



Scuola Superiore dell'Università di Siena



2010 **LabSi** CONFERENCE

"NEUROSCIENCE AND DECISION MAKING"

September 20 to 21, 2010

**Collegio Santa Chiara
University of Siena**

Keynote Speakers

Stefano Cappa (Università S. Raffaele Milano)

Angela Sirigu (CNRS Lyon)

Marcel Zeelenberg (Tilburg University)

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Alessandra Rufa, Alessandro Santoni.

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KEYNOTE SPEAKERS

Stefano Cappa (Università S. Raffaele Milano)

Angela Sirigu (CNRS Lyon)

Marcel Zeelenberg (Tilburg University)

ORGANISING BOARD

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Sandro Nannini (University of Siena)

Alessandra Rufa (University of Siena)

Alessandro Santoni (University of Siena)

2010 LabSi Conference

"Neuroscience and Decision Making"

September 20 to 21, 2010
Collegio S. Chiara, University of Siena

PROGRAM

MONDAY 20TH SEPTEMBER

8:30-9:00	Registration and Welcome Address
9:00-10:00	KEYNOTE TALK Chair: Alessandro Innocenti Angela Sirigu (CNRS Lyon) Neuropsychology of human decision making
10:00-11:00	SESSION A. NEURAL FOUNDATIONS OF DECISION MAKING Chair: Alessandro Vercelli Michela Balconi, Andrea Terenzi (Catholic University, Milan) Neuropsychology of moral judgement, responsibility and risk seeking: what in common? Valeria Faralla(University of Siena), Francesca Benuzzi, Fausta Lui, Patrizia Baraldi, Paolo Nichelli, Nicola Dimitri Gain and loss: a common neural network for economic behaviour
11:00-11:15	Coffee break
11:15-13:15	SESSION B. LEARNING AND RISK ATTITUDE IN DECISION MAKING Chair: Alessandro Santoni Gediminas Luksys (University of Basel) Stress, noradrenaline and individual differences in model-based analyses of learning and decision making Antonio Dell'Ava, Simona Conti, Letizia Vaccarella, Stefano Di Piazza, Antonio Rizzo (University of Siena) The root of human knowledge and rationality: emulation vs imitation learning Laura Moretti (CNRS Lyon), Valeria Faralla, Philippe Vindras, Angela Sirigu Making economic decisions for other people: an exception to loss aversion law Josef Schützeichel (Ludwig-Maximilians-Universität), Theresa Michl A neuroeconomic perspective on age and risk-taking behavior
13.15-14.15	Lunch

MONDAY 20TH SEPTEMBER

14:15-15:15	KEYNOTE TALK Chair: Stefano Fiori Marcel Zeelenberg (Tilburg University) What is moral about moral emotions?
15.15-16:45	SESSION C. EMOTIONS IN DECISION MAKING Chair: Sandro Nannini Alessandro Grecucci (University of Trento), Cinzia Giorgetta, Mascha van't Wout, Nicolao Bonini, Alan G. Sanfey Emotional regulation in social decision-making: behavioral and neural evidence Cinzia Giorgetta (University of Trento), Alessandro Grecucci, Nicolao Bonini, Giorgio Coricelli, Gianpaolo Demarchi, Cristhoph Braun, Alan G. Sanfey Waves of regret: A MEG Study of emotion and decision-making Christoph Lumer (University of Siena) Emotional decisions - The induction-of-intrinsic-desires hypothesis
16.45-17:00	Coffee break
17:00-19:30	SESSION D. EVIDENCE ON THE NEUROSCIENTIFIC FOUNDATIONS OF DECISION MAKING Chair: Alessandra Rufa Angela Dalton (Pacific Northwest National Laboratory), Alan Brothers, Stephen Walsh, Paul Whitney Expert Elicitation Method Selection Process and Method Comparison Jordi Brandts, Orsola Garofalo (Universitat Autònoma de Barcelona) How accountability and gender interact: Evidence from a laboratory experiment William Jolley (Norwich University) From habit to addiction: A study in online gambling behavior Lavoslav Čaklović (University of Zagreb) Self duality and conflict resolution Georgios Halkias (Athens University), Flora Kokkinaki Attention, memory, and evaluation of schema incongruent brand messages: An empirical study
20:30	Dinner

TUESDAY 21TH SEPTEMBER

9:00-10:00	KEYNOTE TALK Chair: Antonio Federico Stefano Cappa (Università S. Raffaele Milano) Regret and decision making
10:00-11:00	SESSION E. PROBABILITY AND JUDGMENT IN DECISION MAKING Chair: Antonio Federico Dale Griffin (University of British Columbia), Lyle Brenner, Derek Koehler Testing a Unified Two-System Model of Probability and Pricing Judgment Giuseppe Attanasi (Toulouse School of Economics LERNA), Aldo Montesano The price for information about probabilities and its relation with capacities
11:00-11:15	Coffee break
11:15-13:15	SESSION F. EYE-TRACKING STUDIES OF DECISION MAKING Chair: Nicola Dimitri Susann Fiedler (University of Erfurt, Max Planck Institute for Research on Collective Goods), Andreas Glöckner, Andreas Nicklisch Information search and information integration in repeated Voluntary Contribution Mechanism (VCM) Games: An Eye-tracking analysis Yukihiko Funaki, Ting Jiang (Tilburg University), Jan Potters Eye-tracking Social Preferences Francesco Fagnoli (University of Siena), Pamela Federighi, Nicola Polizzotto, Pietro Piu, Giacomo Veneri, Andrea Fagiolini, Antonio Federico, Alessandra Rufa On multi-sensory integration: influence of pitch on visual attention and visual working memory for shapes. An eye tracking study. Alessandra Rufa (University of Siena), Francesco Fagnoli, Pietro Piu, Elena Pretegiani, Pamela Federighi, Antonio Federico, Alessandro Innocenti Decision making under uncertainty: An eye-tracking study
13:15	End of the conference

ABSTRACTS

MONDAY 20TH SEPTEMBER

8:30-9:00 – Registration and Welcome Address

9:00-10:00 – KEYNOTE TALK

- **Angela Sirigu (CNRS Lyon)**
Neuropsychology of human decision making

How humans make decisions is a core issue in cognitive neuroscience and experimental economics. Neuroscientists and economists have indeed begun to study jointly how strategic thinking and emotions related to reward, self-interest or fairness regulate human individual and social behaviour. Experimental economists have shown the limits of the rational theory for explaining and predicting how people act in such situations. The neural bases of these behaviours are far from understood. Different approaches from non-human primates to human neuropsychological studies can be used to reach this goal. Recently we showed that the orbitofrontal cortex mediates counterfactual reasoning, necessary for experiencing complex emotions such as regret (Camille et al., Science). Interestingly, the intensity of regret, has been found a better predictor of subsequent choices than expected utility alone. I will focus on this work by illustrating the mechanisms of decision making from a game theory perspective and by discussing lesion and neuroimaging findings.

10:00-11:00 – SESSION A. NEURAL FOUNDATIONS OF DECISION MAKING

Chair: **Alessandro Vercelli** (University of Siena)

- **Michela Balconi, Andrea Terenzi (Catholic University, Milan)**
Neuropsychology of moral judgement, responsibility and risk seeking: what in common?

Recent work in cognitive psychology and neuropsychology indicates an important relationship between the sense of moral responsibility and neural correlates, from one hand, and attitude for risk and activation of specific brain areas, from the other. The present research offers an integrated overview on these topics, since emotions and rationality contribution in decision-making were explored in two different contexts: moral judgement and responsibility assumption in response to moral dilemmas; emotive and cognitive strategies in risk seeking. Nineteen subjects were required to make a choice that has a moral valence within a social context by analyzing interactional scripts. Secondly they were asked to participate to a game (IGT), where they may produce a money gain or

loss. Electroencephalographic measures (ERPs), autonomic indexes (skin conductance response, blood pressure, and electromyography), and psychometric measures (personality trait related to moral values) were revealed during the task execution. Specific ERPs deflections (N200/P300) were observed in response to moral judgement, as well as modulations in autonomic responses for the two experimental tasks.

Systematic associations were found between cognitive strategies used in response to risk seeking and moral decision, based on subjective preferences. Specifically, skin conductance was varied as a function of emotional involvement and decisional processes activated, whereas cognitive options were reflected in ERPs modulations. Based on correlation analysis, subjective profiles were delineated in relationship with specific categories for risk seekers and moral choices.

- **Valeria Faralla (University of Siena)**, Francesca Benuzzi, Fausta Lui, Patrizia Baraldi, Paolo Nichelli, Nicola Dimitri
Gain and loss: a common neural network for economic behaviour

Intertemporal choice represents decisions involving tradeoffs among gains and losses occurring at different point in time. Event-related functional magnetic resonance imaging was used to investigate the neural mechanisms underlying intertemporal preference for symmetric monetary rewards and punishments in certain conditions, by asking subjects to choose between two gains or two losses available at different points in time. We also explored the neural networks involved in the influence of euro amount, time delay, and percent difference between the two alternatives of choice. Gender effect was also evaluated. Our results suggested that a common widespread neural network was activated both in processing of gains and losses which mainly included the occipital, the parietal, and the prefrontal cortex, suggesting that the same brain structures supported every economically relevant behaviour, independently from the sign of the outcome. In accordance with McClure et al. (2004a), two different neural circuits were found to be engaged in the processing of immediate and delayed monetary outcomes. Regions of the emotional system, namely the posterior cingulate and the medial prefrontal cortex, were recruited when an immediate option (gain/loss) was available. In contrast, the occipital and the parietal cortex, in association with the lateral and dorsolateral prefrontal cortex, were engaged in delayed choices.

11:00-11:15 – Coffee break

11:15-13:15 – SESSION B. LEARNING AND RISK ATTITUDE IN DECISION MAKING

Chair: **Alessandro Santoni** (University of Siena)

- **Gediminas Luksys (University of Basel)**
Stress, noradrenaline and individual differences in model-based analyses of learning and decision making

Individual performance in learning and decision making tasks depends on many factors such as stress & motivation, attention & memory capacities, use of available knowledge for action selection, and sensitivity to risks, losses and delays. During recent years it has become increasingly popular to analyse behavioural, genetic and neuroimaging data using computational models (such as reinforcement learning or prospect theory) that allow estimating certain parameters of interest and comparing them between experimental groups. These studies made it possible to relate different genetic variations, brain area activations or neuromodulatory activities to quantities like risk & uncertainty, exploration-exploitation balance, and temporal discounting. I will present several such studies: one investigating the role of stress, noradrenaline, and genetic strain for mice performing a conditioning task, and the others addressing the role of human genetic variation and individual differences in memory and decision making.

In the first study, the model-based analysis of mouse behaviour revealed correlations between estimated reinforcement learning parameters and modulatory factors such as stress, genetic strain, affective phenotype, motivation, recent performance feedback, and pharmacological manipulations of adrenergic alpha-2 receptors. The results provided computational insights into how an inverted-U-shape relation between stress/arousal/noradrenaline level and behavioural performance could be explained through changes in exploration-exploitation balance and future reward discounting.

In more recent ongoing studies, human memory and decision making behaviour has been formalized using different computational models and the estimated parameters correlated with genetic variations – single nucleotide polymorphisms (SNPs) as well as with demographic information. Several SNPs (most of which were located in brain expressed genes) predicted differences in learning rate and emotional modulation of memory. We are currently performing fMRI analyses to investigate if brain area activations are associated with different variants of these SNPs.

- Antonio Dell'Ava, Simona Conti, Letizia Vaccarella, Stefano Di Piazza, **Antonio Rizzo (University of Siena)**
The root of human knowledge and rationality: emulation vs imitation learning

Human infants come across the vast majority of material and conceptual artefacts through social interactions with relatives and adults who take care of them for securing their survival. Children come into contact with objects and routines within a social context, and in that social context *learn to interact with objects and persons as one*. For obvious reason there are no studies that investigate the spontaneous encounters with artefacts by rimate ewborns (humans, chimps, bonobos, orang-utans, gorillas), and so it is difficult to see the spring off and establishment privileged modalities of interaction with objects (i.e. affordances) not mediated by co-specific, but the studies conducted to investigate the differences between emulation and imitation in social learning can shed some lights on the production of knowledge instrumental to act effectively and efficiently in our physical and social world.

Moving within the theoretical framework of Cultural Psychology (Cole, 1996) and from the empirical evidence produced by the teams of Michael Tomasello (1996; 1999) and Andrew

Whiten (2000; 2005), we present a view on human cognition leveraged by the principle of shared intentionality. More in to the detail we will present a partial replay of a crucial experiment conducted by Horner and Whiten (2005) where, with modification to the original setting, we introduced two further independent variables with the aim to explore deeply the way in which shared intentionality gives shape to our behaviour and "rational choices".

- **Laura Moretti (CNRS Lyon), Valeria Faralla, Philippe Vindras, Angela Sirigu**
Making economic decisions for other people: an exception to loss aversion law

The most influential model of decision making under risk and uncertainty is "Prospect Theory" (Kahneman and Tversky, 1979). This was formulated to explain why economic choices under risk deviate from rationality and postulates that choices are made using a value function assigning a greater value to losses than to gains. Here we investigated whether risk attitudes of a decision maker would differ when the reference point is no more his own money but somebody else's money. A group of 30 healthy subjects performed three different monetary decision tasks in which they had to make risky choices. Each task was run according to two conditions: (1) "self", subjects were told that their choice had an impact on their final gains; (2) "other", subjects were told that they were delegated to choose for another person and that their choices would only have an impact on the other person's gains. Results obtained in the three tasks demonstrated that loss aversion bias was significantly reduced when the decision maker was delegated to choose for another person. A final analysis revealed that subjects' economic decisions were significantly closer to the rationality level when the reference point is someone else's money. Our findings show that loss aversion law explains choices behavior for self but not for others.

- **Josef Schützeichel (Ludwig-Maximilians-Universität), Theresa Michl**
A neuroeconomic perspective on age and risk-taking behavior

Germany like other developed countries in the world is confronted with an aging population (Beddington et al., 2008). The development of these countries is closely connected with the productivity of older people, both economically and socially, because older people are the majority in our societies. Financial decisions of aging investors will have an increasing impact on the global economy. Therefore it is necessary to investigate risk-taking behavior of elderly people to give implications for daily economic and social life. Recent neuroscientific and neuroeconomic findings show how aging may disrupt rational financial choice at a neural level. Thus, the aim of this study is to summarize these results and give implications for researchers and for practitioners: We focus on the well known effect that older adults are more risk-averse than younger adults and show how this is related to errors in decision-making processes and how these errors can be integrated in the daily financial decision-making and how to prevent such errors (Mohr et al., 2010).

There are numerous studies in economic literature which studied the effect of age on risk-taking. These studies show that risk-taking is decreasing with age (Morin and Suarzez, 1983; Holmstrom and Milgrom, 1987; Kanodia et al., 1989; Riley and Chow, 1992). Using different measures such as observed portfolio allocations of wealth (Jianakoplos and Bernasek 2006) or large scale survey studies analyzing the whole population (Barsky et al., 1997; Donkers et al. 2001; Dohmen et al., 2006), these studies show the well known effect that willingness to take risk is decreasing with age. Using the Iowa Gambling Task, a task to measure ambiguity, various studies also find a negative correlation between risk-taking and age (Fein et al., 2007; Denburg et al., 2005, Zamarian et al., 2008). Further studies found that violations of expected utility theory are decreasing with age (Kume and Suzuki, 2010; Harbaugh et al., 2002).

Contrary to these results is Wang and Hanna's (1997) research. Using the 1983-1989 panel of the survey of consumer finances they find out that relative risk-aversion decreases as people age (i.e., the proportion of net wealth invested in risky assets increases as people age). They conclude that risk tolerance increases with age which is contrary to the constant life-cycle risk-aversion hypothesis. Other studies show differences between decision-making of older and younger people, but with regard to their risk-taking behavior.

Surprisingly there are only few experimental studies which directly tested the demographical differences in risk-taking behavior in the laboratory. One reason for this might be that students are the standard subject pool in laboratory economic experiments and thus not suited to conduct age-related studies. However these few experiments have lead to the same result that risk-taking is decreasing with age (Deakin et al., 2004; Chou et al., 2007). In experimental economics and in neuroeconomics most studies and experiments are conducted with young subjects thereby neglecting possible age differences in economic behavior and associated neurocognitive mechanism (Mohr et al., 2010).

Looking at neuroscientific and neuroeconomic studies which focus on the relationship between risk-taking and age can help to find out the underlying mechanisms of these stereotypic risk attitudes.

There is only little evidence in neuroeconomics of how the brain is reacting to different risk attitudes among different demographic groups. Using fMRI Lee et al. (2008) investigate risk-taking behavior of young and old people and find that older individuals chose significantly less often the risky options. But when older individuals chose the riskier option, they had a stronger activation in the right insula compared to younger adults which is interpreted as an indication that the risky option is perceived as more risky by elderly than by young adults resulting in an increased avoidance of risky situations.

A recent study by Samanez-Larkin and colleagues (2010) investigates age differences in financial decisions by combining functional neuroimaging with a dynamic financial investment task. Their behavioral results show that older adults make more suboptimal choices than younger adults when choosing risky assets. At the neural level they find that this behavioral age-related effect was associated to a temporal variability in nucleus accumbens activity indicating an age-related subcortical deficit which may lead to risky decision-making mistakes.

To conclude, our review shows how aging disrupt rational financial choice behavior at a neural level. The neural mechanisms which lead to the risk-averse behavior of older people are diverse. Only little research has focused on this "deeper" neural analyze of

aging and financial risk-taking (Peters et al., 2007; Mohr et al., 2010). Therefore we seek to fill this gap and analyze the neural evidence to give implications for real financial life.

13:15-14:15 – Lunch

14:15-15:15 – KEYNOTE TALK

- **Marcel Zeelenberg (Tilburg University)**
What is moral about moral emotions?

15:15-16:45 – SESSION C. EMOTIONS IN DECISION MAKING

Chair: **Sandro Nannini** (University of Siena)

- **Alessandro Grecucci (University of Trento)**, Cinzia Giorgetta, Mascha van't Wout, Nicolao Bonini, Alan G. Sanfey
Emotional regulation in social decision-making: behavioral and neural evidence

The ability to successfully regulate our emotions is a necessary skill for navigating our daily social interactions. Emotion regulation refers to the means by which "individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (cf. Gross, 1999). Although there are many different means that people can use to regulate their emotions, the strategy of reappraisal is one of the most well-studied. Reappraisal is capable of lowering emotional experience, reducing or altering psychophysiological activity, and improving social functioning (Gross, 2002; Gross & John, 2003; Ochsner, Bunge, Gross, & Gabrieli, 2002). Our group has recently demonstrated an effect of reappraisal as compared to suppression on a test of social decision-making, the Ultimatum Game (van't Wout, Chang, & Sanfey, 2010), where responders accepted more unfair offers when instructed to reappraise their emotions. However, the question of how emotion regulation strategies affect our actual decision-making abilities remains largely unanswered. In this study, we investigated the effect of both up and down emotional reappraisal (following Ochsner, Ray, Cooper, Robertson, Chopra, Gabrieli, and Gross 2007) on social decision-making in the Ultimatum Game. After being trained on how to use this strategy, in a test phase 21 participants demonstrated the ability to both up and down regulate their emotions, compared to a baseline 'look' strategy, while viewing unpleasant IAPS pictures, as measured by valence and arousal mean ratings. In the experimental phase, participants played the Ultimatum game during fMRI while applying the strategies of up-regulation, down-regulation as well as a baseline 'look' condition. As hypothesized, participants accepted more unfair offers while down-regulating, and also rejected more offers while up-regulating, relative to the baseline condition. The acceptance rate for the fair offers was not modulated by the strategy, suggesting that emotional regulation was selective for the unpleasant emotions elicited by the unequal offers. At the neural level, the effect of strategy demonstrated significant activations of the middle frontal gyrus

bilaterally, together with the right cingulate gyrus (involved in the decision process), the right insula (which codes the aversive reaction to the unfair offer), the inferior parietal lobe bilaterally (implied in quantity evaluation) and the fusiform gyrus bilaterally (coding the faces of the players). Importantly, the insula showed modulation of the BOLD signal for unfair offers: less activation for down-regulation and more activation for up-regulation. The interaction between strategy and offer (fair vs unfair) showed activity in the ventromedial prefrontal cortex, possibly involved in coding and recoding the values according to the reappraisal. These results support and extend previous findings that reappraisal is a powerful emotion regulation strategy that influences and changes how we interact with others even in the face of inequity. Additionally, the study further clarifies some key regions involved in the emotional regulation of our decisions processes.

- **Cinzia Giorgetta (University of Trento)**, Alessandro Grecucci, Nicolao Bonini, Giorgio Coricelli, Gianpaolo Demarchi, Cristhoph Braun, Alan G. Sanfey
Waves of regret: A MEG Study of emotion and decision-making

Recent fMRI studies (e.g., Coricelli et al., 2005; Chua et al., 2009) have investigated brain activity involved in the role of regret while playing a standard gambling task, with these studies showing that the dorsal anterior cingulate cortex, medial OFC and anterior hippocampus (Coricelli et al., 2005) all contribute to the experience of regret. In these experiments gambles with different values and probabilities were used, and regret was studied by manipulating the feedback the subject saw: full-feedback (regret: where subject sees the outcomes from both the chosen and unchosen gamble) vs. partial-feedback (disappointment: where subject only sees the outcome from chosen gamble). However, an alternate conceptualization of regret is that it is characterized by the feeling of responsibility for the negative choice outcome (Gilovich & Melvec, 1994), whereas disappointment is related to external responsibility for choice outcome (Frijda et al., 1989).

Therefore, in this experiment we tested this hypothesis by disentangling regret from disappointment by manipulating the responsibility for the choice: in one condition choice was made directly by subjects themselves (regret), and in the other the choice was made by a computer (disappointment). In both cases, we used a full feedback design. In the task, 16 participants played a total of 480 trials each while undergoing whole head magneto-encephalography (MEG). On each trial one option had smaller, safer outcomes, with the other offering larger, riskier outcomes. After making their choice, subjects saw the outcomes (either gain or loss) from chosen and unchosen options in two separate time windows. The combination of responsibility and outcome resulted in four conditions: regret (human-loss), disappointment (computer-loss), rejoice (human-win) and elation (computer-win).

Event related fields (ERF) were measured using an Elekta Neuromag Vectorview® MEG scanner (306 channels). Data were sampled at a rate of 1kHz, and subsequently analyzed with SPM8 MEG toolbox. The baseline was removed using the average activity in the -100 – 0 ms time window. Furthermore, data were bandpass filtered in the frequency range of 2 to 10 Hz. Eyeblinks were detected by visual inspection and trials containing eye artifacts

were discarded. Grand averages across subjects were computed and compared between different conditions.

ERF waveforms presented a stronger M150 for regret relative to disappointment, with negative magnetic field amplitudes at sensors located over left temporal regions and corresponding positive over right temporal regions stronger. This component was followed by a characteristic polarity reversal. Source imaging localized the corresponding differential evoked potential (regret vs. disappointment) over the temporal-parietal region at maximum peak of 169ms. ERF waveforms presented a similar pattern between regret and rejoice, being stronger for regret. Source reconstruction localized the differential activity over right occipital and left temporo-polar regions with a maximum peak at 140ms.

The present study extends the accumulating evidence for neural activity in processing regret in gambling tasks by using magneto-encephalography in this context for the first time. It shows also evidence that regret may be neurally differentiated from other emotions (disappointment and rejoice), with assessment of evoked magnetic fields determining two separate differential activities and localizations.

- **Christoph Lumer (University of Siena)**
Emotional decisions - The induction-of-intrinsic-desires hypothesis

There are several approaches in the literature to explain the impact of emotion on decision. Some of these theories will be briefly discussed. But the main aim of the paper is to present a new theory about emotional decision, whose main idea is that (strong) emotions and feelings in general induce new intrinsic desires, which alter our usual valuations and grow and vain with the feeling. (1) Originally intrinsic desires are motivational intrinsic desires for those aims for which the subject has no further reason and, since one may have forgotten the reason, never had any reason. (2) The most familiar and important hypothesis about these desires is psychological hedonism. (3) But there are originally intrinsic desires beyond hedonic ones, namely feeling-induced desires, especially emotion-induced desires, e.g. when in a rage the desire to destroy or hurt the 'aggressor'. The origins and mechanisms of such desires are expounded and their irreducibility to hedonic desires is shown. (4) A comparison with other theories shows the progress made by this approach. (5) Being unstable over time, feeling-induced motives are not apt as a basis for rational utility functions; and this explains why we find emotional decisions often problematic.

16:45-17:00 – Coffee break

17:00-19:30 – SESSION D. EVIDENCE ON THE NEUROSCIENTIFIC FOUNDATIONS OF DECISION MAKING

Chair: **Alessandra Rufa** (University of Siena)

- **Angela Dalton (Pacific Northwest National Laboratory)**, Alan Brothers, Stephen Walsh, Paul Whitney
Expert Elicitation Method Selection Process and Method Comparison

Research on integrative modeling has gained considerable attention in recent years and expert opinion has been increasingly recognized as an important data source and modeling contributor. However, little research has systematically compared and evaluated expert elicitation methods in terms of their ability to link to computational models that capture human behavior and social phenomena. In this paper, we describe a decision-making process we used for evaluating and selecting a task specific elicitation method within the framework of integrative computational social-behavioral modeling. From the existing literature, we identified the characteristics of problems that each candidate method is well suited to address. A small-scale expert elicitation was also conducted to evaluate the comparative strength and weaknesses of the methods against a number of consensus-based decision criteria. By developing a set of explicit method evaluation criteria and a description characterizing decision problems for the candidate methods, we seek to gain a better understanding of the feasibility and cost-effectiveness of integrating elicitation methods with computational modeling techniques. This serves an important first step toward expanding our research effort and trajectory toward greater interdisciplinary modeling research of human behavior.

- Jordi Brandts, **Orsola Garofalo (Universitat Autònoma de Barcelona)**
How accountability and gender interact: Evidence from a laboratory experiment

The effect of accountability in decision-making has not been extensively discussed in economics and few papers have attempted at estimating its impact in an experimental setting.

A simple scenario in which a decision-maker expects that she has to justify *ex post* her choices in front of an *audience* (Lerner and Tetlock 1999) will have a profound impact on her *ex ante* decisions (Vieider 2009). Main analyses conducted so far have tested whether the accountability induced by the presence of the audience influences the effort put during the execution of the task and the number of correct answers.

Within this framework, we introduce two novel issues: (1) how does the gender of the *audience* influence the accountability of whom is taking the decision? (2) Do the gender of the player and the gender composition of the *audience* interact to shape the player's decision-making?

Hence, we do not analyze single gender differences in decision-making but rather we suggest to exploring the interaction between gender composition of the audience and gender of the player.

A further contribution to the literature is a methodological one. In addition to the classical measures of accountability based on the *decision theory* (Vieider 2009), we employ two physiological measures: the heart rate and the blood pressure. Such measures allow us to quantify in a clean and unbiased way the scope of accountability on decision-making in the form of stress and psychological pressure. We consider a simple experimental design

that involves one player for each session and a number of persons forming the audience. The player is asked to take some decisions and afterward to justify his/her choices in front to the audience; meanwhile, his/her heartbeat is measured through a chest belt that he/she wears from the beginning of the experiment. In addition, we measure the blood pressure three times during the experiment: (1) at the beginning (the participant does not know yet the structure of the experiment, thus we can use this first measurement as control); (2) as soon as he/she finishes the task but right before the audience comes into the room and the player starts explaining; (3) when the explanation is over (See the appendix for additional details).

The combination of the two methodologies, i.e. decision-making tasks and physiological measurements, allows us to look at the behavior of the single individual from an economic point of view and at her physiological reaction while he/she manages the situation. The measurement of the heart beat is a direct measure of the stress, and thus the results can reveal how and which, if one, of the two genders better manage the situation and if the decision taken is related to the physical reaction.

In the empirical analysis, we will test whether there are significant differences in our main indicators (number of correct answers, time employed by the player to solve the task) and different patterns in our physiological measures, depending on the interaction between the gender of the audience and the gender of the player.

In spite of the simplicity of the framework, our design can resemble an economic scenario in which the CEO of a firm has to take decisions and justify them in front of the board of directors.

The CEO's decisions may be influenced by the gender composition of the board, and lead him/her to shape decisions on a different level of accountability. Furthermore, our results can be used by firms interested in developing specific programs for the worker, like programs to better manage the stress.

- **William Jolley (Norwich University)**
From habit to addiction: A study in online gambling behaviour

Why do some individuals lose control over their gambling habit? Despite progress in understanding the neurobiology of addiction, we still lack an adequate understanding of the factors that govern the transition from habit to addiction. This research examines the factors that cause behavior that begins as intentional and voluntary to become habitual, and in some cases, addictive. Using a web-based model of online gambling, the behavioral, psychological, and neurobiological factors that affect a player's transition from habitual to addictive gambling are measured. The hypothesis that the neurobiological trait of impulsivity has a significant moderating effect on the transition from habitual to addictive gambling behavior was tested among a sample of undergraduate college students. The findings from this study along with implications for gambling operators and public health agencies will be discussed.

- **Lavoslav Čaklović (University of Zagreb)**
Self duality and conflict resolution

A mathematical model of a goal-oriented thinking with feed back is described.

Basic notions: criteria, decision graph, ranking, hierarchy, duality and self-duality are introduced and explained. Mental process of conflict resolution is considered and its mathematical model is made as a decision hierarchy with feedback. Some real world examples (intelligent mobile robots, risk-as-feeling hypothesis and government budget re-evaluation) are solved calculating the fixed point of the self-assessment operator.

A standard approach to conflict resolution is to reconsider the goals and their preferences or to add some new options or actions into consideration. In this article we suppose that decision maker exhausted all possibilities to add some other option into consideration, i.e. that he does not change the structure of the hierarchy and does not change the preferences of the objects inside the hierarchy. The source of the conflict is the unknown importance of his goals.

Self-duality in a decision process arises when some objects are also criteria for themselves. A typical example of self-duality is a group of decision makers who attempt to rank themselves.

In internal conflict, a decision maker reconsiders his goals from the point of view of actions. For each action there are some goals which support the action more than other actions. This means that each action have a tendency to rank the goals, directly or indirectly using some extra criteria. This means that the goals, using actions, are ranking goals.

In the choice under risk, precisely in risk-as-feeling model introduced by Loewenstein (2001), people are assumed to evaluate risky alternatives at a cognitive level, based largely on the probability and desirability of associated consequences.

Such cognitive evaluations have effective consequences, and feeling states also exert a reciprocal influence on cognitive evaluations.

Intelligent mobile robots which are trying to pass through a narrow corridor are solving a similar conflict. To avoid the crash they may move: (R) right, (L) left, (W) wait. If the first robot is waiting (W), the second robot prefers moving (R) or (L) when compared with (W), and moving (R) is preferred to (L), i.e. driving on the right side is preferred to driving on the left side. Their preferences may be organized in the hierarchy with feed back and solved in the same way as the previous problems.

- **Georgios Halkias (Athens University)**, Flora Kokkinaki
Attention, memory, and evaluation of schema incongruent brand messages: An empirical study

Schema theory in cognitive psychology proposes that people tend to simplify reality by organizing and storing all knowledge and experience about their social surroundings in memory-based cognitive structures, known as *schemata* (Fiske and Taylor, 1991). The cognitive schemata that people develop over time guide the perception of new and old information, provide cognitive economy, and lead to a number of assumptions and hypotheses about the nature of the social phenomena encountered (Fiske and Taylor, 1991; Suajan and Bettman, 1989). Given that consumers' knowledge about the market can also be perceived through relevant cognitive structures (e.g., product schema, brand schema, ad schema, etc), schema theory has been applied in the marketing research,

revealing that schematic knowledge greatly affects how consumers process product information and respond to persuasive communications (Sujan and Bettman, 1989; Meyers-Levy and Tybout, 1989; Goodstein, 1993). In a highly competitive market environment, overpopulated by advertising and brand messages, consumers use their schemata to integrate incoming with existing data, retrieve information from memory, draw inferences, and facilitate purchase decisions (Sujan and Bettman, 1989).

A widely held conception in the marketing literature is to develop consistency and relevancy when communicating brand meaning to consumers (Rossiter, Percy and Donovan, 1991; Keller, 2003; Percy and Elliott, 2005). In other words, theories and models of persuasive communication were traditionally based on the matching hypothesis between consumers' cognitive schemata and the content of communication. The underlying idea was that when the content of communication is in line with consumers' knowledge and perceptions, the message becomes more relevant, more comprehensible, and more appealing (Rossiter, Percy and Donovan, 1991; Keller, 2003; Brannon and Brock, 2006; Petty and Wegener, 1998). However, directly matching the brand message to consumers' mind may not always be the most effective strategy. Findings from cognitive psychology challenge the matching hypothesis and point towards a different perspective, according to which schema incongruent information may increase recipient's cognitive arousal and finally lead them to more favorable results (Mandler, 1982).

Drawing insight from cognitive psychology and in particular Mandler's (1982) schema incongruity theory, we present an empirical study that investigates consumers' cognitive and affective responses to advertising information that varies in terms of incongruity (i.e., *congruent*, *moderately incongruent*, and *extremely incongruent*) with their existing brand schemata. The study employed a single-factor, between-subjects design and took place in a laboratory setting. Participants completed a questionnaire assessing the amount of ad processing, memory performance, as well as ad and brand attitude. The hypothesized relationships were tested using analysis of variance with polynomial trend analysis and analysis of covariance. Consistent with predictions, the results supported a non-monotonic, inverted-U relationship, between the degree of incongruity and consumer responses. Moderately incongruent advertisements resulted to more ad processing, better recall and recognition memory, as well as more favorable ad and brand attitude, compared to both congruent and extremely incongruent advertisements. The implications of these findings for consumer research are discussed, and the relevance for future research to further validate the effects of schema incongruity through techniques and measures that capture more closely consumers' cognitive response mechanisms is highlighted.

20:30 – Dinner

TUESDAY 21TH SEPTEMBER

9:00-10:00 – KEYNOTE TALK

- **Stefano Cappa (Università S. Raffaele Milano)**
Regret and decision making

Decision-making is strongly influenced by the counterfactual anticipation of personal regret and relief, through a learning process involving the ventromedial prefrontal cortex. In a first study using Functional Magnetic Resonance Imaging (fMRI) and a gambling task we showed that observing the regretful outcomes of another's choices reactivates the regret-network. Just knowing the regretful outcomes of someone else's choices activated a subset of the regions associated with a first-person experience of regret, including the orbitofrontal cortex, amygdala, hippocampus, anterior cingulate cortex and insula. These results extend the possible role of the mirror-neuron-system in the emotional sharing underlying empathy beyond basic emotions. In a second study, investigated whether this resonant mechanism also underpins interactive-learning from others' previous outcomes. The subjects either played a gambling task or observed another player's risky/non-risky choices and resulting outcomes, thus experiencing personal or shared regret/relief for risky/non-risky decisions. Subjects' risk-aptitude in subsequent choices was significantly influenced by both their and the other's previous outcomes. This influence reflected in cerebral regions specifically coding the effect of previously experienced regret/relief, as indexed by the difference between factual and counterfactual outcomes in the last trial, when making a new choice. The subgenual cortex and caudate nucleus tracked the outcomes that increased risk-seeking (relief for a risky choice, and regret for a non-risky choice), while activity in the ventromedial-prefrontal cortex, amygdala and periaqueductal gray-matter reflected those reducing risk-seeking (relief for a non-risky choice, and regret for a risky choice). Crucially, a subset of the involved regions was also activated when subjects chose after observing the other player's outcomes, leading to the same behavioural change as in a first person experience. We conclude that this resonant neural mechanism at choice may subserve interactive-learning in decision-making.

10:00-11:00 – SESSION E. PROBABILITY AND JUDGMENT IN DECISION MAKING

Chair: **Antonio Federico** (University of Siena)

- **Dale Griffin (University of British Columbia)**, Lyle Brenner, Derek Koehler
Testing a Unified Two-System Model of Probability and Pricing Judgment

We examine the correspondence between patterns of calibration for probability judgment and for asset pricing, and investigate whether asset prices exhibit more or less pronounced biases than judgments of probability. Much research within the "Heuristics and Biases" tradition of Kahneman and Tversky indicates that probability judgments are

case-based, responding primarily to case-specific evidence and disregard aggregate characteristics of the class or population to which the case belongs, resulting in predictable biases (e.g., Griffin & Tversky, 1992; Tversky & Koehler, 1994). We examine the implications of case-based judgment for buying and selling prices in an experimental futures market. It can be argued that the biases that arise when people are asked to make explicit judgments of probability may have little or no impact on actual choices made or prices set in uncertain economic settings. We integrate a case-based model of probability judgment with Prospect Theory (Kahneman & Tversky, 1979), interpreted within a dual-system cognitive processing framework (Kahneman & Frederick, 2002), and use this comprehensive model to explore asset pricing under uncertainty. The two-system framework distinguishes intuitive heuristic evaluations, such as those used in the valuation and weighting of outcomes, from more deliberative assessments, such as those that are used to incorporate prior odds in Bayesian reasoning. Case-based judgment is positioned within the dual-system framework by the assumption that the evaluation of evidence strength is an intuitive or "System 1" operation that does not take class-based considerations as input. Prospect theory is positioned within the framework by the assumption that the transformation of objective value and subjective likelihood into choices through the value and probability weighting functions also reflects the output of purely intuitive operations. We contrast the following two predictions: If the process of making repeated economic pricing judgments with incentives induces more systematic or System 2 adjustment, then price-setting should be more calibrated (and sensitive to class factors) than probability judgment. If, however, the economic judgments are dominated by intuitive System 1 processes, then price-setting should be less calibrated and equally class-insensitive compared to probability judgment. Furthermore, calibration patterns for buying and selling prices will differ due to the distortions induced by the value and probability weighting functions described by Prospect Theory. In a series of experimental studies using a simulated stock market setting, we investigate whether asset prices exhibit more or less pronounced biases than do direct judgments of probability. Results of four studies on 600 participants support the System 1 model of price-setting under uncertainty: similar patterns of case-based miscalibration are present in both probability and pricing judgments, and buying and selling prices show unique distortions consistent with the Prospect Theory transformation functions.

- **Giuseppe Attanasi (Toulouse School of Economics LERNA), Aldo Montesano**

The price for information about probabilities and its relation with capacities

Our aim is to measure subjects' ambiguity aversion through the maximum price they are willing to pay in order to know the probability of an event. First, we derive a mathematical relation between the reservation price for information about the probability of an event and the capacity of this event in a situation in which the subject should play an act. In this case, if the expected utility holds, information should not have any economic value for the subject. Since the choice to pay for knowing the probability cannot be rationalized under expected utility, we move to Choquet expected utility. Then, we derive the same kind of relation in a situation in which if the subject buys information, she has the option to

choose whether to play or not the lottery, after having been told the probability of the event. In this second case, information does have an economic value for the subject even under expected utility. In the last section, we propose an experimental protocol able to implement in the lab the elicitation of subjects' reservation price about unknown probabilities. Once a subject's price for information is known, we can calculate the corresponding capacity of the event and measure ambiguity aversion accordingly. The measure of ambiguity aversion that we propose requires that Choquet expected utility holds.

11:00-11:15 – Coffee break

11:15-13:15 – SESSION F. EYE-TRACKING STUDIES OF DECISION MAKING

Chair: **Nicola Dimitri** (University of Siena)

- **Susann Fiedler (University of Erfurt, Max Planck Institute for Research on Collective Goods), Andreas Glöckner, Andreas Nicklisch**
Information search and information integration in repeated Voluntary Contribution Mechanism (VCM) Games: An Eye-tracking analysis

Several studies have shown that participants' social value orientation is predictive for contributions particularly in one-shot VCM-games. In repeated VCM-games, however, this finding usually does not hold. We investigated over rounds prevailing differences in information processing by recording information search using eye-tracking technology. When deciding about their next contribution, participants with pro social value orientation considered information on pay-offs and contributions from the last round equally often, while pro self oriented players were mainly interested in the pay-offs. Furthermore, pro-social participants showed prevailing longer individual fixations than pro self oriented people indicating a more thorough information processing. The results indicate that social value orientation is associated with enduring differences in information processing in repeated VCM-games.

- **Yukihiko Funaki, Ting Jiang (Tilburg University), Jan Potters**
Eye-tracking Social Preferences

We track subjects' eye-movements while they make choices in simple three-person distribution experiments as in Engelmann and Strobel (2004). We characterize individual subjects in terms of three different types of social preferences: efficiency, maximin, and envy. For the characterization, we use either the choice data or the eye-movements data. The hypothesis tested is that if a subject is "really" motivated by particular social preferences, then choosing in accordance with different preferences will lead to distinct patterns of eye movements. The hypothesis is based on the supposition that different choice rules require different information to be acquired and processed, which will be

reflected in different eye-movements. For the three types of social preferences studied, we find that the classification based on the choice data and the classification based on the eye-movements data do consistently and significantly correspond to each other. We conclude that the inferences about preferences based on choice data are supported by process data based on eye-movements.

- **Francesco Fagnoli (University of Siena)**, Pamela Federighi, Nicola Polizzotto, Pietro Piu, Giacomo Veneri, Andrea Fagiolini, Antonio Federico, Alessandra Rufa
On multi-sensory integration: influence of pitch on visual attention and visual working memory for shapes. An eye tracking study.

Background

The brain uses multi-sensory stimuli integration to create a high order multimodal representation. Growing evidences indicate that mono-modal perceptual stimulation may interact with other sensory modalities at different levels of integration.

Objective:

We investigate the level of cross-modal correspondence between shapes and pitches. We also investigate the effect of multi-sensory stimuli integration on eye movements and visual working memory.

Methods

In an eye-tracking setting two different tasks were presented to 10 normal subjects: a visual working memory tasks and an association task. 1st we tested the visual workings memory for shapes with sounds (2 different randomized pitches) and without sounds (control experiment). Each experiment consisted in 24 blocks of 2 arrays. In the first array 4 shapes (2 angular and 2 rounded), randomized for position, were presented for 200ms. In the second array, 4000ms, only one shape might change. An inter-array interval of 1200ms was considered. Sound started with the 1st array and ended with the 2nd array. Participants were instructed to detect shape changes.

2nd we tested the level of cross-modal association among shapes and pitches. Arrays and sounds were presented simultaneously for 3000ms. Participants were asked to associate a pitch with a shape.

The first fixation, fixation time over shapes and the explicit preference for shapes were analyzed.

Result

We found a significant cross-modal correspondence among pitch and shapes (chi square $p=0.0001$).

We also found a direct correlation between the high pitch/angular shapes correspondence and the capacity of visual working memory to increase with high pitch ($r=0.77$ $p=0.0142$). No other significant correlations were found.

Conclusions

The main result of this study indicates a cross-modal association between shapes and pitches.

The cross-modal correspondence between high pitch and angular shapes is correlated with the capacity of high tone to "enhance" the target visibility and then to increase the capacity of working memory for shapes. Subjects with the higher level of cross-modal

correspondence between pitch and shapes have a better performance in visual working memory task with high pitch.

- **Alessandra Rufa (University of Siena)**, Francesco Fagnoli, Pietro Piu, Elena Pretegiani, Pamela Federighi, Antonio Federico, Alessandro Innocenti

Decision making under uncertainty: An eye-tracking study

The role of the visual system in the functioning of human brain has been the object of investigation for decades. The passages leading from the electrochemical signals transmitted by the retina to the brain for neuronal processing have been exhaustively described by cognitive scientists and neurobiologists. What remains still controversial is how these neurobiological processes are first activated and finally translated in actual decisions. Both the mechanisms underlying gaze direction and orienting behavior and the relations between image processing and decision-making are currently scrutinized by a variety of different approaches with conflicting results. The importance of these research areas for providing a cognitive framework to the understanding of human decision processes is evident. A particularly interesting application for cognitive economists is given by decisions that are not driven by individual preferences but concern a future event to be guessed on partial-information clues. In decisions under uncertainty, factors like subjective inclinations or tastes do not affect choices and the role of visual attention in determining actual decisions can be investigated in a more neutral setting.

In a previous set of experiments, Shimojo et al. (2003) tested how subjects orient attention in both preference and non-preference tasks. Their main result is that, in choices between two alternative forced-choice tasks, subjects exhibit a statistically significant tendency to gaze increasingly towards the chosen object. This *gaze cascade effect* would provide insight in the mechanisms underlying the mental processing of images. It supports the hypothesis that gaze participates directly in the preference formation process. The brain would use gaze direction to reinforce preference by increasingly looking at the eventually chosen item and by decreasing inspection time for the other one. An attractive consequence of this finding is that gaze bias could be interpreted as preference at subconscious level.

To explore further the relationship between preference and ordering, we consider a more general interpretation of cognitive processes, proposed, among others, by Stanovich and West (2000) and by Kahneman and Frederick (2002). According to the theory of dual reasoning, cognitive processes are of two types, named System 1 and System 2. System 1 includes all the cognitive processes characterized by automatic functioning and heuristic purposes, while System 2 encompasses all the rational and analytic processes. The key difference between the two is that System 1 is activated immediately and often unconsciously by external stimuli, while System 2 is slower and deliberately controlled. According to Kahneman and Frederick (2002), the interaction between the two systems could be described in the following way: "Highly accessible impressions produced by System 1 control judgments and preferences, unless modified or overridden by the deliberate operations of System 2." Moreover, being both systems an evolutionary product, it would not necessarily follow that errors on tasks from the heuristics and biases literature are universal. On the contrary, this view would provide an explanation of people

heterogeneity as the result of individually specific patterns of interaction between the two systems. In this theoretical framework, gaze direction could be a revealing signal of how automatic and immediate reactions to visual stimuli are modified or sustained by more conscious and rational processes of information collecting.

In order to investigate this hypothesis, we performed some experiments by using the stylized decisional framework of informational cascade. In this non-preference task, experimental subjects are asked to guess an event about which they have probabilistic assessments, which are both private and publicly revealed. The process of detecting these partial-information signals is investigated by means of eye-tracking methods.

Our first result is that gaze direction gathers information according to automatic and unconscious mechanisms depending on the individually specific cognitive biases. In particular, we find significant statistical correlation between subjects' first fixation and their revealed patterns of choice. Overconfident subjects, who rely exclusively on private signals to take decisions, look initially at their own private signals by displaying a mechanism of attention orienting seemingly dependent on System 1, while Bayesian subjects, who process rationally both private and public information, do not exhibit any gaze bias. In a slightly different experimental design, we also find experimental confirmation of the gaze cascade effect postulated by Shimojo et al (2003).

In terms of the dual reasoning theory, our findings support the hypothesis that cognitive processes classified as System 1 determines initial gaze direction and that patterns of interaction between System 1 and System 2 revealed by attention orienting are individually specific and cognitively based. Our conclusion is that information collection and decision processes are individually related to somatic-based behaviors, such as gaze orienting. Initial gaze direction is driven by cognitive biases in a way that is not necessarily consistent with efficient information processing.

13:15 – End of the conference

