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A NEW FRAMEWORK TO MEASURE INTUITIVENESS IN DECISION PROBLEMS

UN NUEVO MARCO DE MEDICIÓN PARA LA INTUICIÓN EN LOS PROBLEMAS DE TOMA DE DECISIONES

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ABSTRACT

Intuition in decision-making is often seen as a set of heuristic or holistic mental processes applied to decision problems when they exceed cognitive capacity, or whenever there is a will to achieve a solution that does not exhaust cognitive resources. In this regard, to date it has been solely treated as a personal and frequently solipsist tendency. This paper tests whether different types of problems carry different degrees of 'intuitiveness' and whether it would be possible to produce a realistic experimental model of such problems. To cope with both demands, standardized stimuli (mostly IAPS figures) were used to model decision problems as conflicts (approach-avoidance, approach-approach, and avoidance-approach conflicts). Intuitiveness was argued to be inversely related to arousal, as measured by GSR levels. Several solutions to methodological problems involving decision-making designs in the environment of the software BioExplorer were created. Kruskal-Wallis and Mann-Whitney-Wilcoxon tests were used to rank problems. According to our analyses, ap-av conflicts are by far less intuitive than av-ap, and av-av (p <.0001). The latter two are not very different in this regard (p = .5712).

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RESUMEN

Palabras clave:
toma de decisiones, intuición, electrofisiología, incertidumbre

La intuición en la toma de decisiones se asume con frecuencia como un conjunto de procesos mentales heurísticos u holísticos que se aplican a la toma de decisiones cuando exceden la capacidad cognitiva, o cuando se quiere obtener una solución que no agote recursos cognitivos. En este sentido, se ha tratado este tema hasta ahora sólo como una tendencia personal y con frecuencia solipsista. El presente trabajo se propone probar si diferentes tipos de problemas llevan consigo diferentes grados de "intuición", así como plantearse si sería posible producir un modelo experimental realista de dichos problemas. Con el fin de atender a ambos requerimientos se utilizaron estímulos estandarizados (mayormente imágenes del Sistema Internacional de Imágenes Afectivas – IAPS) para modelar problemas que demandasen una decisión a manera de conflictos (conflictos de tipo aproximación-evitación, aproximación-aproximación y evitación-aproximación). Se arguye que la intuición se relaciona de manera inversa con la activación cuando se la mide por niveles de respuesta galvánica de la piel (GSR). Se crearon así varias soluciones a los problemas metodológicos que involucraban diseños de toma de decisiones en el ambiente del Software BioExplorer. Se utilizaron las pruebas de Kruskal-Wallis y de Mann-Whitney-Wilcoxon con el fin de clasificar los problemas. A la luz de nuestros análisis, los conflictos de aproximación-evitación (ap-av) son de lejos menos intuitivos que los conflictos de tipo evitación-aproximación (av-ap) y evitación-evitación (av-av) ($p < .0001$) los dos últimos no fueron significativamente diferentes en este aspecto ($p = .5712$).

The psychology of decision-making under risk or uncertainty (Knight, 1921) has several points in common with the dynamics of conflict resolution. Choices are much like competitors, whose pros and cons struggle in a cost/benefit multidimensional mental framework. That is especially true when equilibrium among these dimensions (or 'utility values') prevails over the capacity to decide confidently.

A 'feeling of knowing' (FOK), that certain object or course of action is potentially more desirable than others, usually precedes self-assured choice selection (Koriat, 2000; Metcalfe, 1986). Such psychological state becomes increasingly important in accordance with the importance attributed to the problem as a whole and it is not hard to foresee that it may become a source of distress when perceived as unachievable. Contrary to the assumption that the closer choices are to a state of equilibrium the greater will be the indifference of decision makers, decision problems which involve valued issues tend to remain psychologically demanding in relation to the aim to achieve high levels of assurance, regardless of the impracticability of such attempt. Outcomes may be hammed into uncertain probabilities of occurrence and incorporate considerable amounts of randomness (for stochastic unpredictability, see Gell-Mann, 1995), and still remain psychologically appealing.

Self-assured choice selection sometimes becomes impracticable due to the set of variables involved in problem, which may outnumber the ones that we are able to manage (for a classic on heuristics and limitations of the capacity to evaluate and compare complex decision options see Payne, Bettman, & Johnson, 1993). Additionally, sometimes it becomes impracticable because options depend on events or decisions which are beyond prediction.

Despite existing limitations to reach FOK experiences in all cases, it is clear that most people tend to have the capacity to select an option in most cases. This has an important function to the preservation of the psychological equilibrium, as it avoids the negative psychological and practical consequences of procrastination (for an introduction to this matter: Ferrari, Johnson, & McCown, 1995; Ferrari & McCown, 1994), and much in this sense there are known affective biases in rational decision-making, which tend to increase the utility attributed to selected options after a decision has been made - a trend known as confirmation bias (De Martino, Kumaran, Seymour, & Dolan, 2006; Nickerson, 1998).

From a strictly rational point of view, one may consider that naive people tend to be particularly skilled in deluding themselves to believe that their decisions dominate the course of the future more than they really do (Koriat, Lichtenstein, & Fischhoff, 1980). But how do we reach the necessary confidence to generate the psychological experience of a FOK, when noticing the randomness of future events or the absence of necessary information to achieve such a state by way of a sequence of cognitive processes capable of endorsing the superiority of an option? This paper will provide a partial and context-specific answer to this question, based upon the argument that this is precisely what "intuition" is all about. In our opinion, there are some non-trivial conceptions which must be presented in relation to these concepts so as to properly support our goal, and we will review them in this introduction.

Preference can be seen either as a behavioral dimension, as originally described by renowned preference theorists, (e.g., Samuelson, 1938), where preference of A over B is a conceptual translation of the observation that in the presence of both A and B, one chooses A; or as a mental dimension, where preference of A over B is the mental representation endorsing the opinion that in the presence of both A and B the former tends to be preferred (for a discussion, see Hausman, 2000).

The latter conception is clearly the one that matters in this context. Herein it is reasonable to assume that settling preference frequently involves a mental (time) travel (MTT) to hypothetical scenarios of development of the concurrent courses of action that the agent infers from the options, as long as he/she is provided with sufficient information and time to mentally prospect potential consequences of choice selection. Another condition is that the subject attributes enough importance to the problem as a whole, so as to invest cognitive energy in achieving the best possible solution. As stated by Hausman and McPherson (1994), preference is not just gut feeling; for a discussion on the application of the idea of MTT to the understanding of the psychology behind decision-making (see Boyer, 2008).

There is a basic difference between the establishment of preference in such contexts to its establishment when mentalization is impossible, due to unpredictability (MTT is not possible, hampering the achievement of a FOK by such means), related to the fact that the latter case forces one to rely exclusively on gut feelings. This dependence on gut feelings defines a class of heuristic processes popularly known as intuition (more specifically 'holistic intuition'; for an experimental definition of holistic intuition, see Pretz & Totz, 2007), which is known to be particularly suited to confirmatory biases (Simmons & Nelson, 2006).

Among the many old and new theories of intuitive processes in decision-making, a trend that has become popular is that the achievement of a FOK in contexts where choice selection as a byproduct of deductive or inductive operations is beyond the subject's possibilities is accomplished along with or by means of transient electrophysiological shifts from stable states (Bechara, 2004; Bechara, Damasio, Tranel, & Damasio, 2005).

This trend is at the heart of the somatic marker hypothesis, which became popular after the creation of the Iowa Gambling Task (IGT) (Damasio, 1994). This game involves four piles of cards, whose pay-off is not only different (such that if all card values are revealed, options can be ordered in terms of their financial utility), but also involves different magnitudes of values (in such a way that the pile with the highest rewards and punishments has the worst overall pay-off).

In a famous series of experiments, Bechara et al. (2005), demonstrated that after selecting approximately half of the cards (during a game involving 4 decks and a total of 100 cards) normal people start to manifest a notable preference toward piles with the highest overall pay-offs (in other words, they start to decide advantageously) and that this tendency tends to be present regardless of their incapability to manifestly rank the piles in terms of their overall utility (Damasio, 1994, Bechara et al., 2005).

The authors also added that the adaptive behavior that is observed is mainly guided by an intuitive FOK that one experiences along with the intention to select a pile and that such feeling of knowing that emerges without conscious knowledge (a trend that they termed 'know without knowing') is related to anticipatory changes in galvanic skin response that guide card selection (GSR - a classical marker of autonomic activation, arousal, and stress) (Bechara, et al., 2005; Damasio, 1994, 1996).

These anticipatory responses are characterized by increases in GSR levels, which are typical of increased arousal, due to higher sympathetic activity. Within the context of the game, this is experienced as stress responses, triggered as the decision agent considers the selection of cards from piles that had led to severely negative outcomes in previous rounds (Damasio, 1994).

The somatic marker hypothesis states that people avoid piles that trigger anticipatory stress; it also says that selection is intuitive, in that it is guided by a process of knowing with fully conscious knowledge. Once we add these two ideas together, we reach the perspective that the less advantageous piles with their associated anticipatory stress responses are less intuitive.

Bearing that in mind, it is reasonable to consider the extent to which these piles with worst overall pay-offs can be designated as "less intuitive", one may say that there is an inverse relation between the "intuitiveness" of an option and the degree to which it generates electrophysiological responses of stress. This is at the heart of the development that we propose.

Another idea that we would like to add is that the selection of options resemble the process of solving a conflict among possible choices that compete in the mind for preference. As one may note, such conflict can be topologically represented as a demand to sequentially establish the fittest of a set of potential attractors, amongst which some start to lose their appeal after each round, much as theorized in classic conflict theory.

For instance, if we consider a two piles version of the IGT and two initial choices that lead a decision agent to sequentially win some money (from both piles), the conflict to be solved by the next move (one which can be trivially reduced to the comparison of gains) can be defined as an approach-approach conflict.

In his classical attempt to systematize conflict theory, Lewin (1935) defined three elementary types of conflicts: avoidance-avoidance (av-av), approach-approach (ap-ap) and approach-avoidance (ap-av) (for critical discussion and additional information, see Atthowe Jr., 1960; Coombs & Avrunin, 1977). The most common way to define an av-av conflict is to say that it occurs in face of the necessity to select among two or more repulsive possibilities; for instance "either I stay at work until nine o'clock at night or I pick to be penalized by not having concluded my assignment". An ap-ap conflict is characterized when the available options are all potentially positive; for instance deciding between earning a new car or a sponsored vacation. Ap-av conflicts are a little more complex and can be said to happen in light of the necessity to decide when faced with goods whose positive and negative attributes tend to equilibrium. If the hypothetical IGT player that we depicted above was to continue playing to the point of winning and losing money from all piles, the structure of the psychological conflict that would emerge from thinking his subsequent decisions would change from ap-ap to ap-av.

The Role of Phenomenological Anchoring in Realistic Decision-Making Scenarios

The use of epistemological frameworks from conflict theory in decision-making analysis is not orthodox and was introduced here because we noticed that it allows the systematization of an important aspect of all naturalist decision-making dynamics, which has never been accomplished by available decision games and associated analysis: the relation established between the state of affairs existent before exposure to the game's options and the subsequent decision.

For instance, taken the topological representation of a conflict between negative options, a variation of the classic av-av decision conflict is defined and can be studied as such when someone making a choice whose valence he/she considers to be negative is faced with the necessity to trade it for one among a set of options that are also characterized by negative valence. That is, when considering the situation where a decision agent has to abandon a negative attractor in favor of a decision tree constituted of few other negative attractors. An av-av conflict can be seen when someone who has just lost their money gambling is faced with the options of either borrowing money from a gangster or skipping dinner and lunch.

Along the same lines of thought, one can think of a two-stage variation of the classic ap-av decision conflict, consisted a first phase where a positive attractor is presented and a second phase where the agent is forced to select one among several negative ones; for instance, after receiving a promotion someone is faced with the demand of either firing one of his closest colleagues or one of the most promising newcomers of the team. As one may note, classic conflict theory has little to say about this kind of problem.

It is clear that these cases portrait much more realistic designs than most decision games (no matter whether they are zero-sum or non zero-sum), since they deal with the existence of both a pre-scenario and a decisional scenario. In real life, decision problems to which we are exposed do not emerge from previous "blank slates", but emerge in the context where previous states of affairs already existed (since there is a phenomenological continuum in the realm of psychological experience). These affairs define a "psychological anchoring point", that is, an angle from which the agent starts to consider the problem. Much as hunger affects consumers' buying behavior (Mela, Aaron, & Gatenby, 1997), agents are generally anchored in pre-scenario contexts from which they start to consider any decision problem (for an introduction to anchoring effects: Tversky & Kahneman,1974).

This very perspective opens a venue to study the mysteries of intuition in a broad and significant manner: considering a multi-round decision task, characterized by the presence of pre-scenarios and decision scenarios paired in accordance with the above designations from conflict theory (av-av, ap-ap, ap-av); would it be possible to rank different "conflicts" in terms of their relative intuitiveness?

Which type of decision problem suits more easily the achievement of a FOK; one where we are forced to exchange a worthy possession for one of three new positive choices, one where we are forced to change it for one of three negative ones, or one where we are forced to change an unworthy possession for one of three other negative ones? Is there a specific naturalist context (pre-scenario to decision scenario design), where we tend to be more intuitive than others?

To provide an answer to such questions, it is necessary to generalize lessons from early IGT studies, which have pointed to the aforementioned inverse relation between "intuitiveness" (as easiness to select) and stress (measured as GSR level) to a broader sets of decision problems, including cases where there is neither a better option nor an actual, rational solution.

Considering such set of decision problems, we can assert a precise context where "intuition" can be used and scrutinized: once there is a problem designed to stimulate the agents' intentions to maximize the efficacy of their choices (at the same time that the options are designed to produce a state of equilibrium), and the problem as a whole is designed to be rigorously sheltered from the achievement of a rational solution, it is possible to take for granted the fact that choice selection will be forcedly based on gut feeling and will involve different degrees of easiness, related to the nature of the choice stimuli (e.g., selecting among negative valence options after dropping a positive pre-scenario; selecting among positive options, etc.).

In this context, intuitiveness of a problem that involves a set of imponderable options can be assumed as inversely correlated to the curve drawn by the subject's GSR level from the predecision scenario (baseline) to the moment of selecting an option in the decision scenario, in such a way that the initially unassailable problem of categorizing decision problems in terms of their potential to be solved intuitively turns out to be a matter of ranking conflict resolution in terms of baseline-to-peak GSR activation, from pre-scenario exposure to option selection. This conception is justified by the fact that the state of affairs (herein referred exclusively to stress level due to its unpaired relevance to the proposed question) manifested in pre-scenario represents the anchoring state from which option selection will be psychologically defined, in accordance with the phenomenological changes caused by the necessity to respond to this demand.

The objectives of this study are two-fold. On the one hand, this study seeks to introduce some new perspectives on the psychology of decision-making, ad on the other to apply them experimentally in order to investigate the possibility of ranking three elementary types of decision problems (herein conceived under the theoretical framework of classical conflict theory) in terms of the easiness of selecting an option, when there are no clues as to what option is better suited to satisfy the proposed demand and wherein the subjects are stimulated not to guess, but rather to deliberate in face of the achievement of a FOK.

Considering that the achievement of a FOK when the route to a rational or partially rational solution is impossible calls for an intuitive deliberation, this study can be considered as a proposal to rank problems in terms of their intuitive profiles. Thus it would aid in the development of a new line of studies, which may apply to several other categories of decision problems, yet to be defined or systematized.

Method

Participants and Experimental Preparation

The study was conducted in compliance with the Declaration of Helsinki and its amendments (for a review: Lewis, Jonsson, Kreutz, Sampaio, & van Zwieten-Boot, 2002), and the norms of local institutional review board. The experimental protocol was approved by the local research ethics committee, and all patients provided written informed consent.

The experiment involved the voluntary participation of 30 undergraduate (equally divided by sex) students from psychology, medicine and engineering courses of the University of Sao Paulo, Brazil, whose age ranged from 18 to 28 years old (mean age: 23.4 years). Exclusion criteria were: (a) having less than 5 hours of sleep in the previous night; (b) suffering from strong psychological pressure; (c) use of drugs of abuse or alcohol in the previous three days; (d) history of psychiatric or neurological disorders; (e) obesity (observational criteria). These criteria were defined in face of findings reporting them to bias psychological and electrophysiological assessments (Groth-Marnat, 2009). A psychiatric inventory (mini-mental) was applied, while the other exclusion criteria were investigated in a semi-structured interview.

Participants undertook the test while seated in a comfortable chair in a quiet room. All had their second and third fingers of the non-dominant hand attached to a GSR sensor (J&J Engineering Inc.) and were instructed to leave their dominant hand over the computer's mouse, to easily advance the figures. The design was tested by each participant prior to the beginning of data capture and we ensured that all had proper understanding of the instructions.

Experimental Design

The experimental design introduced by this study is the result of improvements over an earlier version, used for a pilot study in this very year (unpublished data). It is built on the conception of decision problems as different types of conflicts, categorically defined from the pre-scenario to decision scenario, so that exposure to a stimulus of negative valence in the pre-scenario would categorize the problem as av-(), whereas a pleasing stimulus in the pre-scenario would categorize it as ap-(). Conversely, a set of unworthy stimuli in the decision scenario would categorize the problem as ()-av, whilst a set of positive options would make it ()-ap. We did not include av-ap problems, for reasons that will be made clear in due course.

The decision problems involved in this study are all non-declarative and were preceded by very simple instructions. The stimuli that define the problems consist of images projected in a computer screen. Most of these images were selected from the IAPS inventory, while the remaining ones are public domain images taken from the internet. Three categories of images were included: human faces, landscapes/locations, and food; each of which appeared three times, leading to nine decision problems, categorically divided in three blocks. The categories were consistently maintained during all pre-scenario to decision scenario exposures. Presentation of the figures was not fully randomized, but only pseudo-randomized (in order to avoid categorical recurrence), and this created a mathematical proof that lack of complete randomization did not bias the results, as we will further consider.

During each of the nine times that participants had to pick an image, they were initially exposed to an image for 5 seconds, after which a black screen appeared for another 5 seconds, and then this very image along with three other images; the first image sets the 'pre-scenario', whereas the latter set the decisional scenario.

Below we find a copy of a typical decision problem (ap-av) of our experiment.

Procedure

Participants were initially informed that the images are all part of a large inventory and were previously ranked in terms of their respective valence by thousands of other lay subjects, whose social-demographic profiles resembled their own. They were also informed that, among the figures presented in the decision scenarios, there was always one that statistically surpassed the others in terms of preference/valence.

With this information in sight the instruction was to try to select the best rated figure (statistically) in each of the nine trials. In this sense, the task was not to select the image that appeared to be the most attractive in a personal basis, but the one that was assumed to be rated as so by a proportionally large number of lay people. Such a necessity to prospect intentional content from the mind of unknown subjects (adapted from theory of mind studies that we are also developing) represented our solution to the necessity to create problems that were sheltered from rational or partially rational solutions.

We also included in the presentation of the instructions the declaration that the experiment aimed to define (and rate people in relation to) one of the dimensions of Social IQ. The latter is a trend that we are really developing in a multicentric collaboration; it involves the application of several new tasks, including the first neuro-

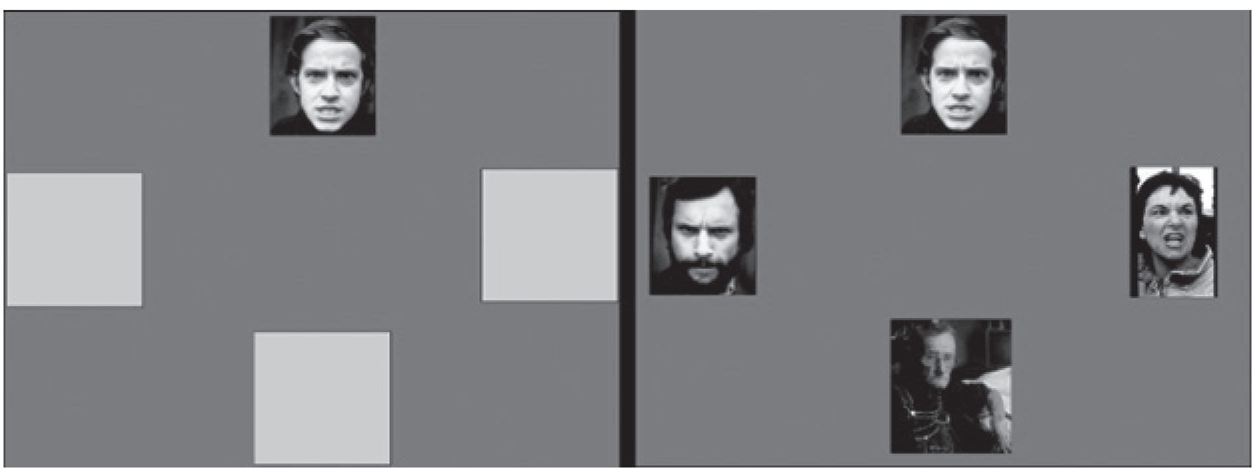

Figure 1. Pre-scenario and decision scenario images of an av-av decision problem related to 'faces'.

psychological instrument capable of quantifying Theory of Mind performance: http://hq.oda.mat.br/en/. This statement was finally associated to the commitment to provide data on personal performance after the completion of the task, in terms of its superiority, correspondence or inferiority to the average performance collected so far. This procedure aimed to increase personal adherence to the objectives of the experiment.

After completion of individual data capture, participants were asked about whether they believed our statements about the nature of the experiment and whether they really tried to find the correct answer (subjects declaring not having believed or not having tried to figure out the correct response were to be eliminated, but this did not prove to be necessary). Finally, all subjects were informed about the real structure of the experimental design and the reasons why it was impossible to actually rate their performance.

While declaring that the images had different ranked valence, this study selected images whose valence were as statistically equilibrated as possible, thus ensuring that no simple solution was possible in any trial and safeguarding the challenge to standardize option selection in categorically diverse problems from biases that could emerge from a lack of internal consistency. The method used to achieve such a solution was to use IAPS images whose valence was as even as possible and to complement them with other figures judged by a group of other subjects to match the valence of these.

In this sense, this study also involved a both qualitative and quantitative pre-experiment ($N = 8$) with subjects matched by age and selected from the same environment as the subsequent participants of the study, which analyzed 24 IAPS images and 30 public domain images, in order to select 36 images of equivalent valence, to be included in the decision-making experiment.

Measuring Problem 'Intuitiveness' Electrophysiologically

As said, we deducted from the lessons provided by experiments on somatic markers by Bechara et al. (2005), that the level of intuitiveness of a problem that cannot be solved by rational or near rational means (hypothetical-deductively) is inversely represented by the level of stress generated by option selection, so that more intuitive solutions can be defined as the ones that produce less stress, while problem categorization can be herein regarded as a matter of ranking GSR values.

For instance, if we assume that subjects may vary in the time needed to pick options presented in the decision scenario for reasons that may be unrelated to the level of stress produced (which seems sensible to assume as a recurrent occurrence) and we opt to fix the measure to be compared as the GSR phasic response (that is, the integer of the curve defined by the total GSR activation generated from the moment that recording initiated to the moment that an option was selected), a bias would be immediately created. It is important to bear in mind the fact that stress does not match overall electrophysiological activation in every possible sense, at the same time that peaks in electrophysiological activation tend to match stress peaks (Kaplan & Nguyen, 2010). Therefore, this experiment used peak activation ('GSR max') as its core measure.

Programming the Experimental Design

In order to capture and synchronize GSR measures with the presentations of the images, a multi-media design was created using the signal processing software BioExplorer version 1.5 (Cyber Evolution Inc.) and FLASH images (SWF), which were created using the Impress module of the Open Office software. The design programmed in BioExplorer allows two independent interfaces; one for the subject, where the images are shown, and one exclusively for the researcher, where graphics of real-time acquisition can be analyzed. The subject's screen was displayed in a second computer screen, in order to aid the proper development of the experiment.

The researcher's interface also includes a third, hidden screen, named signal diagram. This screen contains all the programming information necessary to run the experiment, developed in the software's intuitive 'flowchart' language.

Herein the statistics of interest are selected in order to be exported to .txt files, and be analyzed. Two problems emerged during the creation of the signal diagram: BioExplorer was not capable of receiving signals from SWF interfaces, and a time protection that seems not to have been foreseen by the software developers was needed in order to prevent variation in the time demanded to select an image affected the interval defined to the presentation of the next block of images. Both problems received original solutions that now can be applied to all other experimental designs to be developed with this software.

Below we find a copy of the programming design that was created for this study, which will be made publicly available at www.creativecommons.com.

Hardware and Caption

This study involved the use of a six channel acquisition unit (I-330C from J&J Engineering Inc., Poulsbo, WA), a standard laptop computer (Sony Vaio), and an additional 19-inch monitor. Data were captured from the second and third fingers of the non-dominant hand, while the other hand was kept free to select the images.

Below we find a table with the most important electrophysiological parameters.

Results

To analyze the results of this experiment we created macros that automate the exportation of any set of selected data from the software's

Table 1
Main electrophysiological parameters

Number of available channels: 6
Number of used channels: 2
Optical isolation: 400 VAC
Range of GSR caption: 0.5-100 µΩ
Impedance test of the electrodes: 250 ohms to two mega ohms
Impedance: 10 Gohms
Data sampling: 512 samples/second
Artifact elimination: 60Hz line filter

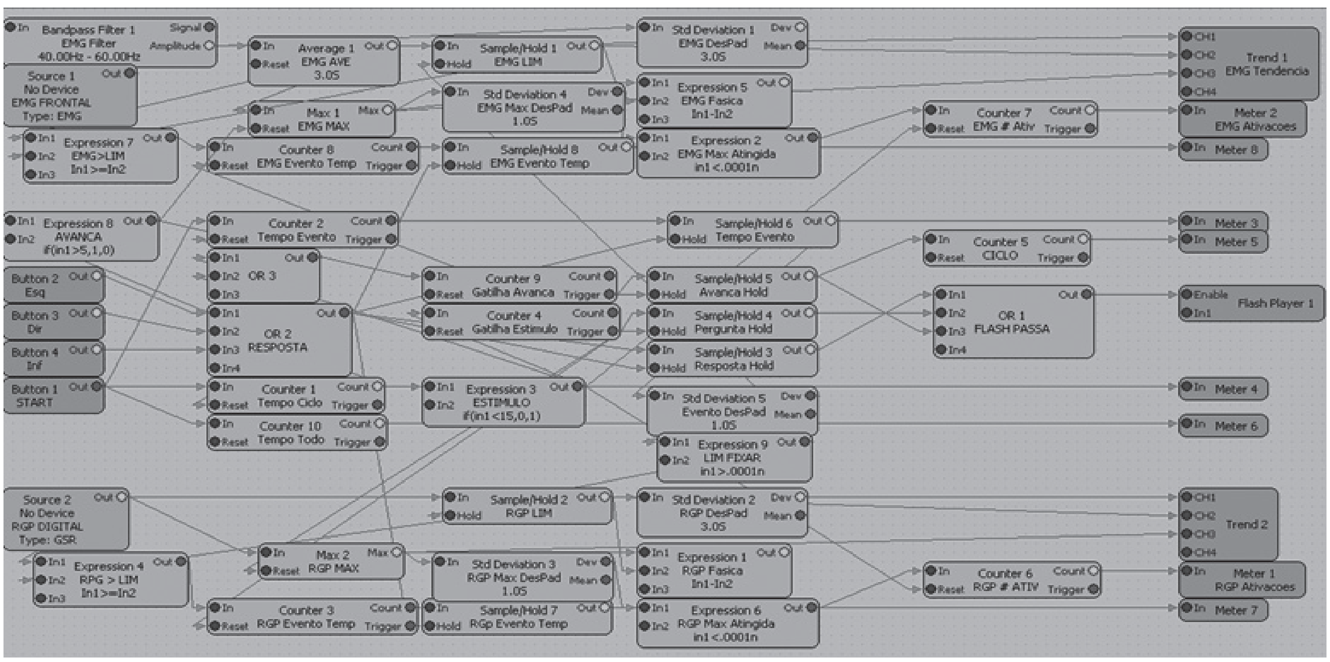

Figure 2. Digital programming design created for this experiment, in the environment of the software BioExplorer. Electromyography (EMG) was recorded but not used, due to excessive noise.

basic output, which is rigidly processed in 1 second epochs. These macros will also be made available in www.creativecommons.com.

Considering that GSR levels vary substantially from time to time and, most importantly, from person to person, our proposal to avoid biases in the establishment of the 'intuitiveness' of the different categories of problems was to divide the nine problems into three sets of categorically different problems (three problems per set, one ap-av, one av-av, and one ap-ap), and only one type of stimuli (faces, foods, landscapes/locations), calculating performance by ranking stress level within each set.

Thus, data collection led to three ranks for each subject, before a final result was generalized for the whole dataset. In sum, we concluded that cardinal but not ordinal preference was the best option to deal with natural variations in GSR levels, both by limiting the time window of sequential collection and comparison for each subject and by avoiding the direct comparison of GSR levels among different subjects.

Finally, we used Kruskal-Wallis and Mann-Whitney-Wilcoxon tests, using Stata software (Hamilton, 2003) to define the final intuitiveness rank.

By attributing the number '1' to ap-av problems, the number '2' to av-ap, and the number '3' to av-av problems, we found that the less intuitive type is ap-av, whereas av-ap and av-av have the same intuitiveness. The achievement of such conclusion can be tracked for the following overall results:

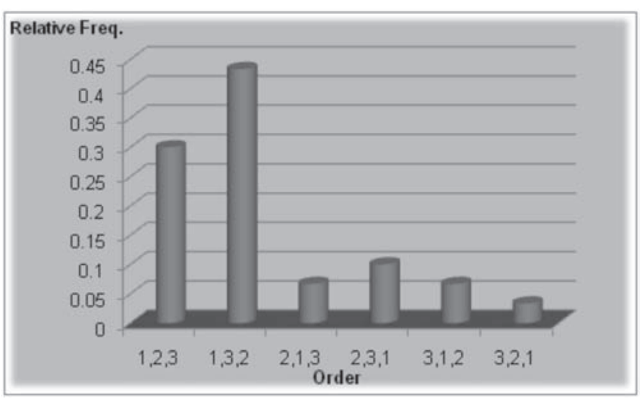

Figure 3. Stress level related to the different categories of problems represented by their relative frequencies.

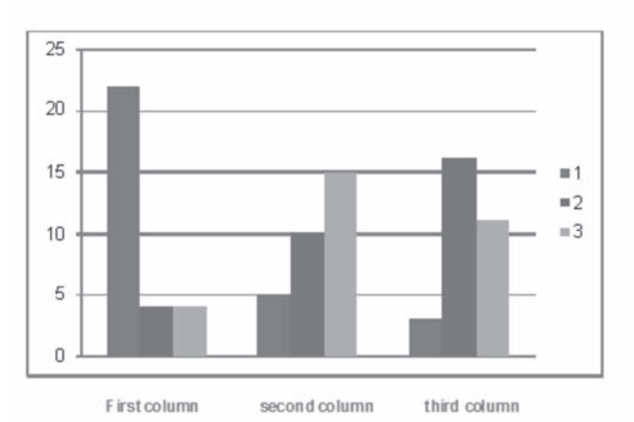

Figure 4. Class 1 = subjects to whom ap-av was the most stressful category of problem. Class 2 = av-av as the most stressful. Class 3 = av-ap as the most stressful

First we plotted the relative frequencies in which the different orders appeared. Next, we addressed the number of subjects to which each category of problems produced the higher stress level. Finally, we approached the relative intuitiveness of problems av-av (class 2) and av-ap (class 3). As one may note, while the former appears more in the first position (5 times vs. 3 times for av-ap), the latter appears more often in the second position (16 vs. 13 times for av-av). We considered that data collection ended with 90 classifications and proceeded as following: each time a category was classified as the most stressful, it received a '1'; each time it was the second, it received a '2'; and each time it was the third, it received a '3', so that each category ended with 30 1-3 classifications, in relation to which the highest sum equals higher intuitiveness.

Having obtained these results, we used Kruskal-Wallis (for the three groups) and Mann-Whitney-Wilcoxon (for 2x2 analyses) tests to rank them.

The former test showed a clear difference amongst categories (p = .0001), thus endorsing the perception of decreased intuitiveness of ap-av problems that can be easily seen in the previous figures. This finding was endorsed by 2x2 comparisons using Mann-Whitney-Wilcoxon tests. The comparison of av-av and av-ap categories did not yield statistically significant differences (p = .5712), therefore suggesting that it was not possible by this means to statistically discriminate them in relation to relative intuitiveness, albeit it is still worth noting that av-av problems appeared more in the first position than the latter.

Discussion

One thing that emerged from conducting this experiment is the perception that people adhered significantly to the task and with no reluctance in trying to figure out the imponderable. Why did no one complain or act as if the task was imponderable? This is a very interesting psychological trend on its own, which we speculate to relate with the proposition that most people tend to have a general limitation in seeing things as imponderable or random (for a discussion: Falk & Konold, 1997).

From the perspective that adherence took place and will probably take place in replications of this study, the discovery that ap-av problems show the smallest intuitiveness of all studied problems suggests that a decrease in the overall utility of the options to be selected in a context were no rational selection is possible represents the core variable to hamper intuitiveness. To the extent that this finding can be generalized to real life situations, one may conclude it suggests that as people may lose their faith due to deterioration of their options, they may lose intuitiveness with it.

Along these lines of thought, the fact that av-av problems followed ap-av problems in occupying the first position among all three categories may be seen as an indication that the next significant psychological variable to intuitiveness is simply valence (in opposition to dynamic changes in valence). Up to the point that this applies to real world choices, one may hypothesize that intuitiveness increases with the rating of available options, in cases where an equilibrium that cannot be solved rationally is established. It is worth noting that we did not test ap-ap problems, but as long as these results define a hierarchy of potential intuitiveness, it is expected that ap-ap problems reveal to be the most intuitive.

Together, one may speculate that these perspectives endorse the idea that intuitiveness in decision-making is somehow related to hedonistic experiences. This could explain why drops in valence turns the process of deciding in face of the imponderable so much more stressful (as evaluated electrophysiologically) than the recurrence of low valence scenarios.

The extent to which our GSR data is the best possible correlate of intuitiveness is certainly open to debate. Our position is not that this is necessarily true, but that GSR is the most traditional and probably the most reliable electrophysiological measure available, and for that reason appears to be the most sensible option to inaugurate a new line of explorations.

A greater question that remains open to debate is the extent to which these stress measures can be mapped into the concept of intuition/intuitiveness. Our position is that intuition and intuitiveness have several definitions, each of which carry traces generated vis-à-vis the demands of different contexts. Considering that the problems that we are dealing with were not systematized in the same designs as before, it is easy to argue that such mapping does not hold. However, when we consider the ties that this use of intuition establishes with previous uses (especially in IGT-based research) and assume that the only means of selecting an option confidently in our experimental framework is by gut feelings, it becomes apparent that new uses of the concept makes sense and has a good chance of being incorporated both by lay people and the scientific community.

We actually go beyond this claim and assume that it can be said that the degree to which a decision is intuitive relates with the level of stress that it evokes, provided that the problem as a whole is not treated analytically; that is, intuitive decision-making involves a decision style by which the agent uses his spontaneous attraction to the different options, while not analyzing them hypothetically-deductively, as the main decision criteria. In that same vein, problems and decision trees as a whole can be defined as more or less intuitive, in relation to their tendency to force the agent to appeal to gut feelings and in terms of the average degree of stress that they tend to evoke.

The current study introduces a new theoretical problem and some original ideas to shed light onto it, converging into an attempt to treat the affective anchors that precede and influence decision-making under uncertainty; a new experimental design that can be used with a plethora of cheap-to-expensive acquisition devices (a list of which will be made available as this paper is published); and preliminary results regarding the intuitiveness of three types of problems, ap-av, av-av, av-ap, based upon the assumption that this trend can generalized to sets of options in the same vein that it has been linked to decisions in the IGT.

This study has several limitations: our decisional experiment involved a small N; it relied on non-conventional analyses (which were proposed to deal with natural limitations of GSR data that could easily bias the conclusions), and it was limited to few categories of conflict problems. For these reasons, we believe that it should be dealt with more n the lines of a proposal to start a new line of explorations, rather than as a flagship conclusive statement with definitive findings in intuitiveness in decision-making. On the other hand, it is interesting to note that it restated old conclusions regarding the particular stressfulness which Lewis found to be inherent to ap-av conflicts (Lewis, 1935), which now can be problematized within the context of intuition and decision-making.

References

Atthowe Jr., J. M. (1960). Types of conflict and their resolution: A reinterpretation. *Journal of Experimental Psychology, 59*(1), 1-9. doi: 10.1037/h0046912

Bechara, A. (2004). The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage. *Brain and Cognition, 55*(1), 30-40. doi:10.1016/j.bandc.2003.04.001

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (2005). The Iowa Gambling Task and the somatic marker hypothesis: some questions and answers. *Trends in Cognitive Sciences, 9*(4), 159-162. doi:10.1016/j.tics.2005.02.002

Boyer, P. (2008). Evolutionary economics of mental time travel? *Trends in Cognitive Sciences, 12*(6), 219-224. doi:10.1016/j.tics.2008.03.003

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

Damasio, A. R. (1996). The somatic marker hypothesis and the *possible functions of the prefrontal cortex. Philosophical Transactions of the Royal Society B: Biological Sciences, 351*(1346), 1413-1420. doi: 10.1098/rstb.1996.0125

De Martino, B., Kumaran, D., Seymour, B., & Dolan, R. J. (2006). Frames, biases, and rational decision-making in the human brain. *Science, 313*(5787), 684-687. doi: 10.1126/science.1128356.

Falk, R., & Konold, C.E. (1997). Making sense of randomness: Implicit encoding as a basis for judgment. *Psychological Review, 104*(2), 301-318.

Ferrari, J., Johnson, J., & McCown, W. (1995). *Procrastination and task avoidance: Theory, research, and treatment*: Springer.

Ferrari, J., & McCown, W. (1994). Procrastination tendencies among obsessive-compulsives and their relatives. *Journal of clinical psychology, 50*(2), 162-167. doi: 10.1002/1097-4679(199403)50:2.

Gell-Mann, M. (1995). *The Quark and the Jaguar: Adventures in the Simple and the Complex*: St. Martin's Griffin.

Groth-Marnat, G. (2009). *Handbook of psychological assessment*: Wiley.

Hamilton, L. (2003). *Statistics with STATA*: Duxbury.

Hausman, D. (2000). Revealed preference, belief, and game theory. *Economics and Philosophy, 16*(01), 99-115.

Hausman, D., & McPherson, M. (1994). Preference, belief, and welfare. *The American Economic Review, 84*(2), 396-400.

Kaplan, P., & Nguyen, T. (2010). *Clinical electrophysiology: a handbook for neurologists*: Wiley-Blackwell.

Knight, F. (1921). *Risk, uncertainty and profit*: Houghton Mifflin Company.

Koriat, A. (2000). The Feeling of Knowing: Some Metatheoretical Implications for Consciousness and Control. *Consciousness and Cognition, 9*(2), 149-171. doi: 10.1006/ccog.2000.0433

Koriat, A., Lichtenstein, S., & Fischhoff, B. (1980). Reasons for confidence. *Journal of Experimental Psychology: Human Learning and Memory, 6*(2), 107. doi:10.1037/0278-7393.6.2.107

Lewin, K. (1935). *A Dynamic Theory of Personality*. New York: McGraw-Hill.

Lewis, J., Jonsson, B., Kreutz, G., Sampaio, C., & van Zwieten-Boot, B. (2002). Placebo-controlled trials and the Declaration of Helsinki. *The Lancet, 359*(9314), 1337-1340. doi:10.1016/S0140-6736(02)08277-6

Mela, D. J., Aaron, J. I., & Gatenby, S. J. (1997). Relationships of Consumer Characteristics and Food Deprivation to Food Purchasing Behavior. *Physiology and Behavior, 60*(5), 1331-1335. doi:10.1016/S0031-9384(96)00241-7

Metcalfe, J. (1986). Feeling of knowing in memory and problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*(2), 288-294.

Nickerson, R. S. (1998). Confirmation Bias: A Ubiquitous Phenomenon in Many Guises. *Review of General Psychology, 2*(2), 175-220.

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). *The adaptive decision maker*. Cambridge: Cambridge University Press.

Pretz, J. E., & Totz, K. S. (2007). Measuring individual differences in affective, heuristic, and holistic intuition. *Personality and Individual Differences, 43*(5), 1247-1257. doi:10.1016/j.paid.2007.03.015

Samuelson, P. (1938). A note on the pure theory of consumer's behaviour. *Economica, 5*(17), 61-71.

Simmons, J. P., & Nelson, L. D. (2006). Intuitive Confidence: Choosing Between Intuitive and Nonintuitive Alternatives. Journal of Experimental Psychology: General, *135*(3), 409-428. doi:10.1037/0096-3445.135.3.409

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science, 185*(4157), 1124-1131.