Theory of Mind and Strategic Decision-Making

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Abstract

In a laboratory experiment, 338 participants were asked to communicate in pairs and then play two games with their partners: the 11-20 money game (a common tool for assessing level-k reasoning) and a public goods game. Their communication occurred prior to any knowledge of what is to follow, but nevertheless seemed to play an important role in allowing them to develop theories of the sort of person they face ("theory of mind") which turned out to be important explanatory factors in the analysis of game play. We tested both their awareness of the personality and intelligence of their partner, how they play in the games and also analysed the language that they used during communication. The results indicate that beliefs about others "type" is biased by one's own type. In particular, extraverts, who are characterised by their positive emotions, project their extraversion or positive emotions onto their partners. The level-k strategy chosen in the 11-20 money game is impacted by the perceived similarity between player and their partner's type. The smaller the perceived difference, the higher the level-k strategy chosen. In the public goods game, players cooperated more when they believed their partners to be extraverted, due to the positive association between trait extraversion and pro-social behaviour. The analysis of the text used during communication sheds some light on how participants draw inferences about their partner's type: for instance the use of more words is strongly associated with being an extravert.

JEL codes: D91, D83, C92.

Keywords: theory of mind, cheap talk, communication, level k reasoning, public goods game, cooperation, extraversion, perceived similarity, self-projection bias, laboratory experiment, text analysis.

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"What is consciousness? Our brain simulates reality. So, our everyday experiences are a form of dreaming, which is to say, they are mental models, simulations, not the things they appear to be."

Stephen LaBerge.

"We perceive through our senses a person, a situation or an event, and in an instant, we project our mental models - our fears, background and experiences - onto that perception. This often results in cognitive errors, which means we judge and respond incorrectly."

Elizabeth Thornton.

1 Introduction

Imagine meeting someone for the first time, perhaps a new colleague at work. An initial conversation might leave a lasting impression, but even if not, most likely you will have started to form beliefs about the sort of person you have just met. Intelligent or dumb? Fair or biased? Extrovert or introvert? In thinking this way you have started to build a mental model of that colleague, one that will develop the more you interact or think about them and one that you can start to use to predict their behaviour. This process of mental modelling, of thinking about others' thoughts and mental states to predict their intentions and actions is commonly referred to within the psychological sciences as "Theory of Mind" (Coricelli and Nagel (2009)). The goal of this paper is to analyse the role played by subjects' *theory of mind* while making strategic decisions in outcome interdependent games.

The paper uses an experimental approach to show how communication prior to strategic interaction leads to the development of *theory of mind* (ToM) or mental models of others. These mental models are then used to judge or infer the intentions or likely behaviour of others. Based on this inference, players decide their own strategy.

Communication or 'cheap talk' before strategic interaction has been observed to affect behaviour. For example, communication in social dilemmas can increase the frequency with which people choose joint income-maximising strategies, even when player have conflicting interests (Ostrom, Walker, and Gardner (1992); Bochet, Page, and Putterman (2006); Dawes, McTavish, and Shaklee (1977); Krupka, Leider, and Jiang (2017)). Communication can increase the play of the efficient equilibrium strategy in coordination games (Kriss, Blume, and Weber (2016); Blume and Ortmann (2007); Cooper, DeJong, Forsythe, and Ross (1992, 1989)). Communication has also been known to affect behaviour in dictator games (Andreoni and Rao (2011)), trust games (Charness and Dufwenberg (2006))

and others (Ellman and Pezanis-Christou (2010)).

A common feature of all these studies is that the nature of the strategic decision to be made was known to all parties involved during communication. Under such a scenario, communication before playing outcome interdependent games leads to the formation of non-binding informal agreements. Although, these agreements are non-binding there is a cost incurred while breaking them. Several studies have suggested different rationales for this cost such as social norms (Kessler and Leider (2012)), guilt aversion (Charness and Dufwenberg (2006)) and lying aversion (Ellingsen and Johannesson (2004)). Now, what happens if the nature of the decision to be made was unknown while individuals interacted? If the rules of the game are unknown to the players it's harder to form an informal contract. Will communication still affect decision making? The paper proposes that communication will still impact decision making and the reason is that while communicating with others, players develop theory of mind or beliefs about each other. These beliefs, in turn, impact decision making.

The study measures ToM using a direct and an indirect approach. The direct approach involves asking the subjects to take the 'Reading the Mind in Eyes Test' (Baron-Cohen, Wheelwright, Hill, Raste, and Plumb (2001)). In this test, each subject has to select the best description of an actor's mental state from a photograph of their eye region. The indirect approach involves asking subjects for their beliefs about their opponent's cognitive and non-cognitive abilities, as well as beliefs about their actions in the experiment. Beliefs about non-cognitive abilities are elicited by means of beliefs about the partner's personality, where as beliefs about cognitive abilities are measured by asking about beliefs about partner's performance in an IQ task. Personality is categorized into 5 traits or the Big Five personality (John and Srivastava (1999)) traits. Of the Big Five, the paper focusses on the two fundamental traits, Extraversion and Neuroticism (Costa and McCrae (1980), Guilford, Zimmerman, and Guilford (1976), Cattell (1973)). Sociability, enthusiasm, tempo and vigour, observed among high trait extraversion individuals, is linked with high positive affect. On the other hand, temperamental traits of emotionality, fearfulness, hostility and impulsivity, associated with trait neuroticism, is related to high negative affect.

ToM has two distinct components - a social perceptual component and a social cognitive component (Sabbagh (2004), Tager-Flusberg and Sullivan (2000)). The social-perceptual component of ToM is the ability to detect the mental states of others, by using immediately available cues such as facial expressions and bodily movements. The Eyes Test is a widely used measure of the social perceptual component of ToM. The social-cognitive component is related to the ability to reason about the content of another individual's mental state and use it to predict or explain their behaviour. While the social

cognitive element of ToM is associated with one's personality and sex, the social perceptual component is independent of both (Nettle and Liddle (2008)). Measurement of the social-cognitive component of ToM generally involves hearing stories or scenarios, and making correct inferences about what the individuals involved know or believe. Hence, while the direct measure of ToM used in this experiment measures the social perceptual component, the indirect measure is more in line with the social cognitive component.

To omit learning effects the experiment is restricted to one-shot games. In order to examine the generality of the findings the design involves two different one-shot games. The games used are a two-person public goods game (PGG) and the 11-20 money request game. While the former examines social preferences, the 11-20 money request game (Arad and Rubinstein (2012)) is a simple two player game which triggers level-k reasoning. The Public Goods game offers the perfect setup to analyse how decisions involving social preferences are affected, based on beliefs formed about others in a social dilemma. A real world example of this would be a person in a long-term relationship trying to make a decision, like booking a table at a restaurant for a surprise dinner with their partner, while trying to figure out if the partner will be happy with the restaurant choice. If the partner likes the restaurant, then it increases the utility of both individuals. The 11-20 game on the other hand provides the perfect framework for examining strategic decision where people try to out reason or out think one another. A real world example for this would be campaigning decisions by political parties before elections.

The design allows for interaction between partners before the tasks. Players are allowed to chat with each other though a chat box on their screens. It is hypothesized that the language used during interaction between partners is the tool through which players develop theory of mind. So analysis of the text used by players, during the experiment, is expected to shed light on how theory of mind or beliefs about others is developed.

This paper broadly contributes to the following branches of research. The first branch of literature analyses the impact of theory of mind on strategic decision making (Fe and Gill (2018); Yoshida, Dolan, and Friston (2008); Coricelli and Nagel (2009)). Such studies measure theory of mind using existing psychometric tests such as Imposing Memory Task (Fe and Gill (2018)), Heider-Simmel test (Bruguier, Quartz, and Bossaerts (2010)) and Eyes Test (De Martino, O'Doherty, Ray, Bossaerts, and Camerer (2013)). This paper, on the other hand, uses a new and indirect approach to measure theory of mind. This indirect method is concerned with capturing the mental model or beliefs one forms while interacting with an individual.

Secondly, the paper contributes to the literature on strategic sophistication which finds that individuals adjust strategies given the information they have about the opponents (Fe and Gill (2018); Gill and Prowse (2014); Georganas, Healy, and Weber (2015)).

In the existing literature, people have been known to adjust strategies based on *exogenous* information provided, or information learnt through repeated play and feedback. For example, Fe and Gill (2018) conduct an experiment where child subjects are told whether their opponent has above or below median cognitive ability. The authors find that older children are more likely to adjust behaviour in a level-k reasoning game, based on the exogenous information provided to them about their opponent's cognitive ability. This paper is novel because it examines how individuals adjust their behaviour due to *endogenous* belief formation about the opponent.

Third, this paper is related to the literature on communication before strategic decision making (Krupka, Leider, and Jiang (2017); Bochet, Page, and Putterman (2006); Dawes, McTavish, and Shaklee (1977)). This paper studies how communication between players, before a decision making game, can affect behaviour even if the nature of the decision to be made (or the rules of the game) is unknown to the players at the time of interaction. The study also adds to the literature on examining the role of personality theory in strategic decision making. Several studies have highlighted the role of own personality on decision making, especially those involving cooperation (Proto and Rustichini (2014); Johnson, Rustichini, and MacDonald (2009); Hirsh and Peterson (2009)). This paper's novel contribution lies in it's examination of the role of beliefs about the partner's personality in strategic decision making.

The final strand of literature deals with the relationship between language and personality. The role of language as a powerful indicator of personality has been suggested by Pennebaker and King (1999), Furnham (1990), Weintraub (1989), Scherer and Giles (1979) and Sanford (1942). This study contributes to this field by proposing that language used by an individual is the tool through which beliefs are formulated about them by others.

The paper finds that, beliefs about partner's personality are biased by the player's own personality. An extraverted person, who is subject to positive emotions, fosters a positive social environment (Eaton and Funder (2003)) and judges neutral events more positively (Uziel (2006)). She is prone to *complementary self projection bias* which causes her to project her positivity onto people she interacts with. This projection of positive emotions also causes her to overlook the negativity in others. Thus, extraverts find their partners to be more extraverted and less neurotic. With regards to accuracy of beliefs, a brief chat is sufficient only to accurately detect the trait extraversion in others.

Level chosen in the 11-20 money request game is impacted by perceived similarity, or differences, between the player and their partner's extraversion. The smaller the perceived difference, the higher the level-k strategy chosen. This result is consistent with the *perceived similarity hypothesis* which states that people believe, that those similar

to themselves will act like them when faced with a similar situation. Hence, when the partner is believed to be similar to oneself (i.e. when the perceived difference between the player and the partner's personality is small), the player chooses a higher level-k strategy, believing that the partner will reason similarly and choose a higher level themselves. This makes it harder for a player to best respond to the distribution of level-k beliefs when the perceived difference between the player and the partner is small, as it becomes harder to out think the opponent.

Furthermore, cooperation levels in public goods game increase when the partner is believed to be extraverted. This is presumably due to the association of trait extraversion with pro-social behaviours like cooperation (Graziano and Eisenberg (1997); Graziano (1994)). The player's own extraversion on the other hand has a negative effect on cooperation. This is consistent with literature (Koole, Jager, van den Berg, Vlek, and Hofstee (2001); McNeil (1995); Mills, Robey, and Smith (1985)) that also find a negative effect of extraversion on cooperation. The reason is that introverts, and not extroverts, cooperate more in an attempt to avoid confrontation owing to non-cooperation. Besides, beliefs about partner's extraversion has a greater effect on cooperation decision relative to own extraversion.

The analysis of the text used during communication sheds some light on how participants draw inferences about their partner's type. Partners who use more number of words and words which evoke more arousal and dominance are believed to be extraverted. On the other hand, partners who use fewer words, words with lower valence, arousal and dominance content and more abstract rather than concrete words are associated with trait neuroticism.

To summarise, the novel contributions of this study are examining if different measures of theory of mind are effective in explaining strategic decision making and to what extent one's beliefs about their opponents can be biased by their own characteristics. While psychometric measures of ToM have recently gained prominence as an explanation for level-k reasoning, to the best of the authors' knowledge there are no existing papers investigating the role of theory of mind - as measured via beliefs about opponent's cognitive and non-cognitive abilities - in choices reflecting level-k reasoning as well as social preferences. Nor is their any work examining how such beliefs are formed.

The rest of the paper is structured as follows: Section 2 proposes a simple framework for belief formation and decision-making. Section 3 details the experiment design used to test the hypotheses formulated by the authors. Section 4 presents the results obtained from analysing the experimental data. Section 5 analyses the language used by the players during pre-game communication. Section 6 concludes.

2 A Simple Framework

2.1 Framework for Belief formation

Let a_i be the ability of individual i, either non-cognitive or cognitive, as reported by i themselves. For non-cognitive abilities, a_i is the personality of individual i as reported by them in the personality questionnaire. It should be noted that, personality, includes all five traits (Big Five) - Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness - into which each individual's personality is categorized. For cognitive abilities, a_i is the fluid intelligence of individual i as measured via a cognitive ability test. Individual i chats with partner j before performing two one shot tasks. Through the medium of this chat, i forms certain beliefs or predictions about partner j's non-cognitive and cognitive abilities. These beliefs help i infer or predict j's behaviour during the course of the experiment.

At the end of the chat, i is asked questions to elicit her beliefs about partner j's personality and IQ. For a rational individual i, her beliefs about the personality or IQ of partner j, $E_i(a_j)$, should depend solely on partner j's personality or IQ, as given by j's true abilities a_j. So an *unbiased* belief would be:

$$E_i(a_j) = f(a_j) + e_i \tag{1}$$

Where, $f()$ is a general function to show how j's abilities affects i's beliefs about j, and e_i is an error term.

This paper, however, proposes that, the beliefs formed by i about partner j, are *not* unbiased. The beliefs are, to some extent, *biased* by i's own personality or IQ, a_i. Thus, the beliefs should be given by:

$$E_i(a_j) = f(a_j) + g_i(a_i) + \epsilon_i \tag{2}$$

Where g_i is a function which governs the extent to which predictions are biased by one's own personality or IQ. It should be noted that g_i is not necessarily equal to g_j, meaning that impact of own personality or IQ on beliefs about the partner, varies across individuals. Thus, for example, an extravert, will perceive the personality of her partner differently, compared to an introvert. The underlying idea, here, is that a chat between partners, shapes i's views about j and j's views about i, differently. This difference in perception is explained by individual differences in the players' characteristics.

Without loss of generality, equation 2 can be re-written as:

$$E_i(a_j) - a_j = h_i(a_i) + error_i \tag{3}$$

where $E_i(a_j) - a_j$ is the inaccuracy in beliefs formed. This inaccuracy variable measures the quantity by which players *overstate* or *exaggerate* their partners' personalities or IQ. The function $h_i()$ modulates the extent to which i overstates j's personality traits or IQ.

2.2 *Framework for Decision-making*

Conventionally, decision making has been associated with an individual's abilities like intelligence, individual characteristics like gender, age etc. and preferences such as risk preferences and time preferences. In recent economic literature, personality theory has gained prominence in explaining decision making (Rustichini, DeYoung, Anderson, and Burks (2016); Proto and Rustichini (2014); Johnson, Rustichini, and MacDonald (2009)). Thus, individual i's decision in a task, depends not only on their cognitive abilities but also their non-cognitive abilities i.e. personality. These cognitive and non-cognitive abilities are represented by a_i. The decision will also be affected by other factors guiding i's judgement, such as age, gender, IQ, risk preferences, etc., all grouped under z_i. Thus:

$$Choice_i = \lambda(a_i) + z_i + \mu_i \tag{4}$$

Where, $\lambda()$ is a function explaining the impact of i's non-cognitive and cognitive abilities on i's decision and μ_i is a white noise error.

This paper takes a step further and proposes that, individual i's decision in any task, is not *just* explained by i's own abilities. The decision *also* depends on i's beliefs about partner j's non-cognitive and cognitive abilities i.e. $E_i(a_j)$. So equation 4 is modified as:

$$Choice_i = \lambda(a_i) + \gamma(E_i(a_j)) + z_i + \varepsilon_i \tag{5}$$

Where, $\gamma()$ is a function controlling the impact of beliefs about partner j's personality and IQ, on player i's decision, and ε_i is the error term.

Further, as proposed earlier, i's beliefs about j's abilities is not solely dependent on j's true abilities. i's perception about j's personality and IQ is also influenced by i's own personality and IQ (equation 2). Therefore, equation 5 can be re-written as:

$$Choice_i = \lambda(a_i) + \gamma(E_i(a_j)[a_j, a_i]) + z_i + \varepsilon_i \tag{6}$$

3 Experimental Design

3.1 Overview

The experiment was conducted between May and November 2018. Subjects were recruited through the SONA online recruitment system at the University of Warwick. The participants were undergraduate, postgraduate and staff members at the University. The experiment was implemented using Z-tree (Fischbacher (2007)). In total 338 subjects took part in the study, with 170 subjects in the control condition and 168 in the Treatment group. There were 17 sessions conducted, 20 subjects per session on average. An experimental session lasted for approximately 75 minutes. The average earnings from the study was £13.20, including a show-up fee of £4. The design was registered with the AEA social science registry before conducting the experiment.[1]

3.2 Procedure

At the onset of the experiment each subject was asked to take a personality test, followed by an incentivised cognitive ability test. For the personality test, the Big Five Inventory or BFI (John and Srivastava (1999)), was used. and for the cognitive ability test, the Raven Progressive Matrices test was used[2]. After the Raven test the subjects were asked their beliefs about their own performance in the test (this was incentivised as well). Following this, each subject was randomly allocated to one of two groups. Each subject was then randomly paired up with a partner from the same group. The two groups were:

1. Control: Players were not allowed to communicate with their partners in this condition. Subjects were asked to take part in a placebo task for 4 minutes (Appendix B). Then the players were asked their beliefs about their partner's non-cognitive and cognitive abilities. Beliefs about non-cognitive abilities or personality traits were elicited using an 11 item short version of the BFI questionnaire, proposed by Rammstedt and John (2007). For beliefs related to cognitive abilities subjects were asked their beliefs about their partner's performance in the Raven task.

   After answering the questions related to beliefs, subjects were explained the rules of the first game. They were asked their beliefs about the partner's strategy followed by their own decision in the task. After completing the first task they were explained the rules of the second task or game. Similar to task 1, they were asked their beliefs about the partner's strategy and their own decision in the task. The outcome of both games were announced at the end of the experiment. All questions about

[1] The AEA registry can be found here: https://www.socialscienceregistry.org/trials/2903

[2] The raven test is a set of 30 visual puzzles designed to measure one's cognitive ability.

beliefs - beliefs about the partner's cognitive and non-cognitive abilities and beliefs about her strategies - were incentivised.

2. Treatment: The procedure in the treatment group was the same as the control except, instead of the placebo task, subjects were allowed to electronically communicate with their partners through a chat box on their screens (instructions provided in Appendix B). The communication time was limited to 4 minutes. Following communication, the players were asked to answer the same belief questions as the control group. After answering the questions, the subjects were explained the rules of the first game and asked to play the game. The process was repeated with the second task, similar to the control condition.

Following the two tasks, subjects were asked to take the *eyes test* (Baron-Cohen, Wheelwright, Hill, Raste, and Plumb (2001)) which is an advanced test of theory of mind. For this test, subjects were shown 36 photographs of just the eyes of celebrities and were provided with 4 response options (such as playful, terrified, joking etc.), per photograph. The participants were asked to pick the option which most closely described the mental state of the person in the photograph. Then, subjects were asked to answer a list of 30 questions about their risk attitude. This was the Domain Specific Risk Taking Scale or DOSPERT (Blais and Weber (2006)) which is a measure of risk aversion. Further, each subject was asked a series of demographic and other questions such as age, gender, year and course of study, prior knowledge in game theory, native language and nationality. Finally, they were be asked to rate their life satisfaction on a 7 point Likert Scale where 1 was not satisfied at all and 7 was completely satisfied.

3.3 Description of the tasks

1. *Public Goods Game*: Each subject was allocated 20 Experimental Pounds (EP) and were simultaneously asked to choose how much to contribute (c_i) to a joint project. c_i could be any integer between 0 and 20. Payoffs were determined as follows: $\pi_i = (20 - c_i) + 3/4(c_i + c_j)$ where i and j were the two players. Higher actions while more costly, were more socially beneficial. In the PGG, the selfish equilibrium is 0 and the mutually cooperative response is 20.

2. *11-20 Money Request Game*: Participants were asked to play the basic version of the game, as proposed by Arad and Rubinstein (2012). Each player was randomly matched with another player. They were both asked to request an amount of money. The amount of money had to be (an integer) between 11 and 20 experimental pounds (EP). Each player received the amount she requested. A player received an

additional amount of 20 EP if she asked for exactly one less than the other player. In this game, 20 is the salient and level-0 choice, 19 is the level-1 choice as it best responds to the level-0 strategy and so on. The game has no pure Nash equilibrium.

The order of the two tasks were randomized across sessions. Out of the 170 control group subjects, 110 subjects played the Public Goods game first followed by the 11-20 money request game and 60 subjects played it in the reverse order. Out of 168 Treatment group subjects, 106 played the Public Goods Game first and 62 played the 11-20 money request game first.

3.4 Final Payoff

Final payoff comprised of a show up fee of £4 for the entire experiment. The players also received payoffs based on performance in one of the two randomly picked tasks or games (PGG or 11-20). Furthermore, 2 questions out of the 36 questions of the Eyes Test and 2 puzzles of the 30 puzzles of the Raven test were randomly selected. For each correct choice players were rewarded £1. Lastly, the belief questions were also incentivised. The belief questions were beliefs about own cognitive ability, beliefs about partner's personality and cognitive ability and beliefs about partner's decisions in the two tasks. For the personality beliefs, 1 out of 11 questions was randomly picked and if the answer matched that of the partner, then the subject was awarded £1. For the other 4 belief questions, subject was awarded £1 for each correct answer. The payoffs of the tasks were in experimental pounds with the exchange rate as 5 EP = £1. The payoffs ranged between £6.2-20.8.

4 Results

The results are classified into 3 categories - results from belief formation, results from the 11-20 money request game and results from the public goods game. All regressions reported were run with standardised variables and the standard errors were clustered at the pair level.

4.1 Belief Formation

This section discusses what impacts the beliefs the players develop about their partner's non-cognitive and cognitive abilities. Table 1 reports the results of an OLS regression model. The dependent variable is the beliefs reported by the player about the partner's personality traits. The beliefs were elicited using the 11-item short version of the BFI as proposed by Rammstedt and John (2007). The 11-item questionnaire comprises of 2 items

each for the traits extraversion, conscientiousness, openness and neuroticism and 3 items for trait agreeableness. An average score was computed for each traits and the trait scores were then standardized (so that each trait distribution had mean 0 and standard deviation 1). The independent variables are the player's own personality scores, the partner's true personality scores, as reported by the partner, and the Treatment dummy which equals 1 if the player was in the chat condition and 0 otherwise. In accordance with the AEA registry, the paper will only focus on the results for traits extraversion and neuroticism, the two fundamental personality traits. The regression also controls for the variables subject's IQ, score in the Eyes Test, age, gender (a dummy which equals 1 if the subject was female) and risk aversion.

Table 1: Impact of own personality on beliefs about partner's personality

	Extraversion Belief				Neuroticism Belief			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OwnExtraversion × Treatment	0.2342**	0.2134*	0.2151*	0.2955**	-0.1949**	-0.1117	-0.1255	-0.0581
	(0.091)	(0.117)	(0.119)	(0.125)	(0.092)	(0.118)	(0.131)	(0.123)
OwnNeuroticism × Treatment	0.1406	0.1481	0.1512	0.1527	-0.0008	-0.0475	-0.0423	-0.0450
	(0.091)	(0.124)	(0.124)	(0.131)	(0.074)	(0.111)	(0.110)	(0.111)
PartnerExtraversion × Treatment	0.2820***	0.4097***	0.4010***	0.4188***				
	(0.081)	(0.108)	(0.110)	(0.110)				
PartnerNeuroticism × Treatment					0.1148	0.0272	-0.0005	0.0195
					(0.075)	(0.104)	(0.103)	(0.101)
Own Extraversion		0.0208	0.0606	0.0247		-0.0832	-0.0726	-0.0890
		(0.073)	(0.079)	(0.080)		(0.074)	(0.076)	(0.074)
Own Neuroticism		-0.0075	0.0078	0.0008		0.0468	0.0607	0.0705
		(0.085)	(0.086)	(0.087)		(0.084)	(0.081)	(0.082)
Partner's Extraversion		-0.1277*	-0.1242*	-0.1336*				
		(0.070)	(0.074)	(0.075)				
Partner's Neuroticism						0.0876	0.1081	0.0960
						(0.072)	(0.071)	(0.070)
Treatment	0.3768***	0.3768***	0.3490***	-0.2838	-0.5214***	-0.5214***	-0.1973	-0.5138***
	(0.098)	(0.098)	(0.100)	(0.631)	(0.104)	(0.104)	(0.558)	(0.103)
Controls	No	No	Yes	Yes	No	No	Yes	Yes
Controls × Treatment	No	No	No	Yes	No	No	Yes	No
N	338	338	338	338	338	338	338	338

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Columns 1 and 2 of Table 1 show that the player's beliefs about the partner's extraversion increases with the player's own extraversion in the Treatment group. In the Treatment group, an increase in the player's extraversion by 1 standard deviation increases the beliefs about partner's extraversion by .2 standard deviations more than in the control group. Partner's true extraversion also significantly (at 1% level) impacts beliefs about partner's extraversion in the treatment group. An increase in 1 standard deviation in partner's true extraversion increases player's beliefs about partner's extraver-

sion by 0.3-0.4 standard deviations more in the treatment group than the control group. Columns 3 and 4 show that the effect persists and remains significant even after taking into account the control variables.

Column 5 of Table 1 shows that the player's beliefs about the partner's neuroticism decreases with the players own extraversion in the Treatment group. In the Treatment group, an increase in the player's extraversion by 1 standard deviation decreases the beliefs about partner's neuroticism by .2 standard deviations more than in the control group. However, columns 6-8 show that this impact reduces and becomes insignificant when the regressions take into account the control variables. Partner's true neuroticism has no significant impact on the player's beliefs about partner's neuroticism. Thus, an extraverted player believes their partner is more extraverted and less neurotic. Further, while a partner's true extraversion can be detected by the player to some extent through a chat, partner's true neuroticism is not detected.

Table 2: Inaccuracy of personality beliefs

	Inaccuracy of Extraversion Belief		Inaccuracy of Neuroticism Belief	
	(1)	(2)	(3)	(4)
OwnExtraversion × Treatment	0.2509*	0.3035**	-0.0676	-0.0692
	(0.136)	(0.143)	(0.116)	(0.118)
OwnNeuroticism × Treatment	0.1665	0.1916	-0.0943	-0.0809
	(0.116)	(0.128)	(0.121)	(0.127)
Own Extraversion	-0.0636	-0.0335	-0.0891	-0.0666
	(0.112)	(0.116)	(0.076)	(0.070)
Own Neuroticism	-0.0711	-0.0813	0.0846	0.0864
	(0.082)	(0.093)	(0.085)	(0.087)
Treatment	0.3437***	-0.0418	-0.3523***	-0.1057
	(0.104)	(0.676)	(0.108)	(0.636)
Eyes Test Score × Treatment	0.0482	0.0890	0.0892	0.1462
	(0.093)	(0.094)	(0.126)	(0.131)
Eyes Test Score	-0.0111	-0.0459	-0.1109	-0.1761**
	(0.070)	(0.074)	(0.080)	(0.086)
Controls	No	Yes	No	Yes
N	338	338	338	338

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2 examines the inaccuracy of the personality beliefs formed. The dependant

variable i.e inaccuracy of personality beliefs is computed by taking the difference between the player's beliefs about their partner's personality and the partner's true personality scores. This difference is then standardized. The dependent variable is thus a measure of overestimation or underestimation of the partner's personality by the player (refer to equation 3). The independent variables are the player's own personality traits, the treatment dummy and the player's eyes test score. The control variables are the player's IQ, gender, age and risk aversion and these variables interacted with the treatment dummy.

Columns 1 and 2 of Table 2 show that the overestimation of partner's extraversion increases with the player's own extraversion in the Treatment group. A 1 standard deviation increase in the player's extraversion increases the overestimation of the partner's extraversion by 0.3 standard deviations more in the Treatment group than in the control group. The player's performance in the eyes test has no significant impact on the accuracy of beliefs formed by the player. Columns 3 and 4 show that the overestimation of the partner's neuroticism decreases with the player's own extraversion in the Treatment group. However, the impact is insignificant.

Table 3 presents the results from the beliefs about the partner's cognitive abilities. Columns 1 examines the impact of the player's beliefs about own IQ, partner's true IQ and the Treatment dummy, on beliefs about the partner's IQ. While own IQ belief interacted with treatment dummy has no significant effect, own IQ belief positively impacts beliefs about partner's IQ. Column 2 includes the dependant variables the players true IQ as measured by the Raven test, the players eyes test score and control variables player's age, gender and risk aversion, as well as the 3 control variables interacted with the treatment dummy. An increase in own IQ belief by 1 standard deviation increases the beliefs about partner's IQ by 0.7 standard deviations for both control and Treatment groups combined.

Columns 3-6 examine the inaccuracy of the IQ beliefs formed by the player. For columns 3 and 4 the dependant variable is the standardised difference between the beliefs about partner's IQ and the partner's true IQ (as measured by the partner's performance in the Raven test). For columns 5 and 6 the dependant variable is the standardised *absolute* difference between the same two values. Hence, for columns 3 and 4 the dependant variable is a measure of the degree by which the player overestimates their partner's IQ. On the other hand, for columns 5 and 6 the dependant variable is how far apart the player's beliefs about partner's IQ is from the partner's true IQ. Columns 3 and 4 indicate that an increase in player's own IQ belief leads to overestimation of the partner's IQ, irrespective of being in the treatment or control group. Columns 5 and 6 indicate that an increase in 1 standard deviation of the player's own IQ belief leads to a decrease in the difference between partner's IQ belief and partner's true IQ by 0.2-0.3 standard deviations.

To summarise, this subsection finds that extraverted players tend to believe that their

Table 3: Impact of beliefs about own cognitive ability on beliefs about partner's cognitive ability

	IQ Belief		Inaccuracy of IQ Belief		Inaccuracy of IQ Belief (absolute values)	
	(1)	(2)	(3)	(4)	(5)	(6)
Own IQ Belief × Treatment	-0.0586	-0.0624	0.0136	0.0181	-0.2038*	-0.3135**
	(0.086)	(0.116)	(0.095)	(0.122)	(0.112)	(0.143)
Partner's IQ × Treatment	-0.0345	-0.0186				
	(0.081)	(0.082)				
Own IQ belief	0.6686***	0.7297***	0.4902***	0.5443***	-0.0848	0.0204
	(0.060)	(0.078)	(0.062)	(0.081)	(0.078)	(0.106)
Partner's IQ	0.0937*	0.0895*				
	(0.050)	(0.050)				
Treatment	-0.0866	0.4422	-0.1811*	0.2953	0.0656	0.4072
	(0.083)	(0.514)	(0.096)	(0.567)	(0.110)	(0.621)
Own IQ × Treatment		-0.0172		-0.0036		0.1465
		(0.110)		(0.132)		(0.121)
Eyes Test Score × Treatment		0.0279	0.0908	0.0977	0.1729	0.1705
		(0.100)	(0.101)	(0.100)	(0.124)	(0.126)
Own IQ		-0.0714		-0.0783		-0.1223
		(0.069)		(0.092)		(0.087)
Eyes Test Score		0.0196	-0.0258	-0.0228	-0.1709**	-0.1915**
		(0.078)	(0.073)	(0.068)	(0.086)	(0.085)
Controls	No	Yes	No	Yes	No	Yes
N	338	338	338	338	338	338

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

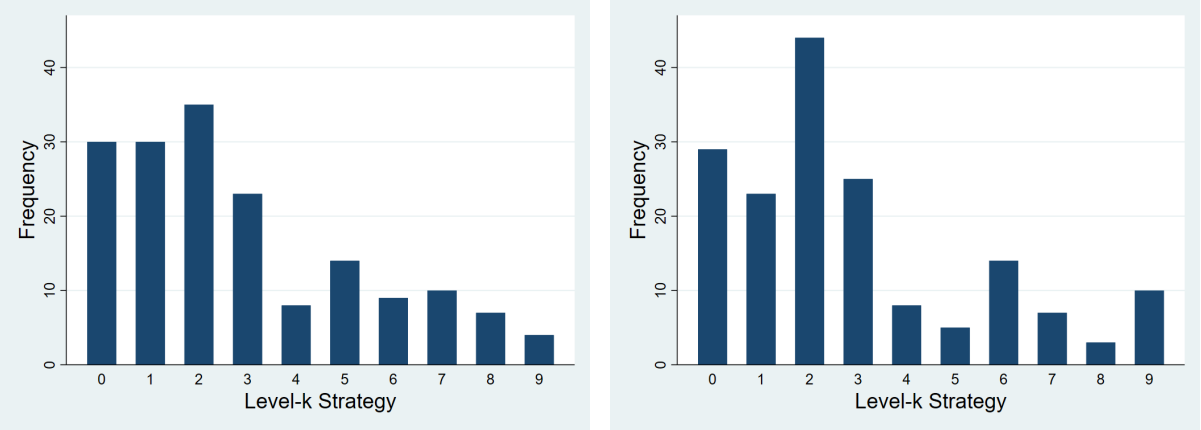
partners are extraverted as well and less neurotic. This effect is significantly stronger in the Treatment group than in the control group. An extraverted person, who is subject to positive emotions, fosters a positive social environment (Eaton and Funder (2003)) and judges neutral events more positively (Uziel (2006)). She is prone to *complementary self projection bias* which causes her to project her positivity onto people she interacts with. This projection of positive emotions also causes her to overlook the negativity in others. Thus, extraverts find their partners to be more extraverted and less neurotic. This projection is significantly stronger in the Treatment group where the players get to communicate with the partner.

With regards to beliefs about partner's cognitive abilities, it was observed that player's project beliefs about their own IQ onto beliefs about partner's IQ, irrespective of whether they are in the control or Treatment group. Further, it was found that an increase in the

player's beliefs about own IQ leads to more accurate predictions about partner's IQ in the Treatment group than in the control group.

4.2 11-20 money request game

This section will discuss the results from the 11-20 money request game. Figure 1 shows the distribution of level-k strategies chosen by the control and treatment groups. The Kolmogorov-Smirnov test revealed that there is no statistical difference between the level-k strategy distributions of the 2 groups. Level-2 is the most frequently played strategy by both groups.



(a) Control (b) Treatment

Figure 1: The distribution of level-k strategies

In accordance with the framework proposed earlier, this section examines if strategy choice in the 11-20 money request game is affected by the player's own personality, as well as, beliefs formed by the player about the partner's personality. The 11-20 money request game is a level-k reasoning game. In level-k models (Nagel (1995); Stahl and Wilson (1995, 1994)) players levels or types are heterogeneous but they are assumed to be drawn from the same distribution. Peoples' beliefs are based on naive initial assessment of others' likely response called level-0 or L0 and then beliefs are modified via iterated best response. So level-1 or L1 best responds to L0, L2 to L1 and so on. As per Arad and Rubinstein (2012), this paper assumes that in the 11-20 money request game 20 is the salient or L0 choice. An L1 player will best respond to their beliefs by choosing one less i.e. 19 (and hence receiving a bonus of 20), an L2 player will best respond by choosing 18 and so on.

The level-k model suggests that the level chosen by a subject is a measure of her strategic sophistication or *type* or more precisely a measure of the player's beliefs about the partner's type (Georganas, Healy, and Weber (2015)). This paper examines if the

Table 4: Impact of (absolute) difference between own personality and predicted on level-k strategy chosen

	Level Belief			Level Chosen		
	(1)	(2)	(3)	(4)	(5)	(6)
DiffExtraversion × Treatment	-0.5241*	-0.4891*	-0.3765	-0.6521***	-0.5991**	-0.4846*
	(0.266)	(0.286)	(0.311)	(0.234)	(0.251)	(0.280)
DiffNeuroticism × Treatment	0.1920	0.2798	0.2936	-0.0424	0.0810	0.0718
	(0.254)	(0.278)	(0.286)	(0.254)	(0.274)	(0.276)
Treatment	0.1704	-2.7390	-2.1611	0.0705	-2.0793	-1.4173
	(0.267)	(2.047)	(2.125)	(0.278)	(1.831)	(1.871)
DiffExtraversion	0.1453	0.0989	0.1128	0.2022	0.1342	0.0330
	(0.196)	(0.194)	(0.205)	(0.175)	(0.174)	(0.190)
DiffNeuroticism	-0.1614	-0.2511	-0.2677	-0.1640	-0.3098*	-0.2928
	(0.187)	(0.203)	(0.209)	(0.178)	(0.182)	(0.186)
Own Extraversion × Treatment		0.1219	0.7077		0.1887	0.8699
		(0.324)	(0.644)		(0.295)	(0.652)
Own Extraversion		-0.1171	-0.0887		-0.2809	-0.6816
		(0.181)	(0.405)		(0.197)	(0.421)
OwnExtraversion × Q2 × Treatment			-0.6707			0.5285
			(1.910)			(1.801)
OwnExtraversion × Q3 × Treatment			-1.4108			-2.3728
			(2.397)			(2.267)
OwnExtraversion × Q4 × Treatment			-1.2594			-1.4958
			(1.152)			(1.144)
Own IQ × Treatment		-0.2390	-0.2145		-0.2463	-0.2214
		(0.286)	(0.291)		(0.297)	(0.304)
IQ Belief × Treatment		0.3313	0.3063		0.1904	0.2104
		(0.305)	(0.306)		(0.261)	(0.264)
Eyes Test Score × Treatment		0.4923*	0.4997		0.5358*	0.5383*
		(0.294)	(0.303)		(0.302)	(0.307)
Female × Treatment		-0.7721	-0.7485		-0.9905*	-0.9761*
		(0.594)	(0.606)		(0.546)	(0.561)
Order × Treatment		1.1342**	1.1671**		1.0958*	1.1291*
		(0.572)	(0.581)		(0.584)	(0.589)
Own IQ		0.1853	0.1610		0.2278	0.1672
		(0.199)	(0.206)		(0.207)	(0.217)
IQ Belief		-0.3371*	-0.3416*		-0.3130	-0.3238
		(0.200)	(0.201)		(0.190)	(0.197)
Eyes Test Score		-0.4134*	-0.3986		-0.4390*	-0.4334*
		(0.242)	(0.247)		(0.243)	(0.245)
Female		1.0815***	1.0931***		1.4610***	1.4770***
		(0.408)	(0.414)		(0.364)	(0.375)
Order		-0.7868**	-0.8241**		-1.0018**	-1.0161**
		(0.390)	(0.399)		(0.408)	(0.411)
Extraversion × Extraversion quartile	No	No	Yes	No	No	Yes
Controls	No	Yes	Yes	No	Yes	Yes
N	338	338	338	338	338	338

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

perceived similarity between player's own personality or type and the partner's personality or type, influence strategy choice. The results are presented in Table 4.

In columns 1-3 of Table 4, the dependent variable is the player's beliefs about the level-k strategy chosen by the partner and in columns 4-6 the dependent variable is the player's strategy choice. The independent variables are perceived differences between player's own personality and the partner's personality. This is computed by taking the standardised absolute difference between the player's own personality trait scores and the player's beliefs about the partner's personality trait scores. Columns 2 and 4 also look at the impact of the player's beliefs about partner's IQ, player's eyes test score, gender, order of play of the two tasks (which equals 1 if the 11-20 game was played first and 0 otherwise) and the control variables, player's age and risk aversion.

Beliefs about partner's level choice as well as own level choice decrease with increase in perceived difference in trait extraversion, in the Treatment group. An increase in 1 standard deviation in perceived difference in extraversion decreases the player's beliefs about partner's level choice, and player's own level choice, by 0.5 and 0.6 standard deviations respectively, more in the Treatment group than in the control group. Hence, the smaller the perceived difference between the two players the greater the beliefs about partner's level choice and greater the level chosen by the player.

This result supports the *perceived similarity hypothesis* which posits that people project their own thinking and decision-making process to predict how their partners might think and act when individuals believe their partners to possess attributes similar to their own (Thomas, DeScioli, Sultan Haque, and Pinker (2014)). Thus, when players believe their partners to be similar to themselves they believe their partners will reason more and choose a higher level-k strategy. This in turn makes them choose a higher level-k strategy as well.

Columns 3 and 6 of Table 4 examine if there is a differential impact on the dependant variables, depending on whether the player is highly extraverted or less extraverted. For this, the regression incorporates interaction effects of the player's extraversion with a categorical variable which equals the quartile in which the player's extraversion score lies. The results remain similar. Furthermore, Table 4 shows that in the control group order of the tasks has a negative effect on level belief and level chosen, where as in the treatment group it has a positive effect. This implies that playing the 11-20 game first increase level belief and level chosen when the player gets to communicate with the partner, but the reverse happens when there is no communication.

Being female enhances beliefs about partner's level as well as player's own level chosen in both control and treatment conditions. It has been observed (Nettle and Liddle (2008); Stiller and Dunbar (2007)) that women score higher on the social-cognitive element of

Theory of Mind indicating greater ability to reason about others mental states. This could explain why women choose higher level-k strategies. Lastly, an increase in the eyes test by 1 standard deviation increases level belief and level chosen by 0.5 and 0.6 standard deviations more in the treatment group than in the control group. This supports the finding (Fe and Gill (2018); Georganas, Healy, and Weber (2015)) that greater ToM ability is associated with superior level-k reasoning, however in this study the effect is only observed when the players get to communicate with their partners. Player's beliefs about partner's IQ has no significant effect on level belief or level chosen in the Treatment group.

Table 5: Distribution of Level-k beliefs

Level	0	1	2	3	4	5	6	7	8	9
Equilibrium (%)	5	10	15	20	25	25				
Treatment (%)	12.50	32.14	17.26	5.95	4.17	11.31	4.17	2.38	3.57	6.55
Control (%)	17.06	25.88	18.82	5.29	7.06	10.00	7.06	3.53	1.76	3.53

Next the paper looks at the distribution of the players' beliefs about the level-k strategies chosen by their partners. The distribution is presented in Table 5, along with the unique mixed strategy Nash equilibrium distribution for risk-neutral players. The distributions of beliefs observed in both treatment and control groups are different from the equilibrium distribution. In both groups, L1 (i.e choosing 19) is the most frequently believed level. Table 6 calculates the expected payoffs based on the distribution of level-k beliefs observed. For both control and treatment groups, L2 (i.e choosing 18) has the highest associated expected payoffs.

Table 6: Expected Payoffs

Level	0	1	2	3	4	5	6	7	8	9
Treatment (EP)	20.00	21.50	24.43	20.45	17.19	15.83	16.26	13.83	12.48	11.71
Control (EP)	20.00	22.41	23.18	20.76	17.06	16.41	16.00	14.41	12.71	11.35

Table 7 uses a probit model to examine the effect of perceived differences in the player's and their partner's personalities on the probability of best responding to the distribution of level-k beliefs in the control and treatment groups separately. The dependent variable is the probability of choosing the best response to the distribution of beliefs which, in this case, is L2 for both conditions. Column 3 shows that the probability of best responding significantly (at 1% level) increases by 8 percentage points with a 1 standard deviation increase in the perceived difference in extraversion, in the Treatment group. The effect is negative and insignificant in the control group. This implies that the greater the similarity between the player and their partner, as perceived by the player, lesser are the chances

of the player best responding in the Treatment group.

Table 7: Impact of (absolute) difference between own personality and predicted on the probability of choosing the best response - Probit Model

	Control		Treatment	
	(1)	(2)	(3)	(4)
	Pr(Level=2)	Pr(Level=2)	Pr(Level=2)	Pr(Level=2)
DiffExtraversion	-0.0448	-0.0499	0.0837***	0.0909***
	(0.037)	(0.036)	(0.029)	(0.029)
DiffNeuroticism	-0.0008	-0.0138	-0.0469	-0.0461
	(0.031)	(0.032)	(0.033)	(0.033)
Own IQ		0.0612*		0.0551
		(0.036)		(0.036)
IQ Belief		-0.0438		-0.0053
		(0.029)		(0.036)
Eyes Test Score		0.0474		0.0419
		(0.038)		(0.032)
Controls	No	Yes	No	Yes
N	170	170	168	168

Standard errors in parentheses

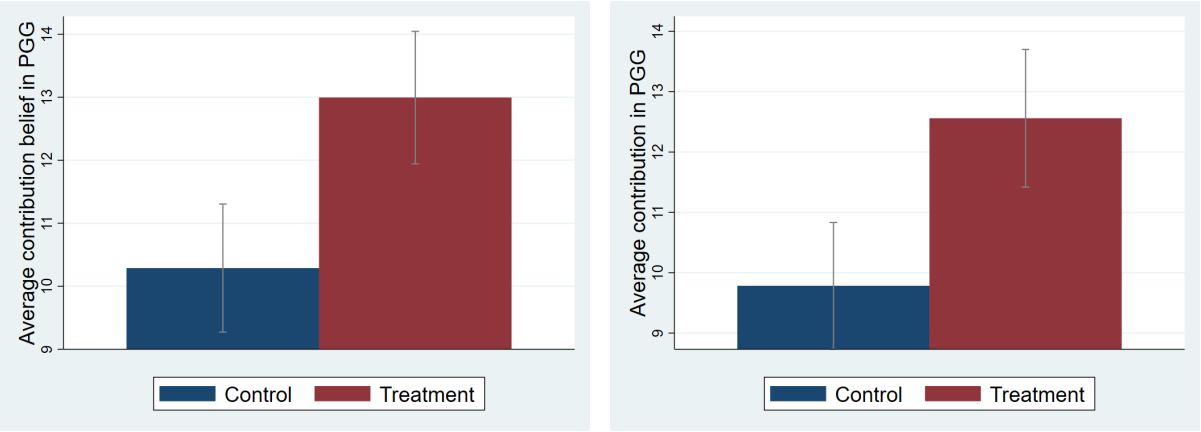
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This result is consistent with Table 4 which supported the perceived similarity hypothesis. When the perceived difference in extraversion is small, the player believes that their partner will act similar to themselves. This makes it harder to out think or out reason the opponent, thus reducing the probability of best responding. This result holds only when the players get to communicate as otherwise the player has nothing to base their personality beliefs on and thus their beliefs are unlikely to affect decision making. The results hold even after controlling for the player's IQ and eyes test score, the player's beliefs about partner's IQ and other controls - player's age, gender, risk aversion and the order of tasks. In the control group, increase in the player's IQ by 1 standard deviation increases the probability of best responding by 6 percentage points. Table 7 is replicated using a logit model, showing similar results and presented in Appendix A. Further, the results from the control and treatment groups are pooled together (using interaction terms) and the results are replicated using a linear probability model and presented in Appendix A.

To summarise, this subsection shows that it's the perceived similarity or differences between the player's and their partner's personalities which influence decision making in level-k reasoning games. In level-k reasoning game's a player's strategy is reflective of

the player's beliefs about the opponent's type. The player then best responds to these beliefs, thereby out-reasoning or out-thinking the opponent. Hence, in level-k games it is the perceived similarity or differences between the player and their partner's types which decide strategy choice. When the player believes the partner is similar to them in their type, it becomes harder for her to out-reason the partner. This is due to the *perceived similarity hypothesis* which states that when a player believes they are faced by a similar opponent, they think the opponent will think and act similar to them. This makes the player believe that the opponent, undergoing the same thinking process, will reason harder and thus pick a higher level-k strategy. This in turn makes the player choose a high level-k strategy as well. Consequently, when the player believes their partner's type is similar to their own, the probability of them best responding to the distribution of level-k beliefs is lower.

4.3 Public Goods Game



(a) Contribution belief

(b) Own Contribution

Figure 2: Average contribution and beliefs about partner's contribution in PGG

This subsection will discuss the results from the Public Goods Game which is a game of cooperation. The unique pure strategy Nash Equilibrium of the game is to contribute nothing, where as the joint profit maximisation strategy is to contribute everything. The average beliefs about partner's contribution and player's own contribution are presented in Figure 2. The treatment group subjects, on average, believe their partner's will contribute more and the player's themselves contribute more, compared to the control group. The average contribution belief in the Treatment group is 13 EP, where as in the control group it is 10.3 EP. This difference is significantly different at the 1% significance level with p-value 0.0003 and a t-statistic of -3.640. The average contribution in the Treatment group is 12.6 EP, where as in the control group it is 9.8 EP. This difference is significantly

different at the 1% significance level with p-value 0.0005 and a t-statistic of -3.525.

The regressions reported in this section will only consider the observation in which the subject played the public goods game before the level-k reasoning game. The reason is that, playing the level-k game first, triggers level-k reasoning (Georganas, Healy, and Weber (2015)), thus biasing decision-making the social preferences task. On the other hand, since the level-k game strictly requires level-k reasoning, without invoking any social preferences (Arad and Rubinstein (2012)), the results of the 11-20 game are not biased by playing the public goods game first. The results from the public goods game, for those who played the 11-20 game first are presented in Appendix A.

This paper is interested in examining the impact of own personality and beliefs about partner's personality on decision making in the Public Goods Game. Of the personality traits, this paper is interested in trait extraversion as, of the two fundamental traits, extraversion is associated with pro-social traits (Graziano and Eisenberg (1997), Graziano (1994)).[3] Hence, it is hypothesised that players who believe their partner's are extraverted will believe that their partners will cooperate more and in turn, cooperate more themselves. This hypothesis is examined using equation 7. $personality_i$ is player i's personality, $E_i(personality_j)$ is player i's beliefs about partner j's personality, z_i are individual characteristics of i and ε_i is an idiosyncratic error term.

$$Choice_i = \beta_1 personality_i + \beta_2 E_i(personality_j) + \gamma z_i + \varepsilon_i \tag{7}$$

$$E_i(personality_j) = \lambda_1 personality_j + \lambda_2 personality_i + \rho z_i + \epsilon_i \tag{8}$$

However, Table 1 showed that player i's personality can influence i's beliefs about partner j's personality in the treatment group. This creates an endogeneity issue and estimation of equation 7 requires valid instruments. Beliefs about partner's extraversion depend on two components - the player's own extraversion and the partner's true extraversion, as discussed in section 4.1. These two components are independent, as the two players are randomly matched. Thus, beliefs about partner's extraversion can be instrumented with the partner's true extraversion. Equation 8 is the first stage or reduced form equation. $personality_j$ is the partner j's true personality.

The first stage results are presented in Table 8. Partner's true extraversion significantly enhances beliefs about partner's extraversion in the treatment, but not in the control group. Table 9 presents the results of 2SLS instrumental variable regression. To test for weak instruments, a Wald test is conducted, which tests the null that the coefficients of the

[3]Also, Table A.5, in Appendix A, finds that beliefs about partner's neuroticism has no significant effect on decision making in the PGG.

Table 8: First Stage

	Control		Treatment	
	(1) Extraversion Belief	(2) Extraversion Belief	(3) Extraversion Belief	(4) Extraversion Belief
Own Extraversion	0.0298	0.0332	0.2141**	0.2607**
	(0.086)	(0.102)	(0.106)	(0.103)
Partner's Extraversion	-0.1013	-0.0975	0.3532***	0.3638***
	(0.081)	(0.092)	(0.093)	(0.094)
Own IQ		-0.1016		0.0119
		(0.101)		(0.100)
IQ Belief		-0.0549		0.0163
		(0.144)		(0.093)
Eyes Test Score		-0.0466		0.1186
		(0.106)		(0.073)
Control	No	Yes	No	Yes
N	110	110	106	106

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

endogenous regressors are zero. The null, for the treatment group, is rejected at 5% level. This suggests that weak instruments are not an issue here. Further, the f-statistic in the first stage regression (for 2SLS) is greater than 10, which indicates that the instruments are strong (Staiger and Stock (1997)) for the treatment group. Since the endogeniety bias only exists for the treatment group, equation 8 is estimated without an IV for the control group as well, and presented in columns 1 and 2 of Table 9.

Columns 5 and 6 of Table 9 show that, in the treatment group, beliefs about the partner's extraversion has a significant positive (at the 5% significance level) effect on both beliefs about partner's contribution as well as own contribution. However, the player's own extraversion score has a negative impact on both. An increase in 1 standard deviation in extraversion belief, increases beliefs about partner's contribution and own contribution by 0.6 and 0.5 standard deviations. On the other hand, an increase in 1 standard deviation in own extraversion decreases beliefs about partner's contribution and player's contribution by 0.3 (significant at 5% level) and 0.2 (insignificant) standard deviations respectively. Thus, beliefs about partner's extraversion has a positive and relatively larger effect, compared to own extraversion, on decision-making in the public goods game, in the treatment group. For the control group, column 2 shows that the player's extraver-

sion significantly (at 5% level) negatively impacts contribution. Beliefs about partner's extraversion has no significant effect on both beliefs about partner's contribution and own contribution in the control group.

Table 9: Impact of beliefs about partner's personality and own personality on beliefs about partner's contribution and own contribution in Public Goods Game

	Control OLS		Control IV		Treatment IV	
	(1) Contribution Belief	(2) Own Contribution	(3) Contribution Belief	(4) Own Contribution	(5) Contribution Belief	(6) Own Contribution
ExtraversionBelief	0.0617	0.1140	-0.4136	-0.9698	0.6251**	0.5325**
	(0.084)	(0.095)	(1.043)	(1.353)	(0.271)	(0.269)
OwnExtraversion	-0.0751	-0.2091**	-0.0605	-0.1759	-0.3147**	-0.2067
	(0.097)	(0.090)	(0.126)	(0.178)	(0.137)	(0.141)
Own IQ	-0.0588	-0.0421	-0.1052	-0.1478	0.0864	0.1564
	(0.097)	(0.085)	(0.162)	(0.216)	(0.094)	(0.104)
IQ Belief	0.1261	0.1151	0.0977	0.0504	0.0879	0.2425***
	(0.092)	(0.100)	(0.135)	(0.201)	(0.086)	(0.089)
Eyes Test Score	-0.0439	-0.0015	-0.0619	-0.0426	0.1062	0.1531
	(0.097)	(0.121)	(0.093)	(0.186)	(0.119)	(0.142)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	110	110	110	110	106	106

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The result that, an extraverted player is expected to cooperate more in a social situations, is consistent with the finding in psychology that trait extraversion is associated with pro-social behaviour (Carlo, Okun, Knight, and de Guzman (2005), Graziano and Eisenberg (1997), Burke and Hall (1986)). Thus, the player themselves cooperate, expecting cooperation from their partner. Contrastingly, with regards to the effect of a subject's own extraversion on cooperation, the literature is conflicted. While Hirsh and Peterson (2009); Ross, Rausch, and Canada (2003) and Lu and Argyle (1991) find a positive effect of extraversion on cooperation, Koole, Jager, van den Berg, Vlek, and Hofstee (2001); McNeil (1995) and Mills, Robey, and Smith (1985) find the opposite. Hirsh and Peterson (2009) posit that individuals who score high on the enthusiasm aspect of extraversion cooperate more. Individuals that score high on the enthusiasm facet tend to be more positive and are more sensitive to rewards (Depue and Collins (1999)). Hence, they view cooperation as rewarding and owing to their positivity expect others to cooperate as well. The opposing argument is that introverts, and not extroverts, are likely to cooperate more as they are more inclined to avoid conflicts. This paper supports the latter argument.

Following Soto and John (2009), this paper divides extraversion of the player into

two facets, assertiveness and activity. This is done to examine which particular facet of extraversion is responsible for driving cooperation decisions. Assertiveness is an attribute which helps individuals meet societal demands and thrive amidst people. An assertive person is one with strong interpersonal communication skills. Activity or enthusiasm, on the other hand, describes both positive emotions and outgoing friendliness or sociability (DeYoung, Quilty, and Peterson (2007)).

Table 10: Impact of beliefs about partner's personality and own personality facets on beliefs about partner's contribution and own contribution in Public Goods Game

	Control OLS		Control IV		Treatment IV	
	(1) Contribution Belief	(2) Own Contribution	(3) Contribution Belief	(4) Own Contribution	(5) Contribution Belief	(6) Own Contribution
ExtraversionBelief	0.0557	0.1064	-0.3217	-0.8384	0.6331**	0.5404**
	(0.081)	(0.091)	(0.911)	(1.128)	(0.272)	(0.258)
OwnAssertiveness	-0.1287	-0.2326**	-0.1459	-0.2756*	-0.3364**	-0.3170**
	(0.109)	(0.111)	(0.120)	(0.142)	(0.131)	(0.127)
OwnActivity	0.0598	0.0336	0.0978	0.1289	0.0257	0.1575
	(0.116)	(0.118)	(0.171)	(0.213)	(0.125)	(0.107)
Own IQ	-0.0501	-0.0326	-0.0822	-0.1129	0.0788	0.1409
	(0.095)	(0.084)	(0.144)	(0.183)	(0.099)	(0.106)
IQ Belief	0.1403	0.1313	0.1234	0.0891	0.1050	0.2734***
	(0.085)	(0.098)	(0.118)	(0.183)	(0.092)	(0.093)
Eyes Test Score	-0.0349	0.0116	-0.0455	-0.0150	0.1215	0.1784
	(0.099)	(0.118)	(0.096)	(0.168)	(0.120)	(0.142)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	110	110	110	110	106	106

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10 reports the results of the facet analysis. Columns 1 and 2 report the OLS regression results for the control group and columns 3 and 4 report the IV regression results. Column 2 shows that the players own assertiveness has a negative significant (5% level) effect on contribution levels where as facet activity has an insignificant positive effect. An increase in 1 standard deviation in the player's assertiveness score reduces their contribution level by .2 standard deviations. None of the facets significantly impact beliefs about partner's contribution. The IV regression results reflect the same results.

For the treatment group, columns 5 and 6 show that beliefs about partner's extraversion positively (significant at the 5% level) effect beliefs about partner's contribution as well as own contribution. With regards to the player's own personality, facet assertiveness has a significant (5% level) negative effect on both contribution belief and own contribu-

tion, where as facet activity has an insignificant positive effect.

To summarise the findings of this subsection, when a player believes that their partner is extraverted, they believe that their partner's will cooperate more. The reason is because trait extraversion is associated with pro-social behaviours like cooperation. This in turn encourages the players to cooperate more themselves. Contrastingly, a player's own extraversion has a negative effect on beliefs about partner's cooperation as well as own cooperation. This negative effect of extraversion is driven by the assertive facet of an extravert's personality. Lastly, beliefs about partner's extraversion have a relatively larger effect on decision making in the public goods game than own extraversion.

5 Text Analysis

In this paper, players form beliefs about each other after chatting through a chat box on their computers. Language or words used by an individual can be reflective of their personalities and social behaviour. Communication between partners, in social interaction games, is the medium through which partners build theory of mind or mental models of the other. Individuals form beliefs about the likely behaviour of their partners and formulate strategies accordingly. This section examines the different characteristics of language use by players, which might explain why players develop specific beliefs about their partners.

Table 11: Impact of number of words spoken by the partner on beliefs about partner's personality

	(1) Extraversion Belief	(2) Extraversion Belief	(3) Neuroticism Belief	(4) Neuroticism Belief
Number of Words	0.0094***	0.0088***	-0.0020	-0.0021
	(0.003)	(0.003)	(0.002)	(0.002)
Own IQ		-0.0745		0.0827
		(0.086)		(0.077)
Eyes Test Score		0.0644		0.0326
		(0.060)		(0.097)
Age		0.0269		-0.0380*
		(0.020)		(0.020)
Female		-0.0819		-0.2122
		(0.158)		(0.155)
IQ Belief		0.0980		-0.0591
		(0.082)		(0.083)
Non-native Speaker		0.3460**		-0.2253
		(0.151)		(0.164)
N	168	168	168	168

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The first thing that is examined is, if beliefs about any personality trait is correlated with the total number of words spoken. Table 11 reports the results. Column 1 shows that beliefs about partner's extraversion increase with the number of words spoken by the partner. Extraversion is characterized by attributes like sociability, gregariousness, enthusiasm and overall positive affect. Hence, those who speak more, appear more social, and are believed to be extraverted. Column 2 shows that the result persists even after controlling for the player's IQ, eyes test score, age, gender, beliefs about partner's IQ and a dummy for non-native speaker which equals 1 if the player is a non-native English speaker and 0 otherwise. Columns 3 and 4 show that beliefs about partner's neuroticism decrease with the number of words spoken by the partner, although the impact is insignificant. Age has a significant positive (at 5% level) and a significant negative (at 5% level) effect on beliefs about partner's extraversion and neuroticism respectively. This implies that younger people are more likely to believe that their partner's are more extraverted and less neurotic. It should be noted that the average age of the subjects in this dataset is 21 with a standard deviation of 3.62.

Table 12: Impact of valence rating of the text used by the partner on beliefs about partner's personality

	(1) Extraversion Belief	(2) Extraversion Belief	(3) Neuroticism Belief	(4) Neuroticism Belief
Valence	0.1029	0.0849	-0.0932**	-0.1070**
	(0.074)	(0.066)	(0.037)	(0.048)
Number of Words		0.0082***		-0.0013
		(0.003)		(0.002)
Own IQ		-0.0865		0.0979
		(0.088)		(0.078)
Eyes Test Score		0.0726		0.0223
		(0.060)		(0.098)
Age		0.0266		-0.0377*
		(0.020)		(0.020)
Female		-0.0848		-0.2085
		(0.160)		(0.155)
IQ Belief		0.1134		-0.0785
		(0.082)		(0.086)
Non-native Speaker		0.3559**		-0.2378
		(0.149)		(0.161)
N	168	168	168	168

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Furthermore, the scores for three affective or emotional components of the partner's language use, namely, *valence*, *arousal* and *dominance*, are calculated, using the ratings proposed by Warriner, Kuperman, and Brysbaert (2013). Valence refers to the pleasantness of a stimulus, arousal is the intensity of emotion provoked by a stimulus, and dominance is the degree of control exerted by a stimulus. Table 12 shows that beliefs about partner's neuroticism decrease with valence rating of the partner's speech. Valence rating of a word refers to the pleasant emotion conveyed by a word, with the rating increasing as it moves from unhappy to happy. Since, trait neuroticism is associated with negative emotions, beliefs about partner's neuroticism decrease with the pleasantness of the words used by them.

Table 13: Impact of Arousal rating of the text used by the partner on beliefs about partner's personality

	(1) Extraversion Belief	(2) Extraversion Belief	(3) Neuroticism Belief	(4) Neuroticism Belief
Arousal	0.1579**	0.1529***	-0.1016***	-0.1284***
	(0.061)	(0.052)	(0.037)	(0.044)
Number of Words		0.0077***		-0.0012
		(0.003)		(0.003)
Own IQ		-0.1113		0.1136
		(0.086)		(0.079)
Eyes Test Score		0.0673		0.0302
		(0.058)		(0.097)
Age		0.0239		-0.0355*
		(0.021)		(0.020)
Female		-0.0879		-0.2071
		(0.158)		(0.154)
IQ Belief		0.1346*		-0.0898
		(0.080)		(0.085)
Non-native Speaker		0.3751**		-0.2497
		(0.149)		(0.162)
N	168	168	168	168

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13 shows that beliefs about partner's extraversion increase and beliefs about neuroticism decrease with the arousal rating of the text used by the partner. Arousal rating of a word is the degree of arousal evoked by it, with value increasing from calm

to excited. An increase in the degree of excitement conveyed by words used by the partner, increases beliefs about partner's extraversion and decreases beliefs about partner's neuroticism. Lastly, Table 14 shows that beliefs about partner's extraversion increase and beliefs about neuroticism decrease with the dominance rating of the text used by the partner. The dominance rating of a word increases when the degree to which it conveys the emotion of *being in control* increases. Extraversion is associated with leadership and social dominance (Watson and Clark (1992)), while neuroticism is associated with insecurity and self-consciousness (Judge, Higgins, Thoresen, and Barrick (1999)). Thus, those believed to convey the message of being in control, or being dominant, trough their text, are believed to be more extraverted and less neurotic by their partners. It should be noted that the relationship between beliefs about partner's personality and the three affective components of partner's language use hold even after controlling for the number of words spoken by the partner and the player's individual characteristics.

Table 14: Impact of Dominance rating of the text used by the partner on beliefs about partner's personality

	(1) Extraversion Belief	(2) Extraversion Belief	(3) Neuroticism Belief	(4) Neuroticism Belief
Dominance	0.1177**	0.1051**	-0.0881***	-0.1095***
	(0.059)	(0.051)	(0.029)	(0.039)
Number of Words		0.0082***		-0.0014
		(0.003)		(0.002)
Own IQ		-0.0908		0.0997
		(0.088)		(0.077)
Eyes Test Score		0.0743		0.0224
		(0.060)		(0.098)
Age		0.0265		-0.0377*
		(0.020)		(0.020)
Female		-0.0725		-0.2220
		(0.161)		(0.154)
IQ Belief		0.1153		-0.0772
		(0.082)		(0.086)
Non-native Speaker		0.3587**		-0.2385
		(0.148)		(0.161)
N	168	168	168	168

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Next, the paper examines if beliefs about partner's personality are related with *concreteness* rating of the partner's speech. Concreteness refers to a word's ability to make specific and definite reference to particular objects (Hills, Adelman, and Noguchi (2016)). The total concreteness score of the language used by the partner is calculated using the list of concreteness ratings proposed by Brysbaert, Warriner, and Kuperman (2014). Compared to abstract words, concrete words are easier to learn (De Groot and Keijzer (2000)), recall, recognize (Paivio (1990)), comprehend (Sadoski (2001); Moeser (1974)) and pronounce (De Groot (1989)). Table 15 shows that an increase in the concreteness rating of the partner's speech increase beliefs about partner's extraversion (insignificant effect) and decreases beliefs about partner's neuroticism (significant at 5% level). This shows that players associate the use of concrete words with trait extraversion and abstract words with trait neuroticism.

Table 15: Impact of Concreteness rating of the text spoken by the partner on beliefs about partner's personality

	(1) Extraversion Belief	(2) Extraversion Belief	(3) Neuroticism Belief	(4) Neuroticism Belief
Concreteness	0.1083	0.0747	-0.1395***	-0.1285**
	(0.077)	(0.070)	(0.052)	(0.059)
Number of Words		0.0084***		-0.0014
		(0.003)		(0.002)
Own IQ		-0.0853		0.1013
		(0.088)		(0.079)
Eyes Test Score		0.0672		0.0278
		(0.060)		(0.095)
Age		0.0265		-0.0375*
		(0.020)		(0.020)
Female		-0.0950		-0.1897
		(0.158)		(0.153)
IQ Belief		0.1116		-0.0825
		(0.081)		(0.089)
Non-native Speaker		0.3255**		-0.1901
		(0.149)		(0.169)
N	168	168	168	168

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Lastly, the *Age of Acquisition* ratings, for the language used by the partner, is also cal-

culated, using the age of acquisition ratings proposed by Kuperman, Stadthagen-Gonzalez, and Brysbaert (2012). Age of acquisition (AoA) of a word is the age at which the word is learnt. Words learnt earlier in life are easier to recall than words learnt later (Izura, Pérez, Agallou, Wright, Marín, Stadthagen-González, and Ellis (2011), Monaghan and Ellis (2010)) as their meaning is more accessible (Sailor, Zimmerman, and Sanders (2011), Brysbaert, Van Wijnendaele, and De Deyne (2000)). Partners who use more words which are easier to recall are believed to be more extraverted and less neurotic.

Table 16: Impact of Age of Acquisition rating of the text used by the partner on beliefs about partner's personality

	(1) Extraversion Belief	(2) Extraversion Belief	(3) Neuroticism Belief	(4) Neuroticism Belief
Age of Acquisition	0.2102***	0.1713***	-0.0951***	-0.1078**
	(0.041)	(0.048)	(0.035)	(0.047)
Number of Words		0.0074**		-0.0012
		(0.003)		(0.003)
Own IQ		-0.0954		0.0958
		(0.087)		(0.076)
Eyes Test Score		0.0733		0.0271
		(0.058)		(0.097)
Age		0.0239		-0.0362*
		(0.021)		(0.020)
Female		-0.0575		-0.2275
		(0.158)		(0.155)
IQ Belief		0.1082		-0.0655
		(0.081)		(0.082)
Non-native Speaker		0.3770**		-0.2448
		(0.147)		(0.162)
N	168	168	168	168

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

To summarise the findings of this section, partners who use more number of words and words which evoke more arousal and dominance are believed to be extraverted. On the other hand, partners who use fewer words, words with lower valence, arousal and dominance content and more abstract rather than concrete words are associated with trait neuroticism.

6 Concluding Remarks

There is a small literature in Economics which addresses the role of theory of mind (ToM) in explaining strategic decision making. Most of this literature has treated ToM as a cognitive skill and measured it using psychometric tests. This paper makes a novel attempt to evaluate a person's ToM, not just as a cognitive skill, but as the set of beliefs one develops about others during interactions. The paper shows that these beliefs, whether accurate or not, influence choices in interactive decision making scenarios. This research is important as it could go a long way in explaining economic, social and political choices that people make, where the outcome of the choice depends on how other people behave.

This paper examines the impact of theory of mind on decision making in two one-shot games. The first game is the 11-20 money request game which is a pure level-k reasoning game and resembles real world scenarios where payoffs depend on having to outwit others, such as competitive sports or partisan politics. The second game is a Public Goods Game which is a game of cooperation and resembles real world scenarios involving social dilemmas such as deciding whether to cooperate to combat climate change, knowing that the outcome will depend on collective action.

The paper finds that people tend to project their own characteristics on others. Extraverts, who are characterised by their positive emotions, suffer from *self projection bias*. They project their extraversion or positive emotions onto their partners and overlook the partners' negativity or neuroticism. Further, the level-k strategy chosen in the 11-20 game is impacted by perceived similarity between player and their partner's extraversion. The smaller the perceived difference, the higher the level-k strategy chosen. Also, believing that their partner is similar to them, reduces the probability of the player best responding to the distribution of beliefs.

In the Public Goods Game it was found that when players believe their partners to be extraverted, they expect the partner to cooperate. This is due to the association of trait extraversion with pro-social behaviours like cooperation. This in turn, enhances the player's own cooperation. While beliefs about partner's extraversion encourage cooperation, the player's own extraversion has a negative impact on cooperation. This is because introverts, and not extroverts, cooperate more in an attempt to avoid confrontation from non-cooperation. Analysis of the language used by players during the pre-game communication revealed that, partners who use more number of words and words which evoke more arousal and dominance are believed to be extraverted. On the other hand, partners who use fewer words, words with lower valence, arousal and dominance content and more abstract rather than concrete words are believed to be neurotic.

Future research could examine if alternate modes of interaction - such as one way or

face to face or longer communication - could improve the accuracy of the beliefs or mental models one forms about others and to what extent they impact decision making. Also, it is important to understand the varying effect of theory of mind depending on the nature of the decision to be made - be it social, economic or political.

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Appendix

A Additional Tables and Figures

A.1 Summary Statistics

Table A.1: Summary Statistics for independent variables

Variable	Mean	Std. Dev.	Min.	Max.	N
Own Extraversion	3.372	0.814	1.25	5	338
Own Neuroticism	2.935	0.811	1	5	338
Extraversion Belief	3.499	0.827	1	5	338
Neuroticism Belief	2.818	0.865	1	5	338
Own IQ	18.604	4.464	4	28	338
IQ Belief	18.213	4.825	1	30	338
Eyes Test Score	27.817	3.759	11	35	338

Table A.2: Summary Statistics for control variables

Variable	Mean	Std. Dev.	Min.	Max.	N
Age	21.154	3.622	17	42	338
Risk Aversion	4.317	0.767	1.533	6	338
Female	0.615	0.487	0	1	338
Non-native English speaker	0.349	0.477	0	1	338

A.2 11-20 money request game

Table A.3: Impact of (absolute) difference between own personality and predicted on the probability of choosing the best response - Logit Model

	Control		Treatment	
	(1)	(2)	(3)	(4)
	Pr(Level=2)	Pr(Level=2)	Pr(Level=2)	Pr(Level=2)
DiffExtraversion	-0.0480	-0.0470	0.0833***	0.0913***
	(0.040)	(0.040)	(0.028)	(0.028)
DiffNeuroticism	-0.0020	-0.0163	-0.0469	-0.0468
	(0.031)	(0.033)	(0.033)	(0.033)
Own IQ		0.0644*		0.0546
		(0.038)		(0.038)
IQ Belief		-0.0433		-0.0070
		(0.028)		(0.038)
Eyes Test Score		0.0497		0.0402
		(0.039)		(0.034)
Controls	No	Yes	No	Yes
N	170	170	168	168

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

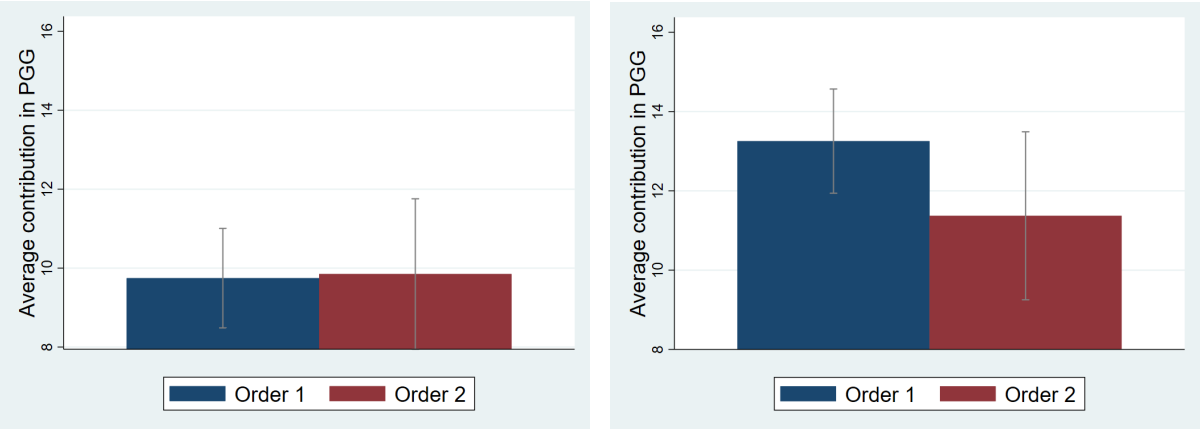
Table A.4: Impact of (absolute) difference between own personality and predicted on probability of best responding - Linear Probability Model

	Level Belief		
	(1)	(2)	(3)
DiffExtraversion × Treatment	0.1333***	0.1444***	0.1068*
	(0.049)	(0.051)	(0.056)
DiffNeuroticism × Treatment	-0.0431	-0.0285	-0.0250
	(0.043)	(0.047)	(0.047)
Treatment	0.0581	0.1340	0.0592
	(0.042)	(0.281)	(0.291)
DiffExtraversion	-0.0441	-0.0437	-0.0175
	(0.036)	(0.035)	(0.040)
DiffNeuroticism	-0.0009	-0.0146	-0.0232
	(0.031)	(0.033)	(0.032)
Own Extraversion × Treatment		0.0232	-0.0867
		(0.059)	(0.113)
Own Extraversion		-0.0077	0.0233
		(0.030)	(0.081)
Own IQ × Treatment		-0.0091	-0.0088
		(0.053)	(0.055)
IQ Belief × Treatment		0.0328	0.0281
		(0.047)	(0.047)
Eyes Test Score × Treatment		-0.0063	-0.0160
		(0.052)	(0.052)
Own IQ		0.0591	0.0595
		(0.036)	(0.037)
IQ Belief		-0.0379	-0.0332
		(0.028)	(0.027)
Eyes Test Score		0.0422	0.0456
		(0.041)	(0.041)
Extraversion × Extraversion Quartile	No	No	Yes
Controls	No	Yes	Yes
N	338	338	338

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A.3 Public Goods Game



(a) Control (b) Treatment

Figure A.1: Average contribution in PGG. Order 1 is when PGG is played first. On average players contribute more in the Treatment group when PGG is played first. There is no difference for control group subjects.

Table A.5: Impact of beliefs about partner's personality on beliefs about partner's contribution and own contribution in Public Goods Game

	Control Order 1				Treatment Order 1			
	(1) Contribution Belief	(2) Contribution Belief	(3) Own Contribution	(4) Own Contribution	(5) Contribution Belief	(6) Contribution Belief	(7) Own Contribution	(8) Own Contribution
ExtraversionBelief	0.0441	0.0590	0.0977	0.1070	0.2016*	0.1929*	0.1933**	0.1712*
	(0.605)	(0.487)	(0.280)	(0.305)	(0.057)	(0.066)	(0.036)	(0.050)
NeurotcisimBelief	0.0445	0.0462	-0.0210	-0.0279	0.1793	0.1647	0.1611	0.1719
	(0.628)	(0.677)	(0.814)	(0.787)	(0.116)	(0.140)	(0.180)	(0.134)
Own IQ		-0.0670		-0.0115		0.1277		0.1800*
		(0.533)		(0.896)		(0.159)		(0.084)
IQ Belief		0.1340		0.1026		0.0973		0.2536**
		(0.178)		(0.348)		(0.322)		(0.013)
Eyes Test Score		-0.0261		0.0225		0.1219		0.1726
		(0.791)		(0.865)		(0.191)		(0.153)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
N	110	110	110	110	106	106	106	106

p-values in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.6: Impact of beliefs about partner's personality and own personality on beliefs about partner's contribution and own contribution in Public Goods Game - Order 2

	Control OLS		Control IV		Treatment IV	
	(1) Contribution Belief	(2) Own Contribution	(3) Contribution Belief	(4) Own Contribution	(5) Contribution Belief	(6) Own Contribution
ExtraversionBelief	-0.0367	-0.2409*	0.5870	1.6483	0.1306	1.3025
	(0.151)	(0.124)	(1.136)	(2.189)	(1.093)	(2.040)
OwnExtraversion	0.1641	0.0325	0.1888	0.1073	0.1248	-0.1196
	(0.162)	(0.162)	(0.156)	(0.270)	(0.194)	(0.329)
Own IQ	0.1385	0.0439	0.0155	-0.3285	-0.0348	-0.0500
	(0.205)	(0.163)	(0.281)	(0.528)	(0.121)	(0.225)
IQ Belief	0.1808	0.0172	0.2185	0.1313	-0.0663	-0.1695
	(0.161)	(0.134)	(0.190)	(0.260)	(0.143)	(0.211)
Eyes Test Score	-0.2721	0.2371	-0.2023	0.4486	0.2621	0.0816
	(0.177)	(0.167)	(0.202)	(0.374)	(0.160)	(0.337)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	60	60	60	60	62	62

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B Experimental Instructions

This following part is read out by the experimenter.

Thank you everyone for coming to our experiment today. Before we begin, please check that the number on the card handed to you matches with the number on the cubicle that you are seated in.

During the whole experiment, please do not speak with each other. If you do not understand something, please ask the experimenter by raising your hand. We will come to you and answer your question individually. Please also refrain from using your mobile phones during the experiment.

Also bear in mind that you may have to wait a few moments during the experiment, as we want everyone to finish at the same time. You will see the message 'Please wait until the experiment continues' on your screen when this is applicable.

Before we begin, I would just like to say, that your participation is very crucial for our research and we truly appreciate all of you being here. Thank you. We will now begin the experiment.

B.1 General Instructions

In the laboratory experiment you are taking part in, you can - depending on your decisions and the decisions of your fellow players- earn money in addition to the show-up fee of £4. It is, therefore, of importance that you read these instructions carefully. Today's experiment consists of the following: In the first section, you will be asked to answer a few questions and solve some puzzles. In the second section, you will be asked to make decisions in a few tasks. Lastly, there will be some questions for you to answer. Please note that the experiment will not involve any deception and your answers today will remain strictly anonymous. The generated anonymous data will only be used for the purpose of our study. Therefore, we request you to answer to the best of your ability as it is integral to our research. The outcomes from each task will be disclosed at the end of the experiment. Detailed instructions for each part will follow. We will now begin the experiment.

a Questionnaire: Personality (44 questions)

You will be asked to answer some questions about yourself. Your payment will not be affected by this. Just to remind you, your answers will remain anonymous so please answer as truthfully as possible as this is critically important for our research. You will see a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please pick an option

next to each statement to indicate the extent to which you agree or disagree with that statement. I see myself as someone who...

START BFI QUESTIONNAIRE

b PUZZLES: Raven Test (30 items)

You will be asked to solve some puzzles, a pattern game. On the screen, you will see a set of abstract pictures with one of the pictures missing. You need to choose a picture from the choices given below to complete the pattern. You will have 30 seconds to complete each set of pictures. The first picture you will see will be an example, no input is required. You will then be asked to solve a total of 30 such puzzles. 2 of these 30 puzzles will randomly be selected. For each correct answer, from the random 2, you will receive £1. Please make sure to click 'submit answer', as otherwise your answer will not be recorded, and you might lose money.

START RAVEN TEST

Out of the 30 puzzles you just saw, how many puzzles do you think you correctly solved? If your answer to this question is correct, then you will win an additional £1. **Now subjects will be allocated to one of 2 treatment groups

B.2 Control Group

Placebo Task 1: (4 minutes)

Can you please indicate the title and summarize the story of the last movie you have seen? Please be as specific as possible and include as many details as possible. Please use a minimum of 250 characters. You will have 4 minutes to write the summary.

Please write the summary in the box provided on the next screen.

(next screen) Please make sure to click 'Submit' after you are done, as otherwise your answer will not be recorded.

Beliefs

You have been randomly and anonymously matched with another person in this room who is participating in the experiment. Please answer a few questions about the other player to the best of your ability, before you proceed with the tasks.

1. You will see a number of characteristics that may or may not apply to the other player. For example, do you agree that the other player is someone who likes to spend time with others? Please pick an option next to each statement to indicate the extent to which you agree or disagree with the statement regarding the other player.

You will see 11 statements about the other player.

1 out of these 11 statements will be randomly chosen and if your answer matches that of the other player, then you will win an additional £1.

START PERSONALITY PREDICTION QUESTIONNAIRE

2. Recall the visual puzzle task from earlier in the experiment. On the screen, you saw a set of abstract pictures with one of the pictures missing. You had to choose a picture from the choices given below to complete the pattern. You had 30 seconds to complete each set of pictures. You were asked to solve a total of 30 such puzzles. How many puzzles do you think the other player, with whom you have been matched, correctly solved? Please indicate a (whole) number between 0 and 30.

   If your answer to this question is correct, then you will win an additional of £1.

B.3 Tasks

You will now take part in a few decision-making tasks with the player with whom you have already been matched. Note that you will be participating in all tasks with the same player. Your payoff from these tasks will be calculated in Experimental Pounds (EP). The exchange rate between £ and EP is 1:5, i.e. 5 EP = £1. The outcomes from each task will be disclosed at the end of the experiment. You will receive payment based on your results from one of the tasks randomly selected from the tasks in this part of the experiment. Please note that each task is equally likely to be chosen for payment.

Task 1: PGG

You will now participate in a task with the player with whom you have been matched. You have 20 EP and the other player has 20 EP as well. Your task in the game, and also the other player's task, is to decide how much to contribute to a joint project. You can choose to contribute any amount between 0 and 20 EP (only integer numbers). Your earnings from the project is the total contribution to the project, made by you and the other player, multiplied by a factor of . Your payoff from this task will be your earnings from the project, plus the amount you did not contribute. Thus, your final payoffs (in EP) will be given by:

Your payoff = (20– your contribution)+3/4(your contribution + the other player's contribution)

Other player's payoff = (20– the other player's contribution)+3/4(your contribution + the other player's contribution)

If for example, you contribute 20 EP to the project and the other player contributes 20 EP then, Your payoff will be: $20–20+3/4(20+20)=30$ The other player's payoff will be: $20–20+3/4(20+20)=30$

If for example, you contribute 0 EP to the project and the other player contributes 20 EP then, Your payoff will be: $20–0+3/4(0+20)=35$ The other player's payoff will be: $20–20+3/4(0+20)=15$

If you have a question, please raise your hand. If you have read the instructions and do not have any questions, please click 'OK' to proceed to a practice quiz. The quiz is to make sure that you understand the task and your answers will not affect your payoffs from the experiment.

Suppose you choose to contribute 20 EP and the other player chooses to contribute 0 EP. Your payoff will be: The other player's payoff will be:

Suppose you choose to contribute 10 EP and the other player chooses to contribute 14 EP. Your payoff will be: The other player's payoff will be:

You have correctly answered the practice quiz. Click 'Continue' to proceed with the task.

How much money do you think the other player will contribute? Please indicate a number (an integer) between 0 and 20.

If your answer to this question matches that of the other player, then you will win an additional £1. How much would you like to contribute? Please choose a number (an integer) between 0 and 20.

Task 2: 11-20 money request game

You will now participate in a different task with the same player.

You and the other player are playing a game in which each player requests an amount of money. The amount must be (an integer) between 11 and 20 Experimental Pounds. Each player will receive the amount he or she requests. A player will receive an additional amount of 20 Experimental Pounds if he or she asks for exactly one Experimental Pound less than the other player.

If for example, you request 19 EP and the other player requests 20 EP then, Your payoff will be: $19+20=39$

The other player's payoff will be: 20

If for example, you request 17 EP and the other player requests 16 EP then, Your payoff will be: 17

The other player's payoff will be: $16+20=36$

If you have a question, please raise your hand.

If you have read the instructions and do not have any questions, please click 'OK' to proceed to a practice quiz. The quiz is to make sure that you understand the task and your answers will not affect your payoffs from the experiment.

Suppose you choose to request 13 EP and the other player chooses to request 14 EP. Your payoff will be: The other player's payoff will be:

Suppose you choose to request 15 EP and the other player chooses to request 18 EP. Your payoff will be: The other player's payoff will be:

You have correctly answered the practice quiz. Click 'Continue' to proceed with the task.

How much money do you think the other player will request? Please indicate a number (an integer) between 11 and 20.

If your answer to this question matches that of the other player, then you will win an additional £1.

What amount of money would you request? Please choose a number (an integer) between 11 and 20.

B.4 Treatment Group

Chat Instructions

You have been randomly and anonymously matched with another person in this room who is participating in the experiment.

Before you proceed with the tasks, you are allowed to chat with the other player for 4 minutes. You can type in the box provided at the bottom of the screen and press Enter on your keyboard to send your messages.

Your message should not contain any personal information such as your name or your computer ID. The purpose is to preserve anonymity throughout the experiment. You are allowed to chat freely in English and in a non-abusive manner.

Beliefs

Now that you have chatted with the other player please answer a few questions about the other player, before you proceed with the tasks.

1. You will see a number of characteristics that may or may not apply to the other player. For example, do you agree that the other player is someone who likes to spend time with others? Please pick an option next to each statement to indicate the extent to which you agree or disagree with the statement regarding the other player. You will see 11 statements about the other player.

   1 out of these 11 statements will be randomly chosen and if your answer matches that of the other player, then you will win an additional £1.

START PERSONALITY PREDICTION QUESTIONNAIRE

2. Recall the visual puzzle task from earlier in the experiment. On the screen, you saw a set of abstract pictures with one of the pictures missing. You had to choose a picture from the choices given below to complete the pattern. You had 30 seconds to complete each set of pictures. You were asked to solve a total of 30 such puzzles. How many puzzles do you think the other player, with whom you chatted, correctly solved? Please indicate a (whole) number between 0 and 30. If your answer to this question is correct, then you will win an additional £1.

B.5 Tasks

You will now take part in a few decision-making tasks with the player you chatted with. Note that you will be participating in all tasks with the same player. Your payoff from these tasks will be calculated in Experimental Pounds (EP). The exchange rate between £ and EP is 1:5, i.e. 5 EP = £1.

The outcomes from each task will be disclosed at the end of the experiment. You will receive payment based on your results from one of the tasks randomly selected from the tasks in this part of the experiment. Please note that each task is equally likely to be chosen for payment.

Task 1: PGG

You will now participate in a task with the player you chatted with. You have 20 EP and the other player has 20 EP as well. Your task in the game, and also the other player's task, is to decide how much to contribute to a joint project. You can choose to contribute any amount between 0 and 20 EP (only integer numbers). Your earnings from the project is the total contribution to the project, made by you and the other player, multiplied by a factor of . Your payoff from this task will be your earnings from the project, plus the amount you did not contribute. Thus, your final payoffs (in EP) will be given by:

Your payoff = (20– your contribution)+3/4(your contribution + the other player's contribution)

Other player's payoff = (20– the other player's contribution)+3/4(your contribution + the other player's contribution)

****Examples and quiz related to the game, then strategy belief and task choice*

Task 2: 11-20 money request game

You will now participate in a different task with the same player.

You and the other player are playing a game in which each player requests an amount of money. The amount must be (an integer) between 11 and 20 Experimental Pounds. Each player will receive the amount he or she requests. A player will receive an additional amount of 20 Experimental Pounds if he or she asks for exactly one Experimental Pound less than the other player.

***Examples and quiz related to the game, then strategy belief and task choice

FOR BOTH CONTROL AND TREATMENT:

B.6 Eyes Test (36 questions)

In this section, you will be asked to look at 36 pictures of different pairs of eyes.

For each set of eyes, choose the word which best describes what the person in the picture is thinking or feeling. You may feel that more than one word is applicable but please choose just one word, the word which you consider to be most suitable. Before making your choice, make sure that you have read all 4 words. You should try to do the task as quickly as possible, but you will not be timed. If you do not know what a word means you can read the meaning of the word provided at the bottom of the screen.

2 of these 36 questions you answer will randomly be selected. For each correct answer, from the random 2, you will receive £1.

You will first see a practice question with four options. The correct option will be highlighted. After that you may proceed to the questions.

**Which word best describes what the person in the picture is thinking or feeling?

START EYES TEST

B.7 Questionnaire

Thank you. Now, in the final section, you will be asked to answer some questions about yourself.

a Risk Please indicate the likelihood that you would engage in the described activity or behaviour if you were to find yourself in that situation

START DOSPERT

b Personal information

1. How old are you? (in years)
2. What is your year of study? (1, 2, 3, Post-graduate Other)
3. What is your gender? (M, F, Other, Prefer not to say)

4. What is your nationality?
5. Is English your Native language? (Yes, No)
6. What is your current degree course?
7. Would you consider your degree course mostly: (quantitative, qualitative)
8. Have you ever taken any game theory modules/courses? (Yes, No)
9. How dissatisfied or satisfied are you with your life in general? (1-7 scale from completely dissatisfied to completely satisfied)

Profit display screen

1. Number of correct answers from the visual puzzles task (out of 30):
2. Your payoff (in EP) from the first decision-making task:
3. Your payoff (in EP) from the second decision-making task:
4. Number of correct answers from the eyes task (out of 36):
5. Additional amount earned (in £):
6. Total earnings (in £):

Thank you for completing the experiment successfully. Please queue at the marked line once you are done, show the number card and collect your payment in cash.

C Eyes Test (Baron-Cohen, Wheelwright, Hill, Raste, and Plumb (2001))

A few examples are provided below. For more details refer to the paper.

(a) (b)

Figure A.2: Adult Eyes Test

D Risk Preferences (Blais and Weber (2006))

For each of the following statements, please indicate the likelihood that you would engage in the described activity or behavior if you were to find yourself in that situation. Provide a rating from 1 to 7 where 1 is *Extremely Unlikely* and 7 is *Extremely Likely*.

1. Admitting that your tastes are different from those of a friend.
2. Going camping in the wilderness.
3. Betting a day's income at the horse races.
4. Investing 10% of your annual income in a moderate growth mutual fund.
5. Drinking heavily at a social function.
6. Taking some questionable deductions on your income tax return.
7. Disagreeing with an authority figure on a major issue.
8. Betting a day's income at a high-stake poker game.
9. Having an affair with a married man/woman.
10. Passing off somebody else's work as your own.
11. Going down a ski run that is beyond your ability.
12. Investing 5% of your annual income in a very speculative stock.
13. Going whitewater rafting at high water in the spring.

14. Betting a day's income on the outcome of a sporting event .
15. Engaging in unprotected sex.
16. Revealing a friend's secret to someone else.
17. Driving a car without wearing a seat belt.
18. Investing 10% of your annual income in a new business venture.
19. Taking a skydiving class.
20. Riding a motorcycle without a helmet.
21. Choosing a career that you truly enjoy over a more prestigious one.
22. Speaking your mind about an unpopular issue in a meeting at work.
23. Sunbathing without sunscreen.
24. Bungee jumping off a tall bridge.
25. Piloting a small plane.
26. Walking home alone at night in an unsafe area of town.
27. Moving to a city far away from your extended family.
28. Starting a new career in your mid-thirties.
29. Leaving your young children alone at home while running an errand.
30. Not returning a wallet you found that contains £200.