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ABSTRACT

Higher Intelligence Groups Have Higher Cooperation Rates in the Repeated Prisoner's Dilemma*

Intelligence affects social outcomes of groups. A systematic study of the link is provided in an experiment where two groups of subjects with different levels of intelligence, but otherwise similar, play a repeated prisoner's dilemma. The initial cooperation rates are similar, it increases in the groups with higher intelligence to reach almost full cooperation, while declining in the groups with lower intelligence. The difference is produced by the cumulation of small but persistent differences in the response to past cooperation of the partner. In higher intelligence subjects, cooperation after the initial stages is immediate and becomes the default mode, defection instead requires more time. For lower intelligence groups this difference is absent. Cooperation of higher intelligence subjects is payoff sensitive, thus not automatic: in a treatment with lower continuation probability there is no difference between different intelligence groups.

JEL Classification: C73, C92

Keywords: repeated prisoner dilemma, cooperation, intelligence

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1 Introduction

Intelligence is a controversial concept. We use here the widely accepted definition proposed in the 1996 report by a Task Force created by the Board of Scientific Affairs of the American Psychological Association (Neisser et al., 1996). There, intelligence is defined as "the ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought". If this definition is adopted, the relation between intelligence and outcomes for a single individual is natural and clear. Higher intelligence functions, everything else being equal, as a technological factor; allow larger, faster and better levels of production. This prediction is natural and is also supported by extensive research in psychology and economics (Neal and Johnson, 1996; Gottfredson, 1997; Bowles and Gintis, 2001; Heckman, Stixrud and Urzua, 2006; Jones and Schneider, 2010).

The relation between intelligence and outcomes is less clear when one considers instead the link between intelligence and social behavior, and wants to explain how outcomes of groups are influenced. The technological factor becomes less important, since social outcomes depend less on skill compared to behavior of others. A conceptual link is missing.

A possible conceptual link between intelligence and behavior in social situations can be given as a corollary to the general view that intelligence reduces behavioral biases (e.g. Frederick, 2005; Oechssler, Roider and Schmitz, 2009; Dohmen et al., 2010; Beauchamp, Cesarini and Johanneson, 2011; Benjamin, Brown and Shapiro, 2013). For example, higher intelligence may reduce violations of transitivity; or, in choice under uncertainty, the behavior of subjects with higher intelligence is better described by expected subjective utility. When we apply this intuition to behavior in strategic environments, we are lead to the conjecture that individuals in real life, and subjects in an experiment, who have higher intelligence will exhibit a behavior closer to the game theoretic predictions. When refinements of the Nash concept are relevant, particularly sub-game perfection, behavior more in line with the prediction of the refinement for the individual is expected in higher intelligence subjects.

This prediction finds some support when games are strictly competitive (as the Hit 15 game in Burks et al., 2009); recently a related result has been shown by Gill and Prowse (2014) in a repeated beauty contest experiment where more intelligent individuals converge faster to the unique Nash equilibrium. While these contributions provide important insights in the way cognition affect game playing, some important puzzles remain. First, in games that are perhaps more relevant for social behavior, this prediction fails. This occurs already in the case of one shot games. In Burks et al. (2009) the authors also study behavior of subjects in a sequential trust game. Using strategy method to identify choices as first and second mover, and relating this behavior to intelligence of subjects, the authors find that initial transfer is increasing with the IQ score; a behavior which is further from the prediction of the subgame perfect equilibrium, and so is the opposite of what we should expect according to the general hypothesis. Similarly, transfers as second movers in higher intelligence subjects are higher when the first mover transferred more, and smaller in the opposite case. Since equilibrium behavior predicts that no transfers should occur in either case, we see that the observed behavior is inconsistent with the prediction. Secondly, repeated games involving one to one interactions generally present a multiplicity of equilibria; games with a unique Nash equilibrium cannot address the crucial issue for social sciences of how individuals coordinate to one among many possible equilibria.

Some insight into a possible association between intelligence and strategic cooperative behavior come from related research in biological and social sciences. The social intelligence hypothesis (Chance and Mead, 1953; Jolly, 1966; Humphrey, 1976) tries to provide an explanation for the differences in intellectual abilities of animals. The proponents of the theory observe that, the evolution of primate intelligence cannot be adequately explained on the basis of different need to observe, gather and process information in the process of finding food, extracting it, or avoiding predators. Instead, it is the richness of the social interaction that demands the development of the ability to use flexible cognitive strategies to be used in real time, as opposed to adaptive rules of thumb. Later research has provided some support for the general hypothesis: for example, Dunbar (1998) and Dunbar and Shultz (2007) have found a positive correlation between brain size and the size of the network of relations and alliances that an animal species develops.

There is also some early analysis of experimental work that provides support for the hypothesis we test here. Jones (2008) studies the cooperation rates in experiments on repeated prisoner's dilemma conducted at different universities and the average SAT score at the university at the time in which the experiment was run. He finds that the cooperation rate increases by 5% to 8 % for every 100 points in the SAT score. Of course, the evidence is very indirect: students at those universities were differing on a large variety of characteristics, and each of them could have been taken as the variable of interest in the correlation. But such evidence is broadly consistent with the findings we are going to present.

In our experiment we test directly the potential association between intelligence and strategic behavior in groups. The strategic interaction takes place between two players, but in a pool of people that are relatively homogeneous in their intelligence level. We rely on well-established methodology in experimental analysis of repeated games, in particular we use the same setting as in Dal Bò and Fréchette (2011) (henceforth DBF), where they show how by changing the probability of continuation and the payoffs matrix in a repeated prisoner dilemma game with random probability of termination, subjects may collectively converge to cooperation equilbria; DBF show that in some instances different groups converge to different equilibria for the same set of parameters.

Accordingly, the hypothesis we test is that higher intelligence in a complex environment (such as repeated social interaction) favors a more flexible, effective behavior; allowing processing of richer information, so higher intelligence allows to reach more efficient equilibria.

We found that Subjects in both high Raven and low Raven sessions show a similar rate of cooperation in the initial rounds, cooperation rate then increases the high Raven sessions to reach an equilibrium where almost everybody cooperates, while it declines in the low Raven session. Subjects in the high Raven sessions increase their level of reciprocation over time, while there is no significant increase in the degree of reciprocation in the low Raven sessions. Intelligence is the only significant determinant of cooperation in the first round choices, other characteristics like personality traits do not seem to play a systematic role.

Furthermore, we used a structural model to estimate the probability of adopting different strategies in the different periods and we found that in the high Raven sessions subjects converge to a probability of two third to play a cooperative strategy and zero to play Always Defect. In the low Raven sessions, subjects converge to a probability of playing Always Defect above fifty percent of the times. Consistently with the other results, the probabilities of playing cooperative and non cooperative strategies at the beginning are roughly similar among subjects in the different Raven sessions. We also show that Cooperation of higher intelligence subjects is payoff sensitive, thus not automatic: in a treatment with lower continuation probability there is no difference between different intelligence groups. Finally, we observe that in higher intelligence subjects, cooperation after the initial stages becomes almost immediate– i.e. the default mode; defection instead requires significantly more time. For lower intelligence groups this difference is absent.

Our findings have potentially important implications for policy. While the complex effects of early childhood intervention on the development of intelligence are still currently being evaluated (e.g. Heckman, 2006; Brinch and Galloway, 2012 ; Heckman et al., 2013), our results suggest that any such effect would have beneficial consequences not just on the personal economic success of the individual, but on the level of cooperation in the society; this is a positive consequence that seems to have been overlooked so far. Furthermore, considering the assortative matching between individuals (Becker, 1973; Legros and Newman, 2002) or the tendency to homophily (McPherson, Smith-Lovin and Cook, 2001; Golub and Jackson, 2011) through which people may associate with those who are similar to themselves, the different degree of cooperation between groups and the resulting different profits achieved may result in a powerful mechanism to magnify inequalities.

To the best of our knowledge we are the first to analyze the effect of the group intelligence on the level of cooperation in a setting with repeated interactions. There is a large experimental literature on the analysis of cooperation with repeated interaction. Cooperation has been shown to be sustainable in experiments with random termination (e.g. Roth and Murnighan, 1978; A. Holt 1985; Feinberg and Husted 1993; Palfrey and Rosenthal, 1994) and also in experiments with fixed termination (e.g. Selten and Stoeker, 1986; Andreoni and Miller, 1993). In experiments with fixed termination, however, the level of cooperation is substantially lower (e.g. Dal Bò, 2005). Other elements can affect cooperation in a repeated interaction, Aoyagi and Fréchette (2009) show that the level of cooperation increases with the quality of the signal if public monitoring is allowed. Duffy and Ochs (2009) find that cooperation increases as subjects gain more experience under fixed matching but not under random matching; DBF show that individuals learn to cooperate after a sufficiently large number of interactions, but only when the benefits of cooperation in the stage game are big enough. Blonski, Ockenfels, and Spagnolo (2011) emphasise the effect of the discount factor. All these contributions suggest that the strategies leading to cooperation or defection, in a repeated interaction setting, are extremely complex because they are sensitive to very large number of factors.

Furthermore, strategies leading to cooperation are unlikely to be based on a fixed rule, on the contrary they need to be flexible in the sense of adapting to the circumstances. In this respect Fudenberg, Rand, and Dreber (2012) show that individuals adapt to mistakes when they play their strategy in order to increase the possibility of coordinating on the most profitable cooperative equilibria; while Friedman and Oprea (2012) show that when agents are able to adjust in continuous time, cooperation rates are higher. A continuous time adjustment allows subjects to work on a more flexible environment, where they can quickly adjust in order to cooperate.

All the above mentioned contributions point out that flexibility and capacity of adapting to a complex environment are the key factors in allowing partners to cooperate within each other. These characteristics are linked to the definition of intelligence we gave at the beginning.

The literature has emphasised how subjects' heterogeneity in terms of different degrees of sophistication determines whether the strategies adopted are more or less rational (e.g. Stahl and Wilson, 1995; Costa-Gomes et al., 2001; Costa-Gomes and Crawford, 2006). Our findings are consistent with this literature, but also go a step further by showing that intelligence plays a role in the selection of different Nash Equilibria. Other interesting insights in order to understand our results might come from the so-called "two-systems" theories of behavior emphasising the tension beteween a long-run, patient self and a short-run, impulsive self (e.g. Bernheim and Rangel, 2004; Loewenstein and O'Donoghue, 2005; Fudenberg and Levine, 2006; Brocas and Carrillo, 2008). If in higher IQ individuals the patient self is stronger as Burks et al. (2009) imply, cooperation might be the result of a more forward looking behaviour. This could also explain the reason why high Raven groups fail to cooperate in the treatment with lower continuation probability.

This paper is organized as follows: in section 2 we present the experimental design and its implementation; in section 3 we present the results of the main treatment; section 4 provides an analysis of the determinants of cooperation; in section 5 we estimate the probability of adopting different strategies in the two Raven sessions; in section 6 we present the main results of the treatment with lower continuation probability, hence making cooperation harder; section 7 presents the analysis of the response time of the subjects in both treatments. Section 8 concludes the paper by providing a general discussion. In the appendix we present the timeline of the experiment, the dates and other descriptive statistics. The questionnaire completed at the end by subjects, the experimental instructions, the recruitment letter circulated are available online as supplementary material.[1]

[1]Available from the page http://www2.warwick.ac.uk/fac/soc/economics/staff/eproto/workingpapers/supplementary_material.pdf

2 Experimental Design

We allocated participants into two groups according to their level of fluid intelligence measured by the Raven's test. The two groups created participated in two separate sessions, defined as *high Raven* and *low Raven* sessions. As we will see below in more details, subjects do not generally know the way the two Raven groups are formed.

They played several repetitions of a repeated prisoner's dilemma game, each repeated game with a new partner. The experiment was run over two days at a time distance of one day between the two. In the first day subjects completed the Raven test, in the second day they played the repeated prisoner's dilemma. We run two different treatments: the main treatment, and another treatment where cooperation is harder. In the Appendix, we present dates and other details of each day one and day two session for both treatments.

Day One

The Raven test

On the first day of the experiment participants were asked to complete a Raven Advanced Progressive Matrices (APM) test of 30 tables. They had a maximum of 30 seconds for each table. Before the test, the subjects were shown a table with an example of a matrix with the correct answer provided below for one minute. For each item a 3×3 matrix of images was displayed on the subjects' screen; the image in the bottom right corner was missing. Subjects were then asked to complete the pattern choosing one out of 8 possible choices presented on the screen. The 30 tables were presented in order of progressive difficulty and were selected from Set II of the APM.

The Raven test is a nonverbal test commonly used to measure reasoning ability and general intelligence. Matrices from Set II of the APM is appropriate for adults and adolescents of higher average intelligence. It is able to elicit stable and sizeable differences in performances among this pool of individuals. The correlation between Raven test scores and measures of intellectual achievement suggests that the underlying processes may be general rather than specific to this one test (Carpenter, Just and Shell, 1990). In the economic literature, individual with an higher Raven scores feature a learning process closer to the Bayesian updating (Charness et al., 2011) and have more accurate beliefs (Burks et al., 2009).

Subjects are not normally rewarded for the Raven test, however it has been reported that there is a small increase in Raven scores after a monetary reward among high IQ subjects similar to the subjects in our pool (e.g. Larson, Saccuzzo and Brown, 1994). Since we want to measure intelligence with minimum confound with motivation, we decided to reward our subjects with 1 British pound per correct answer from a random choice of three out of the total of 30 matrices. Always with the aim of minimising confounding with other factors, we never mention that Raven is a test of intelligence or cognitive abilities and, for the main treatment, subjects were never informed that they would have been separated on the basis of their performances on this test. We will argue by analysing the distribution of the subjects' characteristics in the two Raven sessions that confounding is unlikely to be a concern in our experiment and the Raven test allowed to separate the two groups uniquely for subjects' level of cognitive ability.

Other tests and questions

Following the Raven test participants were asked to respond to a Holt-Laury task (Holt and Laury, 2002), measuring risk attitudes. The first two experimental sessions reported here did not include the Holt-Laury task, and the sessions for the second treatment (where cooperation is harder) did not perform this task either. The participants were paid according to a randomly chosen lottery out of their choices.

Lastly on the first day participants were asked to respond to a standard Big Five personality questionnaire together with some demographic questions, subjective well-being question and questions on previous experience with a Raven test. No monetary payment was offered for this section of the session. Subjects were informed of this fact. We used the Big Five Inventory (BFI); the inventory is based on 44 questions with answers coded on a Likert scale. The version we used was developed by John, Donahue and Kentle (1991) and recently investigated by John, Naumann and Soto (2008).

All the instructions given in the first day are included in the online supplementary material.[2]

Day Two

On the second day participants were asked to come back to the lab after they were allocated to two separate experimental sessions according to their Raven score: subjects with score higher than the median were gathered in one session, and the remaining subjects in the other. We will refer to the two sessions as *high Raven* and *low Raven* sessions.[3] The task they were asked to perform was to play an infinitely repeated prisoner's dilemma game. In our main treatment the participants played the game used by DBF, where they found convergence of full cooperation after the game was repeated for a sufficiently number of times, in every repetition of the same experiment (see DBF p. 419, figure 1, bottom right diagram).

Following standard practice in the experimental literature, we induce an infinitely repeated game in the laboratory using a random continuation rule: after each round the computer decided whether to finish the repeated game or have an additional round depending on the realization of a random number. The continuation probability used in the main treatment was $\delta = 0.75$. The stage game used was the prisoner's dilemma game in table 1. We also add a second treatment with a lower continuation probability, $\delta = 0.5$, where cooperation is harder. Both the above treatments are identical to the ones used by DBF. They argue that the payoffs and continuation probability chosen in both treatments (i.e. $\delta = 0.75$ and $\delta = 0.5$) entail an infinitely repeated prisoner's dilemma game where the cooperation equilibrium is both subgame perfect and risk dominant.[4]

[2] see note 1

[3] The attrition rate was small, and is documented in tables A.1 and A.2 in the Appendix

[4] The subgame perfect equilibrium set of subgame perfect equilibria are calculated as in Stahl (1991) and assuming risk neutrality. The risk dominant strategy are calculated using a simplified version of the game assuming only two possible strategies following Blonksi and Spagnolo (2001). See DBF, p. 415 for more details

The payoffs in table 1 are in experimental units, the exchange rate applied to the payoff table was 0.004 british pounds per unit. This exchange rate was calculated in order to equalise the payoff matrix with the monetary units used in the DBF experiment. The participants were paid the full sum of points they earned through all the repetitions of the game. In the main treatment, the first 4 sessions were stopped once 30 minutes had passed and the last repeated game was concluded. For the last 4 sessions 45 minutes were allowed to pass instead. Concerning the treatment with a lower continuation probability, we run 4 sessions: two High Raven and two Low Raven, all of them stopped once the repeated game was over after 45 minutes. We will give more details about this treatment in section 6.

The subjects in the high Raven and low Raven sessions played the exact same game. The only difference was the composition of each group, as for the high Raven sessions subjects had higher Raven scores compared to those in the low Raven sessions.

Upon completing the Prisoner's Dilemma game, participants were asked to respond to a very short questionnaire about any knowledge they had of the Prisoner's Dilemma game. Additionally, subjects in sessions 5-8 were asked questions about their attitudes on cooperating behavior and some strategy eliciting questions.

Implementation

We conducted a total of 8 sessions for the main experiment, with high continuation probability; four high Raven and four low Raven sessions. There were a total of 130 participants, with 66 in the high Raven and 64 in the low Raven session. The lower continuation probability treatment was conducted in 4 sessions, with 60 subjects; 30 in the high Raven and 30 in the low Raven session.

All participants were recruited from the subject pool of the Warwick experimental laboratory. Participants in the last six sessions of the main treatment did not include economics students. Participants in these non-economists sessions had not taken any game theory modules or classes. The recruitment was conducted with the DRAW (Decision Research at Warwick) system, based on the SONA recruitment software. The recruitment letter circulated is in the supplementary material. The date of the sessions and the number of participant per sessions, are presented in the Appendix tables A.1 and A.2.

As already noted in the beginning of this section, to allocate participants in the two Raven sessions for Day Two, they were first ranked according to their Raven score. Subsequently the participants were split in two groups. In cases where there were participants with equal scores at the cutoff, two tie rules were used based on whether they reported previous experience of the Raven task and high school grades. Participants who had done the task before (and were tied with others who had not) were allocated to the low Raven session, while if there were still ties, participants with higher high school grades were put in the high session.

Table 2 summarises the statistics about the Raven scores for each session. In the main treatment, all but sessions 3 and 4, the cutoff Raven score was 18. In sessions 3 and 4, the cutoff was at 16 because the participants in those sessions scored on average lower than the rest of the participants in all other sessions (mean Raven score for session 3 and 4: 15.69, while mean Raven score for all sessions: 17.89). Figure 1 presents the total distribution of the Raven scores and the distributions in the separate Raven sessions (in the appendix, tables A.3 and A.4 present a description of the main data in the low and high Raven sessions respectively, and table A.9 shows the correlations among individual characteristics).

Subjects on average earned 17.05 GBP (about 28 USD), the participation payment was 4 GBP. The software used for the entire experiment was Z-tree (Fishbacher, 2007). The Ethical Approval of this design has been granted from Humanities and Social Sciences Research Ethics Sub-Co at University of Warwick under DRAW Umbrella Approval (Ref: 81/12-13).

A detailed timeline of the experiment is presented in the Appendix and all instructions and any other pertinent documents are available online in the supplementary material.[5]

3 Cooperation with high discount

This section focuses on describing the results of the main treatment, with high continuation probability, $\delta = 0.75$.

Different degrees of cooperation in the high and low Raven sessions

Table 3 shows that the samples in the high and low Raven sessions have similar characteristics. Only the differences in the Raven score are statistically different at the 5 percent confidence level. All in all we can say that subjects in the high and low Raven sessions differ only for their intelligence. The two groups are similar in terms of personality, in particular there is no difference in the Conscientiousness score.[6] This lends support to the fact that motivation had a negligible effect on the Raven scores, as it is reasonable in subjects with higher than average cognitive ability. If this was not true, subjects with low level of Conscientiousness would disproportionately belong to the low Raven sessions.[7]

A similar argument applies to the possibility that anxiety to perform well in the Raven test might have affected the the performances of some subjects; if this was true more neurotic subjects should have performed worse.[8] From table 3 we can observe that the average level of Neuroticism in the two groups

[5]see note 1

[6]This is true even when we consider a non parametric test. The Kolmogorov-Smirnov test for equality of distribution functions cannot reject the hypothesis the distribution of Conscientiousness is the same in the two groups with a $p - value = 0.985$.

[7]Conscientiousness is usually defined as: *"The degree to which a person is willing to comply with conventional rules, norms, and standards.* The trait is usually measured by survey questions, some of them explicitly asking subjects to report reliability and care in work. The entire questionnaire is in the supplementary material.

[8]Neuroticism is associated with anxiety and fear of failing. Some statements entering into the Neuroticism score are: Is relaxed; handles stress well (R); Can be tense; Worries a lot; Remains calm in tense situations (R); Gets nervous easily.

is not statistically different.[9]

There is a large difference in the performances of the two Raven sessions (table 3). Final average earnings in the low Raven sessions are almost half the amount earned by participants in the high Raven sessions. The better results of the subjects in the high Raven sessions are obtained both because they played more rounds per session and because they coordinated in more efficient equilibria in each round.

In sessions 1 and 2 there is a large difference in the proportion of economics students: one half in session 1 (high Raven), but only one fourth in session 2 (low Raven). The better performances in the Raven score for the economics students is probably a characteristic of Warwick University, where the entrance requirement for economics is more selective than for other subjects. If economists were more likely to play cooperation equilibrium in the prisoner dilemma, it could have represented a potential confounding. For this reason, we excluded the economists and all subjects that declared to have taken a course of game theory when we sent the invitation to recruit subjects for sessions 3 to 8. It will become clear later that there is no qualitative difference between sessions with and without economists.

Cooperation rates by Raven sessions over time

In our experiment subjects play several instances of a repeated game, each repeated game entailing a sequence of rounds. To take into account the order position of a round in the session, we number it as period to take into account the rounds that have already taken place but belong to a earlier repeated game. For example the first round of the second repeated game in a session where the first game lasted seven rounds is labelled period 8.

In figure 2 we present the evolution of cooperation in the low and high Raven sessions. Each point on the line represents the proportion of subjects cooperating in blocks of 10 rounds; we take the averages over Raven session of

[9]The Kolmogorov-Smirnov test for equality of distribution functions cannot reject the hypothesis the distribution of Neuroticism is the same in the two groups with a $p-value = 0.780$.

the same type (high and low respectively). After the first two blocks (20 rounds overall), where there is no significant difference between the two types of Raven sessions, cooperation rate clearly diverges: the rate in the high Raven sessions increases, whereas in the low Raven sessions it declines. This is confirmed by table 4, showing in columns 1 and 2 that there is a significant difference in the trend of cooperation between the two Raven sessions, in column 3 that the odds of cooperating significantly increases 1.7 percent per period in the high Raven sessions, and in column 4 that cooperation slightly decreases in the low Raven sessions (note that throughout the paper, the coefficients of the logit estimations will be always expressed in odd ratios).

The top panel of figure 2 depicts only aggregated first rounds of each repeated game. Looking separately at first rounds is important since different repeated games may result in a different number of rounds, and the percentage of cooperation may vary across rounds.

Figure 3 presents different aggregation of rounds and Repeated games. The top panels shows no differences in the first repeated games. The bottom panels show that the average cooperation considering all rounds is significantly higher in the High Raven sessions. In particular, in the first round of each repeated game it is nearly 80%, while in the low Raven session this is just above 50%. As we stated above there is no difference in the cooperation when individuals start playing. The difference is entirely due to learning.

Figure 4 shows that the same pattern is replicated in each pair of contiguous sessions. In sessions 3 and 4 (top right panel) the divergence is less significant.[10] However the black solid line in the figure, representing the *lowess* estimate, shows that a divergence was starting to take place around the 30th round, consistent with the other sessions.[11] We conclude this section with the following:

[10]This is due in part to the fact that in session 3 a particularly slow subject prevented the group from playing a sufficiently large enough number of repeated games. Also recall that this session was set to last 30 minutes.

[11]Considering the right bottom figure, we note a decline in the cooperation in session 7. This is possibly due to the fact that subjects might have started to understand that the experiment was coming to a close, so it could be an end of game effect, the last repeated game of this session lasted unusually longer

Result 3.1. *Subjects in both high Raven and low Raven sessions show a similar rate of cooperation in the initial rounds. Cooperation then increases in the high Raven sessions to almost full cooperation, while it slightly declines in the low Raven sessions.*

4 Determinants of the degree of cooperation

In what follows we analyse the mechanisms that lead to the different patterns of cooperation in the two Raven sessions.

Effect of partners' choices

In figure 5 we plot the level of cooperation conditional on partners' choice over different periods; the figure reports the evolution of the choice of cooperation when the partner cooperated the previous round, and the choice of cooperation after the partner's defection in the previous round. From the top left panel of figure 5, we conclude that in the high Raven sessions subjects evolve to reciprocate cooperation. In the last few periods the reciprocation occurs almost always. In the low Raven sessions individuals reciprocate cooperation significantly less, and the learning effect is less steep. There is no difference in the first period, so subjects in the high Raven learn to reciprocate faster than in the low Raven. From the bottom left panel we note that the subjects in the high Raven subjects reciprocate cooperation 20 % more often than the low Raven.

In the top right panel we note a tendency to decrease the rate of cooperation when the partner defects, in other words subjects learn to forgive less in general. Again this reciprocation is stronger for the high Raven than for the low Raven, although this difference is much smaller than the reciprocation to cooperation (bottom right panel).

In table 5 we investigate further the way subjects learn to reciprocate. We estimate how the cooperation choice of a player (say player 2) at round 1 induces the same choice of her partner (say player 1) at round 2. The choice of player 1 in round 2 of a repeated game can be influenced by player 2 choice at round 1. Player 2 choice at round 1 is clearly independent from the choice of player 1 since the action is simultaneous. Hence, the coefficient of player 2 choice at round 1 over the player 1 choice at round 2 can be reasonably considered an unbiased estimator of the way individuals reciprocate cooperation.

Column 1 of table 5 shows that individuals increase the level of reciprocation over time significantly more in the high Raven sessions, while in the low Raven session the reciprocation does not significantly increase. Column 2 shows that there is no significant difference between the two Raven sessions in the level of reciprocation of the first repeated game at period 2. Hence columns 1 and 2 show that subjects start from a similar level of reciprocation, but learn to reciprocate over times only in the high Raven sessions. Column 3 suggests that the odd of reciprocating in the high Raven sessions increases to about 4 percent in each period, once this is taken into account there is no significant increase in cooperation due to the general trend. Column 4 shows that the level of reciprocation does not change significantly in the low Raven sessions; always from column 4, can observe again that the sing of the coefficient of the trend (Period) is negative and significant in the low Raven session.

We summarise the results in this session with the following

Result 4.1. *The degree of reciprocation in subjects belonging to the high Raven sessions increases over time; there is no significant increase in the degree of reciprocation in the low Raven sessions.*

Effect of the Individual characteristics

Table 6 presents the effect of the individual characteristics in the cooperation choice. We consider only the choice in the first round of a repeated game to abstract from the effect of partner's choice. From column 1, we note that only intelligence, measured in terms of score in the Raven test, is a significant predictor of cooperation at least at 5 % level.[12] None of the Big Five personality traits, risk aversion or gender have a significant effect on cooperation at the 5 percent level in the first rounds of the repeated games. In column 2, we only consider the first round of the first repeated game (hence period 1 only), thus abstracting from experience of interaction with the other players. Consistently with what noted above, intelligence has no impact in the first period behavior. In conclusion, the higher level of cooperation we observe in the high Raven sessions is the outcome of a cumulative process rather than of a characteristic that produces cooperation independently of experience.

After controlling for the Raven scores, the dummy indicating the high Raven sessions are not significant suggesting that is the individual intelligence more than the session effect (due to the fact that individuals play with more intelligent individuals) to drive the effect on cooperation, this finds further support from the fact the size of the two coefficients measuring the effect of the Raven scores presented in columns 3 and 4 of table 6 are similar in the two Raven sessions.

We conclude this section with the following:

Result 4.2. *Intelligence is the only significant determinant of cooperation in the first round choices. In the first round of the first repeated game there is no difference between the two groups: hence this effect is produced by the learning of the subjects in the sequence of repeated games.*

5 Strategies in the different Raven sessions

In the previous section we showed how past partners' choices affect subject choices in the two Raven sessions; here we analyse the strategies used in the two sessions. We follow DBF, restricting our attention to a finite set of common and natural strategies; in particular, we consider the six strategies listed in table 7. They have been chosen with respect to their importance in the theoretical literature: Always Cooperate (AC), Always Defect (AD), Grim (G),

[12]Sessions 1 and 2 are excluded because in these two initial sessions we did not measure subjects' risk aversion, including them would not change our conclusions

Tit for Tat (TFT), Win Stay Loose Shift (WSLS) and a trigger strategy with two periods of punishment (TFT, after D C C). In table A.10 following Dal Bò and Frechette (2013) we present the same exercise with 12 possible strategies, but our conclusions below will remain qualitatively the same.

The likelihood of each strategy is estimated by maximum likelihood, assuming that subjects have a fixed probability of choosing one of the six strategies in the time horizon under consideration. We focus on the last 5 (columns 1 and 2 of table 7) and first 5 interactions (column 3 and 4 of table 7). We assume subjects may make mistakes and choose an action that is not recommended by the strategy they are following. The likelihood that the data corresponds to a given strategy was obtained by allowing subjects some error in their choices in any round, where by error we mean a deviation from the prescribed action according to their strategy. A detailed description of the estimation procedure is in the online Appendix of DBF.[13]

We first consider the final strategies played at the end of the session, specifically the last 5 games. Low Raven subjects play Always Defect with probability above 50 per cent, in stark contrast with high Raven subjects who play this strategy with probability statistically equal to 0. Instead, the probability for the high Raven to play more cooperative strategies (Grim and Tit for Tat) is about 67 per cent, while for the low Raven this is lower (around 45 per cent).

Strategies used in the initial rounds are quite similar across the two groups (see columns 3 and 4), consistent with our earlier finding that cooperation rates are similar across Raven sessions in the initial periods. Both groups play at the beginning Always Defect with probability about 34 per cent and more cooperative strategies (Grim and Tit for Tat) with probability of about 66 percent for high Raven and 57 per cent for low Raven.

We summarise the main findings of this section in the following:

Result 5.1. *In the high Raven sessions subjects converge to a probability of two third to play a cooperative strategy and never play Always Defect. In the low Raven sessions subjects converge to a probability of playing Always Defect*

[13] see p. 6-11, available online at `https://files.nyu.edu/gf35/public/print/Dal_Bo_2011a_oa.pdf`

just above one half. The probabilities of playing cooperative and non cooperative strategies at the beginning are roughly similar among subjects in the different Raven sessions.

6 Cooperation with low discount

Cooperation is harder with a lower continuation probability. In this treatment we set $\delta = 0.5$, while the payoff matrix in the stage game is the same as in the main treatment (as in table 1). Accordingly, differently from the case of $\delta = 0.75$, the experimental results of DBF when $\delta = 0.5$ show no evidence of convergence to cooperation (see DBF, p. 419, figure 1, top right diagram). The scope of this treatment is then to test how cognitive skills affect the pattern of cooperation of the group when cooperation is harder.

Like in the main treatment, subjects are divided in low and high Raven sessions according to their Raven scores. We run 4 sessions; 2 of them with high Raven (numbered 1ld and 3ld) and 2 low Raven (2ld and 4ld). Every session was stopped once 45 minutes had passed and the last repeated game was concluded. High Raven session 3ld and low Raven session 4ld are exactly like the main treatment, the only difference being the continuation probability. In high Raven session 1ld and low Raven session 2ld, there is a difference in the information given to the subjects. At the beginning of the session in day 2, they received on a piece of paper, their Raven score and the summary statistics of the Raven scores of participants within their respective sessions. Hence subjects are informed about the way they have been allocated in the Raven sessions. This treatment is aimed to test whether when subjects are aware that their partner's cognitive skills are similar to their own they coordinate better.

The dates of the sessions of this treatment with low discount and the descriptive statistics of the main variables are in table A.2 and tables A.5-A.8 of the appendix. Figure 6 presents the total distribution of the Raven scores and the distributions in the separate Raven sessions for the subjects in this treatment.[14]

From figure 7 we cannot observe any convergence to full cooperation in both Raven sessions and in both treatments, hence both Raven sessions are similar in this respect to the correspondent sessions in DBF; on the contrary, there seems to be a decline in both Raven sessions.[15] This is true in the sessions where we informed individuals about the allocation (1ld and 2ld) and in the sessions where we did not give this information (3ld and 4ld).

Furthermore, we note that after the first block (10 rounds overall), where there is no significant difference between the two types of Raven sessions, cooperation rates seem to diverge; in both cases decline, but the decline seems faster in the high Raven sessions. In figure 8 we can observe the average level of cooperation in the different Raven sessions and in the treatments with (sessions 1ld and 2ld) and without information (session 3ld and 4ld), in the last we only considered the first 20 periods for sake of comparability between the two Raven sessions. Figure 8 confirms the findings in figure 7: *(i)* Average cooperation overall is significantly lower than the cooperation in the first period in both Raven sessions and in both treatments (with and without information); *(ii)* the initial level of cooperation is similar in the two Raven sessions; *(iii)* in the low Raven sessions individuals cooperate in average more, this difference is significant in the session with information and borderline insignificant, at 5 % level, in the sessions without information.

Figure 9 can provide an explanation on why low Raven subjects cooperate more in this treatment. From the top left panel of this figure, we note that there is no significant difference in the way subjects react to the cooperative choice of the partner. Comparing this with the correspondent panel in figure 5 (top left panel), we can argue that subjects in the high Raven sessions do not seem to learn to reciprocate cooperation like they do in the main treatment. At the same time, from the top right panel of figure 9, we can observe that

[14]The distribution of other characteristics is similar in the two Raven sessions in this series of experiments as well. A formal test like the one performed for the main treatment in table 3 is available upon request.

[15]The session 4ld had to be stopped because a subject in period 24 shouted: "Lets Cooperate!", there was no reason to exclude the data previously collected.

in the low Raven session subjects seem to cooperate more after the defection of the partner for most of the session, the two groups seem to converge only at the end. This can then explain the difference in the average cooperation we observed in the two groups. Some subjects in low Raven keep cooperating even after the partners defect for most of the session, and they learn that this is not leading to more cooperation only toward the end, hence it is possible to argue that low Raven subjects need more time to predict other subjects' reactions.

We summarise the main findings of this section in the following:

Result 6.1. *With lower continuation probability the degree of cooperation declines over time in both low and high Raven sessions.*

A final consideration in this section concerns the effect of the information. A natural conjecture is that when subjects are informed that they will be playing with individuals with a similar level of cognitive ability, they should be able to coordinate better.

From 8 we note that the availability of this information does not lead any group to coordinate to an equilibrium with high level of cooperation. However, in both high and low Raven sessions, the average cooperation is significantly higher in the treatment with information. More specifically, in the low Raven session with information there are 29,9 % cooperative choices, while in the one with no information, cooperative choices in the first 20 rounds are 16.3% (we considered only the first 20 rounds to make this session comparable with the correspondent session with information that, we recall, had to be prematurely stopped), significantly lower with $p-value < 0.01$; in the high Raven session with information, the percentage of cooperative choices is 11.9 % with no information and 16.9% when the information was given. This last number is significantly higher with $p-value < 0.05$.

7 Reaction times

Reaction time is defined here as the length of the time interval between the appearance of the payoff table and the moment in which the decision is entered. The analysis of reaction times, and the comparison between the high and low discount sessions, may give further insights in the way choices are made in the two cases, and how intelligence of the group relates to choices.

In panel A of figure 10 we analyze how reaction time changes during the periods in the different Raven sessions, and according to the choice to cooperate or defect. There is clear evidence of general learning of the task: the response time decreases with periods played. This decrease however is slower in the low Raven sessions (top graph in panel A of figure 10), especially when subjects in the low Raven choose to cooperate (top-right graph). The histogram in the lower panel of figure 10 shows that in the low Raven there is no significant difference in the response time whether subjects decide to cooperate or defect (bottom left panel), but there is a significant difference of about two seconds more when subjects in the high Raven sessions choose to defect (bottom right panel). This seems to suggest that in the high Raven sessions Cooperation became the norm, implemented perhaps by default.

Panel B of figure 10 shows reaction times for the session with lower continuation probability. In panel B of figure 10 we see a smaller difference in the way reaction time decrease over time in the two different Raven sessions (top panels). Moreover, we do not observe the same difference between the choices to Cooperate and Defect in the high Raven sessions (bottom right panels) that we observe for the main treatment in panel A of figure 10. This further supports the idea that a norm of cooperating was created in the high Raven session in the main treatment, but not for the low continuation probability treatment.

We summarise:

Result 7.1. *In the high Raven sessions of the main treatment, the reaction times are on average smaller and decline faster over time than in the low Raven sessions of the same treatment. In the high Raven sessions reaction times are* *longer when subjects choose defection, but are statistically equal in the low Raven. There is no difference between defection and cooperation choices in the high Raven sessions in the low continuation probability treatment.*

8 Conclusions

Our experimental setup was based on a direct test of the hypothesis that groups of individuals with different levels of intelligence, but otherwise similar, would exhibit different levels of cooperation in bilateral interactions with others in the group. The interaction was repeated, so there was time and opportunity for each one to observe, and reflect, on past behavior of the other, and use this inference to guide future choices. A significant and sizeable difference in behavior and insights on the way in which intelligence is relevant in strategic repeated behavior have emerged.

Everything else being equal, higher intelligence groups exhibit higher levels of cooperation. In our data, intelligence of the group is associated with different long run behavior in a sequence of repeated games played within the group, and higher cooperation rates are associated with higher intelligence.

Higher cooperation rates are produced by the interaction over time. Cooperation rates in the initial rounds (approximately 20) is statistically equal in the two groups. Thus, the higher cooperation rate in higher intelligence groups is produced by the experience of the past interaction, not from a difference in attitude in the initial stages. There is no inherent association of higher and lower intelligence with a behavior: the specific history of past interactions matters.

Higher cooperation is sensitive to the stage game payoff, so it is not an unconditional inclination of individuals with higher intelligence to cooperate. When the parameters in the experimental design were chosen to make cooperation less long run profitable, subjects in groups with higher intelligence also experience large and growing rates of defection over time. Environment and incentives matter: intelligence modulates the response to incentives, and does not directly determine behavior.

Intelligence mattered substantially more than other factors and personality traits. When we test for statistical relation with choice of cooperation, we find no significant correlation with personality traits and with high school grades: intelligence as fluid skill is the determining factor. Our design has an asymmetry in the way in which the personality traits and skills are treated, because only intelligence is used to allocate individuals into groups, and the other characteristics are used as controls. Part of future research should test directly the size and significance of the effect of two or more characteristics (such as, say, intelligence and agreeableness). Of course, intelligence is also in part outcome of education, and this may involve learning abut behavior in social situations. However, the two Raven groups are similar for degree of education, which is then unlikely to be a confounding factor in our results.

Intelligence operates through the thinking about strategic choice. Differences in behavior could arise for different reasons. For instance, intelligence might be associated with attitude to cooperation, considered as a behavioral inclination; or with different utility that individuals derive from the outcomes of others. Our data provide support for the idea that intelligence is likely instead to influence the way in which subjects think about the behavior of others, how they learn about it, and how they choose to modify it as far as possible; intelligence is relevant for learning and teaching.

We have produced two pieces of evidence supporting this interpretation. The first is the difference in the evolution over time to the response of individuals to the choice of the current partner in the past. A small, but significant difference to the choice of cooperation of the current partner in the last period builds up over the session to produce a substantial cumulative difference in cooperation rate. The second evidence comes from response times. In higher intelligence subjects, cooperation after the initial stages becomes the default mode. Defection instead requires a specifically dedicated careful balancing of the anticipated loss of future cooperation with the necessity to retaliate to avoid future opportunistic defections of the partner. For lower intelligence groups this difference is absent.

Our data present new evidence and suggest questions for the theory of learning in games. The setup of Dal Bò and Frechette (2011) that we adopt puts our subjects in a novel learning environment when there is a substantial lack of homogeneity among subjects. As they proceed in the experimental session, they have the opportunity to observe the behavior of their peers in the game, and learn about the distribution of characteristics affecting choices in the sample. An adequate model of their sequential choice of actions should incorporate the history of past instances of repeated games in the definition of the strategy. The strategy should also depend on individual characteristics, intelligence being first among them. An initial prior over the distribution of characteristics in the population of the session would then be updated, and thus the distribution over the strategies the subject is facing would change.

The truly novel and interesting side of the research that opens now is the analysis of the link between strategies and intelligence. Is there a systematic pattern of association, and what produces it? A natural conjecture may be formulated ranking strategies by their complexity. For example, a very crude way to classify strategies could focus on the length of the history of moves that a strategy considers. Accordingly, a larger set of strategies is available to individuals who are able to implement the more complex ones, as well as to observe, store and process the richer information that is necessary for their execution.[16] A difficulty with this explanation is that the strategies used by the two groups in our experiment are not substantially different in complexity. Further experimental research to test these initial assumptions seems to us the best way to proceed.

[16]Rubinstein (1986) and Abreu and Rubinstein (1988) among others suggest a natural way to introduce explicitly intelligence in theoretical models of strategic behavior, through the use of automata models with heterogeneous costs among players for the number of states in the automaton; players with higher intelligence have lower costs, which will allow them to be more flexible in the sense of being able to increase the number of states in the automation, thus they can more optimally react to different circumstances. This extension might provide a valuable insight on the way intelligence affects social behavior.

Table 1: **Stage Game: Prisoner's Dilemma.** Payoffs are in experimental units, see the text for the conversion to monetary payoff.

	C	D
C	48,48	12,50
D	50,12	25,25

Table 2: **Raven Scores by Sessions**

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
High Raven - Session 1	20.429	1.505	18	23	14
Low Raven - Session 2	14.063	3.395	6	18	16
High Raven - Session 3	19	2	16	23	18
Low Raven - Session 4	13.188	1.94	10	16	16
High Raven - Session 5	20.444	1.79	18	24	18
Low Raven - Session 6	14.167	3.538	7	18	12
High Raven - Session 7	20.688	2.243	18	25	16
Low Raven - Session 8	15.75	1.372	13	18	20

Table 3: **Differences between the means of the main variables in the high and how Raven sessions.**

Variable	Low Raven	High Raven	Differences	Std. Dev.	N
Age	22.35938	21.24242	1.116951	.7251282	130
Female	.625	.5	.125	.0870282	130
Openness	3.642188	3.595455	.0467329	.1016391	130
Conscientiousness	3.399306	3.405724	-.0064184	.1198434	130
Extraversion	3.349609	3.244318	.1052912	.1308186	130
Agreeableness	3.840278	3.765993	.0742845	.1060675	130
Neuroticism	2.910156	2.835227	.074929	.1361939	130
Raven	14.39063	20.10606	-5.715436***	.4170821	130
Economist†	.25	.5714286 .	-.3214286*	.1753537	30
Risk Aversion	5.5625	5.5	.0625	.2865234	100
Final Profit	2774.297	4675.303	-1901.006***	258.9902	130
Periods	83.3125	116.4848	-33.17235***	5.039728 2	130
Profit $\times$ Period	33.26863	38.546693	-5.278058***	.8951038	130

† only sessions 1 and 2

Table 4: **Trends of cooperation in the high and low Raven sessions.** The dependent variable is the choice of cooperation per individual. Coefficients in columns 1, 3 and 4 are expressed as odds ratios. Standard errors in brackets. * $p-value < 0.1$, ** $p-value < 0.05$, *** $p-value < 0.01$.

	Logit FE All	OLS FE All	Logit FE High Raven	Logit FE Low Raven
Period	0.9945***	–0.0009***	1.0178***	0.9945***
	(0.0014)	(0.0002)	(0.0009)	(0.0014)
H.Rav*Period	1.0234***	0.0031***		
	(0.0017)	(0.0002)		
r2		0.028		
N	12640	13020	7468	5172

Table 5: **Effects of past partners' choice on cooperation.** The dependent variable in columns 1, 3 and 4 is the choice of cooperation per individual, in the second round of each repeated game. The dependent variable in column 2 is the choice of cooperation per individual in the second round of the first repeated game (if this exists and the game did not terminate at round 1). Coefficients are expressed in terms of odd ratio. Standard errors in brackets. * $p-value < 0.1$, ** $p-value < 0.05$, *** $p-value < 0.01$.

	All 2^{nd} Rounds	All 2^{nd} Period	Hig Raven 2^{nd} Rounds	Low Raven 2^{nd} Rounds
Partner Ch.[$t-1$]	6.2396***	2.5412**	7.0759***	6.2396***
	(2.2876)	(1.1483)	(2.2589)	(2.2876)
H.Rav.*Partner Ch.[$t-1$]	1.1340	1.3458		
	(0.5513)	(0.6771)		
Partner Ch.[$t-1$]*Period	1.0126		1.0395***	1.0126
	(0.0078)		(0.0066)	(0.0078)
H.Rav.*Partner Ch.[$t-1$]*Period	1.0265***			
	(0.0102)			
Period	0.9854**		0.9980	0.9854**
	(0.0058)		(0.0047)	(0.0058)
H.Rav.*Period	1.0128*			
	(0.0077)			
r2				
N	2153	112	1383	770

Table 6: **Effects of IQ and other characteristics on cooperation.** The dependent variable in columns 1, 3, 4 is the share of cooperative choices in the first rounds of all repeated games. The dependent variable in column 2 is the cooperative choice per individual in the first round of the first repeated game. Columns 3 and 4 respectively refer to all first rounds in the high and low Raven sessions separately. All coefficients in column 2 are expressed in terms of odd ratio. (Robust) Standard errors in brackets (in columns 1, 3, 4); * $p - value < 0.1$, ** $p - value < 0.05$, *** $p - value < 0.01$

	OLS 1^{st} Rounds	Logit 1^{st} Period	OLS 1^{st} Rounds HR	OLS 1^{st} Rounds LR
Raven	0.0333**	0.9768	0.0389*	0.0376
	(0.0166)	(0.1062)	(0.0228)	(0.0246)
Openness	0.0563	0.7234	0.0799	0.0237
	(0.0744)	(0.3229)	(0.0952)	(0.1246)
Conscientiousness	–0.0089	1.1203	–0.0175	–0.0165
	(0.0536)	(0.4062)	(0.0523)	(0.0999)
Extraversion	–0.0507	1.3014	–0.0687	–0.0696
	(0.0651)	(0.4549)	(0.0719)	(0.0933)
Agreeableness	–0.1041*	0.8327	–0.0380	–0.2124*
	(0.0595)	(0.3301)	(0.0721)	(0.1056)
Neuroticism	0.0119	0.9899	0.0885	–0.1030
	(0.0574)	(0.3481)	(0.0706)	(0.0945)
Risk Aversion	0.0114	0.9801	0.0414	–0.0700
	(0.0278)	(0.1603)	(0.0309)	(0.0570)
Female	–0.1301	0.3828*	–0.2079**	0.0207
	(0.0896)	(0.2062)	(0.0985)	(0.1537)
Age	–0.0048	1.0470	–0.0178	–0.0047
	(0.0063)	(0.0712)	(0.0123)	(0.0099)
High Raven Session	–0.0715	0.8139		
	(0.1319)	(0.5828)		
r2	0.163		0.290	0.148
N	100	98	52	48

Table 7: **Individual strategies in the different Raven sessions in the last 5 and first 5 repeated games** Each coefficient represents the probability estimated using ML of the corresponding strategy. Std Error is reported in brackets. Gamma is the error coefficient that is estimated for the choice function used in the ML and beta is the probability estimated that the choice of a subject is equal to what the strategy prescribes.† Tests equality to 0 using the Waldtest: * $p - values < 0.1$, ** $p - values < 0.05$ **, $p - values < 0.01$ ***

Raven Session	High	Low	High	Low
Repeated Games	Last 5	Last 5	First 5	First 5
Strategy				
Always Cooperate	0.0886	0.0348	0	0.0745
	(0.1041)	(0.0574)	(0.0402)	(0668)
Always Defect	0.0417	0.5148***	0.3395***	0.3415***
	(0.0354)	(0.1049)	(0.1076)	(0.0967)
Grim after 1 D	0.3705***	0.1522**	0.6605***	0.2180***
	(0.1429)	(0.0617)	(0.1248)	(0.0783)
Tit for Tat (C first)	0.2976**	0.2982***	0	0.3540***
	(0.1418)	(0.0846)	(0.1175)	(0.0857)
Win Stay Lose Shift	0.0701	0	0	0.0121
	(0.1289)	(0.0306)	(0.0545)	(0.0473)
Tit For Tat (after D C C)††	0.1315	0	0	0
Gamma	0.3249***	0.4146***	0.5313***	0.6312***
	(0.0774)	(0.0381)	(0.0662)	(0.0525)
beta	0.956	0.918	0.868	0.830
Sessions	1,5,7	2,4, 6, 8	1,5,7	2,4,6, 8
Average Rounds	4.83	5.12	2.11583	3.875
N. Subjects	48	64	48	64
Observations	1090	1676	518	1152

† When beta is close to 1/2 choices are essentialy random and when it's close to 1 then choices are almost perfectly predicted.

†† Tit for Tat (after D C C) stands for the Tit for Tat strategy that punishes after 1 defection but only returns to cooperation after observing cooperation twice from the partner.

Figure 1: **Distribution of the Raven Scores for the main treatment.** The top panel depicts the distribution of the entire sample. The bottom panel presents the distributions in the separate Raven sessions.

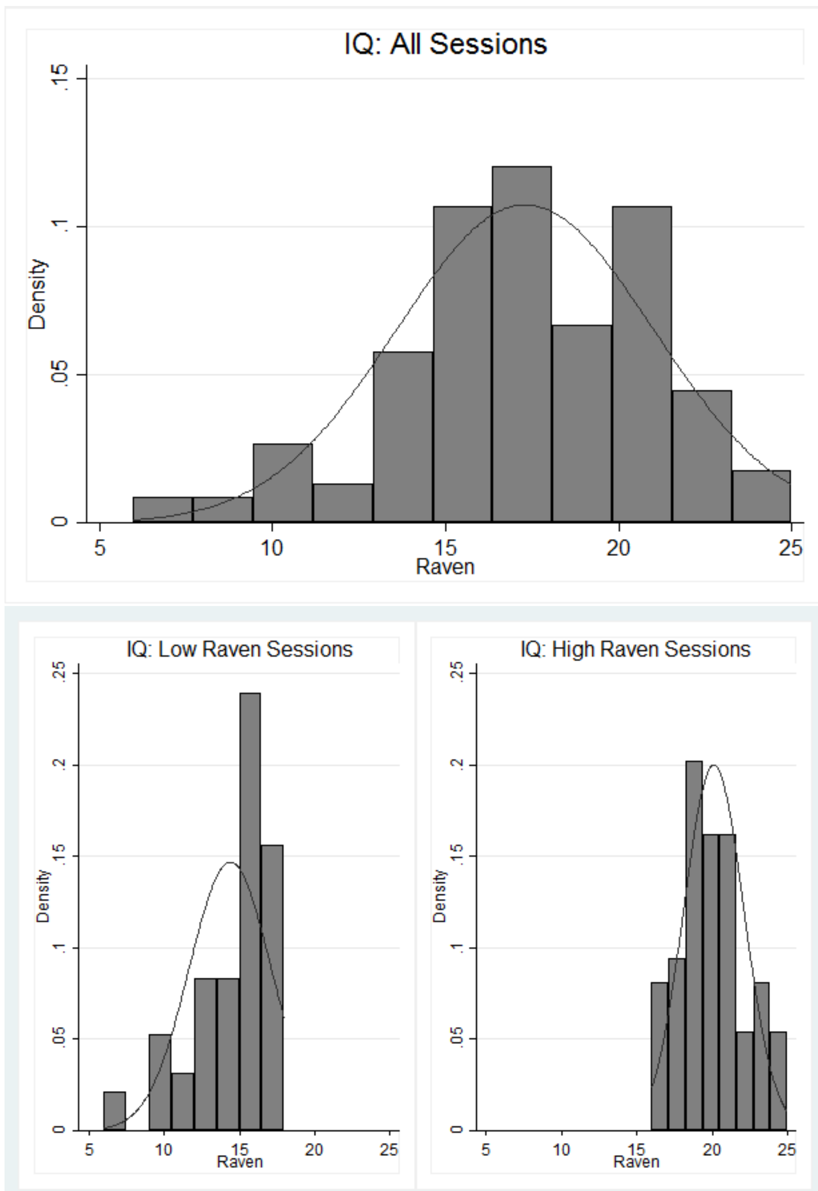
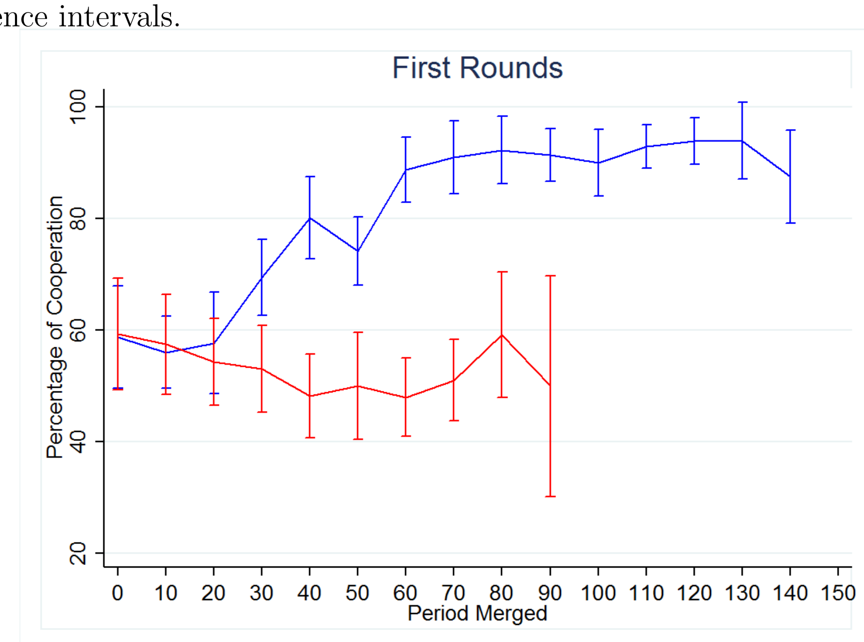


Figure 2: **Cooperation per period in the low and high Raven sessions.** The two panels report the averages computed over observations in successive blocks of ten rounds of all high and all low Raven sessions, aggregated separately. The top panel reports the average of cooperation in the first round (of a repeated game) that occurs in the block, the bottom the average of cooperation for all rounds of the game in that block. The bands represent the 95% confidence intervals.



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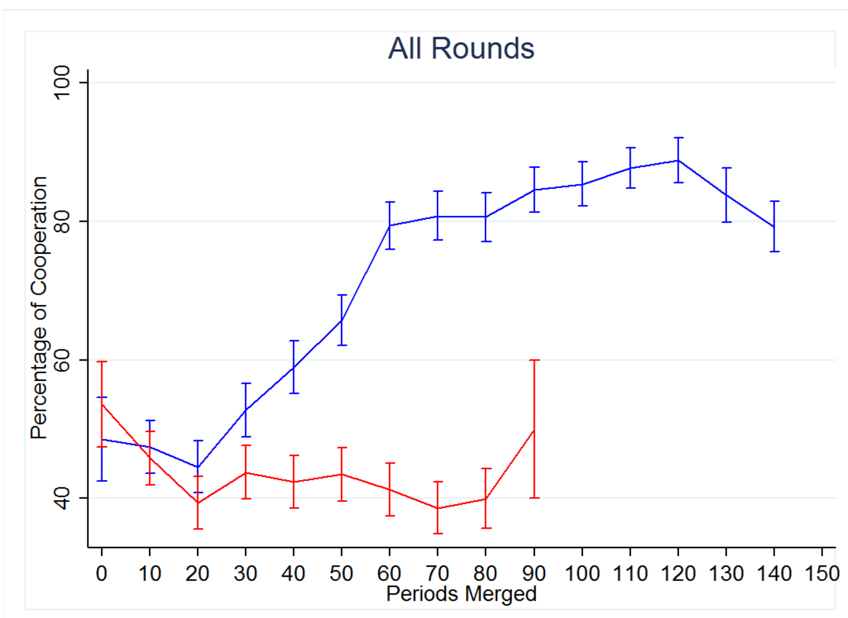

Figure 3: **Average cooperation in the low and high Raven sessions** The histograms represent the average cooperation in each session. Top panel: first repeated game; bottom panel: all games. The bands represent the 95% confidence intervals.

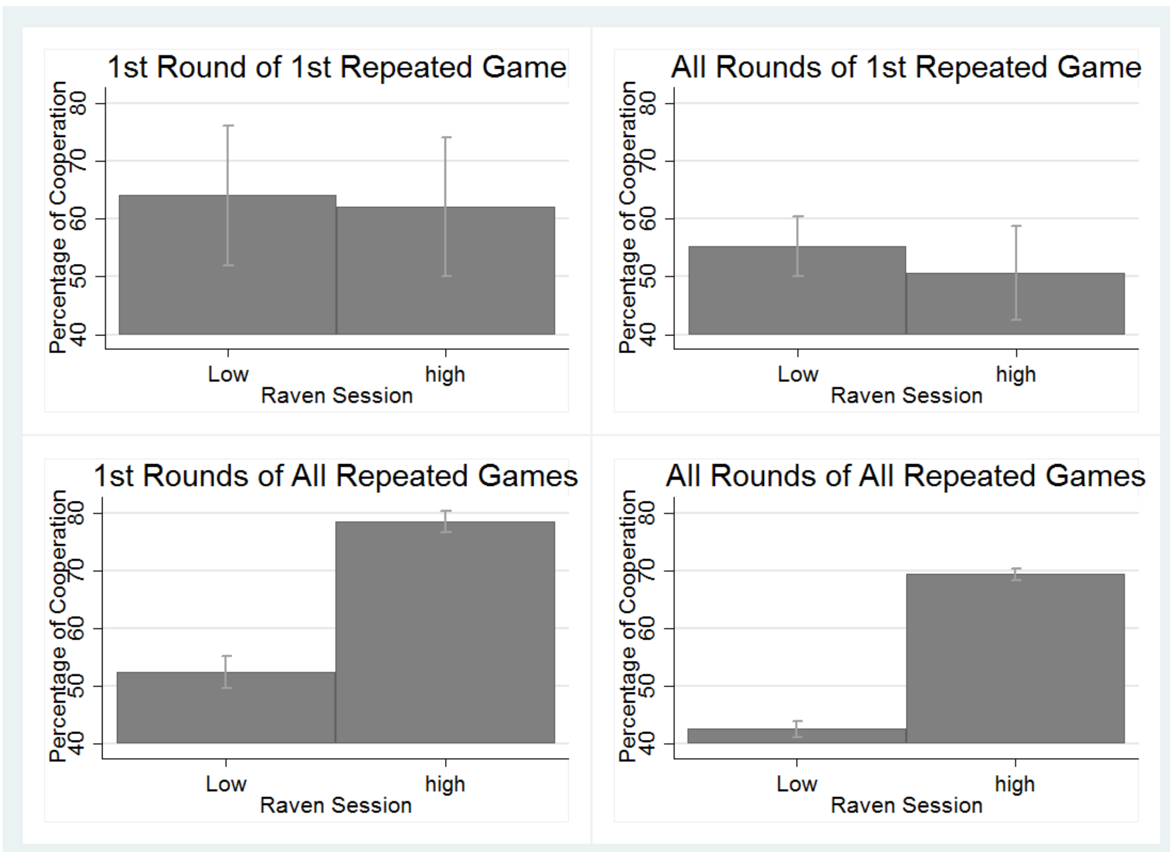

Figure 4: **Cooperation per Period in all the Different Sessions.** The red lines represent the low Raven Sessions and the blue lines represent the high Raven Sessions. The black lines represent the lowess estimator.

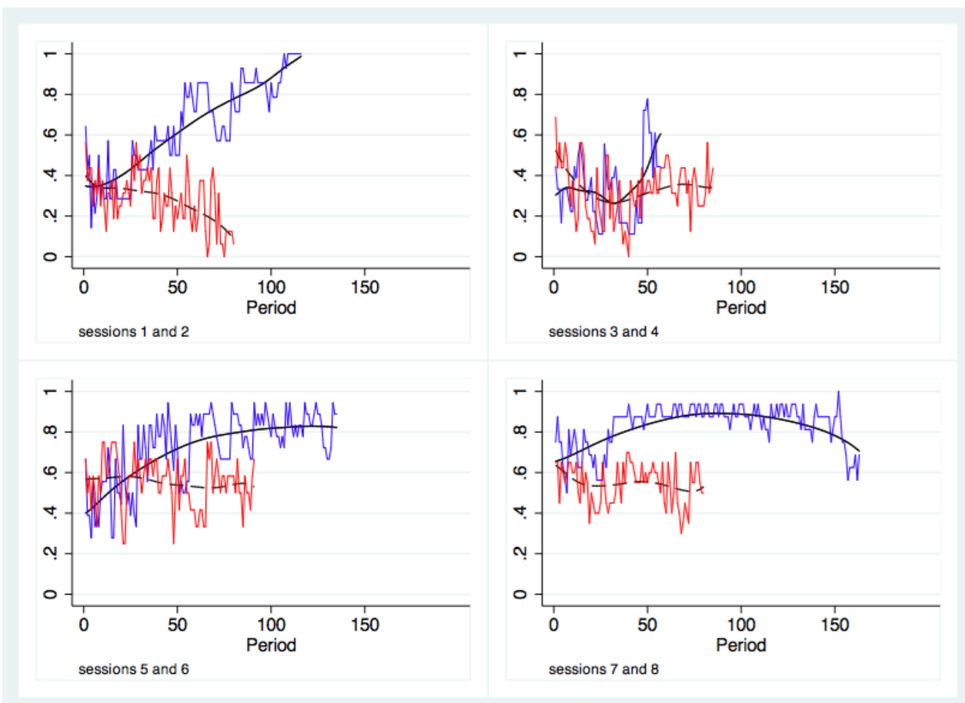

Figure 5: **Conditional Cooperation per Period in the high and low Raven Sessions.** Left Panels: cooperation choice of the subject at t after a cooperation choice of the other player at $t-1$. Right panels: cooperation choice after a defection choice of the other player at $t-1$. The red lines represent the Low Raven Sessions and the blue lines represent the High Raven Sessions. The bands represent 95 % confidence intervals.

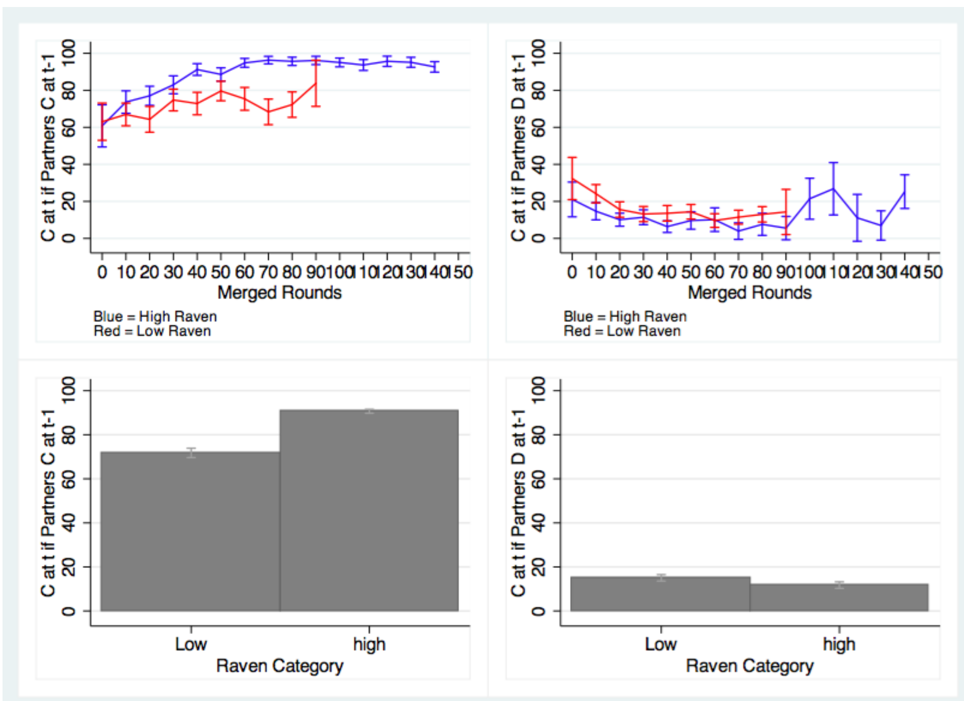

Figure 6: **Distribution of the Raven Scores in the low discount treatments.** The top panel depicts the distribution of the entire sample. The bottom panel presents the distributions in the separate Raven sessions.

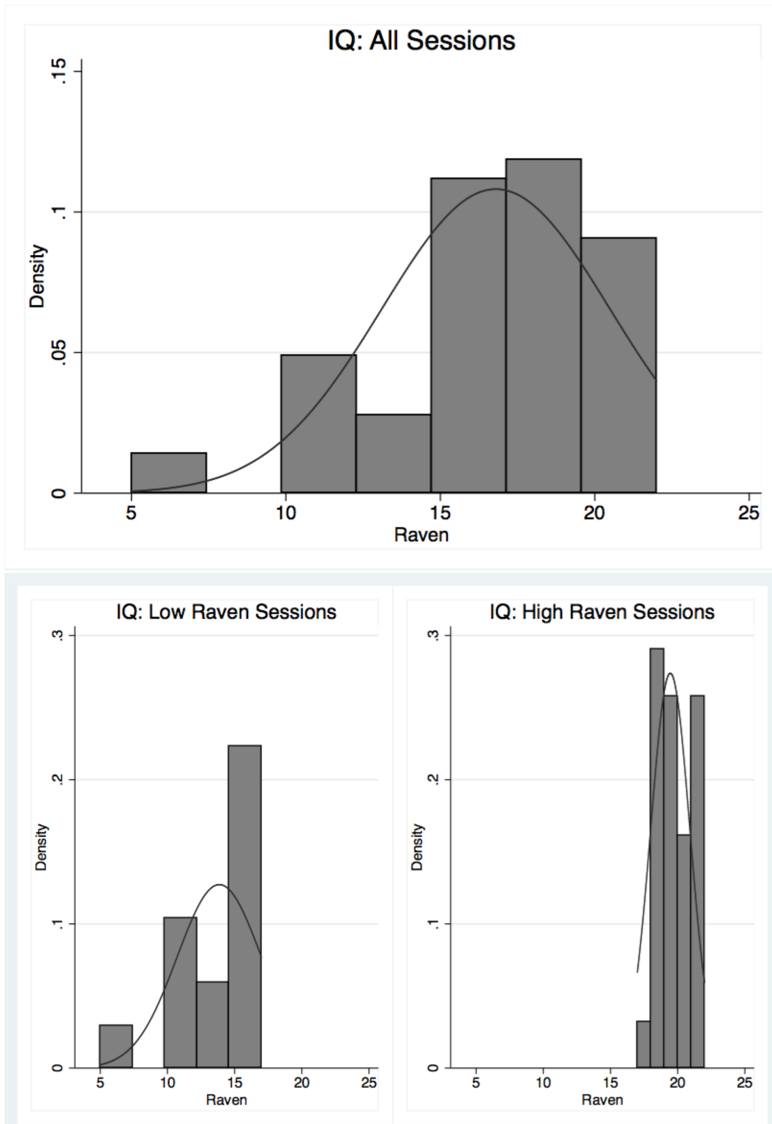

Figure 7: **Cooperation per period in the low and high Raven sessions with low discount.** The red lines represent the Low Raven Sessions and the blue lines represent the High Raven Sessions. In the left panels, the black lines represent the lowess estimator. The two right panels report the averages computed over observations in successive blocks of ten rounds of all high and all low Raven sessions, aggregated separately. The bands represent the 95% confidence intervals.

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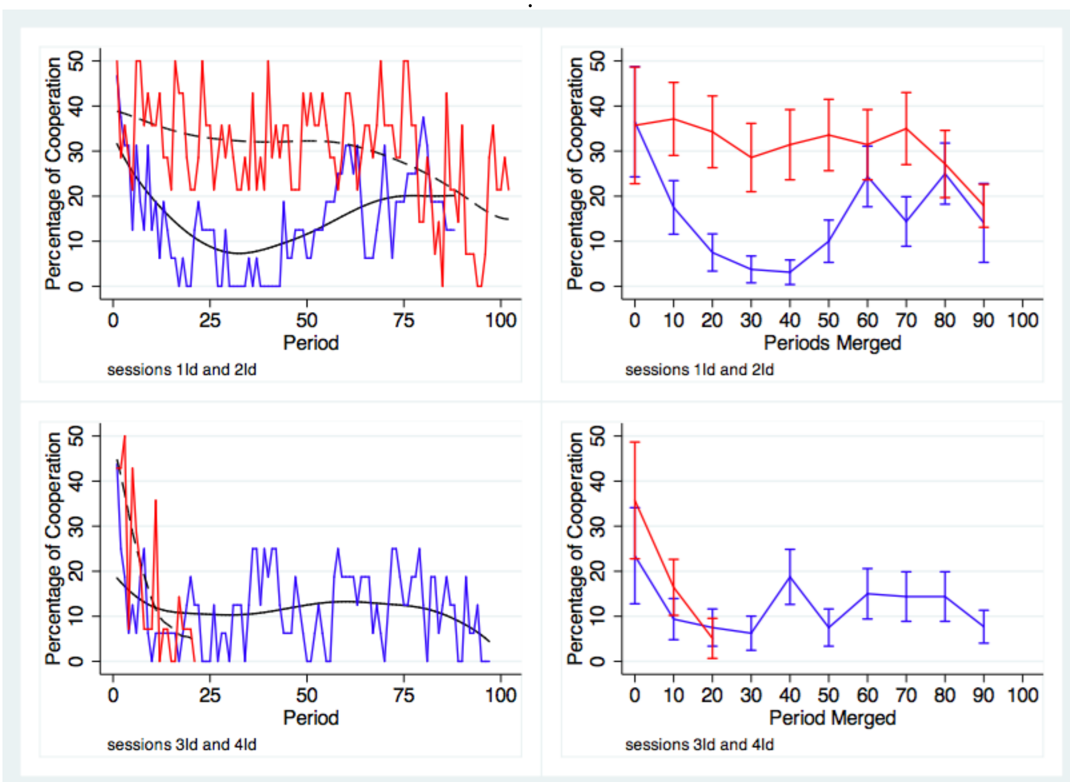


Figure 8: **Average cooperation in the low and high Raven sessions with low discount** The histograms represent the average cooperation in each session. The top panels represent the sessions 1ld and 2ld, where subjects are informed about the way the Raven sessions were formed. The bottom panels represent sessions 3ld and 4ld where –like in the main treatment with high discount–, subjects are not informed. For sessions 3ld and 4ld only the first 20 rounds have been considered. The bands represent the 95% confidence intervals.

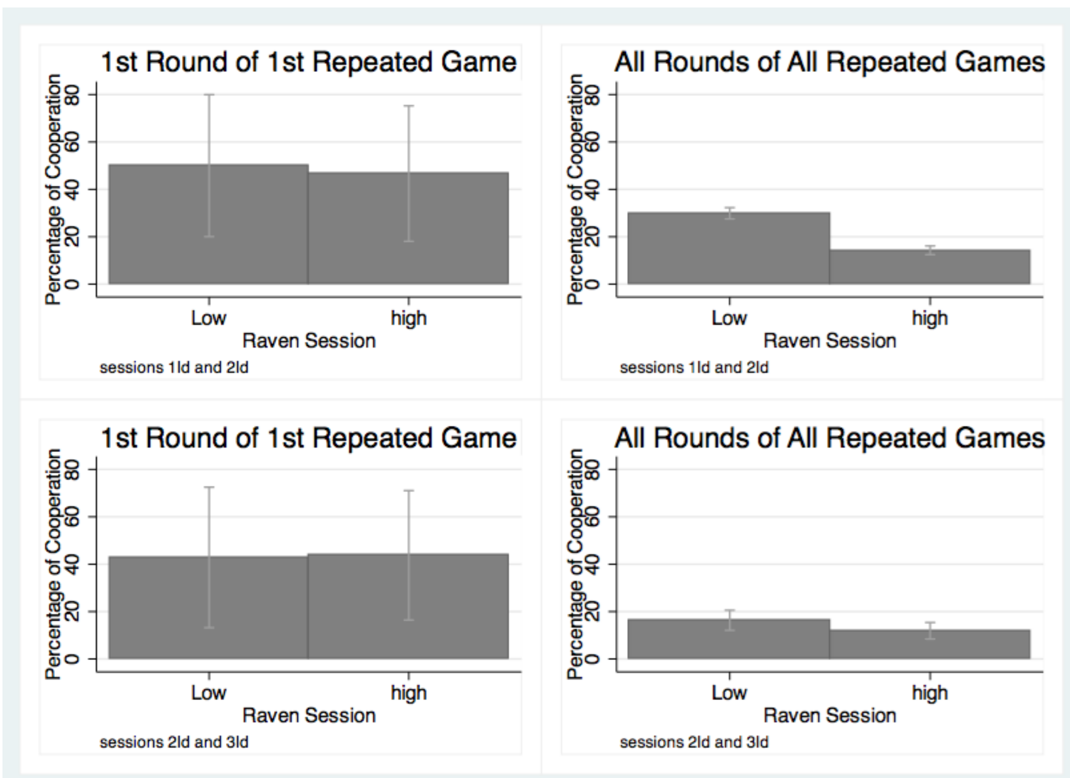


Figure 9: **Conditional cooperation per period in the high and low Raven sessions with low discount** Left Panels: cooperation choice of the subject at t after a cooperation choice of the other player at $t-1$. Right panels: cooperation choice after a defection choice of the other player at $t-1$. The bottom panels represent sessions 3ld and 4ld where –like in the main treatment with high discount–, subjects are not informed. For sessions 3ld and 4ld only the first 20 rounds have been considered. The red lines represent the Low Raven Sessions and the blue lines represent the High Raven Sessions. The bands represent 95 % confidence intervals.

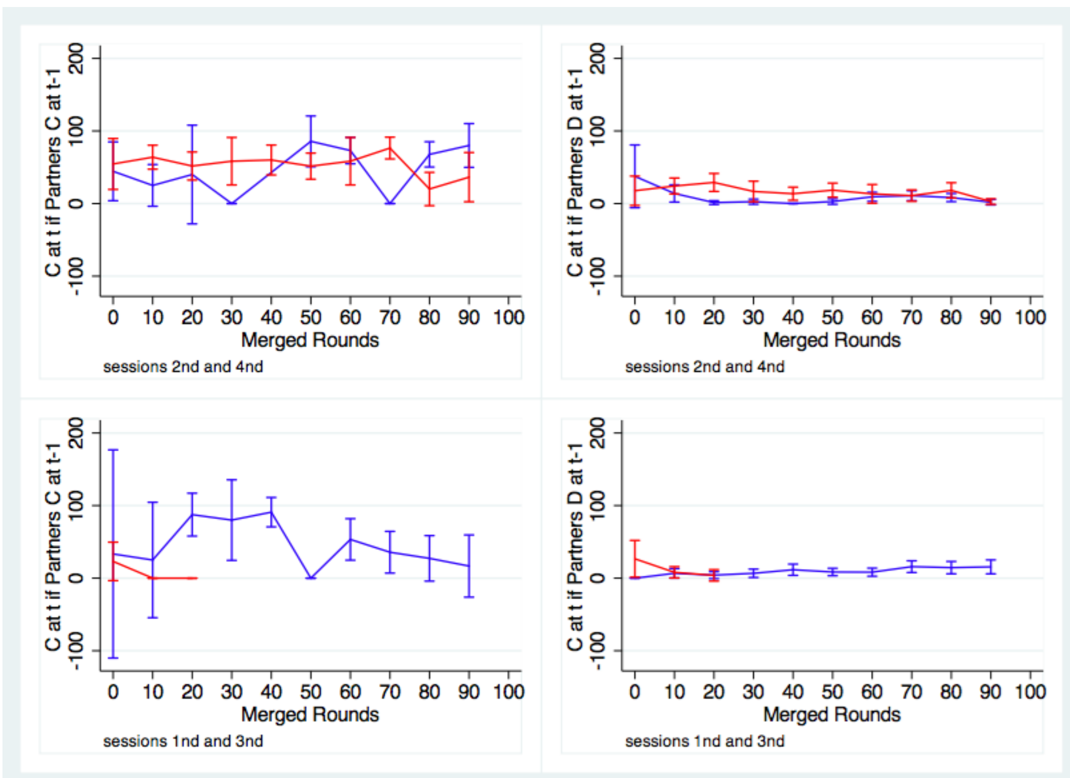
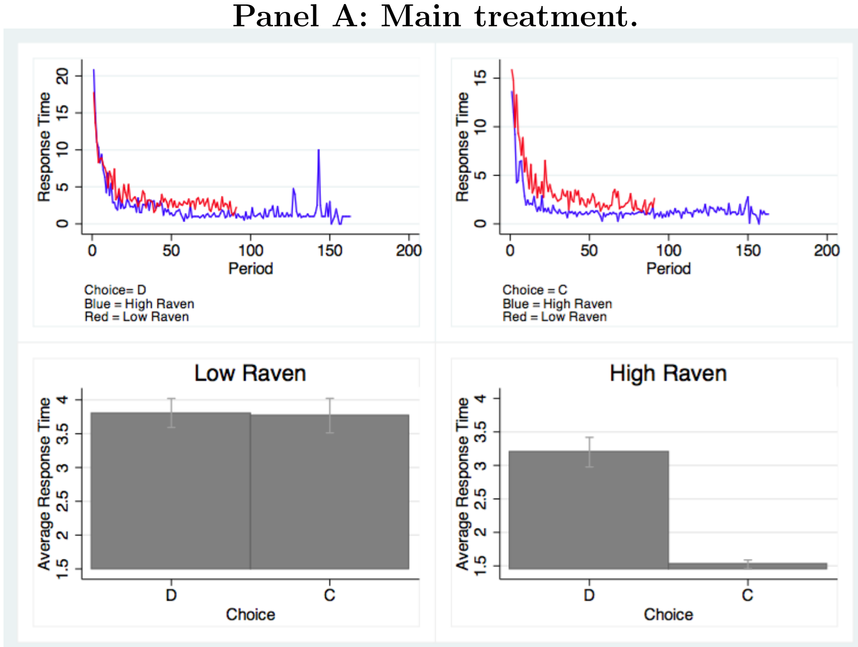
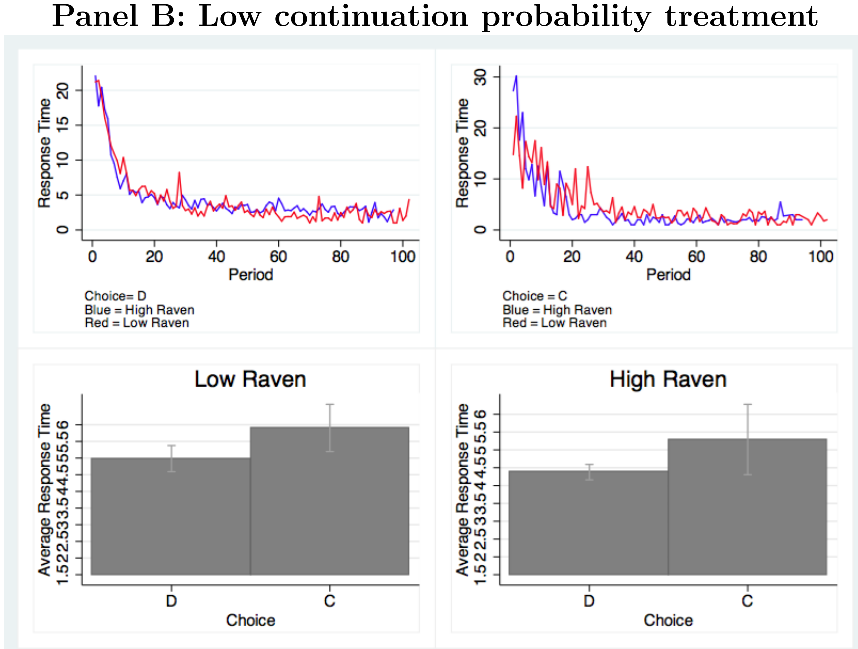


Figure 10: **Reaction Time by choice, period and Raven sessions** C denotes the Cooperation choice, D Defection. The bands represent the 95% confidence intervals.

Panel A: Main treatment.



Panel B: Low continuation probability treatment



References

[1] **Abreu, Dilip, and Ariel Rubinstein.** 1988. "The Structure of Nash Equilibrium in Repeated Games with Finite Automata." *Econometrica*, 56(6): 1259-81.

[2] **Andreoni, James., and John Miller.** 1993. "Rational Cooperation in the Repeated Prisoner's Dilemma: Experimental Evidence." *Economic Journal*, 103: 570-585.

[3] **Aoyagi, Masaki, and Guillaume Frechette**. 2009. "Collusion as Public Monitoring Becomes Noisy: Experimental Evidence." *Journal of Economic Theory*, 144(3): 1135-65.

[4] **Beauchamp, Jonathan P., David Cesarini, D. and Magnus Johannesson**. "The psychometric properties of measures of economic risk preferences". *Harvard University Working Paper*. February, 2011.

[5] **Becker, Gary S** 1973. "A theory of marriage: part I", *Journal of Political Economy* 81: 813-46.

[6] **Benjamin, Daniel J., Sebastian A. Brown, and Jesse M. Shapiro**. 2013. "Who is behavioral? Cognitive ability and anomalous preferences". *Journal of the European Economic Association*, 11(6): 1231-55.

[7] **Bernheim, B. Douglas, and Antonio Rangel** 2004. "Addiction and cue-triggered decision processes." *American Economic Review*, 94(5):1558-1590.

[8] **Blonski, Matthias, Peter Ockenfels, and Giancarlo Spagnolo.** 2011. "Equilibrium selection in the repeated prisoner's dilemma: Axiomatic approach and experimental evidence." *The American Economic Journal: Microeconomics*, 3(3):164-192.

[9] **Bowles, Samuek, Herbert Gintis, and Melissa Osborne.** 2001. "The Determinants of Earnings: Skills, Preferences, and Schooling." *Journal of Economic Literature*, 39: 1137–1176.

[10] **Brinch Christian N. and Taryn A. Galloway** , 2012. "Schooling in adolescence raises IQ scores.", *Proceeding of the National Acadedemy of Science* 109(2):425430.

[11] **Brocas, Isabelle and Juan D. Carrillo** 2008. "The Brain as a Hierarchical Organization", *American Economic Review.*

[12] **Burks, Stephen V., Jeffrey. P. Carpenter, Lorenz Goette, and Aldo Rustichini.** 2009. "Cognitive skills affect economic preferences, strategic behavior, and job attachment." *Proceedings of the National Academy of Sciences*, 106: 7745-7750.

[13] **Carpenter, P.A., Just, M.A., and Shell, P.** 1990. "What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices test". *Psychological review*, 97(3): 404-413

[14] **Chance M.R.A, Mead A.P.** 1953. "Social behaviour and primate evolution." *Symp. Soc. Exp. Biol.*, 7: 395–439.

[15] **Charness, Gary, Ado Rustichini and Jeroen van de Ven.** 2011. "Self-confidence and strategic deterrence". *Mimeo.*

[16] **Costa-Gomes, Miguel A. and Vincent P. Crawford and Bruno Broseta** 2001. "Cognition and behavior in normal-form games: An experimental study". *Econometrica*, 69(5): 11931235

[17] **Costa-Gomes, Miguel A. and Vincent P. Crawford**. 2006. "Cognition and Behaviour in Two-Person Guessing Games: An Experimental Study." *American Economic Review*, 96(5): 1737-1768.

[18] **Dal Bò, Pedro.** 2005. "Cooperation under the Shadow of the Future: Experimental Evidence from Infinitely Repeated Games." *American Economic Review*, 95(5): 1591-1604.

[19] **Dal Bò, Pedro, and Guillaume R. Frechette.** 2013. "Strategy Choice In The Infinitely Repeated Prisoners." *Unpublished Manuscript*, `https://files.nyu.edu/gf35/public/print/Dal_Bo_2013b.pdf`

[20] **Dal Bò, Pedro, and Guillaume R. Frechette.** 2011. "The Evolution of Cooperation in Infinitely Repeated Games: Experimental Evidence." *American Economic Review*, 101: 411–429

[21] **Dohmen, Thomas, Armin Falk, David Huffman and Uwe Sunde** 2010. "Are risk aversion and impatience related to cognitive ability?" *American Economic Review*, 100(3):1238-1260.

[22] **Duffy, John, and Jack Ochs.** 2009. "Cooperative Behavior and the Frequency of Social Interaction." *Games and Economic Behavior*, 66(2): 785-812.

[23] **Dunbar, Robin I.M.** 1998. "The social brain hypothesis." *Evolutionary Anthropology*, 6: 178–190.

[24] **Dunbar, Robin I.M, and Susanne Shultz.** 2007. "Understanding primate brain evolution." *Philosophical Transactions of the Royal Soc. B.*, 362, 649–658.

[25] **Feinberg, Robert M., and Thomas A. Husted.** 1993. "An Experimental Test of Discount-Rate Effects on Collusive Behaviour in Duopoly Markets." *Journal of Industrial Economics*, 41(2): 153-60.

[26] **Fishcbacher, Urs.** 2007. "z-Tree: Zurich Toolbox for Ready-made Economic Experiments." *Experimental Economics*, 10(2): 171-178.

[27] **Frederick, Shane** 2005. "On the ball: Cognitive reflection and decision-making". *Journal of Economic Perspectives*, 19(4):25-42.

[28] **Friedman, Daniel, and Ryan Oprea.** 2012. "A Continuous Dilemma." *American Economic Review*, 102(1): 337-63.

[29] **Fudenberg, Drew, and David K. Levine.** 2006. "A dual-self model of impulse control." *American Economic Review*, 96:1449-1476.

[30] **Fudenberg, Drew, David G. Rand and Anna Dreber.** 2012."Slow to Anger and Fast to Forgive: Cooperation in an Uncertain World." *American Economic Review*, 102(2): 720-749

[31] **Golub, Benjamin, and Matthew Jackson** 2012. "Network structure and the speed of learning: measuring homophily based on its consequences", *Annals of Economics and Statistics*,107/108 July-Dec.

[32] **Gottfredson, Linda S.** 1997. "Why g Matters: The Complexity of Everyday Life." *Intelligence*, 24(1): 79-132

[33] **Gill, David and Victoria Prowse** 2014. "Cognitive Ability, Character Skills, and Learning to Play Equilibrium: A Level-k Analysis" *Oxford Department of Economics Discussion Paper* 712.

[34] **Heckman, James J.** 2006. "Skill formation and the economics of investing in disadvantaged children". *Science*312(5782):19001902

[35] **Heckman, James J., Seong Hyeok Moon, Rodrigo Pinto, Peter A. Savelyev** , 2013 "Understanding the Mechanisms Through Which an Influential Early Childhood Program Boosted Adult Outcomes". *American Economic Review*, 103(6): 2052-2086.

[36] **Heckman James J., Jora Stixrud and Sergio Urzua** 2006. "The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior." *Journal of Labor Economics*, 24(3): 411-482

[37] **Holt, Charles A.** 1985. "An Experimental Test of the Consistent-Conjectures Hypothesis." *American Economic Review*, 75(3): 314-25.

[38] **Holt, Charles A. and Susan K. Laury.** 2002. "Risk Aversion and Incentive Effects." *American Economic Review*, 92(5): 1644-1655

[39] **Humphrey, Nicholas.** 1976. "The social function of intellect." In *Growing points in ethology,* ed. Patrick P. G. Bateson and Robert A. Hinde, 303-317. UK:Cambridge University Press.

[40] **John, Oliver P., Laura P. Naumann, and Christopher J. Soto.** 2008. "Paradigm shift to the integrative Big Five trait taxonomy: History, Measurement and conceptual issue." In *Handbook of personality: Theory*

and Research, ed. Oliver P. John, Richard W. Robins and Lawrence A. Pervin, 114-158. New York: Guildford Press.

[41] **John, Oliver P., E. M. Donahue, and R. L. Kentle.** 1991. "The Big Five Inventory - Versions 4a and 54." Berkley, CA: University of California, Berkeley, Institute of Personality and Social Research.

[42] **Jolly, Alison.** 1966. "Lemur social behavior and primate intelligence." *Science*, 153: 501–506

[43] **Jones, Garett .** 2008. "Are smarter groups more cooperative? Evidence from prisoner's dilemma experiments, 1959-2003," *Journal of Economic Behavior and Organization*, 68(3-4): 489–497.

[44] **Jones, Garett, and W. Joel Schneider.** 2010. "IQ in the production function: evidence from immigrant earnings." *Economic Inquiry*, 48: 743–755.

[45] **Larson, Gerald E., Dennis P. Saccuzzo, and James Brown.** 1994. "Motivation: Cause Or Confound in Information processing/intelligence Correlations?" *Acta Psychologica* 85(1):2537.

[46]

[47] **Loewenstein, George, and Ted O'Donoghue.** 2005. "Animal spirits: Affective and deliberative processes in economic behavior". *Cornell University Mimeograph.*

[48] **Legros, Patrick and Andrew F. Newman,** 2002, "Monotone Matching in Perfect and Imperfect Worlds" *Review of Economic Studies*, 69:4, 925-942

[49] **McPherson, M., Smith-Lovin, L., and Cook, J.** 2001. "Birds of a feather: homophily in social networks." *Annual Review of Sociology* 27, 415-44.

[50] **Neal, Derek A., and Johnson, William R.** 1996. "The Role of Pre-market Factors in Black-White Wage Differences." *Journal of Political Economy*, 104(5): 869–895.

[51] **Neisser, Ulric, Gwyneth Boodoo, Thomas J. Bouchard Jr., A. Wade Boykin, Nathan Brody, Stephen J. Ceci, Diane F. Halpern, John C. Loehlin, Robert Perloff, Robert J. Sternberg and Susana Urbina.** 1996. "Intelligence: Knowns and unknowns". *American Psychologist*, 51 (2): 77.

[52] **Oechssler, Jorg, Andreas Roider and Patrick W. Schmitz.** 2009. "Cognitive abilities and behavioral biases". *Journal of Economic Behavior and Organization*, 72(1): 147-152

[53] **Palfrey, Thomas R., and Howard Rosenthal.** 1994. "Repeated Play, Cooperation and Coordination: An Experimental Study." *Review of Economic Studies*, 61(3): 545-65.

[54] **Roth, Alvin E., and J. Keith Murnighan.** 1978. "Equilibrium behavior and repeated play of the prisoner's dilemma." *Journal of Mathematical Psychology*, 17(2): 189–198.

[55] **Rubinstein, Ariel.** 1986. "Finite Automata Play the Repeated Prisoner's Dilemma." *Journal of Economic Theory*, 39(1): 83-96

[56] **Selten, Reinhard and Rolf Stoecker.** 1986 "End Behaviour in Sequences of Finite Prisoner's Dilemma Supergames: A Learning Theory Approach." *Journal of Economic Behaviour and Organisation*, 7, 47-70.

[57] **Stahl, Dale O.** 1991. "The Graph of Prisoners' Dilemma Supergame Payoffs as a Function of the Discount Factor." *Games and Economic Behavior*, 3(3): 368-84.

[58] **Stahl, Dale O. and Paul W. Wilson** 1995. "On players' models of other players: Theory and experimental evidence". *Games and Economic Behavior*, 10(1): 218-254

Appendix

Timeline of the Experiment

Day One

1. Participants were assigned a number indicating session number and specific ID number. The specific ID number corresponded to a computer terminal in the lab. For example, participant on computer number 13 in session 4 received the number: 4.13.

2. Participants sat at their corresponding computer terminals which were in individual cubicles.

3. Instructions about the Raven task were read together with an explanation on how the task would be paid.

4. The Raven test was administered (30 matrices for 30 seconds each matrix). Three randomly chosen matrices out of 30 tables were paid by the rate of 1 GBP per correct answer.

5. The Holt-Laury task was explained on a white board with an example, as well as the payment for the task.

6. The Holt-Laury choice task was completed by the participants (10 lottery choices). One randomly chosen lottery out of 10 played out and paid (Subjects in sessions 1 & 2 did NOT have this).

7. The questionnaire was presented and filled out by the participants.

Between Day One & Two

1. Allocation to *high* and *low* groups made. An email was sent out to all participants listing their allocation according to the number they received before starting Day One.

Day Two

1. Participants arrived and were given a new ID corresponding to the ID they received in Day One. The new ID indicated their new computer terminal number to which they were sat at.

2. The prisoner's dilemma game was explained on a white board as was the way the matching between partners, the continuation probability and how the payment would be made.

3. The infinitely repeated prisoner's dilemma game was played. Each experimental unit earned corresponded to 0.004 GBP.

4. Questionnaire was presented and filled out by the participants.

5. Calculation of payment was made and subjects were paid accordingly.

Dates and Details

Tables A.1 and A.2 below illustrate the dates and timings of each session. In the top panels the total number of subjects that participated in the Day 1 of the experiment is listed and by comparing with the corresponding 'Total Returned' column from the bottom panels it becomes apparent that there is relatively small attrition between Day 1 and Day 2. For example for the main treatment, only 10 subjects over 140 did not return on Day 2.

Table A.1: **Dates and details for main treatment**

Day 1: Group Allocation

	Date	Time	Subjects
1	18/06/2013	10:00	15
2	18/06/2013	11:00	19
Total			34
3	5/11/2013	11:00	18
4	5/11/2013	12:00	18
Total			36
5	26/11/2013	10:00	18
6	26/11/2013	11:00	17
7	26/11/2013	12:00	18
8	26/11/2013	13:00	17
Total			70

Day 2: Cooperation Task

	Date	Time	Subjects	Group
Session 1	20/06/2013	10:00	14	High Raven
Session 2	20/06/2013	11:30	16	Low Raven
Total Returned			30	
Session 3	7/11/2013	11:00	18	High Raven
Session 4	7/11/2013	12:30	16	Low Raven
Total Returned			34	
Session 5	27/11/2013	13:00	18	High Raven
Session 6	27/11/2013	14:30	12	Low Raven
Session 7	28/11/2013	13:00	16	High Raven
Session 8	28/11/2013	14:30	20	Low Raven
Total Returned			66	

Table A.2: **Dates and details for low continuation probability treatment**

Day 1: Group Allocation

	Date	Time	Subjects
1	11/06/2013	10:00	17
2	11/06/2013	11:00	17
3	11/06/2013	12:00	19
4	11/06/2013	13:00	14
Total			67

Day 2: Cooperation Task

	Date	Time	Subjects	Group
Session 1ld	13/06/2013	10:00	14	High Raven
Session 2ld	13/06/2013	11:30	16	Low Raven
Session 3ld	13/06/2013	13:00	16	High Raven
Session 4ld	13/06/2013	14:30	14	Low Raven
Total Returned			60	

Table A.3: Low Raven Sessions, Main Variables

Variable	Mean	Std. Dev.	Min.	Max.	N
Choice	0.426	0.494	0	1	5332
Partner Choice	0.428	0.495	0	1	5332
Age	22.345	4.693	18	51	5332
Female	0.624	0.484	0	1	5332
Period	42.264	24.242	1	91	5332
Openness	3.639	0.527	2.5	5	5332
Conscientiousness	3.404	0.645	2	5	5332
Extraversion	3.35	0.729	1	4.75	5332
Agreableness	3.84	0.583	2	4.778	5332
Neuroticism	2.899	0.8	1	5	5332
Raven	14.367	2.709	6	18	5332
Economist	0.06	0.238	0	1	5332
Risk Aversion	5.559	1.149	3	8	4052
Final Profit	2774.297	397.304	1731	3628	64
Profit x Period	33.269	4.216	21.638	45.075	64
Total Periods	83.313	4.272	80	91	64

Table A.4: High Raven Sessions, Main Variables

Variable	Mean	Std. Dev.	Min.	Max.	N
Choice	0.694	0.461	0	1	7688
Partner Choice	0.694	0.461	0	1	7688
Age	20.865	2.746	18	36	7688
Female	0.461	0.499	0	1	7688
Period	65.538	42.27	1	163	7688
Openness	3.612	0.59	1.9	4.9	7688

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... table A.4 continued

Variable	Mean	Std. Dev.	Min.	Max.	N
Conscientiousness	3.361	0.739	1.444	4.889	7688
Extraversion	3.228	0.738	1.875	4.5	7688
Agreableness	3.768	0.621	2.333	5	7688
Neuroticism	2.799	0.72	1.25	4.5	7688
Raven	20.331	1.947	16	25	7688
Economist	0.121	0.326	0	1	7688
Risk Aversion	5.541	1.721	2	9	6064
Final Profit	4675.303	2034.416	1447	7752	66
Profit x Period	38.547	5.834	25.386	47.558	66
Total Periods	116.485	40.093	57	163	66

Table A.5: High Raven Session 1ld , Main Variables

Variable	Mean	Std. Dev.	Min.	Max.	N
Choice	0.143	0.35	0	1	1407
Partner Choice	0.143	0.35	0	1	1407
Age	22.688	2.418	18	27	1407
Female	0.5	0.5	0	1	1407
Period	44.531	25.393	1	88	1407
Openness	3.481	0.373	2.7	4.2	1407
Conscientiousness	3.291	0.556	2.111	4.222	1407
Extraversion	3.235	0.716	1.875	4.625	1407
Agreableness	3.541	0.58	2.444	4.444	1407
Neuroticism	2.789	0.625	1.875	4.25	1407
Raven	19.439	1.368	18	22	1407
Economist	0.25	0.433	0	1	1407
Final Profit	2401	151.452	2076	2655	15

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... table A.5 continued

Variable	Mean	Std. Dev.	Min.	Max.	N
Profit x Period	27.284	1.721	23.591	30.17	15
Total Periods	88	0	88	88	15

Table A.6: Low Raven Session 2ld , Main Variables

Variable	Mean	Std. Dev.	Min.	Max.	N
Choice	0.299	0.458	0	1	1428
Partner Choice	0.299	0.458	0	1	1428
Age	23.286	4.08	18	34	1428
Female	0.714	0.452	0	1	1428
Period	51.5	29.454	1	102	1428
Openness	3.736	0.461	3.2	4.600	1428
Conscientiousness	3.857	0.663	2.889	5	1428
Extraversion	3.732	0.526	2.625	4.375	1428
Agreableness	4.024	0.570	2.889	4.778	1428
Neuroticism	2.429	0.919	1.125	4.625	1428
Raven	13.429	3.757	5	17	1428
Economist	0.071	0.258	0	1	1428
Final Profit	3040.143	213.331	2670	3450	14
Profit x Period	29.805	2.091	26.176	33.824	14
Total Periods	102	0	102	102	14

Table A.7: High Raven Sessions 3ld, Main Variables

Variable	Mean	Std. Dev.	Min.	Max.	N
Choice	0.116	0.32	0	1	1552
Partner Choice	0.116	0.32	0	1	1552
Age	22.5	1.937	18	26	1552
Female	0.75	0.433	0	1	1552
Period	49	28.009	1	97	1552
Openness	3.45	0.52	2	4.3	1552
Conscientiousness	3.674	0.504	3	4.667	1552
Extraversion	3.344	0.637	2.125	4.25	1552
Agreableness	3.819	0.602	2.222	4.667	1552
Neuroticism	2.758	0.638	1.75	3.75	1552
Raven	19.375	1.495	17	22	1552
Economist	0.313	0.464	0	1	1552
Final Profit	2601.25	126.24	2380	2810	16
Profit x Period	26.817	1.301	24.536	28.969	16
Total Periods	97	0	97	97	16

Table A.8: Low Raven Sessions 4ld, Main Variables

Variable	Mean	Std. Dev.	Min.	Max.	N
Choice	0.163	0.37	0	1	294
Partner Choice	0.163	0.37	0	1	294
Age	21.071	2.157	18	25	294
Female	0.5	0.501	0	1	294
Period	11	6.066	1	21	294
Openness	3.679	0.72	2.3	4.9	294
Conscientiousness	3.54	0.542	2.222	4.444	294

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... table A.8 continued

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Extraversion	3.268	0.707	2.25	4.625	294
Agreableness	3.619	0.387	3.111	4.222	294
Neuroticism	2.839	0.859	1.625	4	294
Raven	14.286	2.123	10	17	294
Economist	0.214	0.411	0	1	294
Final Profit	575.571	79.642	480	750	14
Profit x Period	27.408	3.792	22.857	35.714	14
Total Periods	21	0	21	21	14

Table A.9: Correlations Table (p$-$*values* in brackets)

Variables	Raven	Female	Risk Aversion	Openness	Conscientiousness	Extraversion	Agreableness	Neuroticism
Raven	1.000							
Female	-0.160	1.000						
	(0.068)							
Risk Aversion	0.030	-0.039	1.000					
	(0.764)	(0.699)						
Openness	-0.152	-0.017	-0.086	1.000				
	(0.084)	(0.844)	(0.396)					
Conscientiousness	0.085	0.004	0.073	0.157	1.000			
	(0.337)	(0.965)	(0.470)	(0.075)				
Extraversion	-0.076	-0.086	0.004	0.319	0.054	1.000		
	(0.391)	(0.330)	(0.970)	(0.000)	(0.539)			
Agreableness	-0.020	-0.052	-0.106	0.183	0.269	0.183	1.000	
	(0.823)	(0.554)	(0.296)	(0.038)	(0.002)	(0.037)		
Neuroticism	-0.036	0.424	0.072	-0.130	-0.305	-0.315	-0.351	1.000
	(0.684)	(0.000)	(0.478)	(0.141)	(0.000)	(0.000)	(0.000)	

Table A.10: **Individual strategies in the different Raven sessions in the last 5 and first 5 repeated games** Each coefficient represents the probability estimated using ML of the corresponding strategy. Std Error is reported in brackets. Gamma is the error coefficient that is estimated for the choice function used in the ML and beta is the probability estimated that the choice of a subject is equal to what the strategy prescribes.[†] Tests equality to 0 using the Waldtest: * $p-values < 0.1$, ** $p-values < 0.05$ **, $p-values < 0.01$ ***

Raven Session	High	Low	High	Low
Repeated Games	Last 5	Last 5	First 5	First 5
Strategy				
Always Cooperate	0	0	0	0.0410
	(0.0055)	(0.0079)	(0.0068)	(0.0436)
Always Defect	0.0417	0.4130***	0.3165***	0.3107***
	(0.0318)	(0.1024)	(0.1076)	(0.0884)
Grim after 1 D	0.3269***	0.1069*	0.5374**	0.2226***
	(0.1050)	(0.0646)	(0.1144)	(0.0772)
Tit for Tat (C first)	0.2316**	0.2890***	0	0.2396***
	(0.1059)	(0.0774)	(0.0790)	(0.0673)
Tit For Tat (D First)	0.0000	0.0600	0.0478**	0.0819
	(0.0010)	(0.0457)	(0.0480)	(0.0649)
Win Stay Lose Shift	0.0623	0	0.0377	0.0159
	(0.0660)	(0.0548)	(0.0423)	(0.0549)
Grim after 2 D	0.0000	0	0.0313	0
	(0.0553)	(0.0100)	(0.0533)	(0.0378)
Tit for Tat (after D D C)††	0.1201*	0.0953**	0.0000	0.0739
	(0.0616)	(0.0453)	(0.0139)	(0.0979)
Tit For Tat (after D C C) †††	0.1223	0	0.0000	0
	(0.0864)	(0.0129)	(0.0207)	(0.0332)
Tit For Tat (after D D C C)	0	0	0.0292	0
	(0.0302)	(0.0584)	(0.0528)	(0.0021)
Grim after 3 D	0.0951	0	0.0000	0
	(0.0645)	(0.0042)	(0.0124)	(0.0402)
Tit For Tat (after D D D C)	0	0.0358	0	0
Gamma	0.3179***	0***	0***	0.0410***
	(0,0553)	(0.0079)	(0.0068)	(0.0436)
beta	0.959	0.936	0.881	0.839
Sessions	1,5,7	2,4, 6, 8	1,5,7	2,4,6, 8
Average Rounds	4.83	5.12	2.11583	3.875
N. Subjects	48	64	48	64
Observations	1090	1676	518	1152

† When beta is close to 1/2 choices are essentialy random and when it's close to 1 then choices are almost perfectly predicted.

†† Tit for Tat (after D D C) stands for the lenient Tit for Tat strategy that punishes only after observing two defections from the partner and returns to cooperation after observing cooperation once.

††† Tit for Tat (after D C C) stands for the Tit for Tat strategy that punishes after 1 defection but only returns to cooperation after observing cooperation twice from the partner.