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### On the role of emotions and social ties in public good games : behavioral and neuroeconomic studies

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# Chapter 1

## Introduction

This thesis presents four essays regarding the role of emotions and their influence on decision making as well as the dynamic development of attachment between interacting parties. If every chapter has been written so that each of them can be read independently (which may entail some redundancies), they are all interested in the behavioral and neural processes underlying social decision making. More precisely, the first three chapters are interested in how social ties are created and evolve in anonymous laboratory interactions. This investigation is done at the theoretical, behavioral and neural levels such that it offers a quite complete view of how social ties are formed and how they guide decisions in repeated social interactions. The fourth and final chapter explores the use of verbal feedback as a tool to increase cooperation and the underlying role played by emotions in this environment.

Social ties are affective bonds that emerge between interacting agents, making them care about the fate of each other and thus influencing their future actions. These bonds can only arise through the occurrence of a social interaction and are influenced by the feelings triggered by the interaction. As a consequence, social ties can be positive or negative depending on experienced emotions and the satisfaction derived from the counterpart's behavior. The "need to belong" (Baumeister and Leary, 1995) has been shown to play a preponderant role in human life and appears as one of the principal motivations underlying our social behavior. However, social ties have been only marginally studied by economists even though they may be highly relevant to explain social and economic repeated interactions. Indeed, economically relevant situations as diverse as team work, neighborhood life, oligopolies or customer-seller relationships are all susceptible to the development of bonds between the parties involved. The latter can be illustrated by a quote from the song "Affreux, bête et dangereux" ("Dreadful, stupid and dangerous") from French rapper Ekoue: "Les sociologues, les politologues qui viennent chez nous pour

acheter de la drogue appellent ça créer du lien social” (which could be translated by “Sociologists, political scientists who come in our neighborhoods to buy drugs call it creating social ties”). This is indeed an illustrative example of the definition of social ties: the occurrence of an interaction (here, an economic exchange) gives rise to contact between previously anonymous persons and may create a social tie between the interacting parties. Also flowing from this definition, the quality of the attachment (positive or negative) of each party toward the other will depend on how satisfactory he found the interaction and it may thus not be symmetric, as implicitly suggested by the quote.

Situations in which it is in the interest of the group to cooperate and share the benefits of cooperation but where each individual has in the meantime an incentive to enjoy these benefits without suffering the costs of cooperating are called social dilemmas. The common ground of this thesis is the very simple conflict between individual and social incentives implied by social dilemmas. Public good games, as a generalized form of the prisoner’s dilemma game, offer us such a framework. As simple as this game can be, it offers a very rich and almost infinite field of research as the more answers we seem to gather, the more questions arise. A lot of behavioral evidence has been gathered by researchers in laboratory settings and several empirical regularities have emerged (Ostrom, 1995; Ledyard, 1995; Chaudhuri, 2011). Most importantly, it appears that, contrary to what standard game theory<sup>1</sup> predicts, individuals contribute initially a significant part of their wealth to the public good (even if repeatedly matched with strangers) before that a progressive decline in contributions takes place. Many tools have been tried in order to increase cooperation levels, such as costly punishment (Fehr and Gächter, 2000) or reward (Sefton and Steinberg, 1996), symbolic sanctions (Masclot et al., 2003), pre-play communication (Bochet et al., 2006), group leadership (Güth et al., 2007) or the endogenous selection of counterparts (Page et al., 2005).

In order to tackle the failure of standard game theory in predicting the fact that individuals are indeed cooperating, even in one-shot settings, researchers started to develop theories including different types of preferences, which are gathered under the broad label of “social preferences”. These preferences are modeled through interdependent utility functions, meaning that one values, positively or negatively and conditional on different factors, the well-being of the other person(s) that one interacts with (Sobel, 2005). Models have been developed to reflect very different motives driving social preferences such as,

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<sup>1</sup> Throughout this entire thesis, we will use the expression “standard game theory” to refer to game theory that assumes only purely selfish and rational agents who are not constrained by any cognitive limitations.

for example, reciprocity (Rabin, 1993), inequality aversion (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000), efficiency (Charness and Rabin, 2002), or guilt aversion (Battigalli and Dufwenberg, 2007)<sup>2</sup>. These models are all assuming that social preferences are based on stable traits and embrace a very ‘cognitive’ beliefs-related approach of human behavior in social dilemmas.

A different way of modeling the way we interact with other persons is to use interdependent utility functions that formalize the development of affective attachments between interacting parties. How do we come to care about strangers we interact with? A very simple mechanism would be that we start to attach a weight to the well-being of others as a function of how satisfied we are with the interactions we had with them. A first theorization of the development of social ties in public good environments has been developed by van Dijk and van Winden (1997). The underlying idea is that our attitude towards others is building along the occurrences of interactions, thus being intrinsically dynamic. This attitude can either be positive (e.g. friendships) or negative (e.g. antagonistic relationships in bad neighborhoods), need not to be symmetric (e.g. non-reciprocal love) and is evolving based on how the individual felt about the interaction. In the end, our feeling toward the other will guide our actions when our decisions have consequences for the considered person.

We used the word feeling here as the literature assigns an important role to emotions, making it one of the driving forces behind social attachment. The formalization of an economic agent as a *homo economicus* attributes to the decision maker infinite reasoning and computing capabilities, allowing him to always choose what is best according to his preferences in all environments and situations. The dominance of such a theory that defines agents as “cold” and rational decision makers may explain why emotions have been absent of most theories of economic behavior until quite recently. However, more and more research is now done in order to uncover the emotional determinants of behavior. If this line of research started by focusing mainly on individual decision making through the development of theories like regret theory (Loomes and Sugden, 1982) or loss aversion (Tversky and Kahneman, 1992), researchers have now started to incorporate emotions into their theories of social decision making (e.g. guilt aversion, betrayal aversion, lie aversion). More empirically, the role played by emotions in social dilemmas has been investigated, especially in games allowing punishment and

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<sup>2</sup> For a more detailed review of the literature concerning social preferences models, see the introduction of Chapter 2.

retaliation (see for example Hopfensitz and Reuben, 2009). Our work will consider the role of emotions both empirically as well as when developing a formal model of the dynamic development of social ties.

As its title suggests, this thesis employs different methodological tools to investigate the role of emotions and social ties in public good games. Behavioral experimental procedures are used throughout this thesis and all the data presented here were collected inside the laboratory. This allows us to fully control the environment where agents were making their decisions and to control for the degree of anonymity between them. In Chapters 2 to 4, we specifically consider social ties built in the laboratory between anonymous counterparts and are not interested here in already existing relationships. As we also want to investigate the impact of emotions on decisions, we used self-reports to measure them. Even though they are not often used in economics, self-reports on emotions appear to be quite a valuable tool to measure them compared to other more invasive techniques. Several researchers showed that they were reliable and, for some complex social emotions such as shame or guilt, unavoidable (Adolphs, 2002; Tangney and Dearing, 2002; Ortony et al., 1988).

If behavioral laboratory experiments are now widely accepted as part of the methods to be employed to gather data on economic behavior, the use of neuroscientific tools to investigate the neural underpinnings of decision making is still far from being recognized as valuable by economists. The development of economic studies using functional Magnetic Resonance Imaging (fMRI) raised an intense debate among economists where quite extreme positions have been taken about what neuroeconomics is and could bring in the future<sup>3</sup>, both from the critical and the more praising sides. For example, Gul and Pesendorfer (2008) reject any potential use of neuroscientific tools for economics “because the latter make no assumptions and draw no conclusions about the physiology of the brain” (op. cit., p4) and seem to discard any pluridisciplinary work between psychologists and economists since “Economics and psychology address different questions, utilize different abstractions, and address different types of empirical evidence” (op. cit., p4). More practically, others have been criticizing the methods and statistics of neuroeconomics without denying its future potentialities (Harrison, 2009). On the other side of the spectrum, Camerer et al. (2005) argue that “advances in neuroscience now make direct measurement of thoughts and feelings possible for the first time, opening the ‘black

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<sup>3</sup> For an overview of this debate, see for example Rustichini (2005), Bonanno et al. (2008), Fehr and Rangel (2011) and Pelloux et al. (2009; in French).

box' which is the building block of any economic interaction and system —the human mind" (op. cit., p53). The content of this thesis as well as the background of the authors involved in some of the chapters indicate that we value pluridisciplinary work and that we believe that psychologists and economists can learn from each other, both at the conceptual and methodological level. However, we distance ourselves from the view that neuroscience enables us to read "thoughts and feelings".

First of all, we see neuroeconomics as an additional source of evidence concerning economic decision making and its underlying motivational processes. Some economic models of choice do make assumptions about the latter and we think that neuroeconomics can gather evidence that can instruct these models. Second, thinking that neuroeconomics is useful does not mean that we should abandon behavioral experiments. We should have a very precise idea about how subjects behave in a given environment before wanting to consider the neural mechanisms supporting their decisions.<sup>4</sup> It seems to us necessary, in order to generate relevant hypotheses about the psychological and neural processes underlying decision making, to refine as much as possible our knowledge about the causes, motivations, thinking processes, environmental characteristics and individual differences that engenders the observed behavior. The absence of such a preliminary behavioral work could lead to misinterpretation of neural activation patterns and wrong conclusions. Finally, we acknowledge that researchers need to be very cautious about the interpretation of their results, especially when they concern such high-level neural processes as the ones required for making economically relevant decisions. The difference should be made clear to the reader between what constitutes the data and the extrapolations and conjectures that are made on the basis of these data.

Chapter 2 starts by extending the theoretical analysis of social ties developed by van Dijk and van Winden (1997). We expand the model by including a probabilistic choice mechanism and, more importantly, by allowing agents to plan ahead. This second feature adds a more strategic dimension to the model and allows for cooperation from agents with selfish preferences. The main goal of Chapter 2, though, is to confront this behavioral model of choice to data gathered in the laboratory. To that purpose, we will use data from different public good experiments that have different characteristics in terms of game structure and number of parties involved. Our empirical objectives are twofold in this

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<sup>4</sup> This is indeed how we proceeded since many behavioral experiments related to the development of social ties in economic games have been run (see Chapter 2 for a review of these previous works and another analysis) before our investigation of these problems at the neural level in Chapter 3 and 4.

chapter. We first estimate the social tie model both at the group and individual level and show that it has explanatory power over the data and that social ties are indeed developed. These results suggest that history is an essential part of the determinants of preferences, that some reciprocity takes place and that about half of the subjects are indeed forward-looking. Second, we generate individual predictions in order to track dynamic changes from round to round in contribution decisions. The performance of the model appears surprisingly good as it is able to track very complex dynamic patterns of contributions. This is true both for games played in pairs and in groups of four players, where the decision-making processes are much more complex. Chapter 2 thus shows that a simple and tractable model of social preferences that is psychologically grounded can account very well for dynamic behavioral patterns in repeated public good games.

Following this behavioral approach and in order to combine different sources of evidence, Chapters 3 and 4 investigate the neural mechanisms underlying behavior in these experiments. In Chapter 3, we examine how individual differences in trait empathy and interpersonal ties modulate neural responses to imposed monetary sharing. First, we find that sharing prompted activation of neural systems associated with reward (striatum) and empathy (anterior insular cortex and anterior cingulate cortex) only after the occurrence of an economic interaction, but not before. We thus extend previous results (Singer et al. 2004; 2006) and show that empathic neural responses occur after some contact between parties, notwithstanding the limited emotional intensity that an anonymous economic interaction can elicit. Second, sharing also provokes activations in areas associated with altruism and social significance (posterior superior temporal sulcus, pSTS) that are correlated with interaction success as well as post-experiment liking ratings of the interaction counterpart. Finally, we show that only tie-related activation predicts prosocial behavior during subsequent interaction while empathy-related activation fails, suggesting the pSTS as a neural substrate for keeping track of social relevance.

These results helped us to generate hypotheses concerning the neural underpinnings of dynamic contributions in public good games. In Chapter 4, we use a model-based fMRI approach to examine the neural correlates of the theoretical model presented in Chapter 2 and try to confirm the role of the pSTS suggested in Chapter 3. We find that at the moment of choice, activity in the bilateral pSTS and temporo-parietal junction (TPJ) correlates with the dynamic estimate of the social tie, supporting the role of these regions in social tie formation. In addition, activity of the medial prefrontal cortex (mPFC; associated with

higher cognitive functions like goal planning and long-term decision making) correlates with the contribution decision in the public good game. Moreover, we gather support for the idea that feelings are involved in the tie formation mechanism: when feedback was provided, the cooperativeness of the other's action is encoded in regions previously implicated in reward-based emotions and especially in affective reactions in social settings (striatum, anterior insula, ACC, pSTS and TPJ). Finally, we found functional connectivity between the pSTS and the mPFC, suggesting that the representation of social ties is integrated in the decision process. Thus, we were able in Chapter 4 to find neural correlates of all the parameters of our theoretical model of social preferences. We found coherent results with evidence from a different task about the role played by pSTS in tracking social ties but also that this signal is used when subjects were making decisions about their contribution, as suggested by our theoretical model.

Finally, Chapter 5 investigates the potential use of verbal communication as a feedback tool to sustain cooperation in public good games. If our daily lives tell us that it is natural to reward or punish others using communication, very few researchers have actually tackled this problem. Even less studied are both the impact of verbal feedback on the dynamics of decision making and the emotional mechanisms involved in these dynamics. Because of its high emotional load and low cost compared to monetary punishment, we saw verbal feedback as a potentially successful mechanism in order to raise prosocial behavior, as suggested by previous results in different games (Xiao and Houser, 2005;2009; Ellingsen and Johannesson, 2008). We find verbal feedback to be of limited effectiveness compared to monetary punishment. It appears able to maintain a higher level of cooperation (compared to the absence of both communication and punishment) for a time but not to maintain it on the long run. Interestingly, guilt provocation appears to be fostering cooperation but this effect disappears on the long run. On the other hand, generating angry reactions was harmful to cooperation. The decay in cooperation after some periods of play is explained by the loss of effectiveness of messages in provoking guilt at that time whereas angry reactions are more and more present.

This thesis combines several methodologies to investigate the determinants of behaviors in repeated public good games. We showed that dynamic social preferences modeled as developing affective ties between parties were performing well in predicting contribution behavior in public good games. Moreover, using an ambitious model-based

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fMRI approach, we were able to track the neural substrates of the parameters of our theoretical model and to find consistent neural correlates of social ties between different tasks, pointing at a network that is involved in the decision making in such public good environments. This thesis also sheds new lights on the impact of verbal feedback on cooperative behavior and on its underlying emotional processes.