The Behavioral Effects of Social Ties: an Experimental Study *
(extended abstract)

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1 Introduction

In classical economic theories, most models assume that agents are self-interested and maximize their own material payoffs. However, important experimental evidence from economics and psychology have shown some persistent deviation from such self-interested behavior in many strategic situations. These results suggest the need to incorporate social preferences into game theoretical models. Such preferences describe the fact that a given player not only considers his own material payoffs but also those of other players [25]. The various social norms created by the cultural environment in which human beings live give some ideas of how such experimental data could be interpreted: fairness, inequity aversion, reciprocity and social welfare maximization are concepts that behavioral economists are familiar with, and which have been shown to play an important role in interactive decision making (e.g. see [16, 12, 26]).

In fact, various simple economic games, such as the trust game [4] and the ultimatum game [19], have been extensively studied in the past years because they illustrate well the weakness of traditional game theory and its assumption of individualistic rationality. Moreover, given the little complexity carried out in such games, the bounded rationality argument [18] does not seem sufficient to justify observed behavior. Social preferences appear as a more realistic option because they allow to explain the resulting behaviors while still considering rational agents.

However, although many economic experimental studies (e.g. [4, 19]) have shown that people genuinely exhibit other-regarding preferences when interacting with perfect strangers, one may wonder to what extent the existence of some social relationships between individuals may influence behavior. In this article we will refer to such social relationships as ‘social ties’. Indeed the dynamic aspect of social preferences seems closely related to that of social ties: one may cooperate more with a friend than with a

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stranger, and doing so may eventually enforce the level of friendship. Yet, in spite of their obvious relevance to the study of human behavior, very little is known about the nature of social ties and their actual impact on social interactions.

Our attempt, through this paper, is to measure the effects that positive social ties can have on human cooperation and coordination. Our main hypothesis is that such relationships can influence a player's choice by modifying his preferences: an agent may choose to be fair conditionally on the relative closeness to his partner(s). In order to investigate these questions, we propose an empirical analysis of a new kind of two player game, that allows us to disentangle predictions from theories based on self-interest, social preferences, and social ties. Furthermore, we demonstrate the need to introduce an alternative model to capture the concept of social ties as continuous variables. Indeed, while we claim that social ties strongly rely on group identification, we show that considering the well known concept of team reasoning [29, 28, 2, 13] is too limited to fill this purpose as it is built upon a binary interpretation of group identification (i.e., either one identifies with a group or not).

2 A definition of social ties

No formal definition of a social tie is provided either in the literature on social psychology or in the experimental economics literature focused on social preferences. Thus, given the vagueness and the ambiguity that the term may suggest, we begin by clarifying the concept that we consider.

First, we choose to restrict our study only to those ties that can be judged to be positive: examples include relationships between close friends, married couples, family relatives, classmates, etc. In contrast, negative ties may include relationships between people with different tastes, from different political orientations, with different religious beliefs, etc.

In order to specify the foundations of such social ties and the possible reasons for their emergence, let us consider the well-known concept of social identity from social psychology. According to social identity theory [32, 23], an individual's social identity is built upon a set of social features, each of which may refer to any type of salient characteristics that can be shared by individuals in a particular context. For example, a person may identify himself as a student of the university of Toulouse, a supporter of Barcelona's soccer team, a Democrat, a Catholic, etc.

According to various theories in social psychology (see e.g., [1, 22]), the construction of an individual's social identity is determined by two complementary motivations. The first motivation is self-enhancement, which is underpinned by one's individual need to promote self-esteem (as pointed out by Luhtanen and Crocker [24], "Being a member of a social group is an important reflection of who I am"). Reduction of subjective uncertainty about one's perceptions, attitudes, feelings, behavior, and one's self-concept and place within the social world is the second motivation.

It can be reasonably assumed that people can give different degrees of importance to those social features defining their social identity, depending on the context: for example, while one's identification as a soccer player is more important than one's identification as a student during a soccer game, the reverse may hold for the same individual during a math exam at the university.

Following this interpretation, our claim is that:

Statement 2.0.1 *A social tie between two individuals exists* ***if and only if*** *they share the same social features defining their social identities, and this is common belief among them.*

Note that the previous claim implies that a *social* tie is necessarily *bilateral* in the sense that, if an individual i is tied with another individual j, then j is also tied with i. For example, an individual who believes to share the same political convictions with a given politician cannot induce a social tie as long as the latter does not also believe so (one could speak of the existence of a unilateral tie in this case, though it is not "social" according to the above statement).

Moreover, the previous statement simply characterizes the minimal condition for the existence of a social tie. As an illustration, one can consider the well known Minimal Group Paradigm (MGP) [30], which corresponds to an experimental methodology from social psychology that investigates the minimal conditions required for discrimination to occur between groups. Experiments using this approach [31] have revealed that arbitrary and virtually meaningless distinctions between groups (e.g., the colour of their shirts) can trigger a tendency to cooperate more with individuals within one's own group than with others. In this case, one should note that such meaningless social features satisfy the minimal condition for being considered as a social tie from the previous statement. However, in principle such social tie should be quite weak.

In this respect, it is worth mentioning that an important property of social ties lies in its quantitative aspect, that is, two individuals can be *more or less* socially tied with each other. To be more precise, we assume that a social tie between two individuals can be measured on a scale ranging from 0 to 1, where 0 and 1 respectively stand for the minimum and maximum strength for the tie.

This interpretation therefore suggests that the strength of a social tie can be determined by the **quantity and importance of shared social features**. One can indeed assume that sharing a high number of social features (defining one's social identity) with high importance leads to a high social tie value. On the other hand, having conflicting social characteristics, or sharing a low number of features with high importance, or sharing a high number of features with low importance can lead to a lower tie value.

Moreover, another aspect that, we believe, influences the strength of a social tie between two individuals is the **quantity and quality of past interactions** between them. More precisely, given two individuals sharing a certain number of social features with a given importance, the strength of the tie between them is higher in the situation in which the two individuals had frequent meaningful interactions in the past than in the situation in which there were no previous meaningful interactions[1].

As a concrete example to illustrate the previous interpretation, one may consider the case of online dating systems on the internet. Those systems, which are clearly meant to build social ties between individuals (assuming an affective tie is a special

[1] With the term "meaningful" we mean that during past interactions, the two individuals had the occasion to know each other by exchanging ideas, opinions, sharing positive emotions (e.g., they mutually enjoyed playing tennis together), etc.

case of a social tie), are based on the matching of social features that define their social identities. However, while one cannot deny the effectiveness of such systems [21], it is suggested in [17] that some interaction between two individuals is also important as it can allow them to know each other more accurately. Indeed, by providing a way to obtain reliable information about one another, social interactions happen to be a relevant tool against possibly inaccurate stereotypes, which can often be considered as an unfortunate consequence of categorizing individuals into social groups, as implied by social identity theory.

The following points summarize our interpretation of social ties:

- The minimal criterion for the existence of a social tie between two individuals is for them to commonly believe that they share the same social features that define their social identities.
- A social tie between two individuals has a quantitative dimension which depends on the following two parameters:
    1. The quantity and importance of shared social features that define both individuals' social identities.
    2. The quantity and quality of past interactions between both individuals.

Following our interpretation, one might then argue that the situation described by the minimal group paradigm (MGT) satisfies the minimal condition for the existence of a social tie, even though this tie has a relatively low degree of strength (the number of shared social features is one) and its importance might be considered to be reasonably low.

3 Experimental design

Having previously analysed the main characteristics of social ties, we now introduce two games that can allow to study their behavioral effects in details: the asymmetric battle of the sexes (ABoS) game is presented in Section 3.1, and the social ties (ST) game is presented in Section 3.2.

3.1 An Asymmetric Battle of the Sexes

The coordination game that we consider is a simultaneous move game with two players, which we will refer to as Alice and Bob, where each has to choose among the same available actions A and B. The corresponding payoff matrix, which is expressed in euros, is represented in Figure 1. In this case, the worst scenario for both players is to miscoordinate (i.e., playing A while the other plays B or vice versa). However, both players have diverging preferences regarding the best outcome: Alice prefers coordination on (A, A) while Bob prefers coordination on (B, B). This definition of this game clearly describes the well known Battle of the Sexes (BoS) from the literature. The only difference concerns the symmetric property of the players' payoffs that we voluntarily removed here: unlike in the BoS game, the lowest payoff is different in the two coordination outcomes (€ $5 \neq$ € 15). In other words, outcome (B, B) is worth more to Alice than outcome (A, A) is worth to Bob. In spite of this difference, the game theoretic properties of the resulting Asymmetric Battle of the Sexes (ABoS) remains as in the classical BoS game: both (A, A) and (B, B) are the only pure Nash equilibria, which also appear to be the only Pareto optimal solutions. There also exists a Nash equilibrium in mixed strategy, which consists of playing A with probability $7/8$ for Alice, and playing B with probability $7/10$ for Bob (in this case, the respective expected payoffs are € 10.5 for Alice, and € 4.375 for Bob).

		Bob	
		A	B
Alice	A	**(35,5)**	**(0,0)**
	B	**(0,0)**	**(15,35)**

Figure 1: Asymmetric Battle of the Sexes (ABoS)

The main features of this game lie on defining the role played by the group's preferences in the players' behavior. As in the BoS game, being self-interested is not sufficient to guarantee any coordination success: every action is indeed compatible with some common belief in the players' rationality. However, in the ABoS game, one can notice the existence of a focal point for the group that is not present in the classical BoS game: out of the two Nash equilibria, the outcome (B, B) is always better for the group. In fact, no matter whether one considers the sum, the average, the difference, or the minimum value among the individual payoffs as a measure of the group's utility, this unique outcome always outperforms every other solution. In fact, the asymmetry in the players' payoffs creates some incentives for them to favor the group as a whole, which can also allow them to eventually maximize their self-interest (any coordination is always better than miscoordination). Both players may then consider this solution as a focal point that can be used to reach coordination. However, one should note that, as the corresponding solution (B, B) favours Bob more than it favours Alice (what is best for the group is also best for him), the players may still choose to deviate from it. Is Alice likely to detect and follow this focal point (B, B), which clearly conflicts with her best outcome (i.e., (A, A))? What can weaken/strengthen the revealing of this focal point to the players? These are the questions we wish to answer through the experimental study.

3.2 The Social Ties game

We define the Social Ties (ST) game, which is shown in Figure 2, as a two player game that extends the previous ABoS coordination game as follows: prior to playing the coordination game itself, Alice is offered the possibility not to play the ABoS game through an outside option. In fact, she may choose to play In, in which case both players play the ABoS game according to the previous section, or she may choose to play Out, in which case the game ends with Alice earning € 20 and Bob earning € 10.

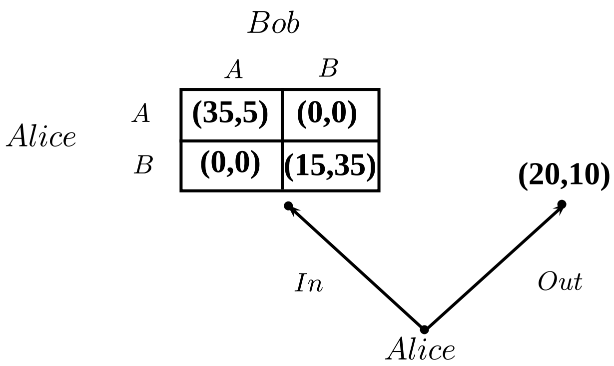


Figure 2: Social Ties game (ABoS game with outside option)

The motivation for adding this outside option to the previous ABoS game is to investigate the effects of the rationality principle on people's choice. In fact, as shown through the previous section, common belief in the players' rationality could lead to any possible outcome. This appears not to be the case anymore in the ST game. In fact, this ST game contains three Nash equilibria in pure strategies, which are the following:

$$(In, \mathbf{A}; \mathbf{A}), (Out, \mathbf{A}; \mathbf{B}), (Out, \mathbf{B}; \mathbf{B})$$

Moreover, the ST game also has a Nash equilibrium in mixed strategy, which consists of Alice always playing Out (i.e., with probability 1) and Bob playing B with probability $3/7$. This solution however has to be distinguished from another Nash equilibrium in behavioral strategy, which consists of Alice always playing Out first (i.e., with probability 1) and playing B with probability $1/8$ in the subgame while Bob then plays B with probability $7/10$ (Note that this corresponds to the Nash equilibrium in mixed strategy in the subgame, as shown in the analysis of the ABoS game from the previous section). Thus, the respective expected payoffs in both of these cases are €20 for Alice, and €10 for Bob. However, it is worth indicating that all Nash equilibria in mixed or behavioral strategies are simply irrelevant to the ST game: if Alice is willing to randomize in the ABoS subgame or believes that Bob will, then she is always better off by playing Out in the first place.

Considering subgame perfect Nash equilibria, which can be computed through the backward induction method, allows to rule out the solution $(Out, \mathbf{A}; \mathbf{B})$ even though it is a Nash equilibrium. Indeed, although the prediction to play Out is perfectly rational for Alice, it here relies on the fact that she would not be rational had she played In in the first place: given that Bob plays B in the ABoS game, Alice's only rational move would be to play B instead of A (which corresponds to a Nash equilibrium in the subgame). Note that the previous Nash equilibrium in mixed strategy is ruled out by this principle while the Nash solution in behavioral strategy still remains.

Furthermore, considering the forward induction principle allows to restrict the previous set of subgame perfect Nash equilibria to those solutions, which resist the iteration of weak dominance. In the context of our ST game, this leads to the following solution: first Alice's strategy $(In, \mathbf{B})$ is weakly (and strictly) dominated by any strategy involving Out. Then Bob's strategy **B** becomes weakly dominated by **A**. Thus Alice's strategies $(Out, \mathbf{A})$ and $(Out, \mathbf{B})$ are both weakly (and strictly) dominated by $(In, \mathbf{A}; \mathbf{A})$. Therefore, the unique forward induction solution, which resists iterated weak dominance, is as follows:

$$(In, \mathbf{A}; \mathbf{A})$$

Indeed it turns out that fully rational players should play this solution, which can be interpreted as follows: while playing In, Alice signals Bob that she intends to play **A** (if she intended to play **B**, she would have played Out in the first place). Therefore Bob's unique rational move is to play **A**. However, while this interpretation justifies the existence of the above solution, it does not explain why the other backward induction solution is not rational. To continue the argument, let us then consider the solution $(Out, \mathbf{B}; \mathbf{B})$, which can be interpreted as follows: Alice plays Out because she expects Bob to play **B** in case she had played In. This chain of reasoning is clearly erroneous because Alice's conditional expectation does not match what she would really expect had she *actually* chosen to perform In. Indeed, as shown before, if Alice performs In, Bob's unique rational move is to play **A**, thus no matter what Alice does during the first stage, she cannot expect anything else than Bob playing **A**. Consequently, her unique rational move is to play $(In, \mathbf{A})$, and Bob's best response is to play **A**. Moreover, note that, for the same reason, the previous Nash equilibrium in behavioral strategy does not resist this forward induction argument.

The interesting characteristics that this analysis brings about is that the validity of this forward induction argument is independent of Bob's preferences. This therefore suggests that such a game introduces some "first mover" advantage, assuming that it is common knowledge among them that they both are self interested agents.

Many studies in the experimental economic literature have provided support to this forward induction argument, see e.g. [9, 27, 14, 15, 33, 10, 11, 3].

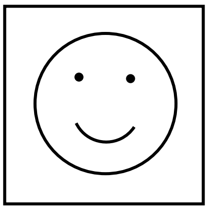
However, all these work consider games that are slightly different from the interactive strategic situation on which we focus in this paper. One may then wonder whether the asymmetry introduced in the ABoS subgame does alter the game theoretical prediction.

4 Measuring social ties

Our goal here is to measure the subjects' social relationships with the group they belong to. In order to quantify such social ties, each subject is first required to rate his/her connection with every member of his/her group. More specifically, the question used to fill this purpose is to ask the subjects to indicate their beliefs about how they are appreciated by each other group member, based on their picture, as shown in Figure 3. Note that the reciprocal property implied by this question satisfies Constraint 2.0.1 from Section 2 that restricts a social tie to be bilateral[2].

[2]The subjects were also asked to answer a similar question to that in Figure 3, where they were required to indicate their direct feeling about each other group member in the same fashion. As we observed that answers to both questions are strongly correlated, we chose to focus on the most restrictive depicted in Figure 3.

Please indicate how **you think** the person displayed in the photo below **feels about you**:
[Select only one answer]



- likes you a lot
- likes you
- dislikes you
- is indifferent

Figure 3: An individual's expected tie with a group member

In the context of this question, we use the four available options to define the scale of a tie according to Figure 4: given a group member, the strongest tie is considered whenever the subject "likes a lot" that person, whereas the weakest tie is considered whenever the subject "dislikes" that person.

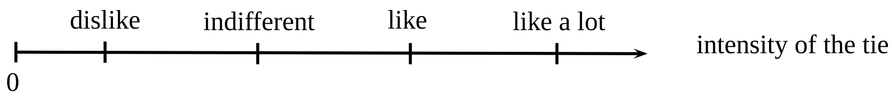


Figure 4: Individual tie measure

Although the above question can reveal what one may call the social value of a certain subject within a certain group (e.g., the more one believes to be liked by others, the more one's social value is important), we claim that it is not sufficient to meet our definition of a social tie with a group. Indeed, let us recall that subjects are expected to interact anonymously so that they know who they may be interacting with (i.e., a member of their group), without knowing who they actually interact with. This means that a subject's tie with an unknown group member can be reasonably interpreted as the tie with the group itself. However, as indicated in Section 2, a social tie is assumed to be bilateral, which therefore implies that the intensity of the relationship with a group one belongs to must be the same for every member of that group. In order to illustrate this interpretation, let us consider the following scenario: suppose that Alice is socially very close to Bob, Carol, and Daniel, while, at the same time, these three characters dislike each other (i.e., they are all only socially tied to Alice). Let us also suppose that Alice actually interacts with Bob. In this case, although Alice is indifferent between interacting with either character, Bob is not. Indeed, Bob is more likely to actually interact with someone he dislikes, and so Alice should take this information into account in order to make her choice. One's tie with a group should then not only rely on one's individual ties with other members, but it should also take into account the ties existing between every pair of members from the group. This is why we ask all subjects in our experiment to give their estimate about which member is socially tied to whom within the group they belong to. As shown through Figure 5, a subject is required to draw lines between members they believe are actual “friends”.

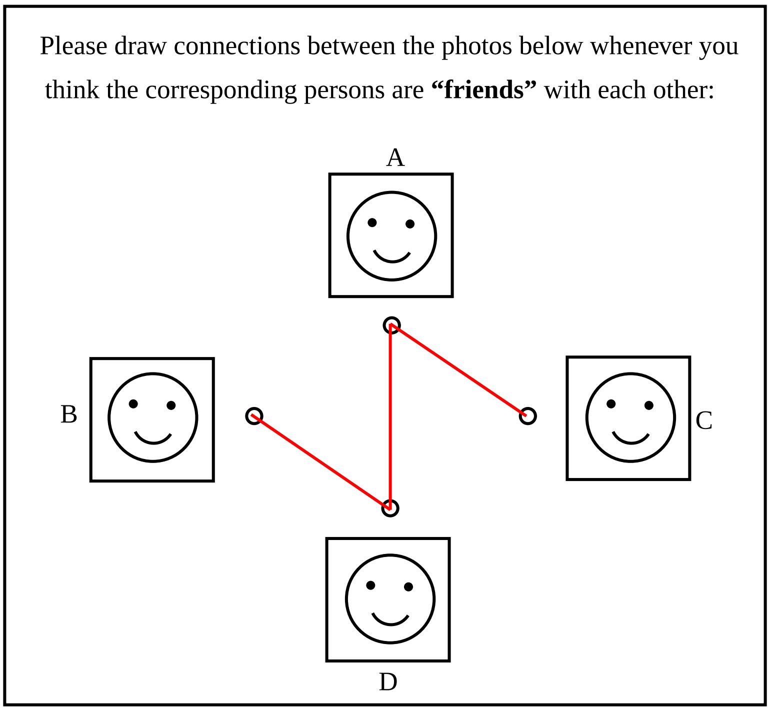


Figure 5: An individual’s subjective estimate of others’ ties

In this case, the presence of a connection between two members is interpreted as the existence of a tie between them according to the subject who answered. Conversely, an absence of connection between two members is interpreted as a non existent tie between them according the same subject. To illustrate this with the particular example depicted in Figure 5, where four individuals A,B,C, and D are considered, the subject X (who answers the question) indicates his beliefs that B is only tied with D, C is only tied with A, and A is also tied with D (in addition to being tied to C). Such binary measures of ties are used in order to keep the question as simple as possible to the subjects, without removing too much valuable information (as subjects are asked about others’ ties, the imperfection of such an information may indeed lead to introduce unnecessary noise through more detailed questions).

5 Experimental procedure

In our experiments, students from Toulouse 1 university capitole who are also members of the main university volleyball club were recruited as participants. As a preliminary phase during training sessions, every active member of this club was proposed to participate to our study. Upon acceptance, every subject was then photographed for the purpose of later measuring social ties with their own teammates (see Section 4).

The experiment itself was run in November 2011 during two training sessions. In total, 70 subjects participated, including 37 men and 33 women. As active volleyball players within the club, all subjects were divided into 9 single-sex teams: 5 teams were exclusively made of men, and 4 teams were exclusively made of women. The minimum (resp. maximum) number of subjects in a given group was 7 (resp. 9). Both training sessions can be defined as follows:

- Session **A**: 31 subjects divided into 3 male teams and 1 female team.
- Session **B**: 39 subjects divided into 2 male teams and 3 female teams.

All (male and female) teams were ranked based to their performance according to the official volleyball coach of the club. The best (i.e., higher ranked, most efficient) male/female teams all belong to Session B.

It is assumed from this population of subjects that members of the same team do naturally share some social ties with one another. In fact, considering our definition of social ties from Section 2, these players do share some common social feature that define their social identity (e.g., they are all students at the same university, they all like sport, and particularly enjoy playing volleyball) while also having regular meaningful interactions with one another (they at least all play volleyball together for 2 hours every week).

The paper and pencil method was used all along in our experiment. At the beginning of both sessions, all subjects were asked to fill a questionnaire, which includes rather personal questions (e.g., about their hobbies, study, religious/political beliefs), as well as questions related to measuring their social tie with their own team (see Section 4 for details).

The purpose of answering this questionnaire prior to playing both games is simply to prevent the subjects' behavior in both games to influence their ratings of social ties. Indeed, our goal is to measure genuine ties, which are independent of any social context. On the other hand, it is worth mentioning that eliciting social ties before playing the games is not a problem. In fact, it is likely that answering the related questions may influence the subjects' behavior in both games, which is precisely the purpose of our experiment. Moreover, one should note that, while measuring a social tie with an individual seems quite straightforward (either one likes/dislikes someone or is indifferent), measuring a social tie with a group seems rather more ambiguous. It can therefore be assumed that letting the subjects answer these questions beforehand may lead them to become more aware of the actual level with which they are close to their group.

Every subject was then asked to play both of the above ABoS and ST games, according to three different types of matching processes. The use of such a within-subject design is clearly justified by the reasonable assumption that social ties are individual intrinsic characteristics. The purpose of this experiment is indeed to study any possible change of behavior that may be induced by different levels of social ties.

The three different matching processes can therefore be described as follows:

- The **"university"** scenario: the interaction involves a member of the volleyball club (i.e., a participant of this experiment) and some randomly selected student from Toulouse 1 university capitole who does not belong to the volleyball club[3]. This situation defines our control treatment, as very little information is made available about the co-player. In this case, we assume the existence of a very weak tie (if not absent) between the players.

- The **"club"** scenario: the interaction is made between two randomly selected volleyball club members (i.e., participants of this experiment) who do not belong to the same volleyball team. This situation illustrates the existence of some social tie of intermediate strength between the players that mainly relies on the limited sharing of some common social feature (e.g., enjoying playing volleyball) and some possible few past interactions (during a usual training session, students may indeed occasionally interact with students that do not belong to their own team).

- The **"team"** scenario: the interaction is made between two randomly selected members of the same volleyball team. This situation characterizes the case with the strongest social tie existing between two subjects in this experiment. As said earlier, such a scenario indeed illustrates well our definition of social ties from Section 2.

In each of these cases, one should note that information imperfection is symmetric, that is, the type of scenario is made common knowledge among both of the players involved.

It is clear from the definitions of the above matching processes that each scenario characterizes a different level of social tie between partners, as shown through Figure 6.

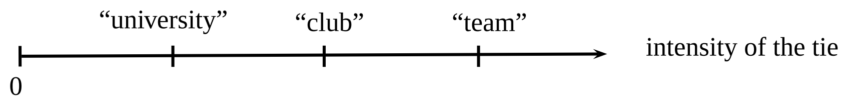


Figure 6: Quantifying social ties based on the matching process

These three scenarios are then played in sequence by every subject in the context of both games, using the following meta-strategy method: for each scenario, all subjects had to indicate their decision if assigned the role of *player (1)*, as well as their decision if assigned the role of *player (2)*.

Furthermore, in order to detect any possible influence the order of playing these scenarios may have on the subjects' behavior, we distinguish two different experimental sequences in both sessions:

- In Session **A**: subjects first played the ST game before playing the ABoS game, and in each case, they considered scenarios in decreasing order of the level of social ties (i.e., starting with the "team" scenario).

[3]Furthermore, this particular scenario was also independently replicated between economics students from the Toulouse School of Economics and randomly selected students from Toulouse 1 university capitole who are not economics students.

- In Session **B**: subjects first played the ABoS game before playing the ST game, and in each case, they considered scenarios in increasing order of the level of social ties (i.e., starting with the "university" scenario).

It is also worth pointing out that, although each game was played repeatedly (i.e., once for every situation), each case remains a one-shot game as it is guaranteed that a subject cannot interact more than once with the same co-player in the same situation. However, note that the probability p of interacting with the same individual in both games is $p < 1/18000$ in the "university" scenario, $1/63 < p < 1/61$ in the "club" scenario, and $1/8 < p < 1/6$ in the "team" scenario[4].

Moreover, in order to elicit their beliefs about what characterizes their expected behavior in the context of both of the ABoS and ST games played in the "university" scenario, all subjects were asked to indicate their expectations of what decision a randomly selected student from the university would make in both roles (i.e., both as *player (1)* and as *player (2)*). Subjects were also incentivized to answer carefully to these questions (i.e., they were offered a monetary prize whenever their guess was accurate). The obvious purpose of these complementary questions is to provide some extra information regarding the subjects' way of reasoning and rationality (e.g., do people play the best response to their belief about their co-player's choice?).

The whole experiment lasted approximately one hour in both sessions. The participants' payments were distributed during the following training sessions in December 2011. The payment method, which was clarified to all subjects beforehand, did then consist of randomly drawing one role (i.e., *player (1)* or *player (2)*), one game (i.e., ABoS game or ST game), one scenario (i.e., "university", "club", or "team"), and one co-player (depending on the scenario). A subject's payoff was therefore defined according to his choice made as the selected player in the selected situation (which corresponds to the selected scenario in the selected game), and the selected co-player's choice in the same situation. Each effective payment was made individually and anonymously through random draws that were made in front of the subject concerned[5]. All participants received the total sum of their actual earnings, which includes a € 5 show-up fee. The mean of total payments was € 19.03 (standard deviation of € 12.21, with a maximum of € 40 and a minimum of € 5).

6 Preliminary results

This section presents descriptive statistics reporting the various elicited behavior throughout our experiment. More specifically, we describe the players' observed behavior in both the asymmetric BoS game and the social ties game for various levels of social ties. The strength of a social tie is then artificially controlled by changing the type of each subject's game partner: we indeed consider three distinct levels of such social ties corresponding to the three scenarios defined in Section 5 (i.e., "team", "club", or "university").

[4]The actual value of p in the "university" and "club" scenarios depends on the team the corresponding subject belongs to.

[5]The random selection of the co-player was made through some code name in order to preserve anonymity between subjects.

6.1 Behavior in the Asymmetric BoS game

Table 1 represents the players' resulting behavior in the asymmetric BoS (ABoS) game, depending on whether the corresponding co-player is a teammate, a club member, or a university student. Table 1 also includes the p values related to the Wilcoxon signed rank tests for similarity of the subjects' behavior in various scenarios. Note that, in all following tables, only p values lower than 0.2 are displayed. p values larger than 0.2 are classified as not significant (n.s.). The first observation one can make from Table 1 is that the subjects are torn between choosing A and B when assigned the role of *Player (1)* in the presence of some weak tie with *Player (2)* (i.e., in the "university" scenario). This randomizing behavior may simply be the direct consequence of the conflict existing between *Player (1)*'s own preferences, and the group's welfare: *Player (1)* indeed prefers the (A, A) outcome while (B, B) is clearly better for the group (and for *Player (2)*). Moreover, note that the elicited behavior, which largely differs from the optimal mixed strategy (i.e., play A with probability $7/8$), suggests that the subjects are well aware of this conflict, and can therefore hardly choose between satisfying their self-interest and satisfying the welfare of the group.

Players	**Matching types**			**Wilcoxon signed rank test** (p values)		
	team	**club**	**university**	**team** vs. **university**	**team** vs. **club**	**club** vs. **university**
1 (70 obs.)	67%	57%	49%	0.002	0.089	0.108
2 (70 obs.)	75%	76%	73%	n.s.	n.s.	n.s.

Table 1: Choosing B in the ABoS game

One can also observe that subjects tend to favor option B significantly more often whenever the social tie with *Player (2)* increases. This means that, as *Player (1)*, increasing one's social tie with *Player (2)* allows to accept giving up some of one's own payoff in order to favor the group made of both players. In other words, the existence of a (strong) social tie between the players simply allows to reveal the existence of a focal point to *Player (1)*, which corresponds to the unique best outcome for the group. Furthermore, note that the elicited behavior then goes further apart from the optimal mixed strategy as the tie increases, which indicates the presence of some sufficiently strong incentive to satisfy the welfare of the group[6].

Similarly, when assigned the role of *Player (2)*, the subjects clearly favor playing B in all types of interactions, which is a major difference with *Player (1)*'s behavior from Table 1. In this case, *Player (2)*'s observed behavior is close to the optimal mixed strategy (i.e., playing B with probability $7/10$), which may support the subjects' intention to satisfy their self-interest. This result is however not very surprising because, unlike *Player (1)*, *Player (2)*'s preferences perfectly match that of the group (i.e., there is no conflict between *Player (2)*'s individual preferences and the group's welfare). As a consequence of facing no dilemma, the subjects need not care about

[6] Also note from Table 1 that an intermediate level of social ties (i.e., through the "club" scenario) induces some existing but less significant change in behavior.

the welfare of the group when assigned the role of *Player (2)*. However, one should note that *Player (2)*'s choice does not vary significantly with an increase of the social tie's strength. This clearly indicates that *Player (2)* does not even take into consideration his/her corresponding tie with *Player (1)* in order to make a choice. This result is rather surprising because, by anticipating *Player (1)* to choose B more often in the presence of a stronger tie, a purely self-interested rational individual would also choose B more often as *Player (2)*. Therefore, *Player (2)*'s unchanging behavior suggests that the subjects may actually not be so purely self-interested after all.

6.2 Behavior in the Social Ties game

Tables 2 and 3 represent the players' resulting behavior in both stages of the Social Ties (ST) game, depending on whether the co-player is a teammate, a club member, or a university student. More specifically, Table 2 depicts *Player (1)*'s choice between In and Out during the first stage of the game. Table 3 similarly depicts both players' behavior in the second stage of the game (i.e., the ST subgame), in the hypothetical case that the second stage were reached (through *Player (1)* playing In in the first stage)[7]. Tables 2 and 3 also include the p values related to the Wilcoxon signed rank tests for similarity of the subjects' behavior in various scenarios. However, as such statistical tests cannot be performed over *Player (1)*'s whole strategy space in the ST game (i.e., *Player (1)* has four discrete choices: (In, A), (In, B), (Out, A), and (Out, B)), we simply provide the observed behavior in details through Figure 7, which can be read as follows: according to Figure 7(c), among the 42% of subjects who chose In in the first stage of the game, 52% then played A in the subgame. However, in this same context, 43% of the subjects who chose Out first would have played A in the subgame had they chosen In first.

Matching types			**Wilcoxon signed rank test** (p values)		
team	**club**	**university**	**team** vs. **university**	**team** vs. **club**	**club** vs. **university**
62%	53%	42%	0.004	0.083	0.059

Table 2: *Player (1)* choosing In in the first stage of the ST game (70 obs.)

Concerning *Player (1)*'s elicited behavior in the presence of some weak tie with *Player (2)* (i.e., in the "university" scenario), the first observation one can make from Table 2 is that the subjects play Out more often (58%). Moreover, Table 3 shows that in this context, the subjects are then torn between choosing either strategy A or B in the subgame. More precisely, Figure 7(c) indicates that this observation is particularly true among the subjects who played In in the first stage. Such a result is rather surprising as it does not suggest any strong common belief in each other's rationality. Indeed, as shown in Section 3.2, if *Player (1)* believes in *Player (2)*'s rationality and that *Player (2)* believes in *Player (1)*'s rationality, then *Player (1)*'s only rational move is to play

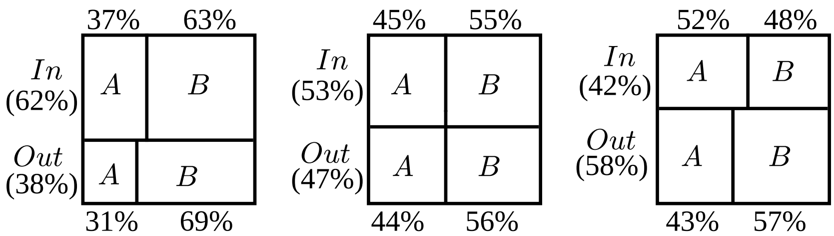
[7] Table 3 therefore includes *Player (1)*'s counterfactual choice in the second stage: if choosing Out in the first stage, what would Player (1) have played in the subgame had he chosen In instead?

$(In, \mathbf{A})$, which corresponds to the forward induction reasoning. Moreover, it appears that considering the weaker assumption of bounded rationality does also not suffice to explain all the elicited behavior: no matter what *Player (1)* believes about *Player (2)*'s future move, playing $(In, \mathbf{B})$ can never be selected as a rational self-interested move. Yet, Figure 7(c) shows that 20% of the subjects actually selected strategy $(In, \mathbf{B})$ in this context. As a means to provide a realistic interpretation of this observation, one can observe that the outside option in the first stage of the ST game is not relevant to the subjects' decision as *Player (1)* in the subgame. This result therefore suggests that, right after playing In, *Player (1)* tends to consider the subgame as a new independent game (i.e., *Player (1)* then forgets about the previous outside option).

Players	**Matching types**			**Wilcoxon signed rank test** (p values)		
	team	**club**	**university**	**team** vs. **university**	**team** vs. **club**	**club** vs. **university**
1 (70 obs.)	65%	55%	53%	0.032	0.133	n.s.
2 (70 obs.)	77%	67%	64%	0.049	0.108	n.s.

Table 3: Choosing B in the second stage of the ST subgame

Considering *Player (2)*'s choice in the context of weak ties (i.e., in the "university" scenario), Table 3 similarly suggests that the subjects tend to play the optimal mixed strategy in the subgame (i.e., playing B with probability $7/10$). Following this interpretation, *Player (2)* may act rationally in response of believing that *Player (1)* also acts rationally in the subgame only (i.e., without considering the outside option). It is also worth noting that *Player (2)*'s observed behavior from Table 3 does largely differ from the optimal mixed strategy in the entire ST game (i.e., playing B with probability $3/7$ as shown in Section 3.2). However, it appears that, unlike *Player (1)*, *Player (2)*'s behavior is somewhat affected by *Player (1)*'s outside option. As a result, the fact that *Player (2)* chooses A significantly more often in the ST game than in the ABoS game suggests that *Player (2)* is sensible to some forward induction reasoning (see Section 3.2).



(a) Team scenario (b) Club scenario (c) University scenario

Figure 7: Elicited behavior for *Player (1)* in the ST game (70 obs.)

Consequently, both players' elicited behavior in the "university" scenario clearly illustrate the failure of the principle of individual rationality. Furthermore, this analysis suggests the existence of some group-oriented behavior: the design of the ST game indeed allows for the dominant solution $(In, \mathbf{B}; \mathbf{B})$ to be the best outcome for the group made of both *Player (1)* and *Player (2)*.

Moreover, focusing on other scenarios that consider the presence of stronger social ties between the players allows to reinforce this hypothesis: one can indeed observe from Figure 7 that subjects (as *Player (1)*) tend to favor option $(In, \mathbf{B})$ more often whenever the social tie level between players increases.

Analysing the effect of social ties on *Player (2)*'s behavior in the ST game, Table 3 also reveals some significant difference: *Player (2)* is more likely to play B in the presence of a stronger tie with *Player (1)*. Note however that, although *Player (1)* cannot be rational to play strategy $(In, \mathbf{B})$, both actions for *Player (2)* (i.e., A and B) are rationalizable: *Player (2)* should rationally select B (resp. A) as a best response of believing that *Player (1)* will also play B (resp. A). In other words, this means that *Player 2*'s observed behavior can always be justified by some rationality assumption.

7 Towards a model of social ties

We first consider some well known theories of social preferences from the literature that appear to be relevant to our study. The main idea behind these theories consist in 'transforming' the players' utility in the original game on the basis of some social feature such as altruism, inequity aversion or fairness in order to obtain a new game in which equilibria can be computed using classical solution concepts (e.g., Nash equilibrium).

In the models proposed by Fehr & Schmidt [16] and Bolton & Ockenfels [8], players are assumed to be intrinsically motivated to distribute payoffs in an equitable way: a player dislikes being either better off or worse off than another player. In other terms, utilities are calculated in such a way that equitable allocations of payoffs are preferred by all players. In the context of the ABoS game, this model predicts that inequity averse individuals (whose utilities are determined by simply subtracting the difference between payoffs to their own original payoffs) would play A as *Player (1)* and B as *Player (2)*. Similarly, in the ST game, it predicts that such individuals would play Out as *Player (1)* and B as *Player (2)*. Such an analysis clearly shows that this inequity aversion theory cannot explain the behavioral effects of social ties as shown in Sections 6.1 and 6.2.

In [12], Charness & Rabin propose another specific form of social preferences they call *quasi-maximin* preferences. In their model, group payoff is computed by means of a social welfare function which is a *weighted* combination of Rawls' *maximin* and of the utilitarian welfare function (i.e. summation of individual payoffs) (see [12, p. 851]). This theory then introduces a generalized solution concept called the social welfare equilibrium that is reached whenever the players choose their best response to each other's strategies while considering the welfare of the group (to some extent) instead of their own individual preferences. The nice properties of such a model allows to specify the outcome $(In, \mathbf{B}; \mathbf{B})$ as a unique social welfare equilibrium in the ST game when both players are sufficiently considering the welfare of the group. This theory of fairness therefore allows to explain our observation from Section 6.2 in the context of social ties. However, the limitation of this model arises when considering the case of coordination games. In fact, when applied to our ABoS game, such a model cannot make any further prediction than classical game theory does under the assumption of individual rationality (this fairness model predicts both (A, A) and (B, B) to be social welfare equilibria, no matter the level to which both players consider the welfare of the group).

Although existing theories of social preferences fail to explain the elicited behavior in our experiment, we show that our observations can be justified by the theory of team reasoning, which is based on group identification, as introduced by Bacharach in [2]. However, this theory appears to have the following limitation: Bacharach's concept of unreliable team interaction structure in [2] can be seen as a special type of incomplete information games[8] where the only uncertainty one can have is regarding the level to which other players identify with different groups (e.g., agent i may identify with the group $\{i, j\}$ with probability ω or with the group $\{i\}$ with probability $1 - \omega$). In other words, this theory relies on the assumption that every agent identifies with a unique team at a given time. This is a strong assumption, as it prevents from modeling situations in which, for example, an agent may be torn between being selfish and identifying with the group, depending on the strength of the existing social tie.

We therefore introduce a novel model that characterizes well the agents' behavior in the presence of social ties in the above games. Similarly to other theories of social preferences, our starting assumption is that a social tie between two individuals induces them to behave according to some aggregation of their individual preferences. Our approach is inspired by the previous concept of empathetic preferences introduced by Binmore in [5, 6, 7]. An empathetic behavior can indeed be reduced to simply choosing the corresponding action from the strategy profile that maximizes the group utility. More precisely, this way of reasoning can be interpreted as "do the right thing for the group, assuming that all other group members also do the right thing for the group".

Furthermore, we validate our model by refining our empirical analysis so that it takes into account subjective measures of social ties, as shown in Section 4. As a result, we show that the actual (objective) value of one's social tie with another individual does not suffice to affect one's behavior. It is instead the subjective interpretation of this social tie by the individual that does matter the most. In other words, the fact that one is closely tied to other individuals is simply irrelevant as long as one does not know about it.

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