fields on investigation, especially on microeconomic and portfolio models. The main features surrounding this postulate are addressed and criticized through the developments achieved on the neuroscience investigation on human being decision-making, mainly the somatic marker hypothesis, the effects of dopamine and oxytocin on judgment and choice, and the formation and usage of memory.

Finally, the paper of Chavaglia et al shows that economic agents have serious limitations on the process of "rational" decision making in their economic lives and that a major bias is found in the way decisions are presented to agents, concerning to the "context effect" on decisions. Given the inability that "school of rational economy" has to explain the economic problems, neuroeconomics aims to explain these problems by studying the brain of economic agents. As a result, neuroeconomics may become a way to find solutions to problems that for several decades economists could not find an explanation to the consumption and investment decisions of individuals in the economy.

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As can be seen in all these papers, the economic decision making is a very wide subject and consequently many branches of science develop studies in this area to better understand the human decision making processes.

ABOUT THE EDITOR

Prof. José António Candeias Bonito Filipe *is Graduated in Economics by ISEG/UTL - Instituto Superior de Economia e Gestão, Universidade Técnica de Lisboa, a Master in Management Sciences by ISCTE-IUL (Instituto Universitário de Lisboa) and a PhD in Quantitative Methods (Operations Research) by ISCTE-IUL. He is Assistant Professor in ISCTE-IUL and Member of BRU-IUL research group. His research interests are, among others, Mathematics; Statistics; Stochastic Processes - Queues and Applied Probabilities; Game Theory; Applications to Economics, Management, Finance and Social Problems; Environmental and Natural Resource Economics. He is Subdirector of the Department of Mathematics, School of Technology and Architecture, at ISCTE-IUL. He has published more than 200 papers in reputed international Journals and published several books and book chapters. He has participated in many conferences around the world (Portugal, USA, India, Czech Republic, North Ireland, Slovakia etc.). He cooperates with numerous International Journals, Publishing Houses and Conferences, being Editorial Board Member, Reviewer, Final Evaluator, Judge for selecting the Best Paper for an International Organization, Track Chair in Conferences, Chair of Sessions, Discussant of papers, Invited Speaker, etc. Prof. Filipe is a examiner of several PhD Theses in Portugal and abroad, participant in several Intercalary Evaluation Panels of PhD Theses and examiner of numerous Master Theses, being President of Board in some of them. He uses to be supervisor of PhD Theses and Master Theses of students from Portugal and abroad. He has cooperated in International Projects and has some scientific partnerships with other scientists around the world. He was Invited Professor in Universities abroad (Spain and Slovakia). He had 18 scientific papers awarded. He got an award for Leadership in an International Organization and several other awarded and distinguished academic achievements.*

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Costa

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REVIEW ARTICLE OPEN ACCESS

IMAGES OF DIFFICULTY

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ABSTRACT

The difficulty of choice refers to the effort involved in the process of deliberation whenever the agent is confronted with a set of alternatives whose consequences are evaluated in a multidimensional space of incommensurable and conflictive values. Tension stemming from the conflict between values (or ends) and reluctance to trade off those values against each other is the source of difficulty. The distinction between a computational and a moral aspect of difficulty is drawn with the support of empirical evidence from psychology and neuroscience research. This research shows not only that individuals spontaneously operate a distinction between non-moral and moral dilemmas, but also that the neural patterns observed during actual decision-making processes are different and dependent on the non-moral or moral coloring of the choice situation. Moreover, this research shows that neural patterns vary across different sorts of moral dilemma. The paper further argues that those advances are putting the neoclassical economics rational choice model under pressure.

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KEY WORDS

Difficulty of choice; Moral difficulty; Values conflict; Moral dilemmas; Taboo tradeoffs; Tragic tradeoffs

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[I] INTRODUCTION

The difficulty of choice refers to the effort involved in the process of deliberation whenever the agent is confronted with a set of alternatives whose consequences are evaluated in a multidimensional space of incommensurable and conflictive values (see Costa [1]). Tension stemming from the conflict between values (or ends) and reluctance to trade off those values against each other is the source of difficulty.

Behavioral sciences, especially cognitive and social psychology, neurosciences and behavioral economics (see for example Tetlock *et al*. or Greene *et al*. in [2-13]), and philosophy (see for example Dewey or Nussbaum in [14-24]) have recognized the difficulty of choice as a pervasive feature of human decision making.

In contrast, for the neoclassical economics rational choice model, commensuration is assumed as a precondition for choice, and choice as evidence of the overcoming of the conflict between values (or ends) through commensuration. In fact, rationality is conceived in neoclassical economics as consistency of choice: a choice is rational to the extent that the agent facing a set of alternatives and another set of consequences of those alternatives is able to articulate preference relations between all pairs of alternatives (completeness) and the resulting preference ordering is transitive. It may be inferred from completeness and transitivity, that there is a preference index (utility function). Utility is thus a unique and abstract measure to which the multiple dimensions of evaluation of alternatives may be reduced and choice involves only a value maximization problem. A crucial implicit assumption of the neoclassical economics rational choice model is the reducibility of all value dimensions to a single common measure, that is, commensurability of value. Accordingly, in the case of conflicts between values, rationality would always demand that concessions in one dimension might be compensated by gains in other(s) along the surface of an indifference curve.

Alternatively, it could be argued that individuals do choose, but they frequently choose with difficulty, and that choice may also be interpreted as evidence of the possibility of overcoming conflict without relying on commensuration (see Costa and Costa and Castro Caldas [1, 25]). Faced with difficulty, individuals may simply refuse to make a choice which requires the establishment of tradeoffs infringing normative concerns; they may experience moral outrage by the mere contemplation of those tradeoffs (see for example Lichtenstein, Gregory and Irwin or McGraw and Tetlock in [26, 7, 2, 5]). Moreover, individuals make choices that deviate from the predictions of the neoclassical economics model of human action. In face of difficulty, individuals often resort to heuristics evoked to cope with value conflicts and value compositions (see Gigerenzer and Gigerenzer and Selten [12, 27]).

Difficulty has both computational and moral aspects. Computational difficulty was described by Simon [28] as a situation in which the individual "may be trying to implement a number of values that do not have a common denominator – e.g., he compares two jobs in terms of salary, climate, pleasantness of work, prestige, etc.". Computational difficulty is part of what led Simon to the concept of bounded rationality. Given difficulty, the individual is compelled to resort to

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heuristic choice procedures, such as choosing the first alternative satisfying aspiration levels, one for each value dimension.

Moral difficulty, which Simon did not consider in his 1955 paper, has the same absence of a "common denominator" to all values in common with its computational counterpart. However, while the second type of difficulty stems from the incapacity to establish the numerical tradeoffs allowing the one-dimensional reduction of the multiple values, moral difficulty is instead a consequence of the dissonance or tension resulting from any attempts at determining these same tradeoffs.

Evidence of a more precise distinction between computational and moral difficulty has been gathered by psychology, mainly cognitive and social psychology, and neuroscience research. On one hand, this research suggests that individuals tend to spontaneously identify the distinction between these two types of difficulty – computational and moral difficulty – and, on the other, that the neural correlates observed during actual decision-making processes are different and dependent on the non-moral or moral coloring of the choice situation. Moreover, the neuroscience research shows that neural patterns vary across different sorts of moral dilemma.

The paper addresses these developments in psychology and neuroscience research with the aim of showing that they are putting the neoclassical economics rational choice model under pressure. It further argues that these advances may indeed cause shifts in the ontology of the individual underlying the neoclassical economics rational choice model. This is not to suggest that economics, or any other social science for that matter, must have a biological foundation. Nevertheless, economists must at least come to terms with the implications of these advances in psychology and neuroscience research; dissonant ontologies across fields of knowledge might be a source of intellectual discomfort.

[II] THE DIFFICULTY OF CHOICE: INSIGHTS FROM PSYCHOLOGY AND NEUROSCIENCE RESEARCH

2.1. Psychology research on the difficulty of choice

In the realm of psychology, Tetlock's and colleagues work has been exploring the reactions in experimental studies of individual participants to different types of transaction: "routine tradeoffs", in which a money counterpart is given for goods and services typically exchanged in the market (for instance, paying someone to clean my home, buying a house, buying food, paying a doctor to provide medical care for me or my family, and paying a lawyer to defend me against criminal charges in court), "taboo tradeoffs", in which a money counterpart is given for goods and services not usually exchanged in the market (for instance, buying and selling of human body parts for medical transplant operations, of surrogate motherhood contracts, of adoption rights for orphans, of votes in elections for political offices, of the right to become a U. S. citizen, of the right to a jury trial, of sexual favors (prostitution), of someone else to serve jail time to which the buyer had been sentenced by a court of law, and paying someone to perform military service which the buyer had a draft obligation to perform), and "tragic tradeoffs", in which equally important values conflict with each other (see Tetlock *et al*. [2]).

In one of the experimental studies, participants have to assess "routine" and "taboo tradeoffs" by allowing or disallowing each one, by morally approving or disapproving these transactions and by describing the emotional reactions that these transactions have triggered in them (see Tetlock *et al*. [2]). This experimental study aims to show that while "routine tradeoffs" are deemed acceptable by individuals as they do not trigger any kind of emotional reaction and moral outrage, "taboo tradeoffs" give rise to expressions of indignation and to emotional stress in the participants.

The other experimental situation implemented by Tetlock *et al*. [2] aims to compare the reactions of spectators to the decisions of a hypothetical health care decision-maker who is faced with a tragic choice between the lives of two patients, or with a transaction that presupposes a monetary valuation to a patient's life. The participants in the experimental study have to assess the decision of the health care decision-maker and describe their own feelings about this decision. Participants also have to consider whether or not if the health care decision-maker should be removed from his job and, if the health care decision-maker was a friend of theirs, whether or not the friendship would end if they knew the decision he made.

In the tragic choice situation, the health care decision-maker is faced with two children who need a liver transplant. Due to the shortage of organs, one of the patients must be chosen. The participants (spectators) in the experimental study are informed of the duration of the hypothetical deliberation process. In this tragic choice situation, the longer deliberation was interpreted as revealing awkwardness stemming from the fact that the consequences of the choice are always detrimental whatever the option taken by the hypothetical health care decision-maker.

In the other situation ("taboo tradeoff"), the health care decision-maker has to decide whether to allow a liver transplant (for a child), or if the monetary resources needed should be allocated to other needs in the hospital (for instance, the acquisition of better equipment, or raising salaries to recruit talented doctors). It is now shown that the longer the deliberation, the worse the evaluation of the health care decision-maker, even if at the end he authorizes the liver transplant. In this situation, a longer deliberation process is

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seen as revealing the admissibility of this type of tradeoff. The mere consideration of the sacrifice of a life in exchange of greater efficiency is perceived as being corrosive of the importance and the meaning of a sacred value (life), even if in the end the alternative chosen still upholds that value.

2.2. Neuroscience research on the difficulty of choice

The neurosciences provide several studies which try to identify the neural correlates of moral judgment and the interaction between the brain regions most directly involved in processing emotions and cognition. Some of these experimental studies contrast different dilemmatic situations – moral and non moral -, as well as different types of moral dilemmas. The studies converge in the identification of the neural correlates of moral emotions and cognition: the frontal lobe (more specifically the Brodmann area (BA) 9/10), the orbitofrontal cortex ((BA 10/11/25), the superior temporal sulcus (BA 39), insula, the posterior and anterior cingulate cortex (BA 24/31/32), the parietal lobe (BA 7/40), the dorsolateral prefrontal cortex and the ventromedial sectors of the prefrontal cortex (see for example Damásio or Adolphs in [29-33], or Greene *et al*. or Koenigs *et al*. in [3, 6, 11, 4, 8]). Additionally, the limbic regions which include the amygdala, the hypothalamus and the thalamus are important in processing certain disagreeable basic emotions, such as fear and disgust, and also in moral emotions processing.
In the case of experimental studies developed by Greene *et al*. [3, 6], the participants are confronted with the description of various moral dilemmas. In each moral dilemma situation, the participants have to decide on which is the correct alternative. While the participants respond to the various dilemmas, magnetic resonance images of their brains are registered.

Greene *et al*. [3] consider non-moral and moral dilemmas which may also be either personal or impersonal (see note 1). The non-moral dilemmas are about choices between conflicting value dimensions, but where these values dimensions are deprived of a moral significance. By contrast, the moral dilemmas involve situations where the moral salience of the conflicts between values is highlighted. In some experimental situations, the conflicts are even between sacred values (a human life versus n human lives). Impersonal versus personal moral dilemmas draw on some puzzling situations. For instance, in the case of impersonal moral dilemmas, a runaway trolley that mortally threatens five people may be diverted onto a side track, where it will kill only one person. In the case of personal moral dilemmas, experimental subjects are faced with the alternative of pushing someone in front of a runaway trolley, killing the person pushed but saving five others (see note 2).

This experimental study shows that dilemmatic situations differ in the extent to which emotions are engaged in reaction. Not only is emotional stress stronger in moral dilemmas than in non-moral dilemmas, but it is also stronger in personal moral dilemmas than in impersonal moral dilemmas. This is revealed by increased brain activity in regions related to social and/or moral emotion processing (see note 3). Moreover, in the personal moral dilemma condition, the experimental subjects who approve an alternative which triggers a negative emotional reaction tend to have a longer reaction time. For instance, in the footbridge dilemma situation, subjects who approve of pushing someone in front of a runaway trolley, killing the person pushed but saving five others, have to override a negative emotional response which requires an additional cognitive control. This is revealed by increased brain activity in the anterior dorsolateral prefrontal cortex (DLPFC) and also by a longer reaction time. In other conditions - impersonal moral dilemma and non-moral dilemma –no difference is found in reaction time.

Greene *et al*. [6] explore the reasons underlying this difference in reaction time between the personal moral dilemma condition and the remaining conditions. The experiment tests the difference between difficult and easy personal moral dilemmas and tests the conjecture that the longer reaction time, which is a feature of the first type of dilemma, results from the conflict experienced when the surveillance of a utilitarian moral reasoning depends on a disgusting personal intervention (see note 4). The conjecture is corroborated by the observation of more intense brain activity in regions associated with the control of cognitive conflicts and processes of abstract reasoning (more precisely, the anterior and posterior cingulate cortex (BA 32/23/31), parietal lobe (BA 7/40) and the dorsolateral prefrontal region (BA 10/46)), together with significant brain activity in neural structures more closely related with the processing of moral and/or social emotions. This pattern of brain activity is not found in the case of easy personal moral dilemmas, in which there is no conflict between an emotional reaction and a utilitarian moral judgment. In these situations, the reaction time is comparatively short, and the activity of the neural structures more directly related with cognitive conflict and processes of abstract reasoning is lower.

These results (Greene *et al*., Greene and Haidt, and Greene *et al*. [3, 34, 6]) suggest that the longer reaction time in situations of difficult personal moral dilemmas is not related to higher computational complexity, which is also present in the case of easy personal moral dilemmas, but to the conflict arising from the moral judgment of competing choice alternatives and the corresponding emotional reaction. The authors proposed a dual process theory of moral judgment, in which emphasis is given to a function of control and inhibition of cognitive processes over emotional responses (see note 5).

Koenigs *et al*. [11] tested these moral experimental conditions in patients with emotion-related damage in the ventromedial prefrontal cortex. Their aim is to identify a causal relationship between the neural structures more closely related with the

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processing of moral and/or social emotions and the moral judgment. This experimental study shows that, in the personal moral dilemma situation, the patients with emotion-related damage in the ventromedial prefrontal cortex are more willing to agree to endorse harmful actions in accordance with a utilitarian reasoning than the other experimental subjects (healthy individuals and individuals with neural lesions in other brain regions).

[III] DISCUSSION

This psychology and neuroscience research is inspiring in terms of the distinction between a moral and a computational dimension of the difficulty of choice. This investigation suggests that: (a) individuals spontaneously operate a distinction between moral and non-moral dilemmas and between different types of moral dilemma; (b) this distinction is grounded on a difference in the specific neurophysiologic processes involved; (c) not only are the chooser and the doer aware of this difference, but also the observers. In fact, observers tend to interpret the same signal (for instance, the reaction time in a deliberation process) differently depending on the type of dilemma evoked; (d) when there is an alternative which is deemed both morally appropriate and triggers a positive emotional reaction, the reaction time is comparatively short; (e) when the consequences of the choice's are all morally and emotionally detrimental or (f) when there is a conflict stemming from the fact that the surveillance of a utilitarian moral reasoning depends on a disgusting personal intervention, the reaction time is longer.

It could be argued that the distinction between a moral and a computational difficulty not only makes sense but is supported by evidence. However, it may be insufficient in that there may be different types of moral and computational difficulty. Moreover, the evidence also suggests that moral difficulty is not different from computational difficulty because the former type belongs to the realm of emotions. Not only do emotions relate to both but cognitive elements may also be present with emotions in the case of moral difficulty. It can even be claimed that this cognitive element may sometimes play a regulative function over emotions (Greene *et al*., Greene and Haidt, and Greene *et al*. [3, 34, 6]). On the other hand, emotional elements may be present even when assessing morally neutral consequences of action, as suggested by the somatic marker hypothesis (see Damásio [29]).

The results also suggest that the different brain regions which are identified as associated to moral judgment also participate in other processes that are not specifically moral, e.g. physiological regulation functions that generate avoidance and approach behavior and social behavior in general. Many of these brain structures sustain the capacity to represent the mental states of other individuals by inferring their beliefs and intentions ("theory of mind", mirror neurons) (see note 6).

However, the neuroscience research so far is not suitable to address moral difficulty in ordinary situations as since it only draws on extreme dilemmatic situations. As stated by Moll *et al*. [8]: "[t]he making of moral judgments on extreme and unfamiliar situations, such as those posed by classic moral dilemmas, offers interesting ways to probe philosophical points of view, but can hardly be taken as a proxy for everyday moral reasoning". The same authors argue in favor of extending neuroscience research to these more familiar and current moral dilemmas. Moreover, an extension of experimental conditions to actual situations of interaction and choice, instead of hypothetical situations, could also offer more insights into how individuals cope with value conflicts that arise in practice.

Nevertheless, the experiments in psychology and neuroscience research suggest that the attribution of a money price to goods and services that are not usually object of market transactions may be a source of moral difficulty. These results are puzzling from the perspective of the neoclassical economics rational choice model. In fact, descriptive validity of its assumptions that rationality always requires the establishment of tradeoffs between all values and that valuing something means ascribing a monetary counterpart to seem to be disproved. The view of individuals as mere "wantons" whose only purpose would be the satisfaction of their first order desires, as is highlighted by the neoclassical economics rational choice model, is also put under pressure. However, the question of how and why certain transactions and not others are seen as problematic remains; why the assignment of a money price to certain goods and not others may corrupt their value and significance. It might be conjectured that this could happen when the attribution of a money price or any other type of tradeoff blocks the possibility for individuals to express certain judgments about themselves, about others and about the nature of the economic and social relations involved in such transactions. This suggests that moral difficulty may not only be relevant in extreme dilemmatic situations, but may in fact be a relatively common feature of choice situations in social contexts.

[IV] CONCLUSION

The paper is grounded on the concept of the difficulty of choice, which has been recognized as a pervasive feature of human decision making by behavioral sciences, especially cognitive and social psychology, neurosciences and behavioral economics. The distinction between a computational and a moral aspect of difficulty is drawn with the support of empirical evidence from psychology and neuroscience research. The limits of this research to address moral difficulty in ordinary situations are also acknowledged. The paper further argues in favor of the idea that the developments from psychology and neuroscience research may put the neoclassical economics rational choice model under pressure by revealing its explanatory fragilities.

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CONFLICT OF INTERESTS

The author declares no competing interests in relation to the work.

NOTES

(1) www.sciencemag.org/cgi/content/full/293/5537/2105/DC1 contains a complete description of the sixty dilemma situations that participants have to deal with.

(2) "Me hurt you" is the label that appears in the literature in connection to the moral personal violations (Greene *et al.* [3, 6]). This type of moral violation pertains to bodily offences, inflicted on a particular individual or group of individuals, and is the result of a direct and deliberate action from the agent.

(3) The brain regions where an increase brain activity is registered, by fMR image, are: frontal lobe (more precisely the BA 9/10), superior temporal sulcus (BA 39) and posterior cingulate cortex (BA 31) (Greene *et al.* and Greene and Haidt [3, 34]). On the other hand, the brain regions correlated with work memory, like the frontal lobe (BA 46) and the parietal lobe (BA 7/40), show an increase in activity in impersonal moral dilemmas and in non moral dilemmas. Finally, there is not a significant difference of brain activity between impersonal moral dilemma and non moral dilemma in the superior temporal sulcus (BA 39), in the frontal lobe (BA 46) and in the parietal lobe (BA 7/40).

(4) One of the tragic examples evoked is of a group trying to hide from a Nazi persecution in which a child may at any moment cry calling the enemies' attention.

(5) Greene *et al.* [35] aim to outline more evidence for a difference between utilitarian and non utilitarian moral reasoning. While the former is more closely related with controlled cognitive processes, the latter tends to be driven by more automatic processes. This experimental study shows that the cognitive load increases the average reaction time only for utilitarian judgments. In the case of non utilitarian judgments, the cognitive load has no significant impact on the average reaction time.

(6) These regions are the frontal lobe (more specifically BA 9/10), the superior temporal sulcus (BA 21/39), the region most anterior of the anterior cingulate cortex (BA 32), and the parietal lobe (BA 40) (see for example Frith and Frith or Decety and Chaminade in [36-39]).

REFERENCES

[1] Costa, Ana. [2008] A Dificuldade da Escolha. Acção e Mudança Institucional, Phd Dissertation, ISCTE-IUL, Lisbon.

[2] Tetlock P, O Kristel, S Beth, M Green,J Lerner. [2000] The Psychology of the Unthinkable: Taboo trade-offs, forbidden base rates, and heretical counterfactuals, *Journal of Personality and Social Psychology* 78: 853–870.

[3] Greene Joshua D, R Brian Sommerville, Leigh E Nystrom, John M. Darley and Jonathan Cohen. [2001] An FMRI Investigation of Emotional Engagement in Moral Judgment, *Science* 293: 2105–2109.

[4] Moll Jorge, Ricardo de Oliveira Souza, Paul J Eslinger, *et al*.,[2002] The Neural Correlates of Moral Sensitivity: A Functional Magnetic Resonance Imaging Investigation of Basic and Moral Emotions, *The Journal of Neuroscience* 22(7): 2730–2736.

[5] Tetlock Philip E. [2003] Thinking the unthinkable: sacred values and taboo cognitions, *TRENDS in Cognitive Sciences* 7(7): 320–324.

[6] Greene Joshua D, Leigh E Nystrom, Andrew D Engell, John M. Darley, Jonathan Cohen. [2004] The Neural Bases of Cognitive Conflict and Control in Moral Judgment, *Neuron* 44: 389–400.

[7] McGraw, A. P. and Tetlock, P. E. [2005] Taboo Trade-Offs, Relational Framing, and the Acceptability of Exchanges, *Journal of Consumer psychology* 15(1): 2–15

[8] Moll, Jorge, Roland Zahn, Ricardo de Oliveira Souza, Frank Krueger, Jordan Grafman. [2005] The Neural Basis of Human Moral Cognition, *Nature Reviews* 6: 799–809.

[9] Lichtenstein, S. and Slovic, P. [2006] The Construction of Preference, Cambridge University Press, New York

[10] Shafir E, Simonson I and Tversky A. [2006] Reason-Based Choice. In: The Construction of Preference, S. Lichtenstein and P. Slovic (eds.), Cambridge University Press, New York, p. 411–433.

[11] Koenigs Michael, Liane Young, Ralph Adolphs, *et al*. [2007] Damage to the prefrontal cortex increases utilitarian moral judgements, *Nature*, March: 1–4.

[12] Gigerenzer G. [2010] Moral Satisficing: Rethinking Moral Behavior as Bounded Rationality, *Topics in Cognitive Science* 2: 528–554.

[13] Berns, Gregory S., Emily Bell, C. Monica Capra, Michael J. Prietula, Sara Moore, Brittany Anderson, Jeremy Ginges e Scott Atran [2012] The price of your soul: neural evidence for the non-utilitarian representation of sacred values, Philosophical Transactions of *The Royal* Society 367: 754–762.

[14] Dewey John. (1930) [1922] Human Nature and Conduct. An Introduction to Social Psychology, The Modern Library, New York.

[15] Wiggins David. [1975-1976] Deliberation and Practical Reason, Proceedings of the Aristotelian Society, New Series 76: 29–51.

[16] Levi Isaac. [1986] Hard Choices. Decision Making under Unresolved Conflict, Cambridge University Press, Cambridge.

[17] Nussbaum M. [1986] The Fragility of Goodness. Luck and Ethics in Greek Tragedy and Philosophy, Cambridge University Press, New York.

[18] Raz Joseph. [1986] The Morality of Freedom, Clarendon Press, Oxford.

[19] Nussbaum M. [1997] Flawed Foundations: The Philosophical Critique of (A Particular Type of) Economics, *The University of Chicago Law Review* 64: 1197-1214.

[20] Radin Margaret J. [1997] Contested Commodities, Harvard University Press, Cambridge.

[21] Richardson Henry S. [1997] Practical Reasoning about Final Ends, Cambridge University Press, Cambridge.

[22] O'Neill J. [1998] The Market: Ethics, Knowledge and Politics, Routledge, London

[23] O'Neill John [2007] Markets, Deliberation and Environment, Routledge, London.

[24] Putnam H. and Walsh V. [2012] The End of Value-Free Economics, Routledge, NY
[25] Costa A. and Castro Caldas J. [2011] Claiming Choice for Institutional Economics, Journal of Economic Issues, XLV(3): 665-684
[26] Lichtenstein S, Gregory R, Irwin J. [2007] What's Bad Is Easy: Taboo Values, Affect, and Cognition, Judgment and Decision Making, 2(3): 169–188
[27] Gigerenzer, G. and R. Selten (eds.) [2001] Bounded Rationality the Adaptive Toolbox, The MIT Press, Cambridge MA.
[28] Simon, Herbert. [1955] A Behavioural Model of Rational Choice, *Quarterly Journal of Economics* 69: 99–118.
[29] Damásio António R. [1994] O Erro de Descartes. Emoção, Razão e Cérebro Humano, Publicações Europa América: Mem Martins.
[30] Adolphs Ralph. [2003] Cognitive Neuroscience of Human Social Behaviour, *Nature* 4: 165–178.
[31] Casebeer William D. [2003] Moral cognition and its neural constituents, Nature Reviews, 4: 841– 846.
[32] Casebeer William D. and Patricia S. Churchland [2003] The Neural Mechanisms of Moral Cognition: A Multiple Aspect Approach to Moral Judgment and Decision Making, *Biology and Philosophy* 18: 169– 194.
[33] Damásio António. [2003] Ao Encontro de Espinosa. As Emoções Sociais e a Neurologia do Sentir, Publicações Europa América: Mem Martins.
[34] Greene Joshua and Jonathan Haidt. [2002] How (and where) does moral judgment work?, TRENDS *in Cognitive Sciences* 6(12): 517–523.
[35] Greene JD *et al*. [2008] Cognitive load selectively interferes with utilitarian moral judgement, *Cognition* 107(3): 1144–1154.
[36] Frith, Uta and Chris Frith [2001] The Biological Basis of Social Interaction, Current Directions in Psychological Science 10(3): 151–155.
[37] Decety, J. and T. Chaminade [2003] Neural correlates of feeling sympathy, *Neuropsychologia* 41: 127–138.
[38] Gallagher, Helen L. and Christopher D. Frith [2003] Functional imaging of 'theory of mind', TRENDS in Cognitive *Sciences* 7(2): 77–83.
[39] Rilling, James K., Alan G. Sanfey, Jessica A. Aronson, Leigh E. Nystrom and Jonathan D. Cohen [2004] The neural correlates of theory of mind within interpersonal interactions, *NeuroImage* 22: 1694–1703.

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A SELF-ORGANIZING MAP OF THE ELECTIONS IN PORTUGAL

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ABSTRACT

As (artificial) neural networks are simulations of the supposed biological neurons work, the structure of human brains - where processing units, the so-called neurons, are connected by synapses - is approximated by (artificial) neural networks. As most of neural networks, self-organizing maps are trained through a learning process. By the use of a neighborhood function in this learning process, self-organizing maps (SOMs) thus allow to visualize which (and how) democratic elections were more similar/distinct. For Portugal the SOM identifies two clusters of elections: one made of those corresponding to a re-election of the incumbent, i.e. in 1987, 1995, 1999 and 2009; and another made of elections that led to a change in the party in power, i.e. 1991, 2002, 2005 and 2011.

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[I] INTRODUCTION

The electoral cycle literature has developed in two clearly distinct phases. The first one, which took place in the mid-1970s, considered the existence of non-rational (naive) voters. In accordance with the rational expectations revolution, in the late 1980s the second phase of the models considered fully rational voters. In terms of the electorate rationality, an intermediate approach, i.e. one that considers learning voters, which are bounded rational, may be more appropriate.

Generally speaking, learning models have been developed as a reasonable alternative to the unrealistic informational assumption of rational expectations models. Moreover, through learning models it is possible to study the dynamics of adjustment between equilibriums which, in most rational expectations models, is ignored. Although a number of different studies modeling learning have been presented, two main classes of models can be distinguished: rational learning and bounded rational learning models (Sargent [1]). In rational learning models, it is assumed that agents know the true structural form of the model generating the economy, but not some of the parameters of that model. In bounded rational learning models, it is assumed that agents, while learning is taking place, use a 'reasonable' rule, e.g., by considering the reduced form of the model. Salmon [2] is, to the best of our knowledge, one of the few references where an innovative bounded rationality approach such as neural networks learning has been applied in a policy-making problem.

Despite the vastness of the literature on the economic importance of the elections and on neural networks, the fact is that there are even fewer references that combine these two aspects. In Caleiro [3] it is proposed to use a kind of neuroeconomics approach within a political business cycles context. Specifically, Caleiro [3] showed how a particular neural network, i.e. a perceptron would classify policies and outcomes as 'electoralist' or not, using Nordhaus [4]' model. In Caleiro [5] it is also explored the problem of how to classify a government showing in which, if so, circumstances a perceptron can resolve that problem. This was done by considering a model recently considered in the literature, i.e. one allowing for output persistence, which is a feature of aggregate supply that, indeed, may turn impossible to correctly classify the government. Following a different objective, but also using a perceptron, Gill [6] addressed the problem of forecasting the result of general elections in India. Given the ability of fuzzy sets to represent vagueness and neural network ability to learn – see Chen [7] – Jiao et al. [8] considered a fuzzy adaptive network to model and also forecast national presidential elections.

Owing the number of relevant variables in any political-economic structure it could be considered a dimension associated with each of these variables. As a matter of fact, it is generally considered that structure to be a system in which the existence of causal relations between the variables which compose it allows the same to be characterized by a smaller number of dimensions. This reduced number of dimensions is, however, limited in view of the existence of random elements. These make causal relationships, although detectable, inaccurate. From this standpoint, it is important, especially when dealing with empirical data, the use of methods which allow the reduction of the multi-dimension of data.

Plainly, the reduction in the multi-dimension of the data is an issue that obviously received a substantial attention in the

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literature. As is known, when the transformation is linear, the principal component analysis (Pearson [9]) is particularly suitable in converting a set of observations of possibly correlated *n* variables into a set of values of their principal components, understood as (linearly) uncorrelated variables, which are to be in a number smaller than *n*.[1] [[1] As well known, the principal component analysis relates to the factorial analysis. The first is concerned essentially with the variance, while the second is concerned essentially with the covariance.] When the transformation is non-linear in nature, there are other techniques for dimension reductions such as principal curves (Hastie and Stuetzle [10]), multidimensional scaling (Kruskal and Wish [11]) or self-organizing maps (SOMs) (Kohonen [12, 13, 14]).

Self-organizing maps are intended not only to reduce the dimensions of data but also as a visualization technique that produces a map (usually in one or two dimensions) which plots the similarities on the data by clustering similar data objects. In doing so, self-organizing neural networks are used. As most of the neural networks, SOMs are trained through a learning process. By the use of a neighborhood function in this learning process, self-organizing maps thus allow to visualize which (and how) democratic elections were more similar / distinct. Notably, by the use of the SOM methodology, Niemelä and Honkela [15] explored the relationship between parliamentary election results and socio-economic situation in Finland between 1954 and 2003.

The use of a SOM methodology is indeed appropriate given the importance of the expected distinction of incumbents and of their performances in democracies. For instance, in accordance to the political version of the electoral business cycles, ideological aspects are not important whereas in the partisan version the ideology of the incumbent is indeed relevant. From this point of view, it is accepted that the evolution of the economy and the consequent election results will be different depending on the type (left-right; conservative-liberal) of the incumbent. The existence of distinct parties in power in Portugal after the restoration of democracy allows, therefore, studying these issues. In this chapter such a study is done using a particular type of neural network, self-organizing maps, which, by their characteristics, are particularly suited in accomplishing the task of checking for how the different democratic elections (in Portugal) were similar or distinct in terms of their results.

In consequence, the remaining of the chapter is structured as follows. In a succinct way, Section II presents the neural network general methodology and, in particular, the method of SOMs. The results of the application of this methodology to the elections in Portugal are analyzed in Section III. Section IV concludes.

[II] MATERIALS AND METHODS

Generally speaking, (artificial) neural networks are simulations of how biological neurons are supposed to work, i.e. the structure of human brains, where processing units, the so-called neurons, are connected by synapses, is approximated by (artificial) neural networks. As such, the interconnected network of processing units describes a model which maps a set of given inputs to an associated set of outputs values.[2] [[2] A more formal definition would consider a neural network $< P, < >$ to be a directed graph over the set P of processors (neurons), where a processor is a mapping from an input to an output space.] As the number of inputs does not have to be equal to the number of outputs, a neural network can, alternatively, be described as mapping one set of variables onto another set of a possibly different size.

The knowledge of the values for the input and output variables constitutes, then, the major part of the information needed to implement a neural network. Despite the minimal information requirement, this constitutes no motive for questioning the results obtained; see Salmon [2]. In fact, this characteristic makes neural networks particularly appropriate for cases where the structure connecting inputs to outputs is unknown.[3] [[3] Take, for instance, Wall [16], which intends to bridge the gap between substantive rationality and procedural rationality. The fact that it is considered that the exact form of the objective function is unknown is what makes this bounded rationality model a good example of a possible application of neural networks.] In this sense, neural networks can be classified as 'non-structural' procedural models. Furthermore, they are in good agreement with a typical characteristic of bounded rationality: the adaptive behavior. Indeed, the adaptation to the environment as a crucial characteristic of a neural network makes it distinct from many (standard) models of learning.[4] [[4] In particular, neural networks relax the constant linear reduced form assumption of least squares learning by considering a time varying possibly non-linear stochastic approximation of that form.]

Neural networks are used mainly to learn two types of tasks; see Swingler [17]:

1. Continuous numeric functions - When the task is to approximate some continuous function, as in the case of a signal extraction;
2. Classification - When the input is a description of an object to be recognized and the output is an identification of the class to which the object belongs. The most common kind of neural network for classification purposes are the so-called perceptrons, see Rosenblatt [18].[5] [[5] For a clear explanation of the link between perceptrons and the statistical discriminant analysis see Cho and Sargent [19].] In this sense, one may consider perceptrons as learning mechanisms used by voters to perform a classification of the incumbent in order to distinguish opportunistic

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(electorally motivated) from benevolent (non-electorally motivated) behavior of the government, Caleiro [3] and Caleiro [5].

Let us then clarify the *modus operandi* of neural networks by a simple formalization as follows.[6] [[6] For a clear mathematical presentation see Ellacott and Bose [20], among others. More advanced references include White [21]. Given an input vector, x, the neural network determines a particular parameterization, say β, which, in conjunction with a function g – also possibly determined by the neural network – leads to an output vector $y = g(x,\beta)$ 'closest' to some target y^*. In other words, the output units $y(k)$, $(k = 1, ..., t)$, process, using a function g, the inputs $x(i)$, $(i = 1, ..., r)$, previously amplified or attenuated by the connection strengths $\beta(i,k)$.[7] [[7] Implicitly assumed is a feedforward model, where signals flow only from x(i) to y(k). It is, nevertheless, also possible to consider feedback effects.]

The simplest neural network structure described above is usually relaxed to obtain flexibility by considering a layer of, so-called, hidden units. In this case, the transformation of inputs into outputs includes an intermediate processing task performed by the hidden units. Each hidden unit, then, produces, by the consideration of an activation or transfer function $f(\cdot)$, an intermediate output $s(j)$, $j = 1, ..., s$, which is finally sent to the output layer.[8] [[8] It is also (and generally) possible to consider a bias node shifting the weighted sum of inputs by some factor b(j). See **Figure–1**.] This situation is illustrated in **Figure–1**.

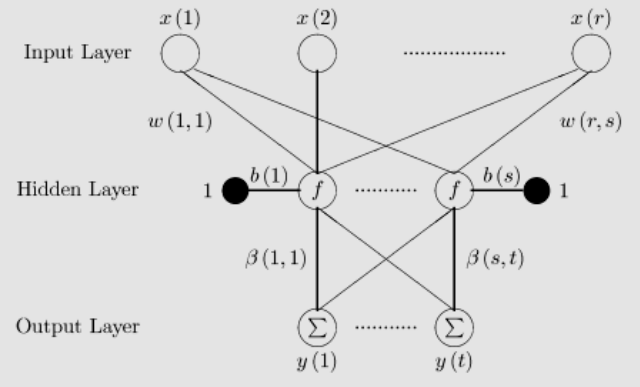

Fig: 1. A neural network representation

The neural network then computes:

1. The input(s) to the hidden layer

$$h(j) = b(j) + \Sigma_i\, w(i,j)\, x(i) \qquad i = 1,\ldots,r;\ j = 1,\ldots,s;$$

2. The output(s) of the hidden layer ≡ the input(s) to the output layer

$$s(j) = f(h(j)),$$

where f is the so-called activation function;

3. The output(s) of the output layer:[9] [[9] It is possible to consider an activation function and/or a bias before the determination of the final outputs.]
4.

$$y(k) = \Sigma_j\, \beta(j,k)\, s(j) \qquad j = 1,\ldots,s;\ k = 1,\ldots,t.$$

As pointed out in White [21], the output vector $y = g(x,\theta)$ can be viewed as generating a family of approximations (as θ ranges over the set Θ, say) for the unknown relation between inputs x and their corresponding outputs y. The best approximation can be determined by a recursive learning procedure known as back-propagation. The learning process – training – is then an iterative procedure of processing inputs through the neural network, determining the errors and back-propagating the errors through the network to adjust the parameters in order to minimize the error between the predicted and observed outputs. This method of learning is referred to as gradient descent as it involves an attempt to find the lowest point in the error space by a process of gradual descent along the error surface.[10] [[10] Two factors are used to control the training algorithm's adjustment of the parameters: the momentum factor and the learning rate coefficient. The momentum term, which is quite useful to avoid local minima, causes the present parameter changes to be affected by the size of the previous changes. The learning rate dictates the proportion of each error which is used to update parameters during learning.]

Back-propagation is a supervised training technique in the sense that the training data consists of an input vector and a target vector such that the weights (and bias) of the network are changed during the learning process in order to reduce the difference between the output and the target vectors. This learning technique is common in most neural networks but, however, does not apply in the case of self-organizing maps, making them a very special case of a neural network.

Given its main objectives, the architecture of a SOM is different from the traditional structure. It usually consists on a 2D lattice of nodes, each being connected to the input layer. Each node is properly positioned in the lattice (for example, by coordinates x, y) and has an associated vector of weights with the same size of the input vectors.

The training process is iterative and follows the steps described below:

1. Each node's weights are initialized;
2. An input vector is chosen at random from the set of training data and confronted to the lattice;
3. Every node is examined in order to determine the so-called *best matching unit*, i.e. the one with weights that are the most similar to the input vector;
4. Starting with the value of the lattice – in order to include all nodes – and making it smaller in every iteration, the radius

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of the best matching unit's neighborhood is calculated. Any nodes found within this radius are considered to be inside the best matching unit's neighborhood;

5. The weights of all neighboring nodes determined in step 4 are adjusted to make in order to make them more similar to the input vector;

6. Step 2 is repeated for *n* iterations.

[III] RESULTS

Constitutional governments have ruled in Portugal after the establishment of democracy in 1974.[11] [[11] The 3rd, 4th and 5th constitutional governments, which were in power between August 1978 and January 1980, were actually governments of presidential initiative.] In any legislative election that took place after 1974, the winning party has always been the Social Democratic Party (PSD) or the Socialist Party (PS), resulting in the formation of governments supported by one of those two parties.[12] [[12] The only exception was the 9th constitutional government, supported by a post-election coalition between the two parties, which was in power between June 1983 and November 1985.] Still, third parties in Portugal have been representing a fairly important role, even in terms of parliamentary seats.

Those facts lead us to consider the following classification in what follows: taking the parties with parliamentary seats, we consider the results of those two main parties, i.e. PSD and PS, and the results of the parties to their left – basically the Democratic Unity Coalition (CDU)[13] [[13] A coalition between the Communist Party and the ecologist party "Os Verdes".] and the Left Bloc (BE) – and to their right – basically the Social Democratic Centre/People's Party (CDS/PP). This classification has the advantage of not introducing distortions because, in time period under consideration, there were parties with parliament seats that have now been extinguished – the case of the Democratic Renewal Party (PRD) – and others that meanwhile were created as is the case of BE.

In what concerns the remaining data,[14] [[14] The source of the data is the Bank of Portugal] ever since the seminal paper of Nordhaus [4], inflation and unemployment have been considered to be the most important economic variables explaining the electoral results, (Caleiro and Guerreiro [22]). More recent literature has shown that the existence of persistence in real variables, such as unemployment, may invert the political business cycle optimal pattern (Gärtner [23], Caleiro [24]). By respecting these facts, it will be considered the average value of monthly inflation and of monthly unemployment in the first and second halves of the mandate ending with each election. The same division of the mandate is also considered in terms of another variable that recently have been associated with election results (in Portugal), i.e. consumer confidence (Ramalho et al. [25]). Finally, a dummy variable taking the value 1 in case of a re-election and 0 in case of an electoral defeat of the (previous) incumbent is also considered. Taking into account the availability of the data, the legislative elections of July 1987,[15] [[15] The previous election took place in October 1985.] October 1991, October 1995, October 1999, March 2002, February 2005, September 2009, and June 2011 are to be considered. **[Table-1]** summarizes the data (all data, except confidence and the dummy are in percentage).

Table: 1. The data

Election	Left	PS	PSD	Right	Inflat_i	Inflat_f	Unemp_i	Unemp_f	Conf_i	Conf_f	Dummy
1987	17.05	22.24	50.22	4.44	0.9691	0.7182	9.1	7.8	-13.750	-9.800	1
1991	8.80	50.60	29.13	4.43	0.9331	0.9473	5.9	4.6	-8.423	-5.654	0
1995	8.57	43.76	34.12	9.05	0.6321	0.3617	4.6	6.9	-20.917	-28.500	1
1999	8.99	44.06	32.32	8.34	0.2000	0.2154	7.1	5.4	-18.917	-8.250	1
2002	9.68	37.79	40.21	8.72	0.3293	0.2753	4.5	4.6	-10.600	-18.600	0
2005	13.89	45.03	28.77	7.24	0.2933	0.1694	6.4	7.5	-32.889	-29.000	0
2009	17.68	36.55	29.11	10.43	0.2689	0.0364	8.7	9.2	-29.536	-37.821	1
2011	13.08	28.06	38.65	11.70	0.1918	0.2945	11.6	12.4	-33.818	-47.091	0

Starting with the minimum x-y neural network configuration, i.e. a 2x2 (hexagonal) topology, the obtained SOM is shown in **Figure 2**.[16] [[16] The results were modeled by Spice-SOM 2.1, written by Cao Thang, available at http://www.spice.ci.ritsumei.ac.jp/~thangc/programs/ (accessed on June 12, 2012).]

Notably, the SOM identifies two clusters of elections: one made of those corresponding to a re-election of the incumbent, i.e. in 1987, 1995, 1999 and 2009; and another made of elections that led to a change in the party in power, i.e. 1991, 2002, 2005 and 2011. This kind of map is remarkable given that, in what concerns economic variables, a re-election or a defeat of the (previous) incumbent happened after a typical, as well as an atypical, pattern of electoral business cycle.

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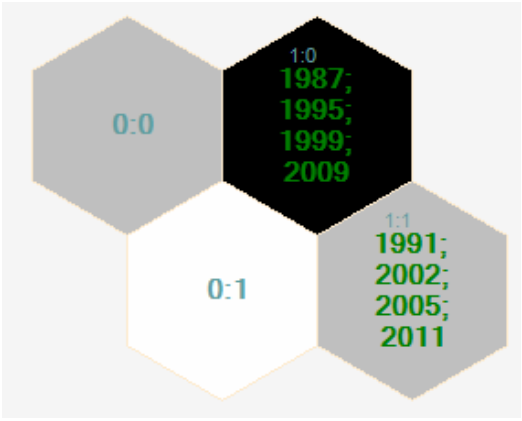

Fig: 2. Elections in Portugal organized by the SOM

Plainly, increasing the x-y neural network configuration would lead to a clearer separation of the elections. As a matter of fact, for instance considering a 8x8 (the number of elections) neural network, the pairs (1995-1999), (1987-2009), (1991-2005), (2002-2011) seem to emerge (see **Figure–3**) but, in general, the same conclusion is achieved.

From the political science point of view the results are interesting from the outset because they provide evidence supporting that (in Portugal) the political version of electoral cycle models cycles prevail over the partisan one. As a matter of fact, the clustering of elections is not based on the winning party, therefore on the alleged difference between the two major parties, which have supported all governments under study. Whilst the, so-called, third parties play a far from negligible role (see Caleiro [26]) in Portugal, the fact is that the convergence of political propaganda towards the position of the median voter has made those two major parties to become very similar in terms of their major decisions - not so much in terms of their political intentions. Thus, it makes sense that the clustering of the SOM does not consider sufficiently significant the remaining partisan differences.

[IV] CONCLUSION

The electoral cycle literature has developed in two clearly distinct phases. The first one, which took place in the mid-1970s, considered the existence of non-rational (naive) voters. In accordance with the rational expectations revolution, in the late 1980s the second phase of models considered fully rational voters. In any of these two phases a distinction between the political and the partisan versions was also made. In accordance to the political version the ideological aspects are not important whereas in the partisan version the ideology of the incumbent is indeed relevant. From this point of view, it is accepted that the evolution of the economy and the consequent election results will be different depending on the type (left-right; conservative-liberal) of the incumbent.

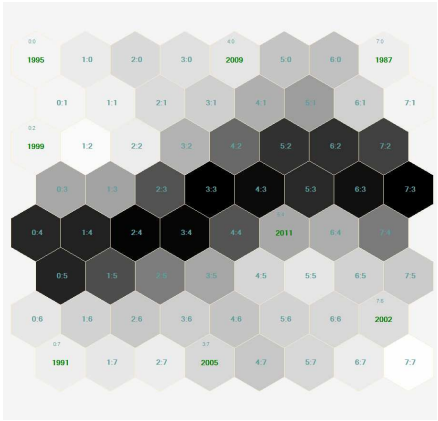

Fig: 3. Elections in Portugal organized by the SOM

The existence of distinct parties in power in Portugal after the restoration of democracy allows, therefore, studying those issues. In this article this study is done using a particular type of neural network, SOMs, which, by their characteristics, are particularly suited in accomplishing the task of checking for how the different democratic elections (in Portugal) were similar or distinct. A SOM of the electoral results combined with some relevant economic variables allows visualizing that the legislative elections that took place in Portugal in 1987, 1995, 1999, and 2009 were similar, the same happening with the 1991, 2002, 2005, and 2011 elections. The clustering is made in terms of the elections that corresponded to an electoral victory or to an electoral defeat of the previous incumbent.

From a political science standpoint, the results are essentially of political nature, given that they are in accordance to the fact that, despite some partisan differences between the two major parties in Portugal, which have being the support of all incumbents, those are not sufficiently clear to emerge in the clustering of the elections obtained by the SOM. This is a result that may as well be valid for other countries and/or future elections. A casual observation of recent episodes has been showing that the implementation of contractionary measures at the beginning of the mandate is more easily justifiable by the incumbent after a substitution of the party in power, i.e. after an electoral defeat of the previous incumbent. From this point of view, if the electoral cycles are to be important, the clustering of the elections in terms of the defeat or victory of the (previous) incumbent seems to be the expected result.

Given the apparent importance of space in the explanation of electoral results (Caleiro and Guerreiro [22], Caleiro [27]) a promising avenue for further research is the combination of the SOM methodology and of spatial clustering and/or GIS (Kaski and Kohonen [28], Skupin and Hagelman [29], Pablo-Martí and Arauzo-Carod [30]).

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REFERENCES

[1] Sargent TJ. [1993] Bounded Rationality in Macroeconomics. Oxford: Clarendon Press.
[2] Salmon M. [1995] Bounded Rationality and Learning: Procedural Learning. In Kirman A., Salmon M. (eds.) Learning and Rationality in Economics, pp. 236-275, Blackwells.
[3] Caleiro A. [2001] Essays on Election Dates, Economic Policies and Voters. Ph.D. Thesis, Economics Department, European University Institute, Florence (Italy).
[4] Nordhaus WD. [1975] The Political Business Cycle. *The Review of Economic Studies* 42(2): 169-190.
[5] Caleiro A. [2008a] How can Voters Classify an Incumbent under Output Persistence. Economics Discussion Papers n.º 2008-16, Kiel Institute for the World Economy (at http://www.economics-ejournal.org/economics/discussionpapers/2008-16/at_download/file; accessed on June 12, 2012).
[6] Gill GS. [2008] Election Result Forecasting Using Two Layer Perceptron Network. *Journal of Theoretical and Applied Information Technology* 4(11): 1019–1024.
[7] Chen CH. (ed.) [1996] Fuzzy Logic and Neural Network Handbook. New York: McGraw-Hill.
[8] Jiao Y. Syau Y.R. Lee ES. [2006] Fuzzy adaptive network in presidential elections. *Mathematical and Computer Modelling* 43: 244–253.
[9] Pearson K. [1901] On Lines and Planes of Closest Fit to Systems of Points in Space. *Philosophical Magazine* 2(6): 559–572.
[10] Hastie T, Stuetzle W. [1989] Principal Curves. *Journal of the American Statistical Association* 84(406): 502–516.
[11] Kruskal JB., Wish M. [1978] Multidimensional Scaling. Sage University Paper series on Quantitative Application in the Social Sciences, Beverly Hills and London: Sage Publications.
[12] Kohonen T. [1982] Self-organized formation of topologically correct feature maps. *Biological Cybernetics* 43: 59–69.
[13] Kohonen T. [1988] Self-Organization and Associative Memory. New York: Springer-Verlag.
[14] Kohonen T. [2001] Self-Organizing Maps. Springer Series in Information Sciences, Vol. 30, 1995; Second edition, 1997; Third, extended edition, 2001.
[15] Niemelä P, Honkela T. [2009] Analysis of Parliamentary Election Results and Socio-Economic Situation Using Self-Organizing Map. WSOM '09 Proceedings of the 7th International Workshop on Advances in Self-Organizing Maps, pp. 209-218, Berlin and Heidelberg: Springer-Verlag.
[16] Wall KD. [1993] A Model of Decision Making Under Bounded Rationality. *Journal of Economic Behavior and Organization* 20: 331–352.

CONFLICT OF INTERESTS

None

[17] Swingler K. [1996] Applying Neural Networks: A Practical Guide. London: Academic Press Limited.
[18] Rosenblatt F. [1958] The Perceptron: A Probabilistic Model for Information Storage and Organization in the Brain. *Psychological Review* 65(6): 386–408.
[19] Cho IK, Sargent TJ. [1996] Neural Networks for Encoding and Adapting in Dynamic Economies. In Amman H.M., Kendrick D.A., Rust J. (eds.) Handbook of Computational Economics, Vol. I, pp. 441-470, Amsterdam: Elsevier Science.
[20] Ellacott S., Bose D. [1996] Neural Networks: Deterministic Methods of Analysis. London: International Thomson Computer Press.
[21] White H. [1989] Some Asymptotic Results for Learning in Single Hidden-Layer Feedforward Network Models. *Journal of the American Statistical Association* 84(408): 1003–1013.
[22] Caleiro A, Guerreiro G. [2005] Understanding the Election Results in Portugal: A spatial econometrics point of view. *Portuguese Economic Journal* 4(3): 207–228.
[23] Gärtner M. [1996] Political Business Cycles when Real Activity is Persistent. *Journal of Macroeconomics* 18(4): 679–692.
[24] Caleiro A. [2009] How upside down are political business cycles when there is output persistence. *Research in Economics* 63(1): 22–26.
[25] Ramalho EA, Caleiro A, Dionísio A. [2011] Explaining Consumer Confidence in Portugal. *Journal of Economic Psychology* 32(1): 25–32.
[26] Caleiro A. [1999] What if Third Parties Disappear? A rational partisan note. *Estudos de Economia* XIX(3): 349–356.
[27] Caleiro A. [2008b] Uma perspectiva demográfico-espacial dos resultados eleitorais em Portugal. In Livro de Actas do XIV Congresso da Associação Portuguesa para o Desenvolvimento Regional, pp. 48–69, Coimbra. Available at http://www.decon.uevora.pt/content/download/5927/26956/file/2008_01.pdf (acessed on June 12, 2012).
[28] Kaski S., Kohonen T. [1996] Exploratory Data Analysis by the Self-Organizing Map: Structures of Welfare and Poverty in the World. In Refenes A-P.N., Abu-Mostafa Y., Moody J., Weigend A. (eds.) Neural Networks in Financial Engineering. Proceedings of the Third International Conference on Neural Networks in the Capital Markets, London, 11-13 October 1995, pp. 498–507, Singapore: World Scientific.
[29] Skupin A, Hagelman R. [2005] Visualizing Demographic Trajectories with Self-Organizing Maps. *GeoInformatica* 9(2): 159–179.
[30] Pablo-Martí F, Arauzo-Carod JM. [2010] Spatial distribution of economic activities: an empirical approach using self-organizing maps. Working Paper 2072/148482, Department of Economics, Universitat Rovira i Virgili.

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NEUROPROBABILITY - THE JANUS PROBABILITY THIRD FACE IN COURT

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ABSTRACT

Usually the probability theory is approached from a purely mathematical viewpoint or, not entirely in alternative, from a philosophical perspective. If one confines to the mathematical perspective, probability" must be seen as a primitive concept, in a Kolmogorov sense. To discuss the content of the concept, a more comprehensive framework of the Knowledge Theory is needed. In this paper it is intended to present another approach based on the concepts that are typical of Neuroeconomics, that go beyond the rationality either quantitative or qualitative. This may be described simply by the word "Neuroprobability". Reflections in the notion of probability, which began with questions related to hazard games problems, allowed a much more simplified approach in many problems that arise every day. But the emergence of different approaches, different schools, and the debate around it suggests that different scenarios allow different mind moves. The epistemological approach is supported following the subjective notion of probability, but not entirely denying that in certain phenomena another one may be adopted. And often some decisions about random events are taken in the form of pure reactions, not supported for any kind of reason, as it happens for example in Neuroeconomics, giving rise to what we may call a different concept of probability, the Neuroprobability.

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[I] INTRODUCTION

In this work it is intended to analyze the different forms assumed by the decision process, about random events, in what concerns mainly the one practiced by the judges in court. Indeed, courts necessarily have to make decisions under uncertainty, consequence of their own nature. They have to produce decisions related to the past events that must be evaluated, but sometimes they are not, in every presented case. Whenever it is mentioned traces or evidence, either scientifically or not, it is understood incompleteness of knowledge, therefore one has to assess uncertainty. A trace is a sign. To be able to say something more, one has to determine its importance, or weight, for each case, using knowledge and considering the hypotheses under evaluation.
The increasing development of the techniques and the methodologies also increase the need to properly evaluate the presented information. Thus, along with a qualitative assessment inevitably arises the quantitative, which reflects the uncertainty evaluation, in the case of the forensic context.

The probability theory can be approached from a purely mathematical viewpoint or, in another view, from a philosophical perspective. If one confines to the mathematical perspective, "probability" must be seen as a primitive concept, in a Kolmogorov sense. To discuss the content of the concept it is necessary a more comprehensive framework of the Knowledge Theory. The first significant developments in the mathematical theory of probability are dated on the second half of the 17th century undertaken by Leibnitz or Locke. Nevertheless the debate enlargement either on the use of mathematical tools or on what concerns the philosophical sense was established in the beginning of the 20th century.

The development of the mathematical probability theory shows that, from Fermat and Pascal to Laplace, the engine of growth set in the hazard games problems, although there were attempts to apply it, by some mathematicians, in other areas specially driven for the first social statistics data collections. There were also attempts aspiring to apply the mathematical approach to problems that intended to estimate the probability of an accused individual being guilty, based on the presented evidence. The earliest use of probabilistic arguments in legal decisions, even in an incipient form, seems to have occurred more than 18 centuries ago in Babylonia and Israel with the Jewish scholars.
The reflections related to the notion of probability, which began with questions related to hazard games problems, allowed a much more simplified approach in many problems that arise every day. But the emergence of different approaches, different schools, and the debate around it suggests that different scenarios allow different mind moves. Here it is supported an epistemological approach following the subjective notion of probability, but not entirely rejecting that to certain phenomena may be adopted another approach. It is assumed a conciliatory attitude as opposed to leave unanswered many problems. To consider probability Janus faced appears to be necessary in

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theoretical terms as in its interaction with the practical applications.
A third alternative is to consider what may be called subjectivity beyond rationality. One aspect of this alternative is that facing the same evidences and probabilities two different judges do not decide necessarily in the same way. The other is that although facing the evidence and the respective evaluation, the decision of a judge may differ in accordance with different stimulus experienced recently or older, even if the written decision is based in the evidence and the respective evaluation. One example of this kind of stimulus are the so called convictions, sometimes passions, the most of the times unexplainable, of the judges and in the same sense of the members of the jury, in jury trials.

It is this mode of dealing with probability that here is called Neuroprobability, the third face of Janus, maybe not very correctly but that emphasizes a different behavior, in face of the same situation, from those described by the two faces of Janus.
Similar situations are studied in the Neuroeconomics context where, for instance, acquisition of goods is determined not necessarily thinking in concepts like price, utility, evaluation, … but due to any stimulus supplied by the experience of the buyer: the advertising, a pleasant experience, …

[II] FOUNDATIONS OF PROBABILITY

The Probability Theory is a powerful tool to model the human, rational, behavior in this context. So, it is important to present its foundations. So considering a transcription in common language of Kolmogorov [1] construction it is usual to consider the probability space (Ω, A, P) in which:

- Ω is a fundamental non empty space - generally named outcomes space - composed by elementary events $w_i \in \Omega$;
- A is a non empty family of Ω subsets, closed for the usual Boolean operations. These sets $\{A \in \mathrm{A}\}$ are entities for which it is possible to associate a non negative real number, i. e., a probability;
- P is an additive function which domain is A, such as:
  If $A \cap B = \emptyset$ then $P(A \cup B) = P(A) + P(B)$.

Kolmogorov [1] also generalized the additive property for non finite spaces (Ω) provided with non finite algebras (A), but contrarily to what had been said he did not advance from the structure of algebra to a structure of σ-algebra. To force a structure A of subsets of Ω to be closed for operations of sets in non finite number gives rise to some small monstrosities which the observer is not able to identify.

One may have some prevention to the generalization of the additive property for non finite spaces provided with non finite algebras. The most common attitude consists in imposing to A a structure of σ-algebra and to substitute the last Kolmogorov axiom with the generalized additivity. In fact, this was not followed by Kolmogorov. He added a sixth axiom:

Axiom of continuity:

Considering $A_1 \supset A_2 \supset \ldots A_n \supset \ldots$ and $\bigcap_n A_n = \emptyset$ then $\lim_n P(A_n) = 0$. ■

He also added the theorem:

Theorem

If $A_1, \ldots, A_n, \ldots$ and $A \in \mathrm{A}$ and $A_i \cap A_j = \emptyset,\ i \neq j$ with $A = \bigcup_{i=1}^{\infty} A_i$ then $P(A) = \sum_{i=1}^{\infty} P(A_i)$. ■

Which demonstration results from the acceptance of the axiom of continuity.

The numerable additivity raises some objections within the Subjectivists (see Kyburg and Smokler [2]). In fact, Epistemological theories see the probability as a state of mental uncertainty about an event. These theories can be divided into logical and subjectivists theories. Logical theories suppose the existence of a single rational degree of uncertainty about the event. However, the problem is that it is not known yet. The subjectivist, but rational, interpretation has become more popular in the last years. Subjectivists regard probability as a degree of reasonable belief in a certain event, from an individual viewpoint. Therefore probability is a numeric subjective measure of a particular person according his/her degree of belief, as long as it is 'coherent' - avoiding the Dutch book.

Following Savage, see [3], an economist that used mathematical tools to model the Economic behavior, "It may seem peculiar to insist on σ-algebras as opposed to finitely additive algebras even in a context where finitely additive measures are the central object, but countable unions do seem to be essential to some of the theorems...

So much of the modern mathematical theory of probability depends on the assumption that the probability measures at hand are countably additive that one is strongly tempted to assume countable additivity or its logical equivalent, as a postulate. But I am inclined to agree with de Finetti and Koopman that, however convenient countable additivity may be, it, like any other assumption, ought not be listed among the postulates for a concept of personal probability unless we actually feel that its violation deserves to be called inconsistent or unreasonable.

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It therefore seems better not to assume countable additivity outright as a postulate, but to recognize it as a special hypothesis yielding, where applicable, a large class of useful theorems".

To Savage's objections one may add the de Finetti's, "No-one has given a real justification of countable additivity (other than just taking it as a "natural extension" of finite additivity); indeed, many authors do also take into account cases in which it does not hold, but they consider them separately, not as absurd, but nonetheless "pathological", outside the "normal" theory.

Countable additivity cannot, therefore, be conceived of as a general principle which leads us safely around within the special field, and allows us to roam outside, albeit in an undirected manner, with an infinite number of choices. On the contrary, it is like a good-luck charm which works inside the field, but which, on stepping outside, becomes an evil geni, leading us into a labyrinth with no way out", de Finetti [4].

These objections are very close within the careful thinking line in Kolmogorov approach that is not taking the σ additivity as an axiom - generalized of finite additivity - but instead consider that it works under certain conditions: axiom of continuity and circumstantial "closeness" - not structural - for a certain numerable union of events - $A = \bigcup_{i=1}^{\infty} A_i \in \mathrm{A}$.

[III] CONDITIONAL PROBABILITY: BAYES THEOREM

Taking into consideration the comments above, one may follow considering $A_1, A_2, ..., A_m$ a finite or non finite partition of Ω with

$$P(A_i) > 0, A_i \cap A_j = \emptyset,\ i \neq j, \bigcup_i A_i = \Omega .$$

Given any other event B, with $P(B) > 0$, it is easy to see the decomposition of B as a union of disjoint sets

$$B = \bigcup_i (A_i \cap B).$$

Consequently, assuming for the present case the additivity of the function P and the definition of conditional probability, then

$$P(B) = \sum_i P(A_i \cap B) = \sum_i P(B|A_i)P(A_i)$$

therefore

$$P(A_i \cap B) = P(B|A_i)P(A_i) = P(A_i|B)P(B)$$

and settling $P(A_i|B)$ it is obtained:

Bayes' Theorem (also called Bayes' Law)**:**

$$P(A_i|B) = \frac{P(B|A_i)P(A_i)}{P(B)} = \frac{P(B|A_i)P(A_i)}{\sum_i P(B|A_i)P(A_i)} .\blacksquare$$

Note:

- Considering

$A_i, i = 1, 2, ..., m$, as m hypotheses, $H_i, i = 1,2,...,m$, and B as data, being I the initial information, Jaynes [5] presents the Bayes's Theorem in a different way (see Andrade [6])

$$P(H_i|Data, I) = \frac{P(Data|H_i, I)P(H_i, I)}{\sum_i P(Data|H_i, I)P(H_i, I)} .$$

[IV] A COMMON PROBLEM

In each case the judge, or jury, has, necessarily, to make a decision - *Non Liquet* principle. Although it is a decision problem, it cannot be understood, studied and solved by the methodologies presented in the Decision Theory.

This context, in which there is always a decision, it is not adequate to use the "tools" of the Decision Theory, which is based on an utilitarian approach for the different possibilities - although there are also followers of the utilitarian theory among the Law area theorists.

On this concern, one can say that there is an agreement in the Law area: The task that the judge has before him is the following: to find a decision, solution, founded by the law, Engisch [7]. Perelman also states that the law as actually works is essentially a decision problem: the legislature must decide which laws are mandatory in an organized community; the judge must decide what is right in each situation brought to his trial, Perelman [8]. And also Larenz [9]: the judge's task is to determine legally factual situations that have occurred, and that there were only imagined.

What seems not to reach a consensus is that lawyers and statisticians may in some issues, to have to deal with similar problems. Of course, it is recognized that Statistics and Law are autonomous and deal with specific problems. In fact, *prima facie*, it seems that those sciences have little or nothing in common. Statistics immediately suggests a quantitative relationship with the phenomenon under approach, whereas Law, using argumentation, the laws and the decisions, which is

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taken following the contours of the laws and the consciousness of the "decider", presents a more qualitative treatment of the topics of interest. Even a layman in the field of Law, accepts that the disciplines are far more than that. Some might even admit that there will be eventually identical points between them. Following Dawid, "although the concerns of Statistics and the Law might seem to have little to do with one other, they do share some fundamental common interests, such as interpretation of evidence, hypothesis testing, and decision making under uncertainty", Dawid [10].

In what concerns those who operate in Law, whether in practice or theoretically, e.g. judges, lawyers, there is an almost unanimous shared idea that mathematics, in a general sense or, more specifically, some branches of Mathematics and Law are not related disciplines or even concilable. "It is not a mathematical formula ...", "It cannot be translated into a number ...". That is why the reasoning of a judge is dialectical opposite to the reasoning of mathematicians, who always walk in one direction, from premises to conclusions. (...) The reasons given by judges would be arguments that are not coercive, as in a mathematical proof, according Perelman [8]. These are examples of beliefs that will be encountered when seeking to inquire about sharing common interests between Statistics and Law, from latter's representatives. In fact, it is not intended to provide an algorithm or sensational formula as a solution, but rather to look for common elements, realizing that the problems that both deal with are, many times and in many ways identical. Although the approaches are different, broadly speaking their common interest is dealing with evidence interpretation.

The question that the judge has to answer is: After the case being presented what is the posterior probability of the facts based on evidence presented? The judge must evaluate the evidence presented and the arguments of the different parts, defence and prosecution, arguing about the hypotheses in dispute. Based on the exposed case, and using a reflective analysis regarding the situation under appreciation, and supported, sometimes also in their experience, the judge reaches a conviction and decides. As it is known the judge mission is to administer justice, and the whole decisions must be justified and grounded, which allows everybody to understand the reasons for either decision. It is important to mention that to accomplish a conviction the judge makes use of legal and not so legal reasons.

"The speakers who addressed the judge can rely on all the rules of law and procedures available to the process and the judge cannot refuse them without being guilty of a violation of the law. Moreover, it is according to those rules that the judge must support his sentence, so as to obtain the consent of their peers, their superiors and the opinion of jurists, on the fact that has issued a decision according to the Law. It is known that, along with rules of law that anyone seeks to challenge, or to interpret its own way, the whole Law system contains a sufficient number of uncertainty elements, which gives the judge enough freedom, and depends on both the inner conviction of Judge regarding the establishment of the facts, that the judges' personality always plays a role, sometimes limited, but often also decisive in the process and its result", Perelman [8].

As Perelman stated in Law one is faced with the dialectic of the reason and the will versus the reality and the value, being the reason and the reality the objective part, the one that the judge must take into account and should be leaning, providing the will and the value subjective part which depends, ultimately, of the judge's decision, Perelman [8]. "Acknowledging the power of judge's decision that manifests itself through the subjective part, it should be noted that this power is not arbitrary, i.e. it is not an optional or despotic power which the judge can use without control, since all decisions must be reasoned. Whatever functions can the irrational sources of the discovery of the judicial statements or the decision perform, the judge confronted in his position (function) and conscience, only can feel justified when his decision may also be based on the Law , which means being derived from it", Engisch [7].

Thus, it is possible to agree that the Law operates with decision making, which is not contrary to reason whenever justified by an argument that is recognized. It is true that conclusions of the arguments are not compelling, and so to agree with all convictions.

The argument based on the evidence presented may allow influencing the direction of the decision, supported by the most convincing arguments, but it is not the only way in concrete situations. Other kind of "reasons", may be called "non-reasons", as the stimulus described above may influence either the initial conviction of the judge or the final appreciation after joining that conviction with the appreciation of the evidence. Cultural aspects, prejudices, education, convictions may be joined or even replace the computation of probabilities and the legal aspects in the building of the decision. And even the appreciation of a number may differ from a judge to one another according to those factors.

This mechanism of belief creation may be interpreted as the replacement of the probability computation by the consideration of a probability built through neuro-stimulus: the so called Neuroprobability.

[V] FROM TWO TO THREE JANUS FACES

The philosophical meaning of the probability concept has originated very different ideas. Consequently in an initial moment, four main currents of interpretation appeared. Following Gillies [11], these interpretations can be summarized as follows:

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- Logic Theory which identifies probability with a reasonable degree of uncertainty. It considers that before the same evidence all rational human beings have the same belief in a certain hypothesis;

- Subjective Theory which identifies probability with a degree of belief that each individual has in a certain hypothesis. It is allowed the difference of opinion between different individuals;

- Frequency theory that defines the probability as the "limit" of proportion of successes in a sequence of experiences;

- Propensity Theory to which the probability is an inherent propensity within a set of repeatable conditions – actual or virtual – (Among those who advocate logical theory of probability was John Maynard Keynes who stressed his more philosophical aspect, for whom the probability is defined as the degree of partial causality (*probability is the degree of partial entailment*). Ramsey and de Finetti, independently, were the forerunners of the ideas concerning the subjective theory of probability, during the 1920s and beyond. The frequentist theory initially followed by Ellis and Venn was later developed by Reichenbach and von Mises two thinkers closely linked to the Vienna Circle. The propensity theory was introduced by Karl Popper in 1957 and latter developed and explained in his works in 1983 and 1990).

During the historical discussion different approaches of the concept have risen, however a systematic classification has not been consolidated. In 1983 Murteira [12] has noticed that compared to the antagonism between the Classical and Bayesian Box attempt through a dualistic theory of statistical inference to reconcile them, Murteira [12], for whom the doctrines more than competing, are complementary. Box "ecumenism" is reflected in a division of the work: to Frequencists the critical (the model is adequate?), to Bayesians the estimation (if the model is adequate then estimate the parameters!), Murteira [12]. In 1994 Gillies [11] proposes to divide the interpretations of probability in Objective and Epistemological. The objective interpretations consider probability as a property of material world, where human knowledge through observation, will quantify the uncertainty, i.e., the uncertainty is in nature. The epistemological interpretations conceive probability as related to the degree of belief or knowledge of human beings. According to this perspective the probability measures the degree of knowledge or belief of each individual, moving the uncertainty into the perspective observer/ phenomenon.

These two conceptions of probability describe the rational approaches to random events appreciation. The emphasis intended here is on what is beyond this rationality even when people thinks that it is acting rationally. In fact, the ambience – time, local, mental, … - influence the behavior of anyone not necessarily in what it called a rational mode.

In the Roman tradition Janus was the god who gave his name to January, god of the beginnings had two sides in its representation - perhaps one looking to the past and the other looking to the future. Since mid-nineteenth century, with Poisson, Cournot and Ellis, it is mentioned the two sides of probability, Hacking in 1975 calls it the two faces of Janus: ... probability... is Janus-faced. On the one side it is statistical, concerning itself with stochastic laws of chance processes. On the other side it is epistemological, dedicated to assessing reasonable degrees of belief in propositions quite devoid of statistical background, see Gillies [11] and also Andrade and Ferreira [13].

It is following this line why it is proposed the name "third face of Janus" to describe the interpretation and the evaluation of probabilities subject to neuro-stimulus, the Neuroprobability, influencing the decision process.

In fact, the interpretation of probability concept is still a subject of intense debate, and even among the supporters of an approach are differences. It seems, however, that, in the essence, the distinction lies in this distinction between objective interpretation and epistemological interpretation of probability.

What has been observed is that the different approaches to uncertainty have declared these two conflicting interpretations. Beyond these interpretations and their consequent proposals of behavior it must be considered, in this context, the "third face of Janus" characterizing behavior.

Uncertainty is in nature and repetition is the mechanism used to determine it, argue the objectivist. But if that is accepted, then there are many problems left to unanswered arising every day, for not be incurring into contradiction. Uncertainty evaluation is supported on nature-observer for the epistemological approach, which does not state a kind of "prescription", but opens the perspective to subjectivity and to a certain plurality of mechanisms.

On one hand the objectivist current argues for the repeatability in what concerns probability, on the other epistemological current attempts have been made to establish some agreement, seeking for an enlargement of the concept.

The subjectivist school while rejecting the essential character of the frequencist theory, does not rejected it to be considered in a process that allows "repetition" and frequency analysis as an element of information in the process. Although this is a tolerant kind of approach it is also an agglutinating proposal, recognizing the viability of the process, frequency analysis, removing the autonomy as a current and coherent. The frequency analysis can be, among others, an element of

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information, but more than one element can be considered a particular case, is only available to a limited number of cases. It can provide information in some cases therefore can be included in its evaluation.

The "repetition" is not essential for Neuroprobability. One only stimulus may be determinant in the conviction building. Although not rejecting it it is not essential. This fact differentiates definitively this probability concept from the others.

In Philosophical Theories of Probability, Gillies [11] describes the various theories and their philosophical meaning, proceeding with a proposal. Gillies [11] advocates a pluralistic view of probability, and admits adopting either of the objectivist or of the epistemological current, depending on the type of phenomenon or process under study, therefore trying to reconcile the concepts and their own daily practical decisions in the most various problems.

If one wants probability to become truly an operational tool in the most diverse areas as hazard games, physics, quantum or deterministic, or even the social sciences, it is important to reach the operationally of the concepts and their connection with specific methodologies in the different application areas, so that the purposes may be achieved. It seems appropriate to consider that certain phenomena exist *per si* regardless the observer and others exist only if observed, Why not to adopt different approaches in different situations?

The Neuroprobability cannot be considered an operational concept. One only may influence it trying to find the adequate neuro-stimulus, there having a lot of examples in the speeches of the counsellors in the final allegations.

The first reflections relating to the probability concept began with the hazard games. Thus, a more simplified approach was allowed. The emergence of different approaches, different schools, and the debate generated by them suggests that different scenarios allow for different approaches. For our part it is preferred a subjective epistemological approach, but it is not absolutely rejected that to certain phenomena it is adopted a different approach. It is admitted a conciliatory attitude in opposition to leave unanswered many problems. Reaffirming the probability two Janus faces, it is necessary to consider them when mentioning probability, in theoretical terms and when related with the practical applications. But of course it is imperative to note that the Neuroprobability is always present, independent of our will. So the consideration of Janus third face.

[VI] DISCUSSION: WHICH FACE TO CHOOSE

The ever-increasing ease of communication among different areas of knowledge and the amount of problems that arise reinforce the need to question: which probability concept to adopt? What and how to articulate application of the concept (s) to the practical question (s).

It is not indifferent to opt for one or another probability concept. Following Dawid "even without (before) one chooses an interpretation it can be considered that "probability" as a purely theoretical term, inhabiting the intellectual universe and without any direct physical counterpart", Dawid [14], being indirect the link between theoretical probability and the physical universe. In this context, the knowledge of the phenomenon under study, supported by the convictions of the "agent", leads the choice of which interpretation to use, in each case.

Given the diversity of problems that arise, the ambition to take advantage of the concept that allows the search for different solutions, which should be wide-ranging? Although there may be (and there always is!) a preference for an interpretation of probability, to make the concept malleable allows us, for sure, a greater number of better answers.

One can say that the core element of Statistics lies in the inference. Indeed, the observation of some data for a particular phenomenon leads in making statements and inferences about one or more unknown characteristics of the system or mechanism that caused it. And that was probably what motivated the work of John Graunt (1662) Natural and Political Observations on the Bills of Mortality, which can be considered an attempt to collect data on births and deaths and the subsequent extraction of conclusions.

Note that, since the mid-seventeenth century some mathematicians have tried to apply their theory to the available empirical evidence. However, recourse to the application of mathematical theory to study real world problems has begun in a strict context of hazard games. It took some time until it could be successfully applied to economic/social practical problems. But, the theory maturation allowed finding innumerable practical applications either in natural sciences or in social sciences.

There were already presented different notions of probability that in practical applications may be different for different particular contexts. If it is true that physical phenomena often originate a large amount of repetitive information, there may not be disregarded social phenomena that are of high interest to human activity, which by their nature do not allow repeatability. The lack of quantitative theories successful in these situations stimulates the need to introduce operational procedures for quantifying what is qualitative by nature.

In court it is preferred to follow a subjective epistemological approach. But it is not absolutely impossible that for certain phenomena a different one is adopted. Reaffirming the probability two Janus faces, it is necessary to consider them

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when mentioning probability, in theoretical terms and when related to the practical applications. This is the recommended procedure in court combining the conviction of the judge, jury, with the practical, experience, knowledge, i.e. the subjective and the objective probability concepts.

The Neuroprobability as it was seen above is not a question of option but of presence. And the counsellors intuitively know it very well.

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CONFLICT OF INTERESTS

The authors declare no conflict of interests.

REFERENCES

[1] Kolmogorov AN. [1956] *Grundbegriffe der Wahrscheinlichkeitsrechnung*. Berlin: Julius Springer, (1933) (in German). Translation: Kolmogorov AN., *Foundations of the Theory of Probability* (2nd ed.). New York: Chelsea.
[2] Kyburg HE,, Smokler HE. [1964] *Studies in Subjective Probability*. John Wiley and Sons, New York (1964).
[3] Savage LJ. [1954] *The Foundations of Statistics*. John Wiley and Sons, Inc. New York .
[4] de Finetti B. [1974] *Theory of Probability*. John Wiley and Sons.
[5] Jaynes ET. [1995] *Probability Theory - The Logic of Science*. http://bayes.wustl.edu/etj/prob/book.pdf.
[6] Andrade M. [2010] A Note on Foundations of Probability. *Journal of Mathematics and Technology*, 1 (1):96–98.
[7] Engisch K.[2001] *Introdução ao Pensamento Jurídico*. Fundação Calouste Gulbenkian.
[8] Perelman C. [1990] *Ética e Direito*. *Colecção Direito e Direitos do Homem*. Instituto Piaget.
[9] Larenz K. [1997] *Metodologia da Ciência do Direito*. Fundação Calouste Gulbenkian.
[10] Dawid AP. [2005] Statistics on Trial. *Significance*, 2: 6–8.
[11] Gillies, D. [2000] *Philosofical Theories of Probability*. Routledge.
[12] Murteira B JF. [1988] *Estatística: Inferência e Decisão*. Imprensa Nacional - Casa da Moeda.
[13] Andrade M, Ferreira MAM. [2010] Janus probability two faces in court. *Journal of the Greek Statistical Association*, 6: 3–14.
[14] Dawid AP. [2004] Probability, Causality and the Empirical World: A Bayes - de Finetti - Popper – Borel Synthesis. *Statistical Science*, 19: 44–57.

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MEASURING STORE EMOTIONAL EXPERIENCE THROUGH FACIAL ELECTROMYOGRAPHY AND SKIN CONDUCTANCE

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ABSTRACT

Over the years, the retail industry has experienced many mutations. Therefore, characteristics such as fast adaptation and the ability to make right strategic decisions will most likely lead the company to achieve its intention: generate profit. In order to achieve such situation, knowing your client is the right tool to get the intended goal, so techniques and studies to understand customer behavior have been proliferating. In addition, there is increasing interest in customer experience and the impact that such situations have on customer buying behavior. Therefore, this project applied in a hypermarket of a retail company works as a constructive element on how to develop a Neuromarketing study, where the main goal is to analyze the emotional impact that basic experiential simulation, associated to variables identified on the in-store environment, has on potential customers. Finally, despite the results have not been as conclusive as expected, the experiential environments generated a slight activation that points towards a positive emotional responses.

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[I] INTRODUCTION

Over the years, the retail industry has faced many complex changes and mostly the market itself has turned highly competitive. Based on this idea, many retail brands are focusing on new variables such as staging experiences within the in-store variables universe. This intention implied an obligation of really know and understand consumer behavior. In this paper we present evidences of a Neuromarketing study that used innovative psychophysiological techniques to the in-store experience.

The main objective of this article is to extract and analyze customers emotional response to the experiential environment staged. Moreover, as second level goals, this project works as constructive element on how to use a different market research tool.
In order to achieve the goals of this project, the conceptual model establishes the foundations of the project, based on three empirical/conceptual models.

The models are Pine and Gilmore [1] on how to stage experiences, Turley and Milliman [2] as identification framework of in-store environment variables and finally Peter Lang [3] integrative model, the major conceptual tool to extract information and measure the identified in-store variables simulated in an experiential way. The psychophysiological techniques in stake in this paper were EMG and SC activation.

After collecting the data; the following step included its statistical analysis through descriptive statistics and validation of the variables significance using Student t' test and Anova. These methods allowed a proper analysis and a conclusion based on statistical evidence.

[II] MATERIALS AND METHODS

2.1 Retail Industry

Acknowledging an increasing competition, Grewal *et al* [4] argued that customers' are demanding and willing to buy in a large variety of stores, given that they are always looking for the products that really fulfill their needs at the best price. Thus, maintaining a customer has become more and more complicated. Therefore there are some important levers of retail success to be taken into account. Grewal *et al* [4] proposed six major retail success levers: store factors, merchandise, supply chain, service factors, price, and technology.

2.2. Experience

In order to proceed with the concept of experience, Sands *et al.* [5] presented two existing models, one by Pine and Gilmore [1] and the other by Schmitt. The Schmitt's model characterizes by a typology of experience built on five key dimensions: Sense, Feel, Think, Act, and Relate (Sands *et al* [5]). On the other hand, Pine and Gilmore model, considered more fairly operational by Sands *et al.* [5], is based on building experiences upon four experience realms: aesthetic, educational, entertaining and escapist Pine and Gilmore [1].

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Based on the stated above, Sands *et al* [5] argued that Schmitt's model appears to be appropriate to build brand experiences, while Pine and Gilmore model is a proper tool for the retail industry. Therefore, I'll dedicate my attention to the Pine and Gilmore's Model Pine and Gilmore [1].
Firstly, Pine and Gilmore [1] introduced their model by explaining the two dimensions of experience, one about the participation and the other about the unity or emotional bond created.

Regarding the first one Pine and Gilmore [1] argued that consumers can lie in two spectrums: passive participation - the consumer is a mere viewer of the event; active participation - originates from the consumers' ability to interact in the experience. In what the other dimension is concerned, Pine and Gilmore [1] divided it in two spectrums too: Absorption and Immersion. Absorption - the experience's ability as an assimilation event; Immersion - the ability to interact with the customers in a more deeply engaging moment.

Supported on these dimensions, Pine and Gilmore [1] purposed four realms constructed along the two dimensions. The four realms are Educational, Escapist and Esthetic or Aesthetic and Entertainment Pine and Gilmore [1].
In the realm of entertainment, the customer participates passively in the experience and the connection with the experiential environment is by absorption Pine and Gilmore [1].
As for the Educational realm, it involves the customers' active participation and absorption connection.
Concerning an Escapist experience, consumers' participate actively in the experiential environment and their connection is by immersion Pine and Gilmore [1].
Finally, Esthetic or Aesthetic experiences involve the customers' immersion in the event, but contrary to Escapist they participate passively Pine and Gilmore [1].

2.3. In Store-Atmosphere

The term atmospheric connected to in-store was firstly coined by Kotler according to Sands *et al* [5]. Moreover, Sands *et al* [5], based on Turley and Milliman [2], argues that since Kotler many researches have been made to investigate the impact of visual, aural, olfactory and tactile dimensions in the behavioral aspects.

Therefore, Turley and Milliman [2] showed that atmospheric variables can be constructed in order to generate stimuli that will affect the consumers and, in consequence, result in a behavioural response. Consequently, they also stated that an atmosphere that leads to certain stimulus at a given point in time, can also change and lead to contrasting stimulus later on Turley and Milliman [2].

In-Store Environmental Variables

To explore in-store environmental variables, one needs to identify the variables in cause. In order to do so Turley and Milliman [2] based on Berman *et al* [6], proposed a framework divided in five categories. The 1st four categories were the exterior of the store, the general interior, the layout and design variables, and the point-of-purchase and decoration variables. The last category presented by Turley and Milliman [2] was the human variables.

Focusing on the most relevant categories of in-store variables for this paper, first there is the General Interior Variables Turley and Milliman [2] that include: Flooring and carpeting, lightning, Tobacco smoke, Ceiling composition, Merchandise, Music, Scents, among others variables.

Turley and Milliman [2] came to the conclusion, that general interior variables influence behaviors such as approach/avoidance, time spent and sales. Moreover, they also identified that the most studied general interior variable is Music.

Concerning this category Turley and Milliman [2] identified 14 empirical studies directly linked to this category. And according to the authors, most of the information regarding variables in this category leads to conclude influences such as impact on consumer choices and on sales.

Another relevant category indicated by Turley and Milliman [2] was Point-of-Purchase and Decoration. The variables included in this category are: Point of purchase display, artwork, signs and cards, product display, wall decorations, usage instructions, degrees and certificates, price display, pictures and teletext.

Finally, the last Category identified by Turley and Milliman [2], Human Variables includes the following variables: Employee characteristics, customer characteristics, employee uniforms, privacy, and crowding.

Turley and Milliman [2] added this category to the Berman *et al* [6] model. The authors identified two subareas, influence of other customers and the influence of employees Turley and Milliman [2]. Regarding the first subarea, Turley and Milliman [2] stated that most literature is centered on the crowding variable. The other subarea, more important for this study, is identified in Turley and Milliman [2] as one critical aspect. The reviews of studies lead the authors to conclude that these variables create impact on consumer behavior, both positive and negative

2.4. Neuromarketing

2.4.1. The existing Market research

Currently there is a debate around all the ranges of market research techniques and studies, and their accurate outcome.
Ariely *et al* [7] argued that despite all the range of techniques available for marketers and managers, all of them present some arguable level of realism and quality of data, leading therefore to possible unsound moves.

According to Ohme *et al* [8] this flaw was previously also indicated by others researchers, who considered that the existing market research tools have problems to measure clients behavior at a subconscious and emotional level.

Furthermore, even if Noble admits that those market research techniques and studies have positive aspects, he also adds that they have an important weak point that should be acknowledged, from what people say and think there is a big difference (Lawton *et al* [9]).

2.4.2. Neuromarketing

This discipline appeared, according to Lawton *et al* [9], in University laboratories in an attempt to understand what goes inside consumers' head. Therefore, Neuromarketing comprehends the use of neuroscientific methods to explore consumers' behavior and reactions to marketing stimulus Lee *et al* [10]. Or even, the discipline that focus on analyzing consumers' (conscious and unconscious) response Valentine *et al* [11].

According to Anonymous [12], Neuromarketing covers five major areas. The areas are brands, products, packaging, advertising and in-store environment Anonymous [12].
In consequence Neuromarketing reveals to be an important tool in decoding consumer behavior at a subconscious level. Therefore, by applying neuroscientific techniques Marketers aim to be able to measure effectively marketing stimuli, such as interest, preference, satisfaction, attraction, attention, and emotions.

2.4.3. Neurometric: Emotions

According to Castellar [13] emotional reactions are normally a consequence of environmental stimulus surrounding a person. He argues

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that what distinguishes emotions from other types of behaviour is there unconscious root, Castellar [13].

2.4.3.1 Identifying emotions

According to Machleit *et al* [14], in order to measure emotional response, Marketing often recurs to three models of the psychology subject. Those models are differential emotions theory Machleit *et al* [14], eight basic emotion categories Machleit *et al* [14], and pleasure, arousal and dominance dimensions of response Machleit *et al* [14]. As observed, the existing methods are tightly connected to interrogative techniques.

In order to study emotions, Castellar [13] presented three ways to properly analyse emotional responses: verbal information, external behaviour and physiological response. These three ways were also referred by Hazlett *et al* [15].

A) Verbal Information

As Castellar [13] noticed verbal information allows inferring experiential information. This way to explore emotions is cognitive and interrogative, hence emotional conclusions are a result of human answers that possibly will be rational and conscious (although the processes behind these answers might be unconscious).
Nevertheless, as Hazlett *et al* [15] indicated, there is some agreement in the research world that the verbal measurement of emotions present limitations. According to them, emotions are not a language-based process; rather it should include cognition in order to properly infer the emotions of an experience through words

B) External behaviour

Pointed out by Castellar [13] as the emotional behaviour that is manifested by approach or avoidance movements, contacts and interactions with persons or objects, or even gestures and facial expressions.

C) Physiological response

Finally, according to Castellar [13], physiological response are changes in human body resultant from emotional response. This creates two categories of emotional responses, a positive or a negative.Castellar [13] also clarifies that these responses only can be access through a set of psychophysiological techniques. The techniques access different parts of the nervous system: autonomic (such as the electric activity of the skin); somatic (e.g., Electromyographic activity or also known as the muscular activity); and finally central (e.g., electroencephalographic activity or evoked potentials, both related with Brain activity).

2.4.3.2 Psychophysiological models

Castellar [13] indicated that psychophysiological models are divided in three main contradictory ideas, which are Central-peripheral, cognitive-physiological and dimensional-specificity. An overview done by Castellar [13] identifies the existing psychophysiological model. In this paper we only explore the integrative model of Peter Lang.

Integrative model of Peter Lang

Castellar [13] identifies Lang as the developer of the theory on emotions. According to him, Peter Lang [3] looked at emotions not as a unitary phenomenon but as a phenomenon which implies three independent systems (external conduct, verbal information and the physiological response).

This proposition implies the existence of a hierarchical structure composed by an inferior level in which the specificity dominates and a higher level where dimensionality predominates Castellar [13]. This situation is easily understood by an experimental project done by Lang, relating Skin Conductance (specificity) and Evoked Potentials (dimensionality) as dimensions of Arousal.

Relatively to the divergence on Central-peripherals and physiological-cognitive, Lang understood that emotions can be manifested through cognitive, behavioral and physiological responses Castellar [13].
In conclusion, Lang purposed a model that is at the same time peripherical and central, physiological and cognitive, and finally dimensional and specific Castellar [13].

2.5. Psychophysiological techniques and the physiological response

Electrodermic activity

According to Mandryk *et al* [16] and Castellar 13], this type of technology extracts information from the palm of the hands, i.e., existing glands in the hands react to psychological and thermal conditions. Focusing on the first condition, the psychological significance of the Electrodermic activity is associated to biological factors of environment adaptation Castellar [13].

From a technical point of view, there are two procedures to measure Electrodermic activity. The first, the endogenous, allows the registration of the natural activity of the sudoriferous glands through the placement of two electrodes (Monopolar).

The second procedure (exogenous) measures the resistance or the conductance of the skin. In order to do so, two electrodes are place in the palm of the hand where there is sudoriferous activity Castellar [13].
Moreover, as Ohme *et al* [8] notice, conductance of the skin permits the analysis of changes resultant from the activation of autonomic nervous system. That activation is an indication of arousal (Ohme *et al*) [8], which in consequence is a reaction that reflect emotional response Mandryk *et al* [16].

Nevertheless, the limitation of this technique, according to Ohme *et al* [8], is the ability to measure the level of arousal, not the direction of the emotional response. Therefore, the real emotional measure of a stimuli could not be defined on its own, but it is also true that it could work effectively combined with other techniques as a validation or correlative tool.

Finally, methodologically speaking, Castellar [13] indicated that the electrodes should be placed in a bipolar way in the intermediate phalanges of the index and middle fingers).

Electromyographic activity (EMG)

The Electromyography measures the muscles activation based on their contraction resultant from an electrical reaction Mandryk *et al* [16] and it is considered the principal psychophysiological measure of the somatic nervous system Castellar [13].

Moreover, Ohme *et al* [8] also showed that several researchers validated the Electromyographic (EMG) activity as a method of both emotional valence and intensity.
According to Castellal [13] there are two general ways to measure the Electromyographic activity.
The first has a preferably neurophysiologic use and consists in registering activity through the placement of an electrode needle under the skin Castellar [13].
The second has a preferably psychophysiological use and consists in registering activity of determined muscles through the placement of superficial electrodes Castellar [13].
According to Dimberg *et al* [17], Ohme *et al* (2009) [8] and Mandryk *et al* [16], the muscles identified in the face, as eliciting emotional responses, are the Zygomaticus major (positive emotional response) and Corrugator supercilii (negative emotional response).

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Finally, Mandryk *et al* [16] stated that the major disadvantage of this second EMG procedure is the fact that results can be distorted by other muscle activity - talking for instance.

Technology Available to perform Neuromarketing

Looking over the technologies available, it is important to have in mind that there is an opposition between technologies, due to its different applications and outputs.
If neuroimaging technologies work entirely in a neurophysiologic level, adjusted to Central and Dimensional perspectives, psychophysiological technologies are used as a way to extrapolate physiologic information, which is clearly linked with peripheral information presented concerning emotions.and specific perspectives, as it could be acknowledged from the information presented concerning emotions.

Neuroimaging Techniques

The table below **[Table-1]** shortly explains the characteristics of the three most used technologies in Neuromarketing studies.

Table 1: Neuroimaging techniques (Source: Adapted from Ariely *et al* [7]; and Perrachione *et al* [18])

Neuroimaging Techniques			
Technique	**Instrument**	**Physical Measure**	**Applied Measure**
fMRI	MRI Scanner	Blood Oxygenation level dependent-BOLD	Metabolic activity
EEG	Electrodes in the scalp	Electrical field in the cerebral cortex	Neural activity
MEG	Requires a magnetically shielded room	Magnetic fields	Neural activity

Psychophysiological Techniques

Regarding these technologies, their usability has been essentially in psychology or related sciences that study human behavior. So, in the scope of Neuromarketing, its use is scarce and the existing studies were performed relatively to advertising, as can be confirm in the research of Ohme *et al* [8]. From all the technologies available to study emotional response, Castellar [13] argued that psychophysiological techniques were the most influential, due to its advantages to register peripherical changes in the human body in result of emotional response. Despite the scarcity of information, the psychophysiological techniques identified by Perrachione *et al* [18] were Voice Pitch analysis (VPA), Galvanic Skin Response (GSR) and Eyetracking. Here should also be included the Electromyography (EMG) **[Table-2]**.

Table 2: Psychophysiological techniques (Source: Adapted from Perrachione and Perrachione, Perrachione *et al* [18] Added EMG information based on Castellar [13]

Psychophysiological Techniques			
Technology	**Instrument**	**Physical Measure**	**Applied Measure**
VPA	N/A	Vocal cord vibration	"Arousal"
GSR (SC)	Electrodes in the palm of the Hand	Skin effects	"Arousal"
Eyetracking	N/A	Pupil Dilatation	"Arousal"
EMG	Electrodes placed in the face	Skeleton-Muscle	Affective valence

Conceptual Model

The three main authors that structure my project are Turley and Milliman [2], Pine and Gilmore [1] , and Castellar [13]. First, Turley and Milliman [2] proposed a reviewed categorization framework. In Table-3 we adapt the variable chosen to the categorization and present some examples of empirical studies made on each of the in-store variables. Second, to properly explore and study the experiential construct, we present the Pine and Gilmore Model Pine and Gilmore [1] on how to stage experiences. This model helps to identify a strategy when developing an experience **[Table–3]**.

Table 3: Model to stage experience (Adapted from Pine and Gilmore [1]).

Conceptual Model to Stage Experience			
Developed by	Variable	Customer	
Pine and Gilmore (1998)	Entertainment	Passive participation	Absorption
	Educational	Active participation	
	Escapist	Active participation	Immersion
	Aesthetic	Passive participation	

Regarding the cognitive dimension, the purpose is to apply and interpret a cognitive questionnaire that centers on the valence dimensions: like and interest. The physiological dimension uses two supporting techniques, EMG and SC. The Electromyography (EMG) records the electrical activity of the facial muscles in which two muscles are identifiable, Zygomaticus Major and Corrugator Supercilii. Each muscle brings forth different conclusions, the Zygomaticus reacts with higher activity in a positive

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emotional stimuli, the Corrugator is strongly activated by negative emotional stimuli. The Skin Conductance records the arousal level.

Due to the inability to infer whether the arousal level symbolizes a positive/negative emotional reaction, it will work as a supportive tool of the results on the EMG.

Finally, the Integrative model of Peter Lang Castellar [13], it is included as a way to structure conceptually the measurement of the emotional response **[Table-4]**.

Table 4: Conceptual Model to analyze emotions (Adapted from Castellar [13])

Used by	Identifying Emotions	Proposed by	Models	Dependent Variable	Technique used
Castellar (1996)	Physiological Response	Peter Lang (1968)	Physiological	Emotions	EMG
					SC
	Verbal Information		Cognitive		Questionnaire

[III] RESULTS

The data was validated and analyzed through the combination of channels. Here channels are Zygomaticus, Corrugator, Skin Conductance and Cognitive answers.

Glasses product

Firstly, it is important to state that the differences between the two conditions in the different channels (EMG-Zygomaticus and Corrugator; SCL), in this scenario, were not significant, meaning that in all comparisons the $\rho>0,05$. This information can be confirmed in the SPSS Outputs 1, 2, 5 and 6 in appendix (pages 64-66). In light of this evidence, the hypotheses are analyzed through the average activation of the EMG (Zygomaticus and Corrugator), the average arousal level of the SC and the relative frequencies of the cognitive questionnaire.

The results of the statistical tests showed that there is no statistical significant difference between the samples tested. Moreover, in general terms, from the four hypotheses formulated only the H4 turned to be valid.

In order to reach some conclusions, a second level analysis showed through average activation per channel and relative frequency per question of the cognitive questionnaire that, there are slight evidences in the data that point in the direction of Corrugator) is considered to point in the direction of a negative emotional response to the lack of experiential environment.

Concluding, although the statistical tests do not validate the difference between samples tested, I consider that in general terms a situation simulated with an experiential construction (lightning presence) points out to a positive emotional response, while the lack of an experiential construction (lack of lightning presence) points out to negative emotional responses.

Pillows product

Regarding this scenario, once again the statistical tests performed (ANOVA for repeated measures) showed no statistical significance ($\rho>0,05$) on the samples tested (SPSS Outputs 3,4,and 7 pages 64-66 in appendix). Consequently, the validation of hypothesis is done by analyzing the average activation of the EMG (Zygomaticus and Corrugator), the average arousal level of the SC and the relative frequencies of the cognitive questionnaire.

Hence the results of the statistical tests showed that there is no statistical significant difference between the samples tested. Moreover, from all the eight hypotheses formulated only the H11 was considered valid. So, to reach some statistical directions I analyzed the information based on a descriptive statistics (Second level analysis).

experiential environments being associated to positive emotional responses. To reach this direction, I consider the average activation of the zygomaticus (slight higher activation in the lightning situation) and the answers to the cognitive questionnaire (higher relative frequency of answers to the light situation). So, despite the hypothesis H1 has not been considered valid, the second level analysis shows that it points in the proper direction of the formulated hypotheses. This information linked with the validation of the hypothesis H4, evidences that the data extracted from the considered channels (Cognitive questionnaire and EMG-Zygomaticus) points in the direction of a positive emotional response to the experiential environment simulated.

The opposing simulated situation (no light), points out to a negative emotional response. To reach this direction, I reflected on the information extracted through SC and Corrugator channels. Regarding the Corrugator channel, the average activation revealed to be slightly prominent in the no light situation, which means that the information extracted and analyzed at a second level points in the direction of the formulated hypothesis (H3). Concerning the arousal level, I consider that the information analyzed at a second level revealed that the arousal level was slightly higher in the no light situation. This means that the extracted information points in the direction of not validating the hypothesis formulated (H2). Therefore, the information extracted from these two channels (SC and EMG-

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Starting with the simulated situation that includes the presence of store employees' as educational help, the information was validated through the EMG-Zygomaticus and Skin Conductance channels. The evidences found on the hypothesis formulated (H7, H8) point out to a positive emotional response. Hence, the analysis of the average activation (Zygomaticus) and average arousal level (SC) suggests slightly higher results, that point in the direction of a positive emotional response for the presence of store employees' as tool of educational help.

In what concerns the situation with the educational posters in the scenario, the information was validated through cognitive questionnaire. In this situation I had, in fact, a hypothesis that is valid, H12. Moreover, it should be noted that in this situation it was registered the second highest average arousal level (SC channel). Nevertheless, the hypothesis H6 was not considered to point in the right direction. Assuming these evidences, I consider that the educational posters point out to a positive emotional response, mainly through the result of the cognitive questionnaire (higher relative frequency), despite being a weaker experiential variable (only one channel point consistently in this direction).

Also regarding the two previous situations (employees' presence and Posters) simulated in the pillows scenario, it should be noted that the results of average activation of the Corrugator channel could be understood as pointing out to a negative emotional response. Nevertheless, this situation can be explained through the effort that each candidate made to read the information in the posters and to visualize better the store employee. Acknowledging this, I have to note that this type of experience should not be considered when thinking in consumer response to store environmental variables studies through psychophysiological techniques.
Finally, regarding the scenario that includes a situation without any kind of educational help, the evidences extracted from the hypothesis formulated (H9 and H10) do not point out to a negative emotional response. Nevertheless, the only channel that could point out to a negative emotional response is the cognitive questionnaire. In this case, since the Corrugator channel results were influenced by meaningless facial activity, due to an effort to read and to properly see the store employee, this situation was not considered to point in any direction.

In conclusion, despite the statistical tests do not validate the difference between samples, I consider that in general terms both educational experiences seem to point out to a positive emotional response, excluding thereof the influential situation stated above. Concerning the lack of educational experience, it is important to attain the lack of evidences pointing in any kind of direction (neither positive nor negative).

Tableware Stimuli

Firstly, it is important to state that from the statistical tests performed (Student t' test of paired sample), the conclusion was that none of the samples revealed to be statistically significant ($\rho>0,05$) (SPSS outputs 1, 2, 5, 6 pages 64-66). Hence, the validation of hypothesis is done by analyzing the average activation of the EMG (Zygomaticus and Corrugator), the average arousal level of the SC, and the relative frequencies of the cognitive questionnaire.

Moreover, it is also important to state that the simulated situations in this scenario (tableware) are weak, due to some contradictory facts. Therefore, I used a different perspective and rather looking to the data as positive and negative emotional responses, I firstly analyzed the situations that generated engagement from the candidates' behalf.

In this experiential scenario, like in the other two scenarios, the results of the statistical tests showed that there is no statistical significant difference between the samples tested. Moreover, the second level analysis (descriptive statistic) did not allow any kind of specific direction in the emotional response. Nevertheless, the second level analysis (descriptive statistic) shows that the average activation in some channels (Zygomaticus, Corrugator and Cognitive questionnaire) turned to be slightly higher in the situation with a constructed product display. This information is also presented and was referred in the analysis of hypotheses H13, H15 and H16. Based on this evidence, I consider in fact that a situation with a constructed product display points in the direction of creating engagement compared with the opposing simulated situation.

In conclusion, despite not being possible to point in any kind of direction of emotional response, the extracted information from the channels allowed to acknowledge that a constructed product display in the scenario creates engagement. This perspective could lead to emotional response; however one may not be able to determine the direction of that emotional response due to the weakness of the data

[IV] DISCUSSIONS

Being aware that the retail industry is a fast changing environment in all its variables (e.g. price, product development, promotions, in-store environment), the data collected and now summed up revealed some interesting findings, through the use of different methods and tools to analyze consumer behavior.

The evidences of the bibliographic review pointed out that retail managers are constantly attempting to boost their business. Moreover, regarding the constructive process of each experiential situation, it involved simple changes in the environment, which do not mean a significant investment but rather a use of existing resources. Hence, the lack of big differences in the activation within each channel is believed to be the consequence of the stated above. This resulted in none of the statistical tests being statistically significant (all $\rho>0,05$).

Starting with the in-store variable (lightning), despite I cannot postulate a statistical significant difference in the samples tested

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and supported on a second level analysis (descriptive statistic), I consider that the information collected shows slightly differences in the samples (Zygomaticus and Cognitive questionnaire), pointing out in the direction of a positive emotional response. The opposing simulated situation (no light) goes in the direction of a negative emotional response. To reach this direction, I considered the information extracted through SC and Corrugator channels. Therefore, the lack of experiential environment is considered to point in the direction of a negative emotional response.

So combining our results with the bibliographic review, we consider our findings consistent with the perspectives reviewed by Turley and Milliman [2]. This means that experiential environments, including lightning, can influence the subconscious behaviour of a customer and most likely generate interest over a product while in-store. The flaw is the inability to prove the influential direction on sales, nevertheless the influential on the enhancement of the product can ease the outcome, the sale.

Moreover, my data also evidenced an example of a possible risky situation resultant from the cognitive questionnaire. The fact arose due to the divergence in what people say. The cognitive questionnaire implied testing two valence dimensions (like and Interest), and despite being two different valences the intention was to point in the same direction. In the first question the answers were clear and consistent and pointed to a higher relative frequency for the presence of lightning in the scenario. The divergence appeared in the second question. In this case, the pattern of answers showed higher relative frequency for an option that was in fact a tricky option (product display that was not altered). Therefore, this example becomes an evidence of a possible flaw associated with the quality of information that is extracted in interrogative studies.

Concerning the second, it includes two simulated situations with in-store variables (Store employees'; Posters/Signs). The overall conclusion of my data was that, although I could not postulate a significant value of the statistical tests, the second level analysis shows differences in the samples that point in the direction of positive emotional responses for educational experiential construct. On the contrary, the lack of experiential construct did not point in any kind of direction of emotional response, due to the lack of consistency in the data collected.

Despite this, between both experiential environments, my analysis evidenced that the presence of store employees' as educational element point out a higher positive emotional response compared with the presence of educational poster, hence the human variable is possibly understood as the most influential of the customer emotional response.

Hence connecting with the information reviewed by Turley and Milliman [2], signs with more information are more effective, meaning increasing sales. This just proves that positive emotional response expectably links with more likelihood of sales.
Concerning the human variable, Turley and Milliman [2] showed that employees' presence is seen as evidence of service quality, e.g. the employees' presence near a product will make the customer notice the overall service as having more quality. Hence, the overall perception of the service could presumably lead to more sales.

Moreover, my data also shows the divergence between what people say and think as Lawton *et al* [9] noticed. This fact was seen through the comparison of the EMG-Zygomaticus and the cognitive answers that validated different simulated situations of positive emotional response. In the EMG-Zygomaticus case, the presence of store employees' as an educational tool point out to a positive emotional response. While in the cognitive questionnaire, the situation that consistently generated higher relative frequencies was the simulation with posters as an educational tool. Nevertheless, it should be referred that both situations are part of the educational experience strategy, so there is not an indication in the opposite side.

Finally, regarding the last in-store environmental variable product display, the results can be seen as contradictory or divergent with my study. Nevertheless, this view is wrong; it is true that concluding whether one scenario generated positive emotional response compared with the opposing scenario, in this simulated environment, was not possible. To overcome this perspective, I used a different approach. So, I intended to identify which simulated situation created a higher engagement.

The data collected of this in-store variable shows that the simulated situation (constructed product display) within the perspective of experiential environment points in the direction of creating engagement.

Hence, although I could not determine any direction of emotional response, the extracted information from the channels allowed acknowledging that a constructed product display in the scenario points in the direction of creating engagement. This perspective could lead to emotional response, without being able to determine the direction of that emotional response due to the weakness of my data.

Therefore, connecting my conclusions with the research done by Turley and Milliman [2] , product display is seen as a variable that influence buying intentions and sales. So, since the constructed product display points in the direction of creating higher engagement compared with the opposing situation, it can be considered consistent with the authors' perspective that an experiential setting can presumably influence sales or being an influential factor of purchase intentions.

The general conclusion of this project supports that, using the conceptual model of Pine and Gilmore Pine and Gilmore [1] on how to stage experience is in fact an important tool to construct scenarios according to an experiential strategic view. This

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strategic view could be seen as too theoretical, but no other model is adjusted to support the construction of experiential environments regarding in-store variables.

Moreover, also a part from the discussion of my data, Ariely *et al* [7] argued that the costs associated with the technology used (psychophysiological techniques in this case) in a Neuromarketing study are normally referred as justification to reject the application of this highlighting study about consumer behaviour. Nevertheless, I should also note that this fact was referred to the neuroimaging techniques. Hence, through this project, companies, managers and marketers can become aware of other techniques apart from neuroimaging, some of them more cost effective than others.

Finally, it is important to address the research goals. Starting with the main goal, the results do not allow to infer more than emotional response directions, therefore I conclude that this purpose was not fully achieved. Regarding the second level goals, I conclude that they were properly achieved and this project can be seen as a learning tool to managers, retailers, and entrepreneurs

Limitations

Regarding limitations, I have to point out that the major one is the lack of studies published about Neuromarketing and even the existing ones seem to be short on information or with an important volume of conceptual information, hence lacking empirical data. This evidence was also raised in studies of Ohme *et al* (2010) [19] and Valentine *et al* (2009) [11].

Moreover, in the data collection step two facts arose. First, due to my lack of experience in video recording and quality of the camera, the final result seen by candidates had low quality. In consequence it limited and influenced the outputs. Second and final, when the candidates had to read information from the poster and to focus on the employees' presence showed a limitation of the EMG technology. The candidates were obliged to make an effort to properly perceive what they were seeing. This situation generated meaningless facial activity

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CONFLICT OF INTERESTS

The authors declare no conflict of interests.

REFERENCES

[1] Pine II BJ and Gilmore JH. [1998] Welcome to the Experience Economy. *Harvard Business Review, July-August*, 97-106.
[2] Turley LW and Milliman ER. [2000] Atmospheric effects on shopping behavior: A review of the experimental Evidence. *Journal Business Research* 49: 193–211.
[3] Peter L. [1968] Cognition in emotion: concept and action". In Carroll Izard, Jerome Kagan and Robert Zajonc (eds.) Emotions, Cognition and Behavior. Cambridge University Press.
[4] Grewal D, Krishnam R, Levy M , and Munger J. [2006] Retail Success and Key Drivers. Retailing in the 21st Century, Springer, 13–25.
[5] Sands S, Oppewal H, and Beverland M. [2008]The Influence of In-Store Experiential Events on Shopping Value Perceptions and Shopping Behavior. *Advances in Consumer Research* 35: 298–303.
[6] Berman B and Evans J. [1995] Retail Management: A Strategic approach. Prentice Hall.
[7] Ariely D and Berns GS. [2010] Neuromarketing: the hope and hype of neuroimaging in business. *Nature Reviews Neuroscience* 11: 284–292.
[8] Ohme R, Reykowska D, Wiener D, and Choromanska A. [2009] Analysis of Neurophysiological Reactions to Advertising Stimuli by Means of EEG and Galvanic Skin Response Measures. *Journal of Neuroscience* 2(1): 21–31.
[9] Lawton G and Wilson C. [2010] Mind-reading marketers. *New Scientist* 207 (2772): 02.
[10] Lee N, Broderick AJ, and Chamberlain L. [2007] What is 'neuromarketing'? A discussion and agenda for future research. *International Journal of Psychophysiology* 63: 199–204.
[11] Valentine M. [2009] It's all in the mind. *Marketing Week* 32(14): 30.
[12] Anonymous [2010] Central Nervous System; Founder of World's leading Neuromarketing Company Reveals Secrets to consumer Marketing and Brain Science in The Buying Brain. *Marketing Weekly News, Atlanta* 14: 289.
[13] Castellar JV. [1996] Una Introduccion a la psicofisiologia clínica, Ed. Piramide, 60–66, 79–88, 117–128.
[14] Machleit KA and Eroglu SA. [2000] Describing and measuring emotional response to shopping experience. *Journal of Business Research* 49: 101–111.
[15] Hazlett RL and Hazlett SY. [1999] Emotional response to television commercials: Facial EMG vs. Self-report. *Journal of advertising research* March-April: 7–23.
[16] Mandryk RL and Atkins MS. [2007] A fuzzy physiological approach for continuously modeling emotion during interaction with play technologies. *International Journal of Human-computer science* 65: 329–347.
[17] Dimberg U and Monika T. [1998] Rapid facial reactions to emotional facial expressions. *Scandinavian Journal of Psychology* 39: 39–45.
[18] Perrachione TK and Perrachione JR. [2008] Brains and brands: Developing mutually informative research in neuroscience and marketing. *Journal of Consumer Behavior* 7: 303–318.

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[19] Ohme R, Reykowska D, Wiener D, and Choromanska A. [2010] Application of frontal EEG asymmetry to advertising research. *Journal of Economic Psychology* 31: 785–793.

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THE HOMO NEUROECONOMICUS – A WINDOW FOR THE FUTURE

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ABSTRACT

This paper analyzes the validity (and also the framework) of the rationality postulate on the moments of decision-making by economic agents, as it is promoted by the economic and financial fields on investigation, especially on microeconomic and portfolio theories and models. The main features surrounding this postulate are addressed to the aims of this study and are criticized considering the developments achieved on the neuroscience investigation on human being decision-making process. There are considerable developments got in several areas, mainly for example in the area of the effects of dopamine on the preference ordering (and the subsequent relation with the reversal of preferences hypothesis), in the area of the proprieties of oxytocin on the decision and choice under social situations and context, and in the areas of the somatic marker hypothesis and of the value of emotions. The magnitude of the importance of memory processes (operative and long-term memory) in connection with somatic states in decision-making problems is also highlighted. These features are sensitized on what can constitute the basis for the construction and definition of an alternative profile of the economic agent, which analysis will be tested later in the investigation, dealing with problems of decision-making and choice in game theory environment (especially in dynamic or iterated games).

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[I] INTRODUCTION

The economic and financial areas had based most of their theories and studies surrounding the postulate that the economic agent, a single human being, is driven by a set of propositions that jointly imply a full rational process of thinking and action. However, the latest occurrences in the economic world (financial crashes, public debt crisis and macroeconomic recessions) have weakened the validity of these models and theories. The solution for this problem may be got on one of the most basic propositions usually made: the rationality postulate.

Especially in last years, the lack of explanatory efficiency of the homo economicus, a notion firstly addressed by Stuart Mill on his "Essays on Some Unsettled Questions of Political Economy" (see Mill [1]) and "Principles of Political Economy" (see Mill [2]), following the ideas of Adam Smith and Thomas Malthus, implied the emergence of a growing number of critiques, firstly made by economic behaviorists, sociologists and psychologists and later by economic researchers in partnership with neuroscientists. Particularly, this last field, denominated as Neuroeconomics and Neurofinance, brings an explanation for the actions made by the economic agent through the analysis of his neural circuits and brain, especially in decision-making moments. Evidences from several studies in this field suggest the launch of a new architecture of the process of decision-making of the economic agent.

Based on this context, in the present study, firstly, a review over the main features of the rationality postulate is made, which are used on several economic, financial and game theory models, as the existence of a stable and complete set of preferences, a full information processing, monotonicity and the utility paradigm. Then, critiques and alternatives based on neuroscience investigation findings are presented, concretely related to the possible dichotomy existing on the moment of choice, the influence of the social environment in decision, the somatic marker hypothesis and the emotions importance, and also the main features of the memory processes. Finally a brief discussion on the main results of the study and on what can be the future for the economic and financial areas is launched, opening a window for the construction of a more realistic profile for the economic agent.

[II] THE POSTULATE OF RATIONALITY IN ECONOMIC AND FINANCIAL AREAS

The notion that the economic agents (as the consumer, the business manager or the investor) base their decisions in a perfect rational structure has become so deep in the economic theory that for many theorists, it is almost impossible to see another "valid" hypothesis. The real problem deals with the real conviction that the greater part of the economists have on this postulate, and their skepticism to accept its anomalies. For instance, Frey and Eichenberger [3] have presented on their

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study of 1989 the reactions from economists to empirical evidences showing the violation of this postulate. The main conclusion reached was based on their denial in order to accept individual behavior anomalies, what is justified as a product that resulted from artificial laboratorial results, and from aggregate behaviors, because is defended that these anomalies are random and compensated with efficient behaviors, like the ones seen on competitive markets. A possible explanation for the general usage of the rationality postulate may reside, in a methodological plan, in the dependence and addiction from economic theorists in the utilization of a normative analysis, which is concerned with the rational solution for a choice and decision-making problem, instead of a descriptive analysis (see Silva *et al*. [4]). Nevertheless, since the Classical Era, the assumption of rationality has been taken as a central premise on almost every model, and it is so strong that for some economists (like Lionel Robbins or Von Mises), it was almost an a priori proposition.

2.1. A brief historic overview

The understanding and usage of the rationality proposition, for economists of different eras, was not always the same. For classical economists, like Stuart Mill [1, 2, 5] or Adam Smith [6], rationality was related to the preference to achieve the highest profitability at the lowest costs in order to accomplish only the self-interest. Later, it evolved to the utility theory, which is related to the maximization of the expected utility of a consistent set of preferences, in a certainty context (see Broome [7]). In the following years, notably in response to the evolution of the financial markets, and benefiting from the expansion of the game theory field, a "refined" notion of rationality was reached.

The works of Von Neumann and Morgenstern [8, 9] and the contributions of John Nash [10, 11, 12, 13] are important in this area in problems dealing with a situation of conflict between two or more agents (or one player versus nature). The main objective is the achievement of the desires and motivations of players, what is accomplished through the use of different strategies, which were essentially based on the rationality proposition presented on the last paragraph (more pronounced on non cooperative games). However, in these cases, the rational decision-making was obtained in a context of uncertainty, which did not invalidate the efficiency of the choice.

This rationality scheme was also explored on the financial area of research, initially by Markowitz [14] on his Portfolio Theory, and followed notably by Sharpe [15], Lintner [16] and Mossin [17] in the Capital Asset Pricing Model (CAPM) and Ross [18] in the Arbitrage Pricing Theory (APT). In these cases, a rational investor maximizes (or should maximize) the discount expected returns and diversifies (or should diversify) his funds among all available securities, conducting him to a situation of maximum return and to a mean-variance portfolio in a market with imperfect information.

2.2. The main features of rationality

Taking support in the previous point, the main features of rationality and consequently the processing and use of information in decision-making process can be summarized on the ideas of Simon [19]. It is assumed that a rational agent has the knowledge to make the best possible decisions in the existing environment and with intrinsic limitations, supported by a well-organized and stable system of preferences, on a context of perfect information (or in cases of imperfect information, with the ability to process and to adapt quickly to new information), what leads him to the best possible decision (see Simon [19] and Silva *et al*. [4]).

Thus, there are three main points that jointly form the basis of the proposition of rationality. Firstly, it is assumed that all agents have a complete, organized and stable set of preferences. By this way, facing a process of decision-making, an individual will choose the highest ranked option on the internal set of preferences, i.e., the alternative which best satisfies his needs of the moment and best matches his self-interest.

The system of preferences is strictly related to the monotonic feature, which, in simple terms means "more is better". The system of preferences is built on the expected marginal utility that comes from a given choice, implying that the decision has to be the one that satisfies, in the larger extent, the needs of that moment. The only allowed moment of ambiguity occurs when the individual faces two choices that are indifferent because he has the same expected marginal utility (see Frank [20]).

Therefore, the individual may have monotonic increasing preferences or monotonic decreasing features, which depends on the type of need or motivation (e.g., for the individual, less pollution is better, what means monotonic decreasing preferences). Thus, in conclusion, the decisions made by the agent have as a goal the improvement of the actual state (intending to reach his self-interest).

Lastly, it is assumed that the individual has the cognitive ability to embrace all available information, and to process it in a way that will help him on the course of a decision. In line with this sentence, new pieces of information are automatically processed in order to increase the expected utility of his choice. However, it is important to note that a failure on the information processing can occur only as a result of an asymmetry of information (Silva *et al*. [4]).

[III] THE HOMO NEUROECONOMICUS - CONTRIBUTIONS BASED ON EMOTIONS AND NEUROSCIENCE STUDIES

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The latest empirical studies made by the neurosciences and especially by neuroeconomics have brought some new evidences about the individual behavior, notably, in moments of decision-making and choice that can be resumed as a critique to the rationality postulate on economics.

Nevertheless, the purpose of this paper is not to assume that the majority of the economic theories based on the rationality postulate are wrong. By doing that, this study falls in naive falsification, because one piece of evidence cannot make a group of theories automatically inadequate (Blaug [21]).

3.1. What is wanted and what is chosen: the reasons beyond possible anomalies

The orthodox rational economic theory postulates that every person has a stable and well defined system of preferences, hierarchically organized by the expected utility of each option in the presence of different needs and motivations. However studies involving the role of dopamine processes on reward have proven that this sentence is not so rigid.

Dopamine has been seen as the measure to value choices that are made by humans and animals. Mesolimbic and neostriatal projections are triggered in situations and by choices that provoke stimulus, like primary' stimulus (food, sex, drugs) and secondary reinforcers (that highlight the stimulus), that are associated with high levels of pleasure. Dopamine systems, in these cases, act as mediators (also known as the hedonia hypothesis) working on phases of motivated behavior, in anticipation to a given choice (see Berridge and Robinson [22], Panksepp [23] and Phillips [24]).

One other function of these systems is related to the attribution of incentive salience (highlighting the possible reward) on given decisions. This hypothesis suggests that the reward of a given choice can be viewed in terms of what is "wanted", and what is "liked" (see Berridge and Robinson [22]). Both wanting and liking can be viewed as two different mental processes that may have implicit different rewards. Also according to this hypothesis, when dopamine function is activated, this can be seen as similar to grab the attention of the individual to a given thing (liking). However, to be wanted, other types of evaluations must be involved. Dopamine role is seen as a mean to highlight a given option. Nevertheless, it is important to note that things and options which have an emotional value have a stronger and quickest activation of dopamine, which arouses attention and makes a given incentive more salient choice (see Berridge and Robinson [22] and Phillips [24]).

For example, in the studies of Phillips [24], it is stated that dopamine is triggered before a given meal, i.e., before making a choice. The dopamine system is activated before a pleasurable reward. However, if the choice ("wanting") is coincident with the desire, the incentive will remain high (which is translated in high dopamine levels), but possibly not in the previous levels.

Other studies conducted by Schultz and colleagues, showed that dopamine neurons discharge in response to the predictive reward, and not in the moments on usufruct of the reward (Berridge and Robinson [22]).

Impulsive reactions can be triggered by these systems of incentive salience, which may lead to a reversal of preferences. For instance, a person addicted to drugs has as a first order preference the avoidance of the consumption of these substances in order to preserve good health. However, in the presence of an opportunity to consume drugs, the dopamine systems are triggered in a high way, what will highlight the salience of the reward. This can imply a change of preferences between good health and the pleasure given by drugs, even if in a short time period (see Berridge and Robinson [22] and Kiyatkin and Stein [25].

In conclusion, on cases as the example presented, preferences can mutate, invalidating the stability of the set of preferences and violating the postulate of rationality.

3.2. A potential violation of the rationality postulate on social environments

"Approaching and avoidance" is a balance in order to which a human being has to deal almost every day, and that derives from living on society.
This balance, based on evidences presented by several studies, can be mediated by oxytocin, a nanopeptide produced within the hypothalamic nuclei that modulates these same processes and facilitates the social behavior mediation (see Petrovic *et al*. [26] and Lim and Young [27]. Oxytocin helps the individual to emotionally understand others and to analyze their expressions in order to evaluate the kind of action to be taken mediation (see Petrovic *et al*. [26]).

However, it is important to note that, based on the study of Wicker *et al*. [28], it is indicated that visual stimuli (generated by expressions of happiness or disgust in other individuals) may trigger' actions of approaching and avoidance, possibly mediated by the Insula and the Cingulate Cortex processes (and not influenced by oxytocin).

However, the general ideas transmitted on several studies indicate that an agent captures the emotions demonstrated by others and activates the same emotion inside of him if the feeling is not new. This last point acquires a major importance because, if a person has not felt that emotion in the past, then it will be almost impossible to realize its importance when is felt by another person. On the studies conducted by Phillips *et al*. [29], Adolphs [30], Wicker *et al*. [28] and Krolak-Salmon *et al*. [31] was possible to prove that an individual copies the emotional state of others (and experiences the same feelings) in cases in which the individual has felt a given emotion in the past, presented in a given moment, by another person.

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These evidences can launch a new hypothesis. In social environment, if an agent holds, a priori, a defined set of preferences, he is prepared, almost in a rigidly way, to make a decision about. However, on the moment of decision, if he is standing ahead of a situation involving more actors, and these actors are expressing emotions of disgust towards a possible option, then it is probable a change in the decision to be made by the agent, even if this option was in the top of his internal scale of preferences. The same can be applied on inverse situations, when the agent perceives a favorable emotion felt by another individual (or individuals).

This hypothesis can imply the violation of the postulate of rationality, because a change in the expected utility of a given option may occur, and this will modify the order of preferences of the agent.

3.3. The role of emotions on the process of decision-making

Economic and financial sciences in a general way have unvalued, across the years, the importance and role of emotions in the process of choice and decision-making. The economic agent, denominated as *homo economicus*, bases his actions in a well defined process of rational choice, wherein the decision is made, in a direct way based on the expected utility of the reward. Because of that, emotions are seen as cognitive bias that, in the moment of choice, can divert the agent of the rational path.

However, in the latest years, studies made essentially by Bechara [32, 33] and Damasio [34, 35, 36, 37] demonstrate that emotions are an intrinsic process on the decision-making, and they play a key role on the maximization of the agent's choice. To introduce this theme, two clinical cases studied by Damasio [34] are presented. Despite some critiques to the findings of Damasio and Bechara, mainly made by Gazzaniga *et al*. [38], it is assumed that these theories fit well on the purposes of this paper.

The first one is related to an individual named Phineas Gage. He was working on the construction of a railroad, when he had an accident, when trying to detonate a pile of rocks. In the accident an iron bar was projected into his face, entering on the left side of the face and getting out by the top of his head. With the resources of today it is possible to know that this situation caused a lesion in the Ventromedial Prefrontal Cortex, and that the other brain lobes were intact. He didn't die and although resumed his normal life, however with dramatic differences into his behavior. The balance between intellectual and impulsive sides was ruined, and he became unpredictable and indecisive, with the display of few emotions. Countless plans were made only to be easily abandoned.

The second one refers to an individual named Elliot by Damasio, who had Meningioma. He was treated surgically by removing the frontal lobe tissue. However, a lesion in the cortical region damaged the Ventromedial Prefrontal Cortex. Despite the good recovery, he, like Phineas, was never the same person, exhibiting a small number of emotions, what was a result of the poor access to the social knowledge, which is essential to an advanced reasoning. Consequently, he was unable to make efficient decisions, and the procrastination got something usual. On both cases, it is possible to conclude, essentially, that there is a big difference on the individuals before and after the accident based on the consequent difficulty to express and feel emotional states after the accidents.

An emotion, quoting Bechara and Damasio [39], "is defined as a collection of changes in body and brain states triggered by a dedicated brain system that responds to specific contents of one's perceptions, actual or recalled, relative to a particular object or event". On the cited cases, and in others related both with lesions on the Ventromedial Prefrontal Cortex, as also in the Amygdala, basal ganglia and anterior cingulated cortex, patients show a diminished emotional profile, and limited access to social emotions (closely related to moral values), which leads to inefficient decisions (or the procrastination of some), deficient planning and difficulties on conducting social relations, despite the maintenance of general intelligence, logic reasoning and knowledge (see Bechara and Damasio [39] and Koenigs *et al*. [40].

The presented profile can be explained with the resource of the Somatic Marker Hypothesis. Somatic states (i.e. internal emotional states) are triggered by primary inducers (innate stimuli, like the fear for something painful or harmful) and secondary inducers (generated by thoughts and memories about stimuli that triggered primary inducers), which makes decisions faster and effective. In cases on which the decision making requires evaluation, the somatic marker classifies possible decisions, as good or bad. However, on the cases presented, somatic signals are interrupted and it is difficult to the individual to classify the expected return of the choice, resulting in indifference to future consequences (see Damasio [34] and Buttman and Allegri [41].

According to some empirical studies, dealing with gambling tasks (like card games), conducted by Bechara *et al*. [42], Bechara, Damasio and Damasio [43], Bechara *et al*. [44], and Koenigs *et al*. [40], individuals with lesions on the Ventromedial Cortex have more utilitarian judgments and act more according to the economic and financial doctrine of rationality and optimization than normal individuals.

They also prefer choices that involve more risk, without taking any considerations about the future outcomes, and do not express difficulty on more emotional and stressful decisions, which imply more inefficient outcomes in a utilitarian perspective. One explanation for these results lies on the fact that in the process feeling a given emotion can help perceiving the risk, especially if that emotion is not new, and that situation

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can modify the probabilities calculated by the individual and help him obtaining a more efficient choice.

Naturally this context can imply that the set of preferences is not rigid and well defined, because it can mutate in response to somatic signals, and because every person has somatic signals that are classified by the somatic marker in different ways (depending on the signals, especially, if they are triggered by a secondary inducer).

3.4. Different features of the memory and his "tricks"

One of the main features of the postulate of rationality in uncertainty refers to the fact that the economic agent possesses all available information; that he can process quickly new pieces of information; and that he can use them correctly to make the best decisions possible in order to maximize the expected utility of a given choice, making valid the proposition of monotonic preferences.

However, to understand if this premise is true, it is necessary to comprehend how the memory processes are structured.
The memory can be divided into two types of processes, that however have strictly connections. The memory that is used on a conscious way is called operative memory (or short-term memory), a limited processor that is used to face immediate problems (that requires the mechanism of reasoning) and that creates and manipulates symbolic representations (see LeDoux [45]). However, in this general process only a limited quantity of information may be maintained (within a limited time). For example, if it is required to memorize a given number, let's say 685291, and next we need to stop, and to count down from 81 to 73, every two, if than is necessary to remember the number firstly mentioned, the most likely is not to remember it. This happens because our mental operative set is extinct to face another task (counting down, every two numbers).
The other type of memory process is the long-term memory, which retains past experiences and information. However, it is important to notice that these pieces of information are saved in a scale strictly related to the importance and impact of these moments in the past (see LeDoux [45] Brown and Kulik [46] and Christianson 47]).

The operative memory does not depend exclusively on the present. It is a partial product and dependent from the long-term memory. If an individual sees an object, like a chair, the visual representation is not enough for the recognition. First of all, this object must grab the attention of the operative memory and next, when the visual stimulus is recognized by the long-term memory, the object is identified. The scheme presented is known as the descending process, from the present to the past (see LeDoux [45] and Kosslyn [48]. There are, however, several considerations to be made about this scheme.

Not all past experiences and information are remembered in the same way, and the somatic signals associate to each piece of information can determine its importance and the details that were kept. However, the intensity of the somatic signal implicit in the saved memory can bias it, whereby the kept details depend on several factors present at the time of the assimilation of the information (see Christianson [49]). The focus and the emotional state at the moment of the evocation of the memory or information can influence the recall. Because of that, when recalling past experiences, several simplifications, additions, rationalizations and omissions are made, what indicates that the agent includes the expectations of that time in his memories, which can change the real content of the information (see Bartlett [50]). Also, the memories details are more easily remembered depending on the mood of the individual (Bower [51]). Because of that, the individual can have higher probabilities of remembering a good memory when he is in a good mood.

By this way, it is easily noticeable that is not simple to accept the fact that an economic agent can process all the available present and past information. Because of the referred limitations, the economic agent depends, in a large scale, on the connection between the memories and information retained and the somatic signals associated, which allow to give more importance to emotions independently they are related to the present or to the past. On the other hand, the limited capacity of the operative memory makes difficult to calculate probabilities in a very dynamic environment (like the financial markets, for example).

[IV] CONCLUSION

This paper aims to address the validity of the postulate of rationality on the economic and financial theory. The main purpose is to discuss some of the rationality main features and to analyze them under the light of developments achieved by neurosciences in understanding the decision-making process. Essentially, from this study it is possible to highlight that:

- Our brain reacts in anticipation to a possible reward, and because of that a mutation in the preference order and subsequent reversal of preferences can happen;
- In social environments, the individual can understand and almost "copy" feelings and emotions from others, what may change several preferences and utilities;
- Emotions are a key feature of decision-making; providing internal information what can imply the maximization of a given choice;
- Operative memory is limited and can be biased by information belonging to long-term memory.

Following these findings, the construction on a more realistic profile for the economic agents, without a stable set of preferences, monotonic preferences and perfect capacity of information processing, represents an objective to be considered on future investigation on the game theory area.

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CONFLICT OF INTERESTS

The authors declare no conflict of interests.

REFERENCES

[1] Mill S. [1844] Essays on Some Unsettled Questions of Political Economy. John W. Parker, London.
[2] Mill S. [1848] Principles of Political Economy: With some of their applications to social philosophy. Hackett Publishing.
[3] Frey BS, Eichenberger R. [1989] Should social scientists care about choice anomalies? *Rationality and Society* 1 (1): 986–994
[4] Silva R, Filipe J, Costa A. [2012] Investor Behavior in Extreme Situations of Speculation and Crash: An Approach based on Iterated Prisioner's Dilemma. *International Journal of the Latest Trends in Finance and Economic Sciences* 2(3):169–189.
[5] Mill S. [1871] Utilitarianism. Longmans, Green, Reader, and Dyer, 4th edition.
[6] Smith A. [1776] Inquiry into the Nature and Causes of the Wealth of Nations. W. Strahan, and T. Cadell, London.
[7] Broome J. [1991] Utility. *Economics & Philosophy* 7(1):1–12.
[8] Von Neumann J. [1928] Zur Theorie der Gesellschaftsspiele. *Mathematische Annalen* 100(1):295–320.
[9] Von Neumann J, and Morgenstern O. [1953] Theory of games and economic behavior. Princeton University Press, 3rd edition.
[10] Nash JF. [1950a] Equilibrium points in n-person games. Proceedings of the National Academy of Sciences of the United States of America 36(1):48–49.
[11] Nash JF. [1950b] The bargaining problems. *Econometrica* 18(2):155–162.
[12] Nash JF. [1951] Non-cooperative games. *Annals of Mathematics* 54(2):282–295.
[13] Nash JF. [1953] Two person cooperative games. *Econometrica* 21(1):128–140.
[14] Markowitz H. [1952] Portfolio Selection. *The Journal of Finance* 7(1):77–91.
[15] Sharpe W. [1964] Capital Asset Prices: A theory of market equilibrium. *The Journal of Finance* 19(3):425–442.
[16] Lintner J. [1965] The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics* 47(1):13–37.
[17] Mossin J. [1966] Equilibrium in a capital asset market. *Econometrica* 34(4):768–783.
[18] Ross S. [1976] The arbitrage theory of capital asset pricing. *Journal of Economic Theory* 13:341–360.
[19] Simon HA. [1955] A behavioral model of rational choice. *Quarterly Journal of Economics* 69:99–118.
[20] Frank R. [2005] Microeconomics and behavior. McGraw-Hill, 6th edition, New York.
[21] Blaug M. [1992] The Methodology of Economics, or How economists explain. Cambridge University Press.
[22] Berridge KC, and Robinson TE. [1998] What is the role of dopamine in reward: hedonic impact, reward learning, or incentive salience? *Brain Research Reviews* 28:309–369.
[23] Panksepp J. [1998] Affective Neuroscience: The foundations of Human and Animal Emotions. Oxford University Press.
[24] Phillips AG, Blaha CD, Pfaus JG, and Blackburn JR. [1992] Neurobiological correlates of positive emotional states: Dopamine, anticipation, and reward. *International Review of Studies on Emotion* 2:31–50.
[25] Kiyatkin EA, Stein RA. [1996] Conditioned changes in nucleus accumbens dopamine signal established by intravenous cocaine in rats. *Neuroscience Letters* 211:73–76.
[26] Petrovic P, Kalisch R, Singer T, and Dolan RJ. [2008] Oxytocin Attenuates Affective Evaluations of Conditioned Faces and Amygdala Activity. *The Journal of Neuroscience* 28(26):6607–6615.
[27] Lim MM, Young LJ. [2006] Neuropeptidergic regulation of affiliative behavior and social bonding in animals. *Horm Behav* 50:506–517.
[28] Wicker B, Keysers C, Plailly J, Royet JP, Gallese V, and Rizzolatti G. [2003] Both of Us Disgusted in My Insula: The Common Neural Basis of Seeing and Feeling Disgust. *Neuron* 40:655–664.
[29] Phillips ML, Young AW, Senior C, Brammer M, Andrew C, Calder AJ, Bullmore ET, Perrett DI, Rowland D, Williams SC, Gray JA, David AS [1997] A specific neural substrate for perceiving facial expressions of disgust. *Nature* 389:495–498.
[30] Adolphs R. [2002] Neural systems for recognizing emotion. *Current Opinion in Neurobiology* 12:169–177.
[31] Krolak-Salmon, P., Henaff, M.A., Isnard, J., Tallon-Baudry, C., Guenot, M., Vighetto, A., Bertrand, O., and Mauguiere, F. [2003] An attention modulated response to disgust in human ventral anterior insula. *Annals of Neurology* 53:446–453.
[32] Bechara A. [2004] The role of emotion in judgment and decision-making: Evidence from neurological patients with orbitofrontal damage. *Brain and Cognition* 55:30–40.
[33] Bechara A. [2003] Risky Business: Emotion, decision-making and addiction. *Journal of Gambling Studies* 19(1):23–51.
[34] Damasio AR. [1994] Descartes' Error: Emotion, Reason, and the Human Brain. Grosset Putnam, New York.
[35] Damasio AR. [1995] Toward a neurobiology of emotion and feeling: operational concepts and hypotheses. *The Neuroscientist* 1:19–25.
[36] Damasio AR. [1999] The feeling of what happens: Body and Emotion in the making of consciousness. Harcourt Brace & Co., New York.
[37] Damasio AR. [2003] Looking for Spinoza, Joy, Sorrow, and the feeling brain. Harcourt Brace & Co., New York.
[38] Gazzaniga M, Ivry R, Mangun G. [2009] Cognitive neuroscience: The Biology of the mind. W. W Norton, 3rd edition, New York.
[39] Bechara A, and Damasio AR [2005] The somatic marker hypothesis: A neural theory of economic decision. *Games and Economic Behavior* 52:336–372.
[40] Koenigs ML, Young L, Adolphs R, Tranel D, Cushman F, Hauser M, Damasio A [2007] Damage to the prefrontal cortex increases utilitarian moral judgments. *Nature* 446:908–911.

[41] Buttman J, and Allegri RF. [2001] A cognição social e o Córtex Cerebral. *Psicologia: Reflexão e Crítica* 14(2):275–279.
[42] Bechara A, Tranel D, Damasio H. [2000] Characterization of the decision-making impairment of patients with bilateral lesions of the ventromedial prefrontal cortex. *Brain* 123:2189–2202.
[43] Bechara A, Damasio H, Damasio AR. [2000] Emotion, decision-making, and the orbitofrontal cortex. Cerebral Cortex 10:295–307.
[44] Bechara A, Tranel D, Damasio H, and Damasio AR. [1996] Failure to respond autonomically to anticipated future outcomes following damage to prefrontal cortex. *Cerebral Cortex* 6:215–225.
[45] LeDoux J. [1996] The Emotional Brain: The Mysterious Underpinnings of Emotional Life. Simon and Schuster, New York.
[46] Brown R, and Kulik J. [1977] Flashbulb memories. *Cognition* 5:73–99.
[47] Christianson SA. [1989] Flashbulb memories: Special, but not so special. Memory and Cognition 17:435–443.
[48] Kosslyn SM. [1980] Image and Mind. Cambridge: Harvard University Press.
[49] Christianson SA. [1992] Handbook of emotion and memory: Research and theory. Erlbaum, Hillsdale, New Jersey.
[50] Bartlett FC. [1932] Remembering. Cambridge University Press.
[51] Bower B. [1992] How might emotions affect learning? In: Handbook of emotion and memory: Research and theory. Christianson SA. Ed. Erlbaum, Hillsdale, New Jersey.

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SPECIAL ISSUE
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REVIEW ARTICLE OPEN ACCESS

NEUROECONOMICS: THE EFFECT OF CONTEXT IN DECISIONS RELATING TO THE BRAZILIAN ELECTRIC SECTOR

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ABSTRACT

Economic agents use to have serious limitations on the process of "rational" decision making in their economic lives. Even those who are prepared to make decisions in the very competitive environment of nowadays markets may have unconscious stimuli. A good example of this reality is the "panic" caused by the crisis in 2008 that reached the economic agents in particular, the economic analysts, governments, etc. Today they try to find explanations for the explosion of the crisis. A major bias is found in the way decisions are presented to agents, concerning to the "context effect" on decisions. Given the inability that "school of rational economy" has to explain the economic problems, neuroeconomics comes to take this place aiming to explain these problems by studying the brain of economic agents. As a result, neuroeconomics may become a way to find solutions to problems that for several decades economists could not find an explanation to the consumption and investment decisions of individuals in the economy.

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Neuroeconomics, neuromarketing, decision-making, effect of context, bounded rationality, biological value.

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[I] INTRODUCTION

Neuroeconomics is the fusion of neuroscience and economics as its name suggests but it is also the junction with many other disciplines (biology, physics, chemistry, statistics, mathematics, psychology, or pharmacology, for example). This makes the decision-making more realistic and appropriate to everyday economic agents. Indeed, neuroeconomics arose from the need to achieve more reliable results about the economic decisions of individuals.

Neuroeconomics, being a new field in economics, analyzes the relationship between the internal organization of the brain and the behavior of the individuals, when individual decision-making, social interaction or institutions like the market are considered – see Sandroni [1]. Neuroeconomics is directed to investigate the variables that actually determine the choices of economic agents. It can be stated in a general way that this approach analyzes the decision-making based on the viewpoint of man as a being who makes his economic decisions in a cognitive way. In short, opposing to the proposed idea of Homo economicus, it is clear that men and women appear emotional, contradictory, fearful, or very human – see Teixeira and Porto [2]. Neuroeconomics consists in an attempt to take the humanization of the behavior of economic agents (in the existing economic models) to better understand and accurately measure the sensitivity of economic variables on the different situations in the present life of man as economic being – see Chavaglia and Filipe [3].

A recurrent problem in the economy is the "effect of context". This effect implies the fact that people are influenced through the way by which decisions are made, in particular, options that involve a positive and a negative version.

Thus this study has the general objective of confirming the existence or not of the context in decisions. The objectives of this study consist on peripheral conducting tests with students of MBA FGV Fundação Getulio Vargas (Brazil) and with doctoral students of business courses at ISCTE / IUL – Instituto Universitário de Lisboa (Portugal).

[II] NEUROECONOMICS

Neuroeconomics is a multidisciplinary science encompassing the fusion of two distinct disciplines (neuroscience and economics), using some others as, for instance, quantitative methods, biology, pharmacology, psychology or sociology. This combination has generated great contributions to the understanding of the process of decision making by economic agents. Thus, the understanding of the mental decision-making processes can contribute significantly to the improvement of the explanation, prediction and stimulation of phenomena related to the agents' behavior.

Some authors argue that neuroeconomics is simply the union of

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neuroscience and economics. However, despite the deserved prominence, these definitions are too simplistic, especially considering just how the brain works in decision making not considering the final results, which are as important as the functioning of the brain mechanisms.
This new field of study is in essence the premise that man is basically irrational and is driven by cognitive biases derived from the unconscious. Hence neuroeconomics offers an opposing view to the traditional view of the economy, what guarantees a recognized and particular importance of neuroeconomics in the development of economic studies, what represents a more reliable way for decision making and understanding of complex economic problems in the nowadays life.

However, before going deeper in the concept of neuroeconomics, it becomes necessary to understand a little better the factors that led to economic theory to this point in history. Therefore, it is advisable to make a clarification on relevant developments in the behavioral approach to economics, culminating in the emergence of neuroeconomics itself.

The first consistent criticism against orthodox economics was presented in Karl Marx's "Capital" (1867), where a critique to capitalism and free markets were made. Later, with the great depression of 1929 and the crash in the New York Stock Exchange, classical theory in its purest form got unsustainable. This event contributed definitively to the appearance of a new and strong criticism of the liberal economy. The work of Keynes (1883-1946) was the one that most has influenced the reality during this crisis. Keynes especially challenged the rationality of economic agents and later would introduce the concept of animal spirits, which was considered by Keynes partly responsible for the economic fluctuations. In 1971, the work of Daniel Kahneman (1934-) and Amos Tversky (1937-1996) made possible the emergence of neuroeconomics. In 2002, they would earn the Nobel Prize in Economics. In 2001 George Akerlof (1993), Professor of economics at the University of California, would also receive the Nobel Prize. Another researcher who has received this award (Nobel Prize in Economics in 1992) was Gary Becker (University of Chicago). His article "The economic approach to human behavior" (1976) was particularly recognized. In the 80s, the economist Richard Thaler (2008) continued the studies of Kahneman and published an article containing the essence of what would be the positive theory of consumer.

Nowadays neuroeconomics is well organized as a discipline. Specific studies and education on the subject are being developed worldwide. The Society for Neuroeconomics has some of the major research centers in this area (in Duke University, University of London, Harvard, MIT, among others). Additionally, search techniques are becoming increasingly sophisticated with the use of revolutionary techniques such as Functional Magnetic Resonance Imaging (fMRI), positron tomography, electroencephalogram (EEG), Eye tracking, facial reading of micro expressions, and physiological excrement collecting for laboratory tests.

Today, after the turmoil of one of the major financial and economic crises, many economies in the globalized world became very affected. New sources of dissatisfaction with the traditional tools of economic analysis became a reality. This time the economy has the collaboration of neuroscientists in the searching for results closer to reality. This fact allowed that neuroeconomics become more important, becoming away from its position of marginal situation to be launched in a prominent position in the global economy.

[III] BIOLOGICAL VALUE AND ECONOMIC DECISIONS INFLUENCE

Professor Antonio Damasio, specialist in Neuroscience, Neurology and Psychology at the University of Southern California, may be considered as the father of the theory concerning the biological value. The studies of this neuroscientist generated very interesting results for the analysis of the value from the perspective of neuroeconomics.

The impending clash between conventional economics and neuroeconomics is inevitable. The orthodoxy defended the idea of an economic agent aware of his actions and decisions, what is contrary to the basic idea of neuroeconomics. Neuroeconomics accepts that man is partly rational (conscious), but points to the fact that the vast majority of decisions are made unconsciously. Thus the concept of value to the light of neuroeconomics cannot be achieved without understanding the biological factors endogenous to the process of decision making.

However, it should be necessary, before anything else, to conceptualize the relationship between consciousness and unconsciousness in the process of decision making. Briefly, the conscious and unconscious processes exist in parallel and, moreover, some unconscious processes are important for survival and occur without any involvement of consciousness.

Due to the evolutionary process a human has different types of brain, with respect to mind and consciousness. Thus, the constant pursuit of maintaining bodily chemical parameters compatible with a situation of healthy life is the most important thing any living being has. In this sense, the concept of biological value is itself essential for understanding the evolution of the human brain, as far as the brain development and the brain activity itself.

In a vulgar manner, the traditional economy applies the concept of price in the lives of agents. It is true that the price of goods is responsible for managing the gap between what is available for offer and demand. The price submits the order of acquisition of goods and services, alongside the budget constraint applies.

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Some assets are more useful than others (utility value). However, just when inserting the concept of need is possible to explain the essence of biological value. That is the question of living individual who strives to maintain life and the needs arising from this effort. However the reason that leads people to assign value to a good or service goes through the logic of maintaining life and needs that emerge from this logic. For the economic life this indicates the first step for understanding the question concerning the value of goods and services – see Hunt [4].

Neuroscience allows now revolutionizing the question of the value in the economy, primarily because it gives an understanding of the process of decision making at the time of release of certain chemicals in the brain when in situations of reward and punishment, which are directly related to the question of value. Moreover, neuroscientists began to give greater importance to the study of brain nuclei (reptilian brain) and that generally are the most responsible for decision making by humans.

But that is not all. The value is linked to the need, which is connected to supporting life. Moreover, the quality of life is also essential to humans. This happens when choosing a holiday destination in summer, the next cell phone fashion, luxury car or a Doctorate in Miami.

In general, the most essential of the value for all organisms is the survival and a healthy age-compatible to reproduction. Natural selection has refined the homeostatic mechanisms so that the target can be achieved.
Therefore, the origin of the biological value is a derivation of the physiological factors. Thus, the biological value leans toward one scale on the effectiveness of the physical life of the individual.

When humans assign the values to objects, activities have some kind of relationship, even indirect it may be. There are some conditions: first the overall maintenance of living tissue must be within the homeostatic limits appropriate to the context in which it is; secondly, conditions necessary for homeostasis work in a sector of the body that allows the well-being on the context in which the organism is.

Chemical components of the brain allow an unconscious monitoring of what deviates from the homeostatic boundaries, as some kind of sensor in terms of the levels of internal necessity. For example, when the homeostatic limits are exceeded corrective actions are taken by the body promoting incentives or deterrence actions. This depends on the urgency of the response. The record of these actions helps the body to predict future conditions. They begin to experience pain and pleasure.

The human being is in essence the impetuosity to move. This was one of the evolutionary advantages that allowed a man to be what he is today. But every action requires an incentive, which is why some actions are chosen over others.
Until then all the mechanisms described above do not point to the existence of consciousness, only automatic and unconscious processes. However, this is directly related to the economy.

The incentive is therefore an important variable to the biological value. The sensations triggered on the pain, pleasure, etc.. in everyone involved in these states or sensations are the hormones and neurotransmitters. In the case of humans, there is the detection and prediction of possible advantages and threats to the body. For example, when you have the expectation of pleasure, the brain releases the neurotransmitter dopamine. But when one is facing a possible threat there is the release of cortisol. In terms of prediction, if two stimuli occur one following the other, a third stimulus would certainly be expected.
The results of the whole system indicate the following: first, the possibility of a differentiated reaction in each context; second, optimized reactions.

As the organisms have evolved, the underlying homeostasis programs have become more complex as regards the condition that triggered the action and its range of results. These more complex programs gradually became what is now commonly known as drives, motivations and emotions.

Humans possess the more advanced motivational system and a keen sense of exploration and sophisticated warning systems directed to future needs, all of them aiming one goal, to keep the body in constant search for "wellbeing".
The emotional feelings are reflections of bodily states or results altered by the emotions, so that feelings serve as indicators for the management of life.

Most regulatory activities are a result of the unconscious and are essential to the survival of the organism. After all, it would be extremely complicated if humans could manage their own endocrine aspects or the immune system.

Before one has in mind the consciousness as something harmful, it is important to note that it is due to the reasoning ability of man, that it was always possible to shape some kind of ways for man survival in different situations (as what has happened for example in extreme cases in the human history in earth or even in the moon). The new combination of factors producing goods and services allows humanity to adapt to any possible environments, so man invents materials to live anywhere in the world.

The development of the conscience allowed man to have a vital regulation more centered on the development of one only mind in each person, focused on survival but also on the "welfare". This allowed that aspects of people's daily lives have arisen, such as the economic exchanges, religious beliefs, social conventions, ethics, law, science, or technology.

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Finally, the biological value depends on the idea that the brain is for managing the life within the body. An economic analysis based on the biological value is fundamental for the understanding of human behavior and to stimulate economic behavior of agents – see Damásio [5].

[IV] THE HUMAN BRAIN

The brain is the organ responsible for thought, beliefs, memories, behavior and "states of the soul." The brain is also called the control of the body and coordinates the powers of movement, touch, smell, hearing and alert states. Of course it provides the ability to reason and make rational decisions (at least some) as well.

The human brain is comprised by 78 percent water, 10 percent fat, 8 percent protein, 1 percent carbohydrate, 1 percent salt, 2 per cent other components.

Taking into account the anatomy of the nervous system, it is considered divided into two parts: the central nervous system and peripheral nervous system. The central nervous system (CNS) is bilateral and symmetrical, compounds itself brain and spinal cord. The peripheral nervous system (PNS) is a nerve net which serves as a connection between the brain and spinal cord and the rest of the body. The three components of the brain are: the brain, the brainstem and cerebellum. The brain - seen from above - is divided into two parts, the right hemisphere and left hemisphere. These parts are connected by nerve fibers in the center, the corpus callosum – see Robert [6].

The cerebral hemispheres are covered by the cerebral cortex, which is organized into lobes (occipital, parietal, temporal, and frontal), including the cingulate cortex, seen only on the inner surface - medial. The insular cortex, hidden under the parietal and frontal regions, and the hippocampus, a special cortical structure hidden in the temporal lobe.

Below the cerebral cortex, the central nervous system includes deep agglomerates of nuclei as the basal ganglia, the forebrain, the amygdala and diencephalon (the combination of the thalamus and hypothalamus). The brain is connected to the spinal cord through the brain stem, which is located behind the cerebellum, with the two hemispheres.

The human brain is divided into three parts (neo-cortex, reptilian brain and limbic system is the proposal developed by MacLean (1913-2007)) in addition to the usual division in the literature (right and left hemisphere). Economic decisions are processed, felt and performed by the brain in general, yet only one brain region (the reptilian brain) is responsible for about 95% of the decisions on the purchase of a product.

The neo-cortex is responsible for the reason, represented by the speech, writing, reasoning. In the action of purchasing a good, the consumer first makes the decision after he justify it. It is in this moment of justification that the cortex comes into play.
In the evolutionary process, the neutral ampoule always continued to be developed: two lateral ventricles were born, occupying their place symmetrically in the right and left, in the interior of the cerebral hemispheres. The regions of the cortex react in a very short time, and although constructed according to the same model, each one of them retains its original function. For example, recognizing a face, a place, a smell or a poem does not require all the cortical cells, just some special cells.

The cortex is thus very important to capture aspects of sensory stimuli, which are studied in neuromarketing and neuroeconomics. This means that the five senses in the process of buying and selling products and services in the market are used.

The limbic system is responsible for processing emotions. When a client moves to buy a Beatles album or to buy the first car, the first house, the trip of a lifetime, or anything else he gets emotions about. When he watches the TV commercials and when a commercial appeals to emotional feelings like surprise or fear, then the limbic system is activated.

The brain structures in the formation of emotions in the limbic system are the amygdala (fear), the hippocampus (long-term memory), the thalamus (connection with other parts of the limbic system), the hypothalamus (to control the autonomous system), the cingulate gyrus (emotional reaction to pain and the regulation of aggressive behavior), the brainstem (action, alertness), the ventral tegmental area (pleasure), the septum (orgasm).

The limbic system is responsible for the memories. The repeated memories, guided by the experience, allows the learning which is essential to the daily life and to the exercise of a profession, and other economic actions of everyday's life.

The reptilian brain is the brain's decision-maker, where the electrical impulses that lead to action are processed. The customer buys by impulse, the customer buys without thinking. Let see again the example of the purchase of a product: first the decision is made, then it is justified.

The reptilian brain, which comprises the "butcher" brain, regulates the basic elements of survival, such as homeostasis. It is compulsive and stereotyped. MacLean illustrates this function by suggesting, for example, that it organizes the processes involved in the return of sea turtles to their birth place for their reproduction.

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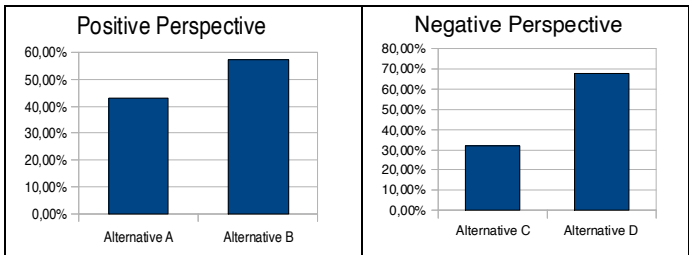

Fig: 1. Positive Perspective **Fig: 2. Negative Perspective**

Source: Own Research

Therefore, for the formation of individual demand, the non-inclusion of variables such as context, perception, emotions, decoys (like free effect), can be fatal to the results of a marketing campaign for a product or service on the market.

[V] RESULTS

5.1. Test Context - Part I

To ascertain whether or not the "context" is important in decision making, we performed a test (see Chavaglia et al, 2012) with 72 students of MBA in Business Management at Getulio Vargas - FGV in Belém, PA. The test was adapted from the studies of Tversky and Kahneman [7]. The researchers presented the dilemma of the disease, in which respondents had to choose between some types of treatments in a positive perspective and others in a negative outlook. A experimental research was used (experiments type before / after - 2 groups), which showed the control group and the experimental group before stimulation, then the stimulation applied in the experimental group, checking the difference between the experimental group (stimulated) and control (without stimulation). The difference between the two was the measure of the applied stimulus (context).

For this study we made some adjustments to the study of Tversky and Kahneman, instead of sick people. Homeless families were considered. The primary objective of the test was to identify the students' decisions concerning the construction of a hydroelectric project. The test was conducted as follows:

1. First the students should consider a decision about a flooded area comprising 600 families, under the following optics:

- Alternative A - 200 families would be preserved on site;
- Alternative B – a probability of 1/3 that the 600 families would be held in the place and 2/3 that no family would remain there;

2. In a second step, students should respond in a negative perspective, considering:

- Alternative C - 400 families would lose their homes, and
- Alternative D – a probability of 2/3 that the 600 families would lose their homes and 1/3 that no family would lose their home.

The issues mean the same phenomenon in both questions.

However each one represents a different approach. Alternatives A and B represent the decision in a positive perspective, and the alternatives C and D represent the decision-making in a negative perspective.

Considering the "positive results" [in the **Figure-1**], 57% of the students of MBA FGV responded that Option B would be the best choice, while 43% claimed that option A would be better. Considering the results for the negative context [**Figure-2**], 68% of students responded that Option D (which is exactly the same as Option B) would be the best choice to be made while 32% said that Option C would be the best among the possible. These results presented in the test carried out in the study and based on issues raised earlier in this chapter can be stated:
1. First, the agents are not as rational as traditional economic theory assumes;
2. Second, variables - hitherto less important to the economy - such as respect, influence in decision making.
The first statement means that, unlike traditional economics suggests that, from where the concept of *Homo Economicus*, which seeks the maximization of economic actions in favor of their own gains, the results were not satisfactory in this sense (rationality), because the change of opinion on a new perspective (positive *vs* negative outlook perspective) implies that the numerical results alone do not influence the final results, unless they are presented from a specific perspective, after all, the change 43% (Option A) to 32% (option C) is quite significant and 57% (option B) in a positive context for 68% (option D) in a negative context - noting that both alternatives (A, B and C, D) show the same result.
The second assertion can be evidenced, and concluded that the presence of context - that is completely disregarded by an information theory approach of traditional economic analysis - was crucial to the results obtained in this study. What in general is that agents, when faced with economic decisions are strongly influenced by the context in which information is presented.

5.2. Test Context - Part II

To test the results obtained in the previous context, it is necessary to extend the test. It was decided to conduct the same inquiry applying it to the students from a doctoral course in Lisbon (Portugal).

All the assumptions concerning the previous test were kept. The goal is to confirm if more qualified people or more familiar with the studies in the Economics area, management or marketing, were less susceptible to the bias relative to the context effect.

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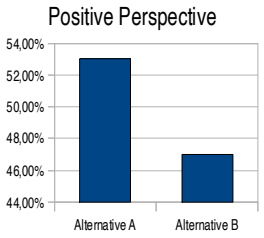

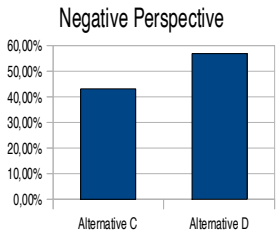

Fig: 3. Positive Perspective **Fig: 4. Negative Perspective**
Source: Own Research

Once again the results were very interesting in the sense that they confirm the existence and the importance of the context in the economic decisions.

On the positive outlook **[Figure-3]** the majority (53% of doctoral students) has chosen the alternative A and 47% opted for alternative B. Now considering the same options on the negative optical **[Figure-4]**, the result has changed, the alternative C (which is the same as A in the positive context) changed to 43%, while the alternative D was chosen by 57% of PhD students, representing an increase to over 10% more in parallel with this same option in the positive context.

At this point very definitive conclusions are not possible. But it seems evident now that the effect of context seems to influence the choices of economic agents. Perhaps this may be because the details relating to the evolutionary process; the mechanism that protects man from the dangers of the world brings us closer to pleasurable situations, which ends up by generating the perception or the distortions arising from it.

[III] DISCUSSION

It is now necessary to make some notes about the results.

Like most of the studies carried out in neuroeconomics, this study permit to conclude that the idea of rational economic agents is not applicable. The effect of context, which is within the specification of the theoretical ground for neuroeconomics and for the analysis made in this study, is considered. This implies that agents decision are greatly influenced by how decision options are presented.

To test this theory, an experimental research was carried out with students of business management and other courses related to the business world.

It is not possible to guarantee that the results are definitive with regard to the condition of irrational agents. To this statement, it is necessary evidently to conduct an investigation involving more complex search techniques for brain imaging, as it is the example of functional magnetic resonance or computed tomography.

But the results can contribute to understand this feasible effect that happens in the decision-making of economic agents. According to the experiment carried out, it is possible now to highlight the following notes:

- The effect of context actually influences the decision making of agents;
- A considerable level of education in management does not free agents of being affected by this effect;
- The positive effect reflects modest responsibility for agents;
- The negative effect shows that the agents choose according to decisions that seem to be more secure.

Therefore, the results apparently indicate the existence of the effect in the economic context. Because it is an unconscious stimulus or situation, agents do not control or cannot defend themselves against the deleterious consequences of the effect of context.

[IV] CONCLUSION

Neuroeconomics permits to analyze effectively about people's decisions and the process of decision making in the market. In this study an example used for the energy sector is presented. However, in many other situations in life, people are faced with this kind of conditions. And often non scrupulous people have important capacity to influence in matters that are considerably important for many people. Sometimes the context is unaware about who does "it" (in the sense of knowing about what you're doing) and in other situations, the effect can occur when the context may help agents to make better decisions. This should be what governments should do, for example.

A point that is usually discussed is the ethical issue concerning the "property" of the concepts and discoveries in this area, considering their origin in neuroeconomics or in neuroscience. In our view, both are used by each other and no conflicts are relevant. In some specific areas, there are some problems. For example, France government is reluctant about the experiments with functional magnetic resonance for economic purposes – see Oullier [8].

Some countries, like U.S.A., Brazil and Chile in America or the Netherlands and Portugal in Europe, are presented as a reference in terms of scientific research and respecting to the professionals working in neuromarketing and neuroeconomics. Surely this is an interesting discussion.
Anyway the main objective of this study is to work on the existence of the context in the economy. In our opinion the criticisms of neuroeconomics have been so far based on the continuation of the status of some defined group of professionals, more orthodox.

In what tests' results is concerned, it seems that the context is relevant in terms of economic decisions. In most of the sciences that study the behavior of people, the way people interact with the environment in which they live, considering physical and chemical factors, is relevant in an analysis for which there are many conditions involved. People have no enough knowledge about the real conditions they face. If they could know effectively about the environment, every person would

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manage easily the consequences of their actions. They would overcome easily any bias encountered in their everyday life.

Consequently, it may be concluded that the effect of context is decisive for the choice of agents. For how, it is easy to understand that choices may influence the final result. The brain acts to choose the odds. The genetic and memetic determine the behavior of each agent, i.e., the evolutionary factors and lessons that humanity carries across the time for a long time determine how the human brain decides.

The effect of context is placed on the agenda of the evolutionary questions, such as: is this good or bad for me? I must run away or fight? In this study, the students of MBA and PhD were faced with the possibility of making decisions of facts that affect positively or negatively families housed in close proximity to a region that would be flooded by the construction of a hydroelectric power. The presence of the effect of context was revealed. The answers to the questions presented in the negative context showed that agents may change their minds. The questions were exactly the same.

Thus, in order to make an exhaustive economic analysis which may consider the biological value of people a first step is necessary like the one presented in this study. This may contribute to allow people to choose what is the best for them. Unfortunately people do not know what they want - and preaching common sense – until they are encouraged to make a choice. The study of the effect of context can be in fact an effective way to guide people.

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CONFLICT OF INTERESTS

Authors declare no conflict of interests.

REFERENCES

[1] Sandroni P. [2007] Novíssimo dicionário de economia, São Paulo, Best Seller.
[2] Teixeira A., Porto E. [2009] Época negócios, Rio de Janeiro, Globo.
[3] Chavaglia JN. Filipe JA. [2011] A view of common property through neuroeconomics in the context of decsision-making processes, International Journal of Academic Research, Vol. 3, No. 3, May, I Part.
[4] Hunt EK. [1981] História do pensamento econômico, Rio de Janeiro, Campus.
[5] Damásio AR. [2010] O livro da consciência: A construção do cérebro consciente, Lisboa, Temas e debates: Circulo de leitores.
[6] Robert JM. [1994] O cérebro, Lisboa, Instituto Piaget.
[7] Tversky A. Kahneman D. [1981] The framing of decisions and the psychology of choice, Science, News Series, Vol. 211, No. 4481, pp. 453–458.
[8] Oullier O. [2012] Clear up this fuzzy thinking on brain scans, Nature.

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