PROSOCIAL ATTITUDE MODULATES MUSCLE ACTIVITY IN A SIMPLE COORDINATION GAME

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ABSTRACT

Social and economic literature generally considers that the relevance of property rights in human interaction arises from an explicit cognitive processes, which emerge with social competence. In the present work we aimed at investigating whether the arbitrary allocation of property rights automatically affects individuals' behavior, within a context with no visual and verbal interaction and removed from any perspective-taking activity. To this purpose we submitted twelve pairs of participants to a simple motor coordination game while recording the electromyographic activity of the muscle mainly involved in the task. By using the answers to a questionnaire to measure the participants' degree of sociability, the correlation between muscle involvement and prosocial attitude revealed that low prosocial individuals, only, significantly changed their motor behavior in response to a reallocation of property rights. Results are discussed in relation to the *endowment effect*, a puzzling phenomenon observed in actual behavior, that had challenged the traditional assumption of rationality in many behavioral models.

INTRODUCTION

In actual societies the most part of collective welfare is generated through market transactions and social services. This bulk of social coordination requires a common set of shared norms to effectively take place, essentially property rights on things and actions. The main focus of the present paper was to investigate if the effectiveness of property rights should be entirely ascribed to cognitive processes related to strategic or "perspective-taking" considerations arising with social competence, or whether they constitute a set of behavioral devices able to automatically influence individual's behavior.

The role of property rights in social interaction have been extensively investigated within the experimental economics framework. A conspicuous amount of recent research has focused attention to investigate the influence of antecedents on the perceived payoffs of others in strategic environments. Typically, the outcomes of a game under perfect anonymity are compared to those obtained in a two stages experimental design. In the first stage one (or both) players accomplish a task by virtue of which they acquire a "role". In the second stage, subjects interact strategically, knowing nothing of each other except for the role gained in the first stage. Overall, empirical findings support the view that the subjects' behavior, and the distribution of payoffs, considerably reflect the "entitlements" earned by participants. For example, in the 'dictator game' the first player (proposer) has to divide a sum between herself and the second player (receiver), who passively receives the share allocated to her. In this context, if the proposer earned some entitlement[1] to the sum assigned to her, the frequency of zero offers[2] to the receiver increases, while positive offers arise more frequently on the part of the proposer if the receiver gained some "role" (Hoffman et al. ;1992, Oxoby and Spraggon; 2008, Cherry; 2002). The 'ultimatum game' is a strategic version of the dictator, widely employed in this literature, where the receiver can either accept or refuse the offer. If the receiver accepts, the stake is split according to the proposal. If she rejects, neither player get anything. In this setting, if the receiver earned a legitimate role, she gets larger shares of money from the first mover (Ruffle; 1998, Cherry; 2001). Overall, this literature

[1] Entitlement may be gained by scoring high on a general knowledge quiz (Hoffman et al.; 1992; Hoffman et al.; 1996, Cherry; 2002) or even by cracking a sufficient amount of walnuts (Fahr and Irlenbush; 2000).
[2] A zero offer corresponds to the standard selfishness-rationality prediction.

shows that having obtained a role by the accomplishment of a specific task, subjects appear to consider that one has a right to outcomes, which in other circumstances may be regarded as unjust. This body of evidence has led to support the interpretation that the perception of *legitimate property rights* on the part of individuals constitutes an important element influencing social interaction.

However, the experimental designs by which these results are obtained, make it difficult to asses the relevance of the subjective perception of property rights clearly distinguished from the legitimation sources of such entitlements. Indeed, the acquisition of a role seems to condition actual behavior of participants through the modulation of other emotional and/or strategic aspects relevant to the decision process. For example, in the dictator game the asymmetry in the perception of the "other" introduced by the distribution of "roles" might affect the participants' sense of equity, or, in the ultimatum context, it might influence the strategic assessment of the risk of rejection. In this respect, the experimental setup designed by this research neglects the possibility that the subjective perception of "property rights" might represent a distinct dimension along which social interaction takes place.

With respect to this approach, the main focus of our experiment was to verify whether the formal entitlements of property rights, regardless of any legitimating activity undertaken by participants, play a significant role within a context where interaction between individuals does not involve any explicit process related to emotional cues and/or to strategic or "perspective-taking" considerations. Furthermore, we wanted to investigate if the allocation of property right automatically influence individual's behavior at a very low level, such as the intensity of muscle involvement during the execution of hand actions. To this purpose, twelve pairs of participants, prevented from any visual or verbal exchange, were submitted to a simple motor coordination task. Each couple had to cooperatively hold a small sphere between their right index fingers and to drop it alternately into one of two containers placed below their hands, while electromyography of the right *first dorsal interosseus* (FDI) muscle of each participant was recorded. Each successful trial was differently rewarded with a given amount of money according to the experimental condition, and the rewarding rules were communicated before starting each session. Consequently, for the same action (e.g., pushing the ball into the leftside container) each participant could receive a reward in one session but not in another. The total monetary reward gained by each subject in each condition was always the same. Finally, we correlated muscle involvement to the scores obtained in a social attitude questionnaire to verify if the degree of prosocial propensity covertly modulates motor behavior.

METHODS

Subjects. Twenty-four female participants were recruited among students of the Law Department of the University of Ferrara (mean age 26 +/- 3). All of them were naïve to the purpose of the experiment, were right-handed according to the Oldfield questionnaire (Oldfield, 1971) and gave their informed consent. They were divided into two subgroups (the "Green" and the "Yellow" group) of 12 participants, and kept in separate rooms after their arrival at the lab. Twelve pairs of subjects were then formed by extracting randomly one partner from each subgroup. Each pair, composed by one Green and one Yellow subject, was submitted to an experimental session lasting approximately 30 minutes.

Questionnaire. In the first stage of the experiment the subjects were asked to answer a written questionnaire based on Putnam's *Social Capital Benchmark Survey* (http://www.hks.harvard.edu/saguaro/communitysurvey/index.html). Following Bobo et al. (1995) we employed the answers provided by subjects to build several indexes aimed at measuring individual prosocial/proself attitude (see the Appendix for details).

Coordination game Before entering the lab room, subjects have been invited to remove rings, bracelets, nail enamel, or other kind of decoration, that could have made them recognizable by other subjects. At the beginning of the experiment, two subjects entered the experimental room from two different doors, standing one in front of the other, their face and trunk hidden by a curtain. Thus, during the experimental session subjects never saw each other. Moreover, they were strictly recommended not to speak to exclude any possible recognition based on subject's voice.

Subjects were requested to pose their forearms on a Plexiglas surface with a square hole in correspondence of their hands. Below the Plexiglas was set an apparatus constituted by two adjacent containers of equal size, with the partition side aligned with participants' sagittal plane. At the beginning of each trial a small glass sphere (1 cm diameter) was placed between the extended right index fingers of the two subjects, and subjects were requested to stay on this position (starting position) until the go-signal. In this position the sphere was exactly above the border between the two containers. Subjects' index fingers were dressed with a soft sponge to

avoid flexion in the course of the play, and to increase the attrition surface to better keep the sphere in the proper position.

Each pair of subjects was asked to play 30 trials of a simple motor ability game. The 30 trials were subdivided into three experimental conditions (C_1, C_2 and C_3) of ten trials each, blocked into three experimental sessions, the presentation of which was pseudo-randomly balanced across pairs. At every trial subjects followed the instruction given by the experimenter indicating to drop the sphere alternately into the two containers. The difference among conditions C_1, C_2 and C_3. consisted in the monetary incentive associated to each trial successfully performed by subjects. Specifically, in condition 1, putting the sphere into either target container yielded a reward of € 0.50 to each subject (Figure 1A). In Condition 2 and 3, two colored sheets, one green and one yellow, were placed onto the floor of each container, defining the Green and the Yellow container. The allocation of rewards coupled containers and subjects of the same color. When the sphere was successfully dropped into the target container a € 1 reward was received by the correspondent colored subject only. In Condition 2, the Green (Yellow) container was placed at the left side of the Green (Yellow) subject: the winning subject had to execute an index finger abduction (contraction of the FDI muscle) to push the sphere towards the container (Figure 1B). In Condition 3, the colors of containers were reversed, so that the Green (Yellow) container was placed at the right side of the Green (Yellow) subject: the winning subject had to execute an index finger adduction (FDI muscle not involved) to "pull" the sphere towards the container (Figure 1C). The total money reward gained by each subject was € 5 in each condition (€ 15 total).

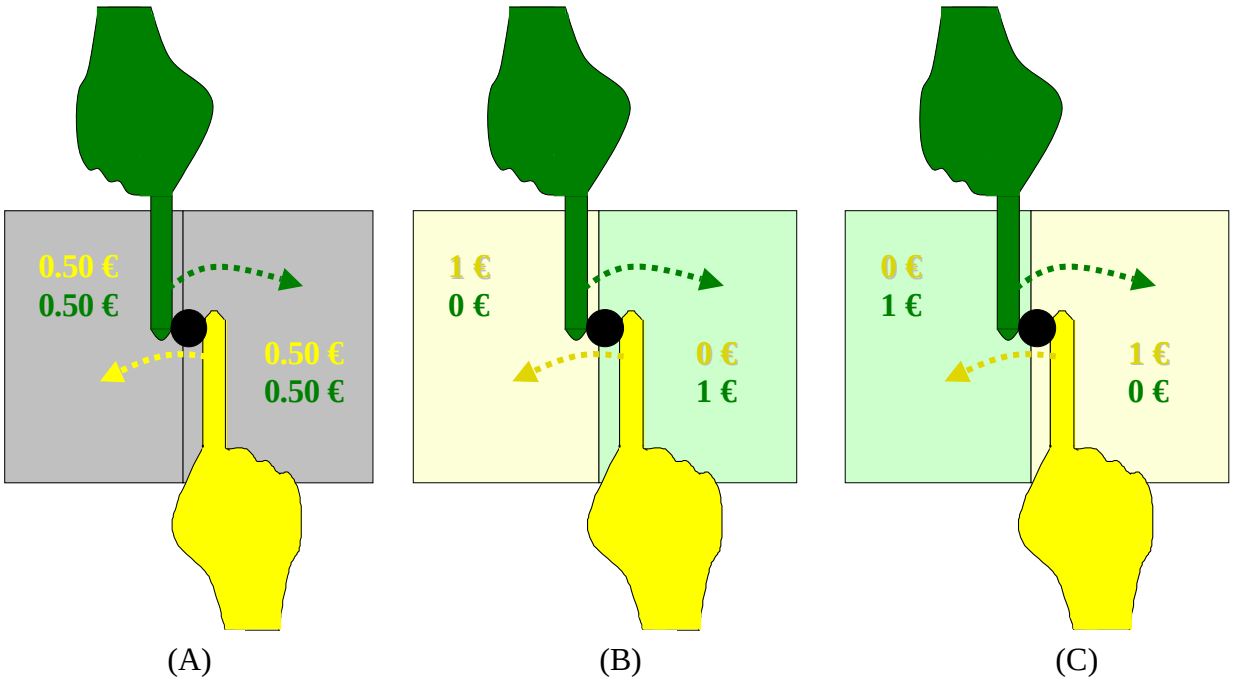


Figure 1. Schematic view of the experimental apparatus used in the three experimental conditions. Subjects' hands laid on a Plexiglas plate with the two index fingers positioned in correspondence of a square hole (the rectangle shown in the figure). Under the Plexiglas plate, at a distance of 10 cm from it, there were two containers (the two grey areas shown in panel A) where the subjects had to drop the sphere held by their index fingers according to the specific instructions provided for each experimental conditions. The moment at which the sphere touched the floor of the container was detected by a load cell**.** The monetary incentives associated to the three experimental conditions were the following: Condition 1 (A): each subject (Yellow and Green) get € 0.50 at any trial. Condition 2: the Yellow (Green) subject is coupled with the Yellow (Green) container; the pushing subject gets € 1 while the pulling one gets zero. Condition 3: the container are reversed; the pushing subject gets zero and the pulling one gets € 1. Ten trial for each condition. Each subject received € 5x3 = € 15.

Electromyographic potentials (EMG) were recorded from right *first dorsal interosseus* (FDI) muscle by using Ag-AgCl surface electrodes (diameter 6 mm) glued to the subjects' skin according to a tendon-belly configuration. After online rectification and integration (time constant 0.05 s) EMG signal was continuously recorded during the experiment and fed to a personal computer for the successive analysis. The acquisition software sampled the EMG signal recorded from the two subjects at 25 Hz. The instant at which the ball touched the bottom of the target container was detected by means of a load cell supporting the container itself. The load cell signal, appropriately amplified, was continuously acquired during the experiment by the same acquisition software used for EMG recordings (at the same sampling frequency).

DATA ANALYSIS AND RESULTS

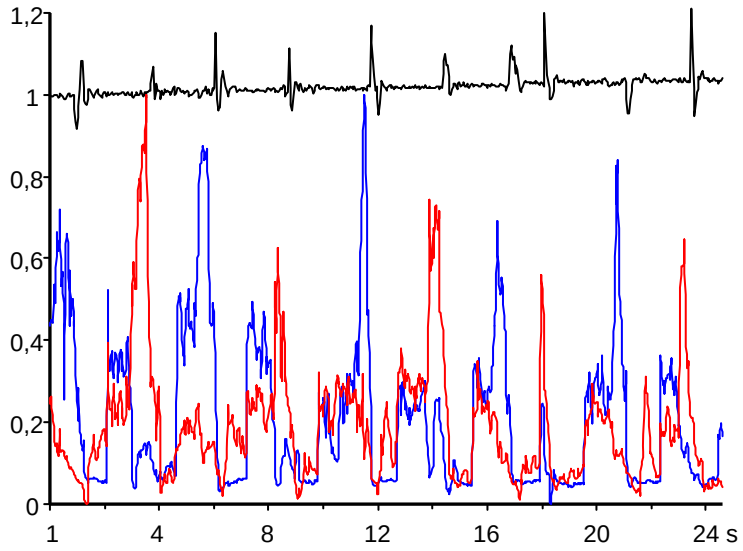
As Table 1 shows, subjects were able to coordinate almost perfectly in all three experimental conditions, with only a negligible proportion of inefficient outcomes (2.7% of total observations), uniformly distributed across conditions.

Condition	*Green wins*	*Yellow wins*	*Inefficient outcomes*	*Total (12 pairs x 10 trials)*
1	58	58	4	120
2	59	58	3	120
3	59	58	3	120
Total	176	174	10	360

Table 1. Outcomes of the game for each condition

Figure 2 depicts the typical EMG traces recorded from both subjects' FDI muscles (blue and red traces) and the signal recorded from the load cell, detecting the instant at which the sphere, after its releasing, touches the floor of the container (black trace), during condition 1 (A) and 3 (B).

(A)



(B)

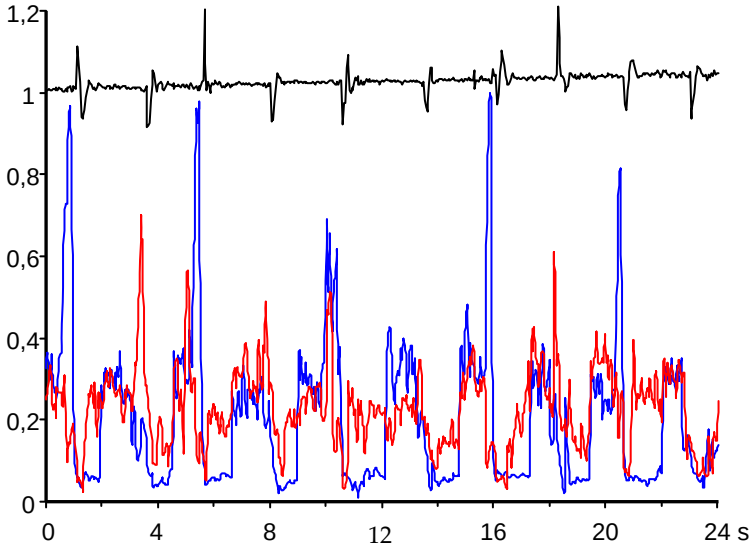


Figure 2. Typical *first dorsal interosseus* electromyography rectified, integrated (time constant, 0.05 s) and intra-subject normalized (z-scores), as recorded from two subjects (red and blue traces) during the interaction game. Panel A, Condition 1; panel B, Condition 3. The signal recorded from the load cell is shown in black and indicates the ten times the glass sphere fell into the container, signaling the end of each trial. The figure depicts ten subsequent trials (sampling frequency, 25 Hz). Abscissas, seconds; ordinates, arbitrary normalization units (see text).

As it appears from Figure 2, at the beginning of each trial there is an increase of both subjects' EMG determined by the involvement of subjects' index fingers in maintaining the glass sphere in the starting position. After the go-signal (not indicated in the figure), one of the two subjects starts to exert a phasic effort to push the sphere into the assigned container, as revealed by a clear peak, slightly anticipating the load cell signal. While in panel A the blue and the red peaks clearly alternate, in panel B the trend is less clear, showing some degree of superimposition of the two traces during some of the trials. Note that in both conditions the instructions were exactly the same: "Place the sphere into the target container". The only difference between the two conditions concerned the monetary reward. In Condition 1, each member of the pair was winning at any trial, while in Condition 3, each member of the pair was winning only when the target container was the one at her right side, requiring the pulling of the sphere towards the container requiring an index finger adduction (FDI muscle not involved).

This qualitative difference between conditions is quantitatively shown in Figure 3, depicting the average values of FDI muscle EMG, recorded from each subject while pushing the sphere into the target container placed at her left side in the three experimental conditions. EMG data, after normalization, were averaged subject by subject (n=24) by pooling the last 12 trials before the signal recorded from the load cell.

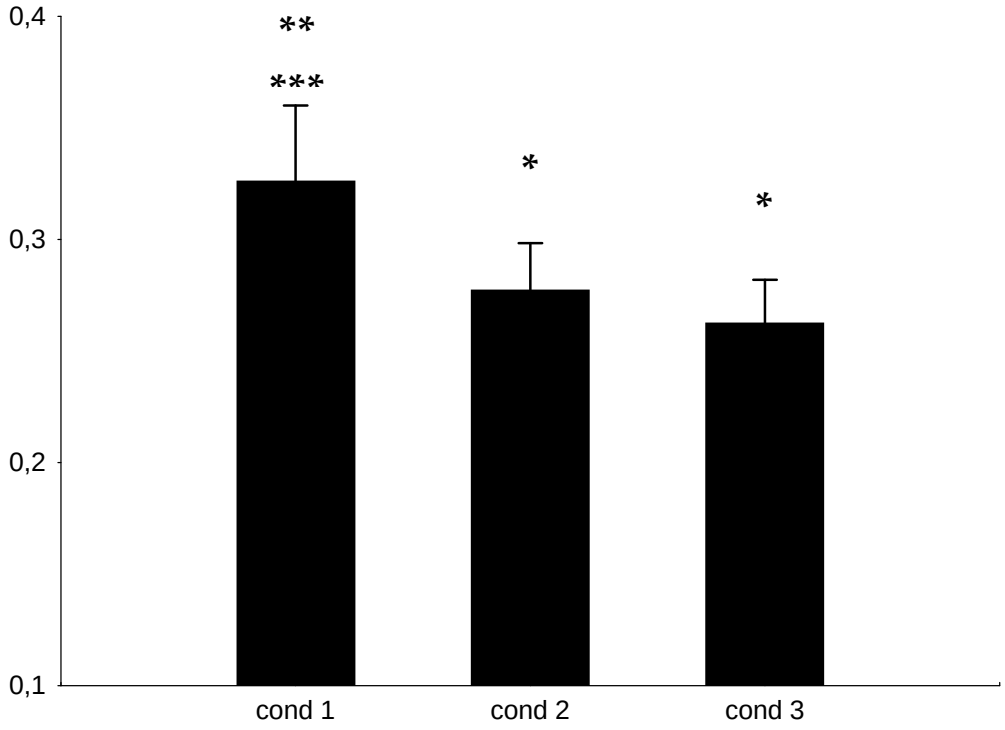


Figure 4. Mean values of EMG signals recorded from the FDI muscle for all subjects in the three experimental conditions, when pushing the sphere into the target container placed at her left side. Whiskers above each histogram depict the standard error of mean. Ordinates: *z*-score of EMG signals. Asterisks indicate the presence of a significant difference between conditions (*, difference from Condition 1; **,*** difference from Conditions 2 and 3, respectively).

An Analysis of Variance (ANOVA) was performed on the data with Experimental Condition as three levels within-subjects factor. Results showed that the factor Experimental Condition was statistically significant ($F(2,46)=4.48$, $p<0.017$). Post-hoc analysis (Newman-Keuls) revealed that Condition 1 was significantly ($p<0.05$) different from Conditions 2 and 3. This result means that the muscle activity is stronger in Condition 1 than in Conditions 2 and 3. However, as indicated in Table 1, the game outcome does not reflect this difference, and subjects, interviewed at the end of the experiment, never reported the voluntary use of different strategies in the different conditions.

Questionnaire

One of the aims of the present work was to verify if the degree of prosocial propensity modulates muscle involvement of the pushing subjects, in response to different monetary incentives among conditions. Using the questionnaire's answers, we built up three indicators (*SC1*, *SC2*, *SC3*) to sort subjects according to their attitude to coordinate and cooperate for mutual benefit (see Appendix

for details). For each of these indicators subjects have been divided into two subgroups with respect to the index-related median score, defining the high- (*H*=above median) and the lowprosocial (*L*=below median) group of subjects.

Regression Behavioural Model.

To process the information gathered through the questionnaire and to control for the robustness of the results obtained with the ANOVA, we developed a regression behavioral model**.** Our data set is distributed along four relevant dimensions: time, trials, subjects and conditions. The potential information of this stock of data is not fully exploited by standard analysis of variance, since ANOVA does not control for many potential sources of variability, such as the muscle effort exerted by subject's couplemate, or individual fixed effects. Therefore, we considered the following dynamic multiple regression model

$$EMG_{it} = \alpha_0 + \alpha_1 EMG_{it-n} + \alpha_2 EMG_{jt-n} + \beta_2 C_2 + \beta_3 C_3 + \gamma_{it} X_{it} + \eta_i + \varepsilon_{it}, \qquad (1)$$

The dependent variable EMG_{it} is subject *i*'s EMG signal at time *t*, when involved in pushing the sphere towards the target container. The righthand side of the equation models the set of explanatory variables. Specifically, EMG_{it-n} is the lagged EMG of subject *i* and EMG_{jt-n} is the lagged EMG of subject *j* (couplemate of subject *i*). To perform successfully the task it is required a continuous exchange of information between subjects, by the pressure exerted by their index fingers. The EMG_{it-n} variables reflect the intention of subject *i* to push the sphere into the target container. At the same time, since the task requires the collaboration of subject *j*, the lagged EMG_{jt-n} take into account that subject *i*'s effort depends on the opposition force exerted by subject's *j* finger. Thus, the dynamic part of the regression model represents the motor communication between subjects *i* and *j*. Other factors that might have influenced the motor behavior of subjects could have been determined by strain or stress and learning-by-doing. To account for these factors, we introduced in vector X_{it} the time length of trials and the sequence order of trials over the entire experiment. The reason of our choice is that lengthy trials may have been more expensive in terms of attention, thus affecting the effort spent by subjects. Furthermore, subjects' effort might have been differently modulated over the course of the experiment, due to a better knowledge of her couplemate and/or to the improvement in their motor ability. Several non

observable characters of subjects (such that religion, education, family conditions etc..) may influence the dependent variable. The term η_i represents a vector of individual dummies, that control the regression model for this individuals' heterogeneity. Finally, C_2 and C_3 are two dummies for condition 2 and 3 respectively, controlling for experimental conditions instructions.

The time horizon of the regression considered 12 observations before the maximum EMG level, included. Lags in regressors EMG_{it-n} and EMG_{jt-n} have been set at 2 and 5 time periods (n=2, 5). This accounts for a period of time ranging from 80 ms (2 * 40 ms, being the sampling frequency 25 Hz) to 200 ms (5 * 40 ms). This choice was based on the observation that when a perturbation is applied during a precision grip a latency of 60-80 ms is required to increase the grip force to restore an adequate safety margin, preventing frictional slips (Eliasson et al., 1995). Thus, we defined this time range in order to include the minimal reaction time to a change in the load force applied by subject *j*, plus a possible delay determined by the fact that the grasping requires a coordination between two subjects and not only between two fingers of the same hand.

Regression Results.

The relevant estimation results are presented in table (2) below. The first column (POOL) reports the estimation results for the entire set of subjects (24). The other six columns provide results relative to each high/low prosocial sub-groups according to indicators SC1, SC2 and SC3. In particular, HSC_z and LSC_z (z=1, 2, 3) refer to High and Low prosocial individuals, respectively.

	POOL	HSC_1	LSC_1	HSC_2	LSC_2	HSC_3	LSC_3
EMG_{it-5}	0.1121	0.1439	0.0838	0.1840	0.0567	0.1560	0.0924
	(4.59)***	(4.22)***	(2.32)**	(5.78)***	(1.56)	(4.72)***	(2.46)**
EMG_{it-2}	0.2898	0.2918	0.2634	0.2634	0.2724	0.2294	0.3233
	(12.69)***	(8.49)***	(8.78)***	(7.67)***	(8.76)***	(6.73)***	(10.54)***
EMG_{jt-5}	0.0898	0.0405	0.1421	0.0473	0.1552	0.0615	0.1196
	(3.82)***	(1.38)	(3.79)***	(1.64)	(4.06)***	(2.11)**	(3.07)***
EMG_{jt-2}	0.0330	0.1153	-0.0451	0.0748	-0.0073	0.0474	0.0281
	(1.41)	(3.61)***	(1.38)	(2.46)**	(0.21)	(1.61)	(0.75)
C_2	-0.0041	-0.0095	0.0003	-0.0098	0.0040	-0.0079	0.0015

	(0.40)	(0.70)	(0.02)	(0.72)	(0.27)	(0.59)	(0.10)
C_3	-0.0244	0.0156	-0.0630	0.0105	-0.0535	-0.0093	-0.0389
	(2.44)**	(1.10)	(4.49)***	(0.73)	(3.82)***	(0.67)	(2.72)***
Constant	0.1044	0.0867	0.1322	0.1319	0.1092	0.1748	0.0632
	(4.46)***	(2.66)***	(0.3.89)***	(3.71)***	(2.80)***	(4.56)***	(2.05)**
Observations	1755	855	870	885	870	880	875
R-squared	0.3955	0.4774	0.3455	0.4276	0.4121	0.4472	0.3665

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2: Ordinary Least Square Regressions keeping 12 observations before the maximum EMG level, included. Normalization over the entire data set.

Overall, coefficients of lagged variables are positive and significant, suggesting that each couple of subjects successfully tried to coordinate their index fingers as a pair of agonists. However, looking at the magnitude of coefficients for different groups of subjects substantial differences emerge between high-prosocial and low-prosocial individuals. In particular, the following results appear

R1) $\alpha_{1,-2}^{H,L} > \alpha_{1,-5}^{H,L}$

R2) $\alpha_{1,-2}^{H} \approx \alpha_{1,-2}^{L}$, $\alpha_{1,-5}^{H} > \alpha_{1,-5}^{L}$

R3) $\alpha_{2,-2}^{H} > \alpha_{2,-5}^{H}$, $\alpha_{2,-2}^{L} < \alpha_{2,-5}^{L}$ ($\alpha_{2,-2}^{H} > \alpha_{2,-2}^{L}$, $\alpha_{2,-5}^{H} < \alpha_{2,-5}^{L}$)

where $\alpha_{1,-n}^{H,L}$ and $\alpha_{2,-n}^{H,L}$ (n=2, 5) refer to coefficients of regressors EMG_{it-n} and EMG_{jt-n} respectively, while H and L apexes stay for high-prosocial and low-prosocial subjects.

For both H and L the autoregressive component of the regression model (the lagged EMG_{it-n} variables) shows that the current effort EMG_{it} of subject i is positively linked to her own past efforts, and that the magnitude of the coefficients decreases the farther-off are the lags (result R1). This is consistent with figure (3), which shows that intensity of muscles effort progressively increases, and reaches its peak at the instant at which the sphere is dropped. However, result R2 reveals that the EMG recording of H subjects display a smoother time profile than that of L's.

Result R3 describes how the current reaction of subject i depends on past motor behavior of subject j. Overall, estimated coefficients are significantly non negative. However, looking at the

size of coefficients it emerges a striking difference between *H* and *L* individuals. Current muscle effort of high-prosocial subjects is influenced mainly by the more recent behavior of their couplemates, while muscle effort of low-prosocial subjects depends only on their own behavior. Considering high-prosocial subjects, the estimated coefficients on EMG_{jt-5} are not significantly different from zero in two of the three regressions (HSC_1 and HSC_2) and significant at the 5% level but close to zero in the HSC_3 case. On the contrary, coefficients on EMG_{jt-2} are positive and significant in HSC_1 and HSC_2 and not significant in HSC_3. Exactly the reverse pattern occurs with low-prosocial subjects: coefficients on EMG_{jt-5} are significant at a 1% level, while those on EMG_{jt-2} are not significant in all cases (LSC_1, LSC_2 and LSC_3).

To suggest an interpretation for this result, one may consider as a benchmark case of perfect coordination two fingers of a single hand grasping an object to the purpose of dropping it somewhere. In this case the applied grip force is synchronically balanced to optimize the motor behavior, and therefore the pressure exerted by finger *i* is instantaneously matched with the pressure of finger *j*. In statistical terms, perfect synchronicity would be revealed by a lack of significant correlation between current effort of finger *i* and past efforts of finger *j*. In light of these considerations, the estimated coefficients on EMG_{jt-n}'s shows that on average high-prosocial subjects have been able to coordinate more efficiently with their couplemates than low-prosocial subjects.

Finally, the estimated coefficients on dummies C_2 and C_3 confirm the main results obtained with the ANOVA procedure, indicating that on average subjects exerted a lower pushing effort in condition 3 than in condition 1. Only the estimated coefficient of C_3 is negative (-0.0244) and 5% significant (t=2.44). However, once we distinguish between high-prosocial and low-prosocial subjects, the estimated coefficients of C_3 is negative and significant at a 1% level in the low-prosocial subsample, only. This pattern arises whatever index of social capital is used.

DISCUSSION

A conspicuous body of experimental economics literature has shown that the allocation of legitimate property rights significantly affect the strategic behavior of individuals (Hoffman and Spitzer, 1985; Hoffman et al, 1994, 1996; Ruffle, 1998; Cherry, 2001; Cherry et al, 2002; Oxoby and Spraggon, 2008). Indeed, individuals often interact, by simply committing themselves to a set of

shared social norms, basically concerned with a broad view of property rights, that include not only specific entitlements on things but also on actions[3]. In this respect, property rights provide an efficient device to prompt cooperation among individuals, avoiding costly mind-reading activity. In the light of these considerations, we set up an experimental framework, aimed at investigating the effects of formal property rights, not supported by the legitimation of a specific task, when interaction is removed from any complex perspective-taking activity. Specifically, we performed an experiment with pairs of subjects, prevented from any visual or verbal exchange, engaged in a pure motor coordination game divided in three conditions, perfectly identical both from the point of view of the motor task and from that of the monetary stake. Each couple of subjects was asked to hold a small sphere between their right index fingers and to alternately drop it into one of two containers placed below their hands, while electromyography of participants' right FDI muscle was recorded. This muscle has the function to abduct the index finger, that is to draw the index finger away from the middle finger. Thus, it is the muscle more involved in pushing the sphere towards the leftmost container, while it remains relaxed when the participant is asked to place the sphere into the rightmost container by exerting a finger adduction. Our aim was to compare FDI muscle activity when participants were asked to push the sphere into the leftmost container under different rewarding schemes. In Condition 1 the completion of each trial entailed an equal prize assigned to both subjects, in Condition 2 only the subject who had pushed the sphere towards the leftmost container obtained the prize. Therefore, FDI muscle involvement in pushing the sphere was coupled with a monetary reward. Thus, in conditions 1 and 2 the rules of the game formally entitled pushing subjects to get a reward at every trial. In condition 3 the reward was given entirely to the pulling subject. Thus, FDI muscle involvement in pushing the sphere was not coupled with any monetary reward.

Subjects were able to coordinate almost perfectly across conditions 1, 2 and 3 (see Table 1). Thus, from a distributional point of view it does not emerge any difference in behavior associated with the different incentive protocols. However, substantial differences arose from EMG data processing, revealing not only that muscle involvement in executing the same motor act is affected by the allocation of formal property rights, but also that the modulation of the effort is correlated with the degree of prosocial propensity of subjects. To measure the social attitude of participants we used the answers to the questionnaire taken from Putnam's *Social Capital Benchmark Survey* to

[3] In this latter sense a property right defines a specific social role.

construct three indexes of *social capital*, that we used to split the sample of subjects into high-prosocial and low-prosocial individuals. With respect to these two groups of individuals our main result was that high-prosocial subjects performed the task without any significant difference among conditions, while low-prosocial subjects exerted a significant lower effort in Condition 3 than in Condition 1.

When a small object is gripped between the tips of the index finger and thumb and held stationary in space, the applied grip force is synchronically balanced to optimize the motor behavior. In addition, the control of the grip force is automatically influenced by the weight of the object (load force) and by a safety margin factor related to the individual subject (Westling et al. 1984, Edin et al., 1995). This is fundamental to avoid the accidental drop of the object. If we consider that the two index fingers of a pair of subjects act on the sphere as a pair of agonists, we can assume that the major effort exerted by low-prosocial individuals reflects a higher level of the safety margin factor. Our results suggest that the reallocation of property right from the 'pushing' to the 'pulling' subject modulated the safety margin factor in low-prosocial individuals, only. A likely interpretation of this effect is that low-prosocials differently evaluated the successful outcome of the pushing action in response to the reallocation of property right to the pulling subject. On the contrary, since the safety margin set by high prosocials did not change across conditions, we argue that their motor behavior did not react to changes in the distribution of property rights.

We believe that these results find place within the debate concerning the *endowment effect*. The endowment effect describes the tendency of individuals to value a good they possess more highly that the same good they do not possess. In other words the mere ownership of something causes to increase the subjective value attributed to it. A huge amount of evidence supports the relevance of this effect in actual behavior (Tversky and Kahnemann; 1981, Kahneman *et al*., 1990, 1991; Thaler; 1992, Plott and Zeile, 2003) and, recently, this phenomenon has been reported even in animals such as chimpanzees (Brosnan et al. 2007). The presence of the endowment effect has questioned the traditional assumption of rationality at the basis of behavioral models in economics and law. More specifically, if the influence of a subjective sense of ownership induces people to evaluate goods and rights irrationally, then the standard prediction of the Coase Theorem fails. This theorem claims that if transaction costs are sufficiently low, private bargaining will lead to an efficient outcome regardless of the initial allocation of property rights. The importance of this theorem is not related to market activity only, but it applies to any conflict may arise in social interaction.

Although the endowment effect is considered one of the most robust phenomenon in the emerging field of behavioral economics, it is recognized to be quit changeable, appearing and disappearing with different degrees of intensity depending on the context (Brown and Gregory; 1999, Sayman and Öncüler; 2005). Thus, as pointed out by Jones and Brosnan (2008), to investigate deeply the nature of this phenomenon, a primary goal in the research agenda should be the identification of those factors that may help to predict its appearance. We think that the evidence reported in our paper provides insight in this direction. In particular, our results suggest that the prosocial attitude might be one factor influencing the emerging of the endowment effect.

The behavior of high-prosocial individuals, revealing that the allocation of property rights doesn't modulate their muscle activity, seems to agree with the rationality principle assumed by the Coase Theorem. On the other side, the result showing that low-prosocial individuals exert different muscle effort according to the ownership of the reward, can be considered a further evidence of the endowment effect.

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APPENDIX: THE QUESTIONNAIRE AND THE SOCIAL CAPITAL INDEXES

The subjects where asked to answer a questionnaire, described in detail below, designed following very closely Putnam's Social Capital Benchmark Survey (Bobo et. al., 2001). An increasing number of applications, from sociology to health economics, political science, business management, human resources and politics have used the concept of Social Capital, depending on circumstances, as synonym of rather diverse concepts, such as "generalized trust", "civic engagement", "religious belief" or "group interaction". Using the questionnaire's answers we build up indicators of these characteristics to sort our subjects according to their attitude to coordinate and cooperate for mutual benefit.

Following Bobo et al. (2001) we build up six indexes. Civic participation (cp) is constructed (see index CIVPART in Bobo et al. (2001)) as the average of three different questions, meant to measure individual involvement in civic and political activity, such as working for a political party in the past year (q1.2), attending political meetings in the past year (q1.5) and signing petitions in the past year (q1.7):

$$cp=(q1.2+q1.5+q1.7)/3.$$

We also build an alternative index cpext, by adding subject's answer to a specific question, namely q5.4 which asked how important was politics in their personal life (answer ranked from 4="very important" to 1="not important at all":

$$cpext=(q1.2+q1.5+q1.7+(q5.4-1)/3)/4.$$

Faith-based Social Capital (fbsc) is an indicator (see index FAITHBAS in Bobo et al. (2001)) constructed as the average of two questions, designed to measure participation in the life of the local religious community such as going to church in the past week (q2.8), or going to church social function in the past month (q3.6)

$$fbsc=(q2.8+q3.6)/2.$$

By analogy with cpext, we also consider the following:

$$fbscext=(q2.8+q3.6+(q5.6-1)/3)/3.$$

Organized Group Interactions (ogi) is built (see index ORGINTER in Bobo et al. (2001)) as the average of six questions, designed to measure participation in the life of the local community such as serving as an officer of some club organization in the past year (q1.1), or in a committee for some local organization in the past year (q1.2), attending a public meeting of club or civic organization in the past month (q3.7):

$$ogi = (q1.1+q1.3+q1.4+q3.7)/4.$$

Informal Group interaction (igi) is an indicator (see index SCHMOOZ in Bobo et al. (2001)) constructed as the average of six questions, designed to measure participation in the informal social network such as having friends in for the evening in the past week (q2.3); going to the home of friends in the past week (q2.4); going to club, disco, bar or place of entertainment in the past week q2.11); going to friends' house for dinner or evening in the past month (q3.4); having friends in for dinner or evening in the past month (q3.5); going to night club, disco, bar in the past month (q3.9):

$$isi=(q2.3+q2.4+q2.11+q3.4+q3.5+q3.9)/6$$

Bobo et al. (2001) also considers five additional indexes, based on social trust (STRSTCAT), group involvement without church participation (GRPINCAT), group involvement with church participation(GRP2CAT), diversity of friendship network (DIVRCAT), and composite racial group trust (RACETCAT). Due to a almost null variability in the subjects' answers (probably due to a higher homogeneity of our subject pool with respect to the relevant dimensions) we could not make any use of these additional indexes.

Finally, since we need to rank our subject pool with respect to a composite scale that would comprise all the relevant characteristics revealing attitude to coordinate and cooperate, we construct three composite measures using the indexes above outlined:

$$C1=(cpext+fbscext+ogi+isi)/4$$
$$C2=(cpext+fbscext+ogi)/3$$
$$C3=(cp+fbsc+ogi)/3.$$

THE QUESTIONNAIRE

In what follows we report the text (translated into English) of the questionnaire.

Please answer to the following questions

1. Which, if any, of these things have you done in the past year?
    - 1.1 Served as an officer of some club or organization
    - 1.2 Worked for a political party
    - 1.3 Served on a committee for some local organization
    - 1.4 Attended a public meeting on town or school affairs
    - 1.5 Attended a political rally or speech
    - 1.6 Made a speech
    - 1.7 Signed a petition
    - 1.8 Wrote a letter to the paper
    - 1.9 Wrote an article for a magazine or newspaper

2. Which, if any, of these things have you done in the past week?

    - 2.1. Discussed politics
    - 2.2. Had dinner in a restaurant
    - 2.3 Had friends in for the evening
    - 2.4 Went to the home of friends
    - 2.5 Saw a movie
    - 2.6 Made a personal long distance call
    - 2.7 Read a book
    - 2.8 Went to church
    - 2.9 Watched a sports event on TV
    - 2.10 Went out to watch a sports event
    - 2.11 Went to club, disco, bar or place of entertainment
    - 2.12 Spent time on a hobby
    - 2.13 Wrote a personal letter or e-mail
    - 2.14 Received a personal letter or e-mail

3. How many times, if any, did you do any of these activities in the past month?
    - 3.1 Made a contribution to charity
    - 3.2 Did volunteer work
    - 3.3 Donated blood
    - 3.4 Went to friends' house for dinner or evening
    - 3.5 Had friends in for dinner or evening

- 3.6 Went to church social function
- 3.7 Went to meeting of club or civic organization
- 3.8 Went to dinner at restaurant
- 3.9 Went to night club, disco, bar
- 3.10 Went to live theater, opera, concerts
- 3.11 Went to sporting event
- 3.12 Went to the movies

4. Which of the following things are part of "the good life" in your opinion?
    - 4.1 A home you own
    - 4.2 A yard and lawn
    - 4.3 A second car
    - 4.4 A vacation home
    - 4.5 A swimming pool
    - 4.6 A happy marriage
    - 4.7 No children
    - 4.8 One or two children
    - 4.9 A job that pays more than average
    - 4.10 A job that is interesting
    - 4.11 A job that contributes to the welfare of society
    - 4.12 College education for my children
    - 4.13 Travel abroad
    - 4.14 A second color TV set
    - 4.15 Really nice clothes
    - 4.16 A lot of money

5) For each of the following, indicate how important it is in your life. Would you say it is:

1. Very important
2. Rather important
3. Not very important
4. Not at all important
5. I don't know

- 5.1 A home you own Family
- 5.2 A yard and lawn Friends
- 5.3 A second car Leisure time
- 5.4 Politics
- 5.5 Work
- 5.6 Religion
- 5.7 Service to others

6) Taking all things together, would you say you are:

4. Very happy

3. Quite happy
2. Not very happy
1. Not at all happy
0. Don't know

7) With which of these two statements do you tend to agree? (CODE ONE ANSWER ONLY)
A. Regardless of what the qualities and faults of one's parents are, one must always love and respect them
B. One does not have the duty to respect and love parents who have not earned it by their behavior and attitudes
7.1 Tend to agree with statement A
7.2 Tend to agree with statement B
7.3 Don't know

8) Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?
8.1 Most people can be trusted
8.2 Need to be very careful
8.3 Don't know

9) Do you think most people would try to take advantage of you if they got a chance, or would they try to be fair?
9.1 Would take advantage
9.2 Would try to be fair
9.3 Don’t know