Iowa Gambling Task and Skin Conductance Response Measurement: the experimental design

by Rosita Borlimi

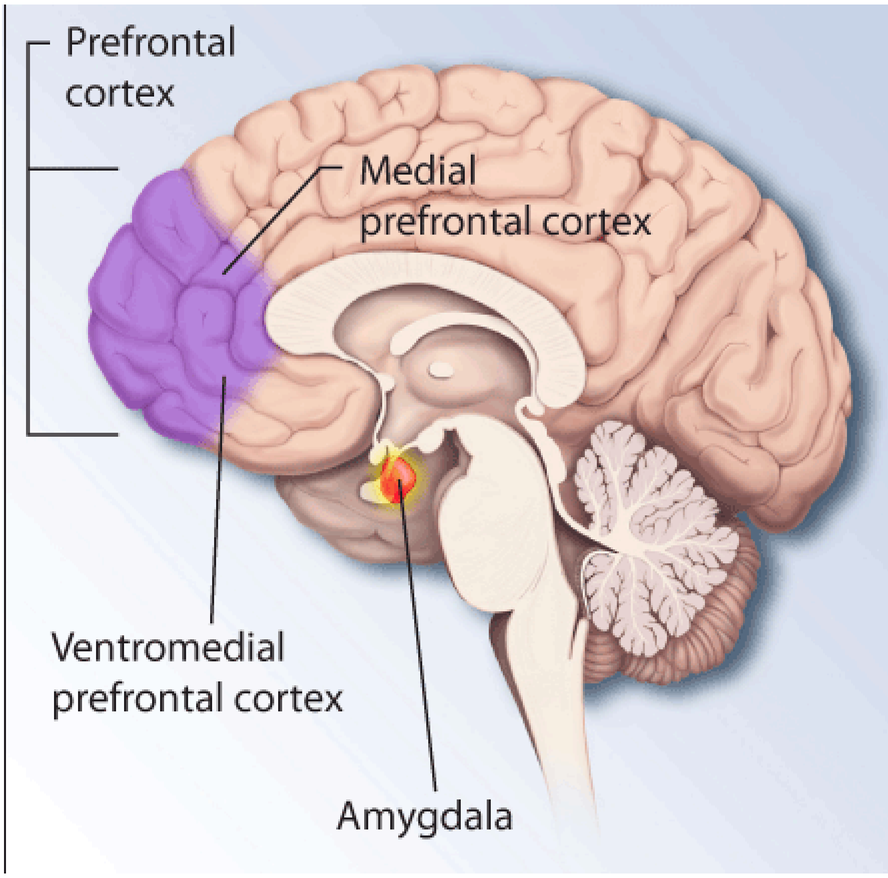
This document provides a short description of the experimental design used in the research project "Risk tolerance in Financial Decision Making". This research was supported by a grant from the Italian Ministry of University and Research as a "Research of National Interest" - PRIN 2007 (September 2008-September 2010). An incremental grant from Assoreti (the Italian Association of Financial Advisors) (Year 2010-2011), and from AIPB (the Italian Association of Wealth Managers), allowed a complementary view of the analysis.

1- Introduction: Emotions and Decision Making

Emotions are now considered the primary constituent of the perception of a decision, to the point that if no emotionally oriented value motivates the decision, it will simply not appear if a decision needs to be made. Paradoxically, in any plausibly emotion free situation that involves a decision, the decision is likely to be neglected. In order to gain a better understanding of the different roles played by emotions in decision making, it is necessary to distinguish between two different ways in which emotions can enter into decision making (Loewenstein and Lerner, 2003). The first influence of emotions consists of predictions about the emotional consequences of decision outcomes. Expected emotions are not experienced as emotions at the time of decision making, but they are expectations about emotions that will be experienced in the future. The second kind of affective influence on decision making consists of immediate emotions, that are experienced at the time of decision making and that influence decision making through a direct or indirect impact. Immediate emotions reflect the combined effects of emotions arising from contemplating the consequences of the decision itself (anticipatory influences), as well as emotions arising from factors unrelated to the decision(incidental influences). Incidental emotions do not arise from considering the consequences of decisions; their influence on decision making is typically considered non normative. According to Loewenstein and Lerner's conceptualisation (cit.), immediate emotions can have both direct and indirect effects (changes in the prediction of consequences, selective processing of information and changes in the quality and depth of processing) and are produced by two types of inputs. Considering that expected affect is fundamentally a cognition (about future utilities), while anticipatory affect is fundamentally an emotion (about future utilities), they indeed proceed along distinct neural pathways and they have different potential to shape behaviour (Panksepp, 1998).

An influential attempt to disentangle these processes comes from Damasio: Somatic Marker Hypothesis (SMH; Damasio, 1994, 1996). As explained by Damasio in 1994, somatic markers are a special instance of feelings generated from secondary emotions. Those emotions and feelings have been connected by learning to predict future outcomes of certain scenarios. When a negative somatic marker is juxtaposed to a particular future outcome, the combination functions as an alarm bell. When a positive somatic marker is contrasted instead, it becomes a beacon of incentive. According to this hypothesis, each behavioral option is specifically associated with unconscious somatic responses, including neural responses, evoked by its previous consequences that either encourage or discourage a certain choice. Damasio postulates that the somatovisceral signals from the body (affective reactions) ordinarily guide individuals' decision making and risk engagement processes. During decision making, somatic signals (for example heart rate, skin conductance, tonicity), the so- called 'somatic markers', arise from the periphery and indicate an emotional reaction to the response option. Accordingly, for each response option a somatic state is generated and stored in memory. The SMH proposes that the somatic markers are represented and regulated in the emotion circuitry of the brain, particularly in the ventromedial prefrontal cortex (fig.1).

Fig. 1 Somatic markers are probably stored in the ventromedial prefrontal cortex.



When a particular situation that is similar to a previously experienced situation arises, information regarding the possible response options and their likely outcomes is reactivated. This information is associated with the somatic responses to the given situation and assists decisions by encouraging the rejection of disadvantageous choices and endorsement of advantageous ones. According to the SMH, the reactivation of the somatic responses is evoked on two different pathways. First, these somatic responses can actually be elicited and projected to the somatosensory cortex (the so-called 'body loop'). Secondly, the representation of the somatic affective response can be directly activated in somatosensory brain regions without eliciting peripheral bodily responses (the so- called 'as if body loop'). The vagal route seems to be especially critical in this process (Bechara, 2004). Somatic markers are held to be particularly important in situations of uncertainty and complexity and are thought to enable a faster and experience driven integration of decision making. Since somatic markers can be represented overtly and covertly, this process can operate both with and without conscious awareness. The somatic marker hypothesis is consistent with the idea of a 'hot' decision making. Specifically, Damasio (1994) hypothesized that the somatic marker's role in 'hot' decision making is to assist the 'cold' decision making process by unconsciously biasing the available response selections in a complex decision making task. 'Cold' decision making is associated with rational and cognitive determinations of risks and benefits associated with options and requires the knowledge of the risk–/benefit ratio, the ability to retrieve them from memory and the ability hold them in mind while comparing and contrasting them (working memory), whereas 'hot' decision making involves emotional and affective responses to the options (Seguin, 2007).

2- The Iowa Gambling Task (IGT)

The Iowa Gambling Task (IGT; Bechara, 1996) was originally developed to explain decision making deficits in people with specific frontal lobe damage. These patients seem unable to learn from previous mistakes, as reflected by repeated engagement in decisions that lead to negative consequences. In striking contrast to this real life decision making impairment, these patients' intellect and problem solving abilities are largely normal, thus their decision making deficits cannot be explained by attention, working memory, or other cognitive impairments (Damasio, 1994). In addition to their inability to make advantageous decisions in real life, patients highlights a generally flat affect and their ability to react to emotional situations is somewhat impaired. This led Damasio to hypothesize that the primary dysfunction of these patients was an inability to use emotions to aid in decision making, particularly decision making in the personal, financial and moral realms. To test this hypothesis, Bechara and colleagues coupled their gambling task with the measurement of skin conductance response (SCR), an autonomic index of emotional arousal(showed in the next paragraph). In a series of experiments, it was shown that normal subjects elicited SCRs that were larger before choosing from the disadvantageous decks than before choosing from the advantageous decks. Furthermore, it was found that this anticipatory emotional response preceded explicit knowledge of the correct strategy. Patients with vmPFC damage did not show such anticipatory emotional responses showing that this region is necessary for anticipating the emotional impact of future rewards and punishment. The IGT has successively proven to be effective in exploring the implications of the Somatic Marker Hypothesis in a variety of psychiatric populations (Viswanath, 2009; Miu et al. 2008) and healthy subjects (Franken et al. 2008). In neural terms when the signals of somatic states are transmitted to the cell bodies of neurons that constitute the major neurotransmitter systems (dopamine - DA, serotonin - 5-HT, noreadrenalina - NA and acetylcholine - Ach), these patterns of information influence and modulate the release of neurotransmission. These changes in neurotransmission contribute to modulate synaptic activity in the telencephalon that produce cognitive and behavioral activities such as the selection between different responses and the type and degree of emotions.

An extension of this model of brain functioning, led Bechara and Damasio [2005], to develop what they called "a neural theory of economic decision-making", in an attempt to explain beneficial or detrimental decisions of a financial nature. Bechara and Damasio cit. argue that the decisions of economic and financial activity does not pertain to the brain amigdalae, selected by evolution to respond to functional emotional responses to events of serious immediate risk, but rather to those of the ventromedial prefrontal cortices, capable of predicting future emotions in a time dimension and in relation to the prediction of the effects of our actions. The mechanisms by which different "thoughts" or "mental representations" bind to somatic states through the prefrontal cortices, would be based directly on the organization of the cortex in relation to the human ability to think about the concepts of time and chance.

The somatic marker hypothesis provides neurobiological evidence in support of the notion that people often make judgments based on 'hunches', 'gut feelings', and subjective evaluation of the consequences (Damasio, 1994; Loewenstein, 2001; Schwartz and Clore, 1983; Tversky and Kahneman, 1981; Zajonc, 1984). In Overskeid's terms, they help select the solution that feels the best.

2- Measurement of Skin Conductance Response (SCR)

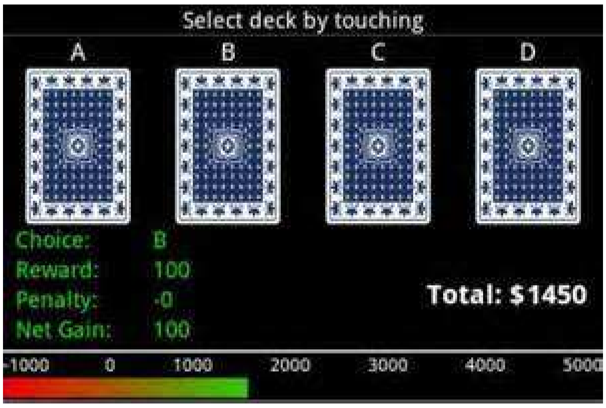
The task requires the use of the computerized version of the Iowa Gambling Task (IGT) based on the original as described in Bechara et al. (1994) and the recording of physiological indices by the use of a system for recording psychophysiological data, (in our case the Biopac Systems Inc., Fig. 2).

Fig. 2 MP150 System with electrodermal devices.

In the computerized version of the gambling task, the subject sees the four decks of cards on a computer screen. The decks are labelled A, B, C, and D at the top end of each deck. Using the keyboard, the subject can choose a card on any of the four decks. Choosing any card from

deck A or deck B yields a maximum of 100 Euros; choosing any card from deck C or deck D yields a maximum of 50 Euros.
However, the ultimate future yield of each deck varies because the penalty amounts are higher in the high-paying decks (A and B), leading to a negative balance, and lower in the low-paying decks (C and D), leading to a final gain. Thus, decks A and B are "disadvantageous," whereas decks C and D are "advantageous." So that they can perform the task, the subjects are given the following instructions: "In front of you on the screen, there are four decks of cards A, B, C, and D. I want you to select one card at a time from any deck you choose, by pressing the corresponding button on the keyboard, Each time you select a card from a deck, the computer will tell you that you won or lost some money (Fig. 3).

Fig. 3 Screen shot of the Iowa Gambling Task



You are absolutely free to switch from one deck to another any time you wish. The goal of the game is to win as much money as possible and, if you find yourself unable to win, make sure you avoid losing money as much as possible. I won't tell you for how long the game will continue. You must keep on playing until the computer stops." The players can't predict when a penalty occur, nor calculate with precision the net gain or loss from each deck. They also do not know how many cards must be turned before the end of the game (the game in fact ends after 100 card selections). The computer tracks the sequence of the cards selected from the various decks. Each time the subject selects a card during that time interval, the computer does not respond, and therefore no record is generated. The task duration is about forty-five minutes for each participant.

As the subject performs the task, skin conductance responses (SCR) are recorded continuously and collected simultaneously on a personal computer. Changes in SCR occur when the eccrine sweat glands, innervated by the sympathetic autonomic nervous system fibers, receive a signal from a certain part of the brain. Electrodes are attached to the palm surface of the second phalanx of the index and middle fingers of the non-dominant hand (Fig. 4).

Fig. 4 Skin Conductance Sensor

Sample rate is set at 1 Hz. Each time the subject selects a card, this action is recorded as a "mark" on the polygraphic signal of SCR activity and it is registered as a selection from the specific deck that was chosen. Thus, SCRs generated in association with a specific card from a specific deck can be identified precisely on the recorded signal. The time interval between two card selections is on average ten seconds. During the six seconds intertrial interval the decks are displayed continuously on the screen, and the subject can ponder which deck to choose next.

The SCRs generated during the task are divided into three categories:

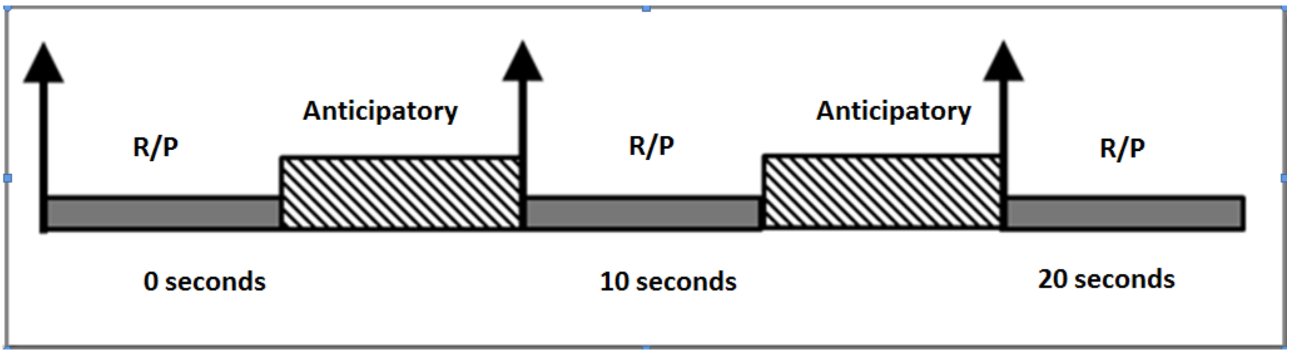
1) reward SCRs, which are generated after turning cards for which there is a reward and no penalty;

2) punishment SCRs, which are generated after turning a card for which there is a loss and an immediate penalty;

3) anticipatory SCRs, which are generated previous to turning a card from any given deck, i.e., during the time period the subject ponders from which deck to choose.

The time windows for the reward and punishment SCRs are the five seconds immediately after the selection of a card. SCRs generated during the end of the reward/punishment window and before the next selection of a card are considered anticipatory SCRs (Fig. 5).

Fig. 5 The time windows



The SCR data are stored on a personal computer, and analyzed by the AcqKnowledge III software for the MP100WS system. The AcqKnowledge software allows for the performance of postacquisition mathematical transformations.

According to Bechara & Damasio (2002), each subject will be classified as one of the following:

1) those who performed poorly on the IGT and are characterized by defective anticipatory SCRs = individuals who do not have any perception of risk, characterized by an abnormal decision-making system (e.g., like a psychopaths).

2) those who performed poorly on the IGT and generate anticipatory SCRs = high-risk takers, thrill seekers, or gamblers.

3) those who performed well on the IGT and generate anticipatory SCRs = risk avoidant.

Short BIO:

Rosita Borlimi is a psychologist and psychotherapist, with experience in research and clinical neuropsychology. She developed experimental research on case studies assessing cognitive abilities (attention, memory, thought) through the use of psychophysiological tools. Using a cognitive-behavioral approach, she has extensive experience in the treatment of Eating Disorder, Obsessive Compulsive Disorder, Generalized Anxiety Disorder, Social Phobia, and Panic Disorder. She recently applied her knowledge to problems related to the economic decision-making under uncertainty.

References

A. Bechara, A. R. Damasio, H. Damasio and S.W. Anderson (1994) ‘Insensitivity to future consequences following damage to human prefrontal cortex’, *Cognition*, 50(1-3), 7–15.

A. Bechara, D. Tranel, H. Damasio and A. R. Damasio (1996) ‘Failure to respond autonomically to anticipated future outcomes following damage to prefrontal cortex’, *Cerebral Cortex*, 6, 215–225.

A. Bechara (2004) ‘The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage’, *Brain and Cognition,* 55, 30–40.

A. Bechara and H. Damasio (2002) ‘Decision-making and addiction (part I): impaired activation of somatic states in substance dependent individuals when pondering decisions with negative future consequences’, *Neuropsychologia*, 40(10), 1675–89.

A. Bechara and A. R. Damasio (2005) ‘The somatic marker hypothesis: A neural theory of economic decision’, *Games and Economic Behavior*, 52, 336–372.

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

A. R. Damasio (1996) ’The somatic marker hypothesis and the possible functions of the prefrontal cortex’, *Philosofical Transactions of the Royal Society of London. Series B, Biological Sciences*, 351, 1413–1420.

I.H. Franken, J.W. Van Strien, I. Nijs and P. Muris (2008) ‘Impulsivity is associated with behavioral decision-making deficits’, Psychiatry Research, 15, 158(2), 155–63.

G. Loewenstein and J. Lerner (2003) ’The role of emotion in decision making’ in: R. J. Davidson, H. H. Goldsmith, and K. R. Scherer (Eds.), *Handbook of Affective Science* (Oxford: Oxford University Press), pp.619-642.

G. Loewenstein, E. U. Weber, C. K. Hsee and N. Welch (2001) ’Risk as feelings’, *Psychological Bulletin*, 127, 267–286

J. Panksepp (1998) *Affective neuroscience* (New York: Oxford University Press).

J. R. Seguin, L. Arseneault and R. E. Tremblay (2007) ‘The contribution of “cool” and “hot” components of decision-making in adolescence: Implications for developmental psychopathology’, *Cognitive Development*, 22, 530–543.

B. Viswanath, Y. C. Janardhan Reddy, K. J. Kumar, T. Kandavel and C. R. Chandrashekar (2009) ‘Cognitive endophenotypes in OCD: a study of unaffected siblings of probands with familial OCD’, *Progress in Neuropsychopharmacology and Biological Psychiatry,* 33, 610–615.

A. C. Miu, R. M. Heilman and D. Houser (2008) 'Anxiety impairs decision-making: psychophysiological evidence from an Iowa Gambling Task', *Biological Psychology,* 77, 353–358.

N. Schwarz and G. L. Clore (1983) 'Mood, misattribution and judgement of well-being. Informative and directive functions of affective states', *Journal of Personality and Social Psychology*, 45, 513–523

A. Tversky and D. Kahneman (1981) 'The framing of decisions and the psychology of choice', *Science*, 211, 453–458.

R. B. Zajonc (1984) 'On the primacy of affect', *American Psychologist,* 39, 124–129.