Can strategic thinking be taught or is it a matter of cognitive ability and personality

An experimental study

Verneri Sirva

Master Essay II - Economics - 15.0 ECTS

Supervisor: Professor Håkan Holm

Department of Economics

Lund University

2021-08-27

Abstract

Can strategic thinking be taught? Randomized experiments were organized to estimate the effect of information nudge on strategic decisions. The information nudge consisted of seeing a short text and a picture with an explanation related to game theory. Test subjects played two games: a p-beauty contest game and a variable-sum game. The main finding was surprising; the treatment was related to answering significantly higher numbers in the p-beauty contest game independent of cognitive ability, personality, and background characteristics. This implies that the information nudge had a negative effect on decisions. The explanation for the finding may be the new information decreasing the test subjects' self-confidence, causing worse decisions (Zheng et al. 2020).

Keywords: behavioral economics, game theory, experiment, strategic decision-making, learning

Contents

1. Introduction

The interest in empirical decision-making has substantially increased during the recent decades developing into a new field of behavioral economics. Despite the numerous papers published in the field, there is little research on whether individuals can be taught rational decision-making. This thesis provides new knowledge of whether individuals make better strategic decisions after receiving an information nudge. The evidence comes from two separate experiments with similar content. The first experiment consisted of Finnish high school students and the second of Amazon Mechanical Turkers (MTurkers).

Friedman and Savage (1948, pp. 298) introduced a famous "as if" analogy of an expert billiard player making the calculations of his shots "as if" he knew the complicated formulas that would give the optimal directions of travel of the ball. Instead, the player can estimate them accurately by using, e.g., the angle of the eye. In other words, despite the relatively high complexity, the player does not need to know the complex formulas to make optimal shots. Similar arguments are used in the various domains of economics to motivate the theoretical models' empirical validity. However, the behavioral economics literature has questioned the rationality assumption by documenting many behavioral anomalies (see, e.g., Dawes and Thaler 1988; Kahneman 2000; Nagel 1995). However, the literature falls short on the knowledge of whether rational decision-making can be taught by providing an information nudge.

A well-known anomaly in strategic decision-making is found in the "p-beauty contest game" (BCG). It is a simple strategic game where players guess a number between 0 and 100 with a target guessing p times the average answer of all players (Nagel 1995). The test subjects in the experiments of this thesis played two BCGs and a variable-sum game with a mixed-strategy Nash equilibrium (NE). In the "basic BCG", the players were instructed to answer the $\frac{2}{3}$ of the average of all players' answers. In the "theoretical equilibrium BCG", the players were instructed to give a theoretically correct answer, being 0 based on NE.

Before playing the games, the test group received treatment. It consisted of a short text on game theory and a picture with explanations with an objective to teach the basic logic of game-theoretic thinking. All test subjects did tests for cognitive ability and relevant personality characteristics. The experimental setup allowed researching whether the players learn from the information nudge and if the treatment effect is related to cognitive ability and personality characteristics.

The hypotheses based on relevant theory and empirical research are presented in section 4.1. The first hypothesis states that all individuals can learn new things. The second and third hypotheses state that individuals with higher cognitive ability, conscientiousness, openness, and agreeableness can learn faster, implying a larger treatment effect in the experiment. The hypotheses are operationalized in the experiment by the test group choosing a lower number in the basic BCG, more frequently NE in theoretical equilibrium BCG, and having a higher probability of choosing B in the variable-sum game.

The main motivation for this thesis is the high empirical validity. The experimental method provides strong evidence with causal inference, and the knowledge from the experiments can be used in many practical applications. Given the relatively short and simplistic treatment, similar applications are quite easy to use in practice. Decisions related to, e.g., saving, health, or buying used goods are sometimes made without fully understanding and considering the counterparty's interests. A well-known example where strategic thinking is required is buying a used car (Akerlof 1970). This problem is also empirically significant. Konsumentverket (Swedish Consumer Agency) reported that the number of complaints from the consumers in Sweden 2018, and regularly many years before, came from buying used cars which often seemed to be in the condition they were promised, but turned out being "lemons". Some of the significant financial losses could potentially have been avoided by educating consumers before buying a used car, making the buyer aware of the seller's potential motives.

There is some previous research on how strategic decision-making is related to cognitive ability and personality characteristics. Gill and Prowse (2016) found that in repeated BCG, individuals with higher cognitive abilities followed higher Level-k rules and converged faster to the equilibrium. Burnham et al. (2009) found with same-sex twins that the cognitive ability was related to the answers closer to the NE. The relationship between personality characteristics and strategic thinking is not much researched. Gill and Prowse (2016) found that individuals who were agreeable and emotionally stable performed better in the repeated BCG. There is also a relatively robust knowledge that conscientiousness, openness, and agreeableness are positively related to learning and academic success (e.g., Komarraju et al. 2011; Chamorro-Premuzic and Furnham 2003; Heinström 2012).

The findings did not give support to the hypotheses. The main finding of the thesis was quite surprising, suggesting that the treatment led to worse strategic decisions in the basic BCG. The treated test subjects answered significantly higher numbers. The negative effect of the treatment may be related to the effect of treatment on self-confidence. Zheng et al. (2020) made an extensive study including 4000 participants and various questions finding that new information decreased the self-confidence leading to worse decisions. No robust evidence was found of individuals with higher cognitive ability or personality characteristic scores having higher treatment effects.

The rest of this thesis is organized as follows: In chapter 2 relevant previous literature is presented. Games and treatment used in the experiments are presented in chapter 3. Method and experimental details are presented in chapter 4. Data from the experiment is presented in chapter 5 and results in chapter 6. chapter 7 discusses further the implication of results, gives recommendations for future research, and concludes.

2. Literature review

In this chapter, the relevant previous literature is presented.

2.1 Cognitive ability, learning and decision making

Already 1904, Charles Spearman introduced a revolutionary theory of general intelligence, the so-called g-factor, and later provided evidence of the empirical existence of his theory (Spearman 1904; Spearman 1927).[1] As of today, there is a large body of robust evidence on the existence of general intelligence across human races and cultures (Warne and Burningham 2019). Higher general intelligence implies a higher ability for abstract thinking, problem-solving, and learning new things (Chamorro-Premuzic and Furnham 2010). These skills are beneficial in strategic decision-making; it typically requires an abstract understanding of the potential strategies, problem-solving under time-constraint and learning from past information. High intelligence is beneficial in many other life-domains as well; there is plenty of research on the individuals with higher intelligence making generally better decisions and having better life outcomes (e.g., Burks et al. 2009; Warner and Pleeter 2001; Heckman, Stixrud, and Urzua 2006; Christo-

[1] There are competing theories of "multiple intelligences" such as well-known Gardner's theory of multiple intelligence. However, there is no convincing empirical evidence of the existence, unlike with the "general intelligence" (Waterhouse 2006).

pher Auld and Sidhu 2005). Literature uses various terms referring to intelligence and mental capability, in this thesis the general term "cognitive ability" is used.[2]

2.2 Big five, learning and decision-making

Personality traits reflect fundamental aspects of human personality and have a strong influence on behavior in various situations (Costa and McCrae 1992). The five-factor model of personality, "big five", is a relatively well-known grouping of personality characteristics. Big five personality characteristics have low correlation with intelligence (Stankov 2018). It brings a different dimension to studying individual performance and learning, capturing the interest and attitude towards learning new things.

The big five characteristics are neuroticism, openness to experience (openness), extraversion, agreeableness, and conscientiousness (John and Srivastava 1999). An individual high on neuroticism finds the world unsafe, threatening and distressing. Emotions are less stable, and the individual is more prone to negative emotions such as depression and guilt. An individual high on openness is curious and open for new ideas and experiences. The individual is comfortable with unfamiliar things and pays attention to inner feelings. An individual high on extraversion is social and outgoing. The individual enjoys being with people, participating in social gatherings, and is high on energy. An individual high on agreeableness is friendly, warm, altruistic and empathetic. The individual puts others' needs and interests above her own. An individual high on conscientiousness is responsible, hard-working, reliable and well-organized. The individual has good self-regulation and impulse control and takes obligations seriously (Diener 2021).

Three of the five personality characteristics are included in the experiment due to their relevance for the decision-making and learning. The three personality characteristics included are conscientiousness, openness and agreeableness. Higher agreeableness and conscientiousness are significantly related to more rational decision-making (El Othman et al. 2020). Conscientiousness, openness, and agreeableness have a significant relationship with learning and academic success independent of the level of cognitive ability. Komarraju et al. (2011) found that the significant estimators for good academic performance were conscientiousness, agreeableness, and openness. Several other studies have also found positive associations. Consci-

[2] In the text and literature, various terms are used; "general mental ability", "(general) intelligence", "cognitive ability" all meaning essentially the same.

entiousness has been found to consistently predict good academic performance and success (Chamorro-Premuzic and Furnham 2003; Busato et al. 2000). Openness is found to be related to higher grades and use of good learning strategies and emphasize critical thinking (Lounsbury et al. 2003). Agreeableness is positively associated with grades and higher attendance and co-operativeness towards the instructor (Farsides and Woodfield 2003; Vermetten, Lodewijks, and Vermunt 2001).

2.3 Previous research on game theory

A game-theoretic experiment is a tool to study strategic decision-making empirically. Quite regularly, results suggest that the empirical behavior deviates from the theoretical predictions. Experimental game theory is not only restricted to testing human behavior.

2.3.1 Experiments with animals

Humans are not the only species able to make rational strategic decisions. Some experiments with animals suggest that animals can also make strategic decisions rationally and learn in games. The experiments with animals may explain the intrinsic biological nature of strategic decision-making in certain situations and raise some human weaknesses.

Chimpanzees are genetically the closest species to humans. Martin et al. (2014) studied chimpanzees' performance in competitive games. Surprisingly, they found that chimpanzees were closer to equilibrium in their answers than humans. When changing the payoff scheme so that the other player earns more by choosing one of the two alternatives, chimpanzees reacted rationally to changes in the payoffs. However, humans did not significantly change their strategy accordingly. Chimpanzees, compared to humans, were also more responsive to the previous games, better learners, and had significantly shorter response times. Conclusively, it seems that chimpanzees are better in competitive game theory. A possible explanation why chimpanzees can outperform humans is the "cognitive tradeoff hypothesis". It states that humans have lost some important capacities for performing in competitive game theory, e.g., pattern recognition and detailed perception of the situation. These functions have been crowded out by the development of language skills leading to worse working memory.

2.3.2 Experiments with humans

Martin et al. (2014) found that humans were not especially good in competitive games. Test subjects chose between two alternatives. One of the players got paid for choosing the same as the opponent, and the other player from choosing the opposite. When the payoff structure was changed, humans did not rationally respond to the changes. This was motivated by the limited working memory compared to the chimpanzees, which understood the changes in payoffs and adjusted their strategy accordingly.

Gill and Prowse (2016) studied how cognitive ability affected the evolution of repeated strategic interactions with 780 participants in total. The participants were recruited from the English as a Second Language student pool. Each test subject did a 30-minute long Raven test to measure the cognitive abilities, big five personality test and played a BCG. The test subjects were classified as “high ability” or “low ability” test subjects based on whether they scored above or below the average result. Theoretical predictions were based on Level-k theory. After the tests, they formed groups based on the cognitive abilities; the groups of three were either “own matched” or “mixed”. The “own match” group was formed of the test subjects from the same ability group, i.e., the groups included only high or low ability test subjects. The mixed groups were formed, including both abilities. After the evaluation process and group forming, the test subjects played ten rounds of the BCG with p=0.7 and choice of number from interval [0,100].[3] The results were the following. Individuals with higher cognitive abilities followed higher Level-k rules and converged towards equilibrium faster than the low ability test subjects. They also responded positively to their opponents’ cognitive abilities, whereas the low-ability test subjects did not respond at all. In the experimental BCG, the theoretically correct answer is not often the best, given that the other player’s answers affect which answers are the closest. Despite this, the high-ability individuals earned more in the game. From the personality perspective, agreeable and emotionally stable individuals performed better. The results with a relatively large sample suggested that cognitive ability and personality affect the performance in BCG.

Fehr and Huck (2015) conducted a BCG with 240 subjects. They studied two topics. First, the relationship between cognitive ability and answers in the BCG. Second, the relationship between cognitive ability and the beliefs about other’s cognitive ability. They used a cognitive reflection test (CRT) consisting of three questions and a 20-question Wonderlic Personnel Test

[3] More information about the BCG is available at chapter 3

(WPT) to measure cognitive ability. The answers in WPT were used to test the robustness of the shorter CRT in assessing the cognitive ability. The CRT results were found to be robust and used in the analysis to more specific views that reveal the individual's cognitive ability. The most difficult question found was the "Bat and Ball" question.[4] The BBQ was a good proxy for the result in CRT-test. The answers by test subjects with lower measured cognitive ability seemed to be randomly distributed over the whole interval. Their answers did not depend on the belief of other subjects' cognitive ability. On the contrary, the individuals with high cognitive ability avoided answers above 50, and their answers also correlated with their expectations of other subject's cognitive ability. It implies that the individuals with high cognitive ability were able to think strategically. Also, they found that individuals above a certain threshold perform better in the game, implying that the benefit of cognitive ability in games was non-linear.

Burnham et al. (2009) tested over 650 same-sex twins in Sweden. They tested the cognitive ability using a standard psychometric test of cognitive ability. The strategic decision-making was tested by the twins playing a BCG. Twins as a test-subject provides relatively strong evidence of the causal effect of cognitive ability on decision-making. They found that the cognitive ability was related to an answer closer to NE.

Rubinstein (2016) introduced a typology of the players in various game-theoretic games; he divided players into "contemplative" and "instinctive" categories. Contemplative actions were often optimal to maximize the outcome; however, when more than two actions to choose, contemplative actions are not always optimal given his data. The individuals with higher cognitive skills are probably more contemplative, trying to figure out the optimal move. He also had the empirical data of many persons over the years, who were students at game theory courses in various countries, played ten different games on a website. The contemplative actions were the answers with higher response time and instinctive with shorter response time in the empirical data. Typically, the contemplative action gives a higher payoff and is closer to the theoretical predictions. Evaluating the games from a theoretical perspective requires assessing the other player's strategy. Normally, instinctive behavior only looks at the player's payoffs instead of strategic thinking of the optimal strategy for the second player who affects the payoffs. The typology is relevant in all three games played in the experiments of this thesis requiring contemplative actions to answer optimally.

[4]"The "Bat and Ball" question (BBQ) refers to the following question: A bat and a ball cost 1.10 Euro in total. The bat costs 1.00 euro more than the ball. How much does the ball cost?" where the intuitive answer is 1 euro, but the correct is 1.05 euro.

2.4 Young adults and strategic behavior

One of the two test groups in this study is 18-19-year-old high school students. It is well-known that cognitive ability develops after reaching the legal age of majority. The prefrontal cortex develops until around the age of 25, and the “rewiring” of the brain stops (Casey, Getz, and Galvan 2008). It means that neuroplasticity, crucial for learning, declines significantly around that age (Pauwels, Chalavi, and Swinnen 2018).[5] The development phase is probably the most fruitful time for some problem solving; Kleibeuker et al. (2013) found that 15-17 year old were better in creative problem solving than 25-30 years old individuals with a fully developed brain.

By looking into data of more than 48,000 individuals Hartshorne and Germine (2015) made, among others, the following finding of the cognitive development of young adults. The information processing speed peaks at the earliest around ages 18-19, and the short-term memory is strongest around the age of 25 and starts declining around the age of 35.

Sutter, Zoller, and Glätzle-Rützler (2019) overviewed the literature of the economic behavior of children and adolescents. A general finding was that kids were already able to behave rationally, and adolescents’ decision-making was quite close to observed behavior among adults. Czermak et al. (2016) studied 196 individuals between ages 10-17 in experimental normal-form games. They found that in 45% of cases, the test subjects played NE, and 40% of the individuals were classified as strategic. Overall the behavior of test subjects was very similar to the behavior of college students in their 20’s.

The literature suggests that young adults around the ages of 18-19 have developed adult-like rational behavior. They can act rationally in an economic context involving various incentives and optimal strategies. It may even be that young high school students are more responsive to new information and can act more rationally than individuals age 25 or above despite the ongoing brain development.

2.5 My contribution to the literature

Some research exists on the relationship between cognitive abilities, personality characteristics, and decision-making. However, there is no research on the effect of information nudge on strategic decision-making to my knowledge. Also, the treatment effect’s relation to cognitive

[5]People can access neuroplasticity even after the age 25, but it is more difficult

ability and personality characteristics are researched. This thesis provides useful knowledge for many practical applications; strategic decision-making is useful in many contexts, from financial decision-making to health decisions. This thesis decreases this significant gap in the literature.

3. Games and Treatment

In this chapter, the games and treatment are presented.

3.1 Beauty Contest Game

Beauty Contest Game is a strategic game named after a famous metaphor by John Maynard Keynes. He described stock markets being a "beauty contest" of smart people trying to guess what average opinion guesses of the average opinion to be (Nagel, Bühren, and Frank 2017). In the experiments of this thesis, test subjects play Nagel's (1995) "p-Beauty Contest Game" (BCG). Players are instructed to answer any real number from an interval [0, 100]. The objective for the player is to guess p times the average of all players' guesses, p commonly being $\frac{2}{3}$. The game provides information on the player's rationality and ability to make strategic decisions. BCG is widely used in studies on the strategic decision-making (e.g., Fehr and Huck 2015; Gill and Prowse 2016; Burchardi and Penczynski 2014).

In the experiments of this thesis, the BCG is played in two forms. In the first one, the players try to guess based on what all players empirically answer. This game is called "basic BCG" in this thesis. In the second form, the players are asked to give the theoretically correct answer. This game is called "theoretical equilibrium BCG" in this thesis. In the basic BCG, the goodness of the answer is assessed by the closeness to the $\frac{2}{3}\times$ average of all players' answers. The answers in the theoretical equilibrium BCG are assessed by whether the answer can be motivated by Nash Equilibrium (NE). When $p < 1$, there is a unique NE of guessing 0. The reason is that unless all other players guess 0, the highest bidder can always gain by guessing a lower number. NE of 0 is the only correct answer in theoretical equilibrium BCG.

Alternative to NE and empirically more valid prediction of test subjects' answers in BCG is the "Level-k" theory. The Level-k theory has been shown to be valid in many academic papers, e.g., Stahl and Wilson (1994), Stahl and Wilson (1995), Nagel (1995), Costa-Gomes, Crawford, and Broseta (2001), and Arad and Rubinstein (2012). In Level-k thinking, as in NE, players respond optimally conditional on their beliefs of other players. A player who relies on Level-k, when $k > 0$, assumes to be the most sophisticated giving her prediction based on other players being one level lower. A level-0 agent is a strategically naive player who randomly guesses a number from the interval. This leads to an average of 50.[6] A Level-1 agent makes her guess based on what Level-0 agent guesses, i.e., best responds by guessing $\frac{2}{3} \times 50$ being approximately 33.33. A Level-2 agent best responds based on what Level-1 agent guesses, i.e., $\frac{2}{3} * 33.33$ being approximately 22.22. In a general form, a Level-k agent guesses $\frac{1}{2} \times (\frac{2}{3})^k \times 100$.

On a group level, guessing lower numbers in BCG indicates more rational answers. Lower numbers are closer to NE and a result of following higher Level-k rules on average. Answering high numbers is a sign of not understanding the game or making a very naive assumption of other players' answers.

[6]Level-0 player is assumed to put the same probability on each number in the interval.

3.2 Variable-sum game

The payoff matrix for the variable-sum game in the experiments is presented in section 3.2. The game is a modification of a zero-sum game in Rubinstein (2016). The transformation has been done by adding two to each row and column. For Player 1 the NE is to play a mixed strategy choosing T with probability $\frac{1}{3}$ and B with probability $\frac{2}{3}$.[7] The more instinctive strategy is to play row T. If Player 2's optimal strategy is not taken into account, choosing row T has an expected payoff of 3$ in comparison to an expected payoff of 2.5$ when playing row B. The payoff currency used depends on the experimental group, MTurkers have USD, and HSS have Euros. Answers for anonymous Player 2s are collected from random individuals prior to the experiment.

The players are instructed with the following text: "You are player 1. You need to choose to play either row T or B. The payoffs you have as player 1 are always the blue ones and player 2 gets the payoffs in red. Let's assume you play row T. If player 2 plays column L, you get 4$, and if player 2 plays column R, you get 2$. Let's assume you play row B. If player 2 plays column L, you get 2$, and if player 2 plays column R, you get 3$. Now imagine that player 2 is a random anonymous player. Which row you choose to play?".[8]

		Player 2	
		L	**R**
Player 1	**T**	**4,0**	**2,2**
	B	**2,2**	**3,1**

Variable-sum game payoff matrix.

[7]Player 1 plays strategy that makes player 2 indifferent between choosing L and R. Let player 1 play L with probability p and R with probability 1-p. Then we have:
$E(s2 = L) = E(s2 = R)$
$0p + 2(1 - p) = 2p + (1 - p)$
$p = \frac{1}{3}$
$1 - p = \frac{2}{3}$

[8]The instruction for HSS is in Finnish, and currency in the text is Euros (€)

3.3 Treatment

The treatment was chosen based on the following criteria. The treatment should be relatively short to have high practical validity and for the test subjects to think it's worth reading. Second, the treatment should provide a clear signal of the importance of considering the other players' strategies. The first part of the treatment was seeing the short text on game theory:

> "Game theory is a mathematical system for analyzing and predicting how people behave in strategic situations. A person making decisions based on game-theoretic thinking must anticipate what other people will do and the outcomes in possible scenarios."

The second part of the treatment was seeing a picture in figure A.1 with thought bubbles and text explaining the decision-making situation.

"Think about the following example. You are a football goalie, and the team you are playing against gets a penalty kick. The kicker is a person you used to play in the same team with for a long time. You remember that he never kicked in the middle, and approximately seven out of ten times, he kicked to the right side of the goal. Because he is known for his hard kick, you need to decide which side you try to save before he kicks. You think strategically and try to save the right side because the probability of saving the ball is higher. However, the kicker knows that you know his tendency to kick right. Thus, he decides to kick the left side instead of the typical right side. Furthermore, the reasoning does not have to stop there..."

Figure A.1: Picture with text

4. Method

In this chapter, the hypotheses, test subjects, and experimental method are presented.

4.1 Hypotheses

The human brain has not changed fundamentally for 50 000 years despite the huge development from hunting and gathering food into developing, among other things, advanced mathematics and physics, institutions, economic theory, and computers. In developed countries, virtually everyone can read, and almost all individuals use some computational device effectively on a daily basis. This all is a result of the superior learning abilities of humans. All individuals can learn new things, even the ones with traumatic brain injury (McGraw-Hunter, Faw, and Davis 2006). However, this does not mean that individuals can learn equally; there are significant differences in learning abilities between individuals (Zerr et al. 2018).

4.1.1 Fast and slow learning

Jensen (1989) reviewed the literature on the concept of learning. The most fundamental distinction in learning is slow and fast learning. Learning truly new things or skills is typically slow, e.g., acquiring motor skills and learning simple arithmetics for the first time. Fast learning is typically related to “getting the idea”, “catching on”, or “grasping the concept” of something. To give a simple example, getting an idea of how to play tennis for a regular adult does not take a long time, but becoming a competitive player takes years. Fast learning can also be related to earlier learned; if a person knows and understands the variance formula, the standard deviation formula is easy to learn. The learning in the experiment falls under the category “fast learning”; the presented material for the treatment group in the experiment is relatively intuitive, and the games require only a basic understanding of the logic in game theory.

4.1.2 General perspective of learning

Cognitive psychology has developed memory and information processing models to explain humans' learning, called "general perspective". The models on general perspective explain the superior human learning abilities by two capacities. First is the function of working memory as a general-purpose resource allowing humans to hold several mental representations simultaneously for further manipulation. Second, the ancient corpus of the modularized core knowledge of space, quantities, and the physical and social world. Working memory allows for connecting this knowledge to language, numerals, and other symbol systems, which provides the basis for reasoning and knowledge acquisition in learning new things if the opportunities are provided. Both resources are innate to all humans (Stern 2017). The first hypothesis presented in section 4.1.4 is based on the "general perspective".

4.1.3 Differential perspective of learning

The learning abilities between individuals are not equal. In the cognitive psychology this is called "differential perspective" (Stern 2017). A well-known "three statum model" explains the structure of individual variation in learning abilities. The model is very comprehensive with three layers. On the top of the model, stratum III is the general intelligence, "g-factor", which was explained in detail in chapter 2. On the middle layer, stratum II is encompassing broader abilities such as comprehension knowledge, reasoning, quantitative knowledge, reading and writing, and visual processing. On the bottom layer, stratum I have 80 narrower abilities such as spatial scanning, oral production fluency, and sound discrimination. In this hierarchical model, backed up by more than 460 data sets, the general intelligence is best conceptualized in a hierarchy of three strata (Carroll 1993).

The theoretical and empirical literature on the relationship between cognitive ability and learning is focused on time differences. Individuals with higher cognitive abilities learn significantly faster compared to individuals with lower cognitive abilities. The theoretical foundations of differences in learning speed are described by models in information processing systems (see e.g., Ackerman 1986; Fisk, Ackerman, and Schneider 1987; Kyllonen 1986; Thorndike 1984). The empirical relationship is often researched by relatively short and simple Elementary Cognitive Tasks (ECTs). The time measures are robustly found to correlate negatively with intelligence, reaction times, and latencies, being significantly shorter for individuals with higher cognitive abilities. Similar findings are also made with more complicated tasks (Gettinger 1984). The reason for the relationship is the processing speed; intelligent individuals can process information significantly faster.

The time constraint in the experiment is quite restricted, making higher processing advantageous. With enough time and guidance, most of the test subjects could probably understand the concepts required to answer rationally in games. However, only individuals with high enough cognitive abilities can do it under the experiment's restricted information and time limits. One factor potentially decreasing the treatment effect is individuals with higher cognitive abilities being better problem-solvers without the information nudge. This gets some support from previous experiments (e.g., Gill and Prowse 2016; Burks et al. 2009). However, this is not likely to make the treatment redundant; not all individuals with high cognitive abilities answer rationally. Also, many individuals with low cognitive abilities probably do not have enough time to process and understand the information making it less useful for them. Thus, higher cognitive ability is assumed to be advantageous, and the nonlinearities may exist after which the processing speed is fast enough to gain from the treatment. Thus, the second hypothesis, based on the differential perspective of cognitive abilities, presented in section 4.1.4, states that individuals with higher cognitive abilities benefit more from the treatment.

The relationship between learning and personality is somewhat more complex compared to cognitive ability. Intelligence describes what and how quickly an individual can do something, whereas personality describes what a person will do and how (Chamorro-Premuzic and Furnham 2005). Personality characteristics do not have a significant correlation with intelligence, implying that personality affects learning independent of the cognitive ability (Stankov 2018).

The personality characteristics of interest in the experiment are conscientiousness, openness, and agreeableness. Heinström (2012) reviewed the literature on the relationship between learning and the five-factor "big five" personality characteristics, concluding that these three characteristics are positively related to learning. Extraversion and neuroticism are not clearly related to learning. Conscientiousness has consistently been found to have a positive effect on learning in various contexts among different people. The reason is that conscientious individuals have a strong will and motivation to succeed in the task at hand. They do not give up if a task looks difficult in the beginning but commit to solving it effectively. Openness is positive for learning because it is related to high motivation and curiosity to learn new things. Individuals high on openness enjoy solving cognitive puzzles, and they have a high need for cognition, focusing deeply, and learning analytically. Thus, openness is beneficial for learning in the experiments, given that the information is likely to be new for most of the test subjects. Agreeable individuals have some positive characteristics to learning. They are willing to comply, want to please, and abide by external demands. In the experiment, they are willing to read and look at the provided treatment material and solve the problem as instructed in the experiment.

To conclude, conscientiousness, openness, and agreeableness are assumed to be positively related to the treatment effect. The third hypothesis presented section 4.1.4 is based on the differential perspective of these three personality characteristics.

4.1.4 Three hypotheses of the experiments

Hypothesis 1: Independent of the cognitive ability or personality, an individual can learn strategic thinking through an information nudge
Hypothesis 2: Individuals with cognitive ability above-median benefit more from the treatment answering closer to theoretical predictions and receiving higher payoffs
Hypothesis 3: Individuals with higher openness to experience, agreeableness, and conscientiousness benefit more from the treatment answering closer to theoretical predictions and receiving higher payoffs

The hypotheses will be operationalized in the experiment in the following way. The treatment group chooses, on average, a lower number in the basic BCG, more frequently NE in theoretical equilibrium BCG, and has a higher probability of choosing B in the variable-sum game. This effect is expected to be larger for test subjects with above-median cognitive ability, conscientiousness, openness, and agreeableness.

4.2 Test subjects

The test subjects of the two experiments consist of Finnish high school students (HSS) and Amazon Mechanical Turkers (MTurkers). A picture of the Finnish school system structure is provided in figure A.1 to understand the background of HSS.

The second group consisting of MTurkers, is a general group of individuals from various backgrounds. It was included due to the unsuccessful recruiting of a sufficient sample size of HSS. No additional selection criteria were applied on the Amazon Mechanical Turk platform, implying that the group is very general, including individuals with various backgrounds. Amazon Mechanical Turk is a global platform implying that it is likely that the test subjects came from various countries and cultures and have a significant variation in ages and educational backgrounds.

In the Amazon Mechanical Turk platform, there is a clear conflict of interest between the experimenter and the MTurkers. The experimenter wants to get serious answers, and the MTurkers maximize the payoff for the time and effort they put into the experiment. The income from the Amazon Mechanical Turk platform may be significant for many MTurkers. The problem is addressed in various ways by the platform and the payoff structure of the experiment. Amazon Mechanical Turk platform evaluates all applications to work on the platform and only accepts individuals meeting their requirements. Secondly, the platform collects statistics of each worker and gives a possibility to achieve higher qualifications giving access to more lucrative tasks. The experimenter also has a right not to pay for unserious answers. This right is not used in the experiment. The payoff structure of the experiment, described in section 4.4, is created to incentivize the MTurkers' answer correctly by giving generous payoffs for correct answers.

Several papers show that the answers in the Amazon Mechanical Turk platform can be used for research purposes. The answers are not significantly less reliable compared to conventional data collection methods, and the results can be used for research purposes on various domains (e.g., Buhrmester, Kwang, and Gosling 2011; Mortensen and Hughes 2018).

4.3 Experimental method

The data for the thesis comes from two experiments. Players are be divided into treatment and control groups. Appendix A includes the exact content of the experiments.

4.3.1 Background information

Test subjects are asked individual characteristics depending on whether the test group consisted of HSS or MTurkers: age, sex, high school class (first, second or third), high school math level (advanced or intermediate), education level, mathematical background, and whether the test subject has previous knowledge on game theory. These background variables could affect the answers in the experiment given the various levels of previous knowledge and some other potentially significant traits.

4.3.2 Cognitive ability and personality tests

All players' cognitive abilities are tested with a 12-question form of nonverbal Raven's Advanced Progressive Matrices test (Raven's test). Questions are randomly chosen from Raven's Advanced Progressive Matrices set II. The full-length test is a 60-item test, but the shorter forms of the test predict cognitive ability well (see e.g., Winfred Arthur and Day 1994; Bors and Stokes 1998; Hamel and Schmittmann 2006). A big five inventory test is done to test subjects, including the questions determining the scores for conscientiousness, agreeableness and openness.[9]

4.3.3 Sample size

Power calculations determine the required sample size. Cohen's d is an effect size used to indicate the standardized difference between two groups' means (Cohen 1988). Cohen's d = 0.2, 0.5, and 0.8 are considered small, medium, and large effect sizes. These can be used as rules of thumb. In the calculations, the power of 0.8 is used.[10]

There are no comparable studies that could be used to determine the treatment effects to my knowledge. Thus, the required sample size is approximated using the earlier described basic rules of the effect sizes. The provided treatment is relatively easy to understand and helpful to answer rationally in the games. The effect is probably larger than small. In both BCGs, the logic is relatively simple when a player understands to consider other players' strategies. Based on this, the treatment effect is assumed to be slightly below the medium effect, being 0.4. This leads to a total required sample size of 52 for both BCGs.

The logic is probably more difficult to understand in the variable-sum game with a mixed-strategy NE. The player should choose more frequently the row with a lower total payoff if the Player 2:s actions are not taken into account. Thus a slightly smaller effect size of 0.3 is assumed. This leads to a total required sample size of 90.

Because all games are performed with the same sample, the largest sample size needs to be chosen. Thus, the required minimum sample size is 90. By having at least 90 test subjects in the experiment, below medium-sized effects can be found.

[9] Relevant questions: 2,3,5,7,8,10,12,13,15,17,18,20,22,23,25,27,28,30,32,33,35,37,38,40,41,42,43,44

[10] For the calculation, software called G*Power is used. The following settings were applied: Test family: F tests, Statistical test: ANOVA: Fixed effects, omnibus, one-way, Type of power analysis: A priori: Compute required sample size - given α, power, and effect size

4.4 Practicalities

HSS-group

Research permission was officially applied and received to recruit test subjects from high schools in Salo in Finland. The invitation emails were sent to students' school emails for everyone at least 18 years old to sign up for the experiment. Basic compensation of 5 euros (ca. 50SEK) was paid for everyone who did the experiment and extra compensation for correct answers.

In the basic BCG, 10% of the closest answers had a payoff of 10 euros. In theoretical equilibrium BCG, providing a theoretically correct answer based on NE had a payoff of 1 euro. In the variable-sum game, the players received the payoff showed in the payoff matrix (2-4 euros). Each correct answer in the cognitive ability test was rewarded with 0.1 euro.

The payments were made through a mobile payment application called MobilePay. The test subjects needed to provide their phone numbers for the payment. To ensure anonymity, the payments were processed as follows. First, the payments were calculated for each anonymous participant. After that, the payment information was printed out to make the payments to the phone numbers, and the electronic information was deleted. The payments were processed by a trustworthy third party who agreed to process the payments confidentially.

The randomization was done on the experimental session-level. Half of the sessions were with treatment, drawn prior to sending the invitations. The experiments were held on 18.5.2021 (control group), starting at 17.00 and 19.00 local time, 19.5.2021 (test group) starting at 17.00 and 19.00 local time, and 23.5.2021 starting at 14 and 16 local times. All groups have spots for 30 individuals (180 in total). The experiments were organized via Zoom, and answers were collected through Google forms.

MTurkers-group

The MTurkers were recruited using Amazon Mechanical Turk platform. The treatment was randomized for all test subjects. Half of the test subjects received the treatment, and half did not. The payoff structure for MTurkers was the same as for HSS, but the payoff currency was USD.

4.5 Preregistering of experiment

The experiments were be pre-registered on American Economic Association's registry for randomized controlled trials to provide transparency and ensure easy replicability. The registrations for HSS can be found from here and for MTurkers from here.

4.6 Data analysis

Experimental data is analyzed by using applicable econometric methods presented in this section. First, the econometric methods and variables are described in general. Later in section 4.6.1 and section 4.6.2 the methods are described more technically.

First, a descriptive analysis of the data is done by analyzing the differences in means between control and test groups and plotting the data. Also, randomization is tested by trying to predict the test group assignment by explanatory variables. After that, the Mann-Whitney-U test is performed. It is a non-parametric version of the student's t-test. It allows comparing whether there were significant differences in the answers between groups. The cognitive ability and personality characteristics are shared into binary groups of having some characteristic or not based on whether the test subject had above median or median or less than score. Also, the same results using nominal values are provided in appendix A. Potential nonlinearities are also examined; after a certain threshold level of cognitive ability or personality characteristic, the treatment may become useful. The nonlinearities are econometrically tested and analyzed if found graphically. The theoretical equilibrium BCG answer is set to binary values correct (=1) and false (=0) based on whether the test subject answered NE. The nominal values from the theoretical equilibrium BCG are not researched, given the high correlation with basic BCG answers.

4.6.1 Mann-Whitney U-test

Unlike the student's t-test, Mann-Whitney U-test requires no assumptions of the distribution of the answers. However, some important assumptions must hold. First, the sample must be drawn from a random population. The experimental design of the thesis should lead to a random sample, which is also tested in the chapter 5. Second, independence within samples and mutual indecency must be assumed, simply meaning that one observation is in one group or the other, being the test or treatment group in the experiment. Third, an ordinal measurement scale is assumed.

The Mann-Whitney U-test tests the following. There are two independent random variables X_c and X_t, where c denotes control group and t test group. The null hypothesis is $X_c \sim X_t$. n_c and n_t are the sample sizes of the X_c and X_t respectively. The data is ranked depending on the sample it belongs. If the data are tied, averaged ranks are used. Wilcoxon's test statistic presented in equation (1) and equation (2) is the sum of the ranks for control and test group samples.

$$T_c = \sum_{i=1}^{n_c} R_{ci} \tag{1}$$

$$T_t = \sum_{i=1}^{n_t} R_{ti} \tag{2}$$

The Mann-Whitney U statistics for both groups is calculated by using formulas presented in equation (3) and equation (4). The p-values are calculated using Fisher's exact test.

$$U_c = T_c - \frac{n_c(n_c+1)}{2} \tag{3}$$

$$U_t = T_t - \frac{n_t(n_t+1)}{2} \tag{4}$$

4.6.2 OLS

The OLS regression is the standard OLS regression presented in equation (5). Y denotes the dependent variable, which is the answer in basic BCG or total payoff, α is a constant, and i denotes individual. T is a dummy for being in the test group, C is the cognitive ability score (binary above-median = 1 or nominal values), P_i is a vector of personality test scores (binary above-median = 1 or nominal values), X is a vector of individual characteristics (depending on the group: previous game theory knowledge, math level at high school, high school class, age, and sex) and ϵ is the error term. $\beta_1 - \beta_4$ are coefficients.

$$Y = \alpha + \beta_1 T_i + \beta_2 C_i + \beta_3 P_i + \beta_4 X + \epsilon \tag{5}$$

To test the second and third hypotheses, the interaction terms are added to the regressions.

The γ and δ are additional coefficients; otherwise, the notation is the same. Regression for the second hypothesis is presented in equation (6) and for the third hypothesis in equation (7).

$$Y = \alpha + \beta_1 T_i + \beta_2 C_i + \gamma C_i T_i + \beta_3 P_i + \beta_4 X + \epsilon \tag{6}$$

$$Y = \alpha + \beta_1 T_i + \beta_2 C_i + \beta_3 P_i + \delta P_i T_i + \beta_4 X + \epsilon \tag{7}$$

4.6.3 Logistic regression

The logistic regression is presented in equation (8) and cumulative logistic regression function F(z) in equation (9). Y is the binary dependent value of test group assignment, the correct answer in theoretical equilibrium BCG, or answering row B in the variable-sum game. Otherwise, the notation is the same as in the equation (5). In a similar way as in the equation (6) and equation (7) interaction terms are added to test the second and third hypotheses.

$$Pr(Y) = F(\alpha + \beta_1 T + \beta_2 C + \beta_3 P_i + \beta_4 X) \tag{8}$$

$$F(z) = \frac{z}{1 + e^z} \tag{9}$$

5. Data

In this chapter, the experimental data is presented, and the quality of the data is discussed and tested. Variables are presented in detail in table A.1. The sample size of HSS was clearly below the required sample size; thus, the main evidence comes from MTurkers. Instructions and all experimental content for test subjects are presented in appendix A.6.

5.1 Summary statistics

In table 5.1 the summary statistics of the MTurkers are presented. Both control and test groups had sufficient sample sizes of 60. The mean answers in both BCGs were higher among the test group, being 51.0 in the basic BCG and 48.6 in the theoretical equilibrium BCG. The same means for the control group were 36.4 and 40.6, respectively. Surprisingly, test subjects in neither control nor test groups answered NE in theoretical equilibrium BCG. The slightly lower share of the test group answered B in the variable-sum game, being 30% compared to control groups 35%. Both of these are significantly lower than the theoretically expected share of $\frac{2}{3}$. The total payoff was slightly lower for the test group. Overall, it seems that the control group performed better in the experiment than the test group. Similar findings on BCGs were also found for the HSS, presented in table A.2.

Cognitive ability and personality characteristics scores were quite similar between the groups. The test group had a slightly lower average age being 32.8 years, compared to the control group's 35.3 years. The test group also had a 13 percentage points higher share of females, being 43%. The slightly lower share of the test group had the highest education of high school or bachelor's degree and higher share with master's degree. As many as 82% of the test group reported strong mathematical background and 60% of the control group. Game theory knowledge was more prevalent in the test group, being 65% compared to 48% in the control group.

In table 5.2 are presented some basic BCG means from previous experiments. The control group's answers seem to be slightly below the answers generally in previous experiments. However, the difference does not deviate alarmingly. The test group's answers were clearly above the means from previous studies without treatment.

Table 5.1: MTurkers summary statistics

	Control group		Test group	
Variable	Mean	SD	Mean	SD
Basic BCG	36.39	24.59	51.03	24.02
Theoretical equilibrium BCG	40.55	23.88	48.59	25.36
Theoretical equilibrium BCG correct	0.00	0.00	0.00	0.00
Row B in variable-sum game	0.35	0.48	0.30	0.46
Total payoff	3.62	3.07	3.50	3.00
Cognitive ability	5.25	2.80	6.05	2.24
Conscientiousness	33.53	6.94	33.75	5.74
Openness	36.85	5.54	36.77	4.36
Agreeableness	32.13	5.74	32.17	5.15
Age	35.32	11.63	32.82	9.75
Sex	0.30	0.46	0.43	0.50
High school or equivalent	0.12	0.32	0.07	0.25
Bachelor's degree or equivalent	0.65	0.48	0.55	0.50
Master's degree or equivalent	0.23	0.43	0.38	0.49
Strong math background	0.60	0.49	0.82	0.39
Game theory knowledge	0.48	0.50	0.65	0.48
N	60		60	

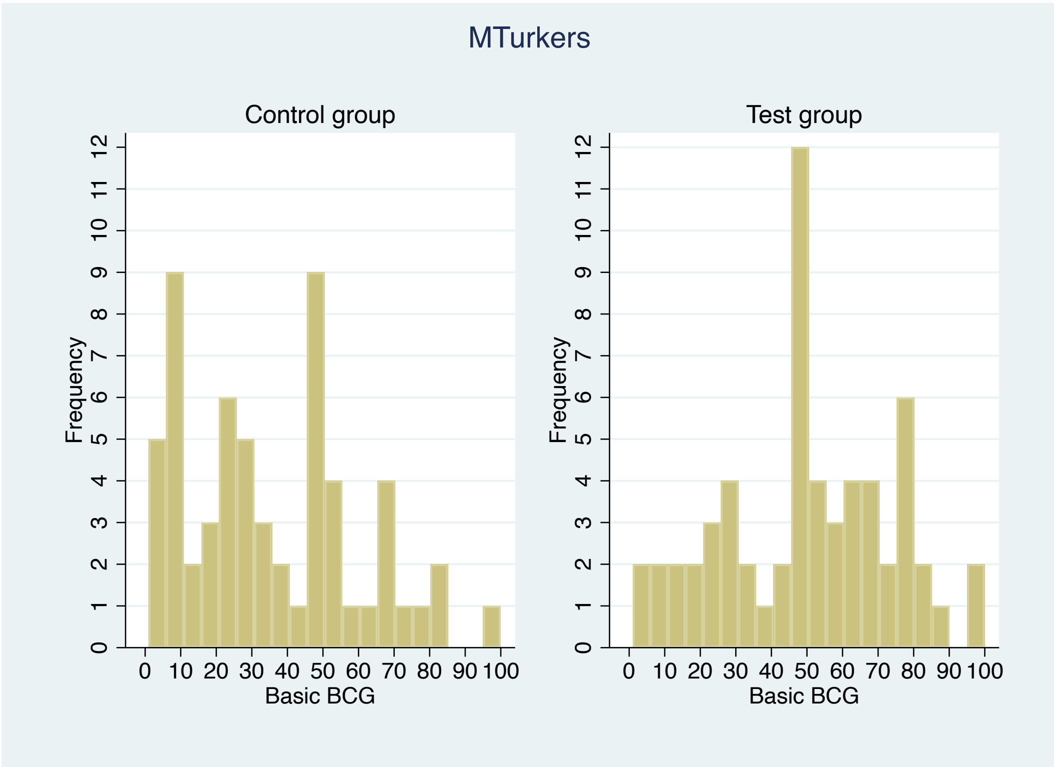
Study	Mean
Fehr and Huck (2015)	45.1
Nagel (1995)	36.7
Brañas-Garza, García-Muñoz, and González (2012)	43.2
Burchardi and Penczynski (2014)	43.9
Gill and Prowse (2016)	44.2

Table 5.2: Basic BCG means in other comparable studies with p=$\frac{2}{3}$ except from the study by Gill and Prowse (2016) where p=0.7

5.2 Distribution of answers

In the figure A.1 the answer distribution in the basic BCG is presented for the MTurkers divided into 20 bins. For both groups, there is a clear spike of answers around 50. For the control group, there is also a spike of answers around 10, which can be motivated by Level-4 thinking. Quite many answers are also distributed between 20-30. The test group's answers are quite equally distributed over the whole interval besides the spike around 50. The distribution of answers in theoretical equilibrium BCG is presented in figure A.2. For HSS distributions for both BCGs are presented in figure A.3 and figure A.4.

Figure A.1: MTurkers basic BCG answer distribution



The graphical presentation to determine whether the data had non-linearities are presented in figures A.5 to A.9. The answers from the basic BCG were compared to cognitive ability, personality characteristics, and education. No clear non-linearities were found in the data. However, interestingly higher education level was related to lower answers in the basic BCG for the control group, but not for the test group. It seems that the treatment took off the positive effect of the education.

5.3 Data quality

For the results to be causal, the randomization must be successful. Randomization was tested by predicting test group assignment with the control variables. Logistic regression results for both MTurkers and HSS are available in table A.3. The test group assignment for MTurkers can be concluded to have been successful; all variables were insignificant. The variable sex was significant for HSS. This finding is probably related to the small sample size. Otherwise, all variables were insignificant.

Some other factors may be of concern in terms of data quality. The central concern prior to the experiment was HSS being too homogeneous, leading to very similar answers. The concern was irrelevant given the relatively high variance of the answers. However, unfortunately, the recruitment of HSS was unsuccessful, leading to an insufficient sample size of only 33. Only large effects can be found from the sample.

The recruitment of the Mturkers was easy and took probably less than an hour. Losing the payment by answering badly or not receiving good bonuses would have been relatively costly for the MTurkers. The answers, in general, seemed to be reasonable and not a result of randomly clicking the options. The MTurkers' answers were in many ways similar to the HSS'. This is a good sign, given that the HSS was probably at least partially motivated and interested in the experiment instead of answering them half-professionally.

The cognitive ability test is probably the best proxy for the seriousness of the answers. All 12 questions had eight options, out of which one was correct. It is not easy to get the questions right by chance. The average cognitive ability score of slightly below six seems reasonable when compared to answers by HSS. In the robustness analysis, the answers with a cognitive ability score below four are left out, trying to leave out the non-serious answers.

6. Results

In this chapter, the results from the experiments are presented. In the main results, binary above median or equal or less than measured cognitive ability, conscientiousness, openness, and agreeableness are used, denoted by "med" after the variable name. The variables take value 1 if above median, otherwise 0. It is probably a more informative way to evaluate the characteristics of each person by having some characteristic or not. In the appendix A are results with nominal values. Answering correctly in theoretical equilibrium BCG is not included in the results because none of the test subjects answered correctly. Results are considered statistically significant if the p-value is less than 0.05.

6.1 Hypothesis 1

Table 6.1 presents results of the Mann-Whitney U-test for MTurkers. In the basic BCG, the distributions of the control and treatment groups deviated significantly on a 1% significance level. The difference was clear also by looking at means; the test group answered 51.0 on average and the control group 36.4. Based on the first hypothesis, the test group was expected to guess lower numbers. However, the finding suggests that the information nudge had a significant negative effect on decision-making, test group choosing significantly higher numbers. This is not likely to be learning from the information nudge. The suggestions of the underlying reason are discussed further in chapter 7. Playing row B in the variable-sum game was clearly insignificant, which was not surprising given the relatively small difference in means between groups. The total payoff was also insignificant; the means between groups were relatively close to each other.

The same results by regressions with control variables using median values for cognitive ability and personality characteristics are presented in table A.5 and using nominal values in appendix A.8.1. Using median values, the test group answered significantly higher numbers in basic BCG on a 1% significance level with a coefficient of 15.784 for the test group and with nominal values on a 0.1% significance level with a coefficient of 16.330 for the test group. This implies that receiving the treatment increased the answer by ca. 16 on average.

The results for HSS from Mann-Whitney U-test and regression with binary values for cognitive ability and personality characteristics are presented in table table A.4 and table A.6. There were no significant results. The small sample size may partially explain the insignificant results.

Table 6.1: MTurkers Mann-Whitney U-test

	(1) Observations	(2) Mean	(3) Rank sum	(4) Expected Rank sum	(5) Exact p-value
Basic BCG					
Control group	60	36.39	3029	3630	0.0014**
Test group	60	51.03	4231	3630	0.0014**
Play Row B					
Control group	60	0.35	3720	3630	0.6970
Test group	60	0.30	3540	3630	0.6970
Total payoff					
Control group	60	3.62	3688	3630	0.7497
Test group	60	3.50	3572	3630	0.7497

Note: Statistical significance in p-values is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

6.2 Hypothesis 2

In the table 6.2 the results related to the second hypothesis are presented. Support for the higher cognitive ability increasing the learning from the information nudge is not found. In table A.8 the regression is run with nominal values for cognitive ability and personality characteristics, and the results remain insignificant. The same results using median values were also insignificant for HSS, presented in table A.7.

Table 6.2: MTurkers Regressions of second hypothesis using binary values for Cognitive Ability and Personality Characteristics based on median

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	16.416*	0.403	-0.438
	(6.569)	(0.714)	(0.827)
Cognitive ability med	3.566	0.924	-0.071
	(7.115)	(0.751)	(0.896)
Cognitive ability med × Test group	-1.303	0.004	0.943
	(9.413)	(1.024)	(1.185)
Conscientiousness med	-2.249	0.917	0.534
	(6.595)	(0.727)	(0.831)
Openness med	-0.885	0.585	0.396
	(4.815)	(0.541)	(0.606)
Agreeableness med	4.060	-0.850	0.199
	(5.948)	(0.680)	(0.749)
Bachelor's degree or equivalent	-7.459	-1.155	-0.152
	(8.980)	(0.883)	(1.131)
Master's degree or equivalent	-7.659	-3.083**	-0.456
	(9.627)	(1.087)	(1.213)
Game theory knowledge	-8.890	-0.812	0.525
	(5.959)	(0.653)	(0.751)
Strong math background	4.087	0.687	0.615
	(6.598)	(0.668)	(0.831)
Age	0.323	0.088***	0.035
	(0.228)	(0.026)	(0.029)
Sex	2.387	-1.764**	-0.689
	(5.069)	(0.661)	(0.638)
Constant	30.910*	-2.944*	1.970
	(14.080)	(1.470)	(1.773)
Observations	120	120	120

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

6.3 Hypothesis 3

In the table 6.3 the results related to the third hypothesis are presented. Support for the hypothesis of the positive effect of conscientiousness, openness, and agreeableness on the learning from the information nudge was not found. The same results for HSS, presented in table A.9, were also insignificant. Same regressions for MTurkers with nominal values are presented in table A.10. These results suggested that the conscientiousness and agreeableness scores had significant effects on the treatment effect. However, in the robustness test presented in table A.11, dropping individuals with cognitive ability scores less than 4 out of 12, the coefficients became insignificant. This implies that the finding is not necessarily robust.

Table 6.3: MTurkers Regressions of third hypothesis using binary values for Cognitive Ability and Personality Characteristics based on median

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	18.542*	-0.062	0.868
	(7.640)	(0.858)	(0.958)
Cognitive ability med	3.404	0.849	0.292
	(5.005)	(0.578)	(0.628)
Conscientiousness med	-11.119	2.405	1.356
	(9.298)	(1.251)	(1.166)
Openness med	3.276	0.020	-0.326
	(7.142)	(0.824)	(0.896)
Agreeableness med	11.837	-2.250	0.815
	(8.636)	(1.227)	(1.083)
Conscientiousness med × Test group	15.968	-2.504	-1.628
	(12.042)	(1.550)	(1.510)
Openness med × Test group	-8.478	1.244	0.873
	(9.878)	(1.138)	(1.239)
Agreeableness med × Test group	-15.388	2.535	-1.044
	(11.814)	(1.533)	(1.482)
Bachelor's degree or equivalent	-6.092	-1.563	-0.048
	(9.102)	(0.944)	(1.142)
Master's degree or equivalent	-5.524	-3.818**	-0.251
	(9.841)	(1.231)	(1.234)
Game theory knowledge	-9.764	-0.876	0.540
	(5.966)	(0.687)	(0.748)
Strong math background	4.413	0.851	0.558
	(6.568)	(0.700)	(0.824)
Age	0.340	0.091***	0.036
	(0.229)	(0.026)	(0.029)
Sex	2.928	-2.003**	-0.560
	(5.091)	(0.697)	(0.638)
Constant	28.068*	-2.530	1.317
	(14.113)	(1.474)	(1.770)
Observations	120	120	120

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

6.4 Robustness of results

The robustness of the main finding of treatment leading to higher answers in basic BCG was tested. It was done by excluding test subjects with a cognitive ability test score below 4 out of 12. These answers are likely to have been "unserious" and a sign of simply clicking the experiment through to get the basic compensation quickly. Some of the cognitive ability questions were relatively easy; having a score below 4 is probably not a result of doing the test properly, indicating other answers in the experiment being random as well. The robustness test was clearly passed, the Mann-Whitney U-test became more significant in table 6.4 and the coefficient for test group in table A.12 became larger and more significant. This indicates that the finding was robust.

A notable concern with the results is the so-called multiple testing problem. The probability can be calculated as follows. Three hypotheses were tested, all of which had three results. The risk of observing at least one significant result even though all results had been insignificant is calculated in Equation (10). It shows that there is a 37% probability of having at least one significant result without having any significant results on the 5% significance level. However, the results in the basic BCG were highly significant. Also, a similar finding of the test group answering higher numbers in the basic BCG was made for the HSS. Even though the results were insignificant, it indicates that the results could have been significant with a sufficient sample size. To conclude, the finding is likely to be causal and robust.

$$\begin{aligned} \text{Pr(at least one signif. result)} &= 1 - \text{Pr(no signif. results)} \\ &= 1 - (1 - 0.05)^9 \\ &= 0.37 \end{aligned} \tag{10}$$

Table 6.4: MTurkers Mann-Whitney U-test with Cognitive Ability > 3

	(1) Observations	(2) Mean	(3) Rank sum	(4) Expected Rank sum	(5) Exact p-value
Basic BCG					
Control group	40	34.96	1428	1860	0.0005***
Test group	52	52.42	2850	2418	0.0005***

Note: Statistical significance in p-values is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

7. Discussion

This thesis provided new experimental evidence to the literature. The main results came from the MTurkers. The treatment of receiving information related to strategic decision-making was significantly related to answering higher numbers in the basic BCG. Despite the significant effect, support for the first hypothesis of learning from the information nudge was not found. The negative treatment effect is not likely to be a result of learning; it may be explained by the negative effect of information nudge on the confidence of the test subjects. Zheng et al. (2020) asked 4000 participants a series of questions with varying degrees of familiarity. For some participants, scenarios had a causal structure, meaning that participants could make the correct decision based on the causal relationship laid out either in text or as a diagram. They found that individuals who got the information became significantly less confident, leading to worse decisions. Authors suggested that giving information is not a bad idea, but it is essential to understand better what people already know and tailor the information based on that mental model. This may also be the reason why the second and third hypotheses of test subjects with higher cognitive ability, conscientiousness, openness, and agreeableness scores benefiting more from the treatment did not get support from the results; all test subjects may have become equally confused, making them answer less rationally. A related finding was that the treatment seems to have taken off the positive effect of education on the answers in the basic BCG. An alternative explanation is an opposite effect of information nudge, making the test subjects overconfident. Information nudge is sometimes found to cause overconfidence (Tsai, Klayman, and Hastie 2008). There were some implications of higher confidence for the test group based on significantly more frequently evaluating their mathematics background to be strong and having knowledge in game theory. However, due to the limited amount of information in the experiment, it is difficult to reason how the treatment could have led to overconfidence.

Future research is needed to make clear conclusions on whether strategic thinking can be taught. Future literature could perform a similar experiment in a normal classroom-type experiment and try other treatment contents. However, too extensive and in-detail treatment could decrease the empirical validity of the evidence; strategic decisions are often made without the possibility to educate decision-makers extensively. It is critical to test various treatments to know whether there is a form of treatment, which do not cause potential confusion and negative treatment effect.

To conclude, the main finding of the thesis was surprising, showing that the information nudge had a negative effect on strategic decisions in the basic BCG. Based on this thesis, it seems that providing an information nudge in strategic decision-making situations is not necessarily beneficial.

Acknowledgment

I want to gratefully acknowledge that the experiment was funded by a grant from the Jan Wallander and Tom Hedelius Foundation (grant P19-0046).

References

Ackerman, Phillip L. (1986). "Individual differences in information processing: An investigation of intellectual abilities and task performance during practice". In: *Intelligence* 10.2, pp. 101–139. ISSN: 0160-2896. DOI: https://doi.org/10.1016/0160-2896(86)90010-3. URL: https://www.sciencedirect.com/science/article/pii/0160289686900103.

Akerlof, George A. (1970). "The Market for "Lemons": Quality Uncertainty and the Market Mechanism". In: *The Quarterly Journal of Economics* 84.3, pp. 488–500. ISSN: 00335533, 15314650. URL: http://www.jstor.org/stable/1879431.

Arad, Ayala and Ariel Rubinstein (Dec. 2012). "The 11-20 Money Request Game: A Level-k Reasoning Study". In: *American Economic Review* 102.7, pp. 3561–73. DOI: 10.1257/aer.102.7.3561. URL: https://www.aeaweb.org/articles?id=10.1257/aer.102.7.3561.

Bors, Douglas and Tonya Stokes (June 1998). "Raven's Advanced Progressive Matrices: Norms for First-Year University Students and the Development of a Short Form". In: *Educational and Psychological Measurement - EDUC PSYCHOL MEAS* 58, pp. 382–398. DOI: 10.1177/0013164498058003002.

Brañas-Garza, Pablo, Teresa García-Muñoz, and Roberto Hernán González (2012). "Cognitive effort in the Beauty Contest Game". In: *Journal of Economic Behavior & Organization* 83.2, pp. 254–260. ISSN: 0167-2681. DOI: https://doi.org/10.1016/j.jebo.2012.05.018. URL: https://www.sciencedirect.com/science/article/pii/S0167268112001278.

Buhrmester, Michael, Tracy Kwang, and Samuel D. Gosling (2011). "Amazon's Mechanical Turk: A New Source of Inexpensive, Yet High-Quality, Data?" In: *Perspectives on Psychological Science* 6.1. PMID: 26162106, pp. 3–5. DOI: 10.1177/1745691610393980. eprint: https://doi.org/10.1177/1745691610393980. URL: https://doi.org/10.1177/1745691610393980.

Burchardi, Konrad B. and Stefan P. Penczynski (2014). "Out of your mind: Eliciting individual reasoning in one shot games". In: *Games and Economic Behavior* 84, pp. 39–57. ISSN: 0899-8256. DOI: https://doi.org/10.1016/j.geb.2013.12.005. URL: https://www.sciencedirect.com/science/article/pii/S0899825613001711.

Burks, Stephen et al. (June 2009). "Cognitive Skills Affect Economic Preferences, Strategic Behavior, and Job Attachment". In: *Proceedings of the National Academy of Sciences of the United States of America* 106, pp. 7745–50. DOI: 10.1073/pnas.0812360106.

Burnham, Terence C. et al. (2009). "Higher cognitive ability is associated with lower entries in a p-beauty contest". In: *Journal of Economic Behavior & Organization* 72.1, pp. 171–175. ISSN: 0167-2681. DOI: https://doi.org/10.1016/j.jebo.2009.05.015. URL: https://www.sciencedirect.com/science/article/pii/S0167268109001450.

Busato, Vittorio V et al. (2000). "Intellectual ability, learning style, personality, achievement motivation and academic success of psychology students in higher education". In: *Personality and Individual Differences* 29.6, pp. 1057–1068. ISSN: 0191-8869. DOI: https://doi.org/10.1016/S0191-8869(99)00253-6. URL: https://www.sciencedirect.com/science/article/pii/S0191886999002536.

Carroll, John B. (1993). *Human Cognitive Abilities: A Survey of Factor-Analytic Studies*. Cambridge University Press. DOI: 10.1017/CBO9780511571312.

Casey, B.J., Sarah Getz, and Adriana Galvan (2008). "The adolescent brain". In: *Developmental Review* 28.1. Current Directions in Risk and Decision Making, pp. 62–77. ISSN: 0273-2297. DOI: https://doi.org/10.1016/j.dr.2007.08.003. URL: https://www.sciencedirect.com/science/article/pii/S0273229707000494.

Chamorro-Premuzic, Tomas and Adrian Furnham (Jan. 2005). "Personality and Intellectual Competence". In: *Personality and Intellectual Competence*, pp. 1–202. DOI: 10.4324/9781410612649.

Chamorro-Premuzic, Tomas and Adrian Furnham (2010). "General mental ability". In: *The Psychology of Personnel Selection*. Cambridge University Press, pp. 95–123. DOI: 10.1017/CBO9780511819308.006.

Chamorro-Premuzic, Tomas and Adrian Furnham (May 2003). "Personality Traits and Academic Examination Performance". In: *European Journal of Personality* 17, pp. 237–250. DOI: 10.1002/per.473.

Christopher Auld, M. and Nirmal Sidhu (2005). "Schooling, cognitive ability and health". In: *Health Economics* 14.10, pp. 1019–1034. DOI: https://doi.org/10.1002/hec.1050. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/hec.1050. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/hec.1050.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Lawrence Erlbaum Associates.

Costa, Paul and R. McCrae (Jan. 1992). “Neo PI-R professional manual”. In: *Psychological Assessment Resources* 396.

Costa-Gomes, Miguel, Vincent P. Crawford, and Bruno Broseta (2001). “Cognition and Behavior in Normal-Form Games: An Experimental Study”. In: *Econometrica* 69.5, pp. 1193–1235. DOI: https://doi.org/10.1111/1468-0262.00239. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/1468-0262.00239. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/1468-0262.00239.

Czermak, Simon et al. (2016). “How strategic are children and adolescents? Experimental evidence from normal-form games”. In: *Journal of Economic Behavior & Organization* 128, pp. 265–285. ISSN: 0167-2681. DOI: https://doi.org/10.1016/j.jebo.2016.04.004. URL: https://www.sciencedirect.com/science/article/pii/S0167268116300440.

Dawes, Robyn M. and Richard H. Thaler (Sept. 1988). “Anomalies: Cooperation”. In: *Journal of Economic Perspectives* 2.3, pp. 187–197. DOI: 10.1257/jep.2.3.187. URL: https://www.aeaweb.org/articles?id=10.1257/jep.2.3.187.

Diener E. & Lucas, R. E. (2021). “Personality traits”. In: *Noba textbook series: Psychology*. URL: http://noba.to/96u8ecgw (visited on 05/16/2021).

El Othman, R. et al. (May 2020). “Personality traits, emotional intelligence and decision-making styles in Lebanese universities medical students”. In: *BMC Psychology* 8. DOI: https://doi.org/10.1186/s40359-020-00406-4.

Farsides, Tom and Ruth Woodfield (2003). “Individual differences and undergraduate academic success: the roles of personality, intelligence, and application”. In: *Personality and Individual Differences* 34.7, pp. 1225–1243. ISSN: 0191-8869. DOI: https://doi.org/10.1016/S0191-8869(02)00111-3. URL: https://www.sciencedirect.com/science/article/pii/S0191886902001113.

Fehr, Dietmar and Steffen Huck (Aug. 2015). “Who knows it is a game? On strategic awareness and cognitive ability”. In: *Experimental Economics* 19. DOI: 10.1007/s10683-015-9461-0.

Fisk, Arthur D., Phillip L. Ackerman, and Walter Schneider (1987). “5. Automatic and Controlled Processing Theory and its Applications to Human Factors Problems”. In: *Human Factors Psychology*. Ed. by Peter A. Hancock. Vol. 47. Advances in Psychology. North-

Holland, pp. 159–197. DOI: https://doi.org/10.1016/S0166-4115(08)62309-2. URL: https://www.sciencedirect.com/science/article/pii/S0166411508623092.

Friedman, Milton and L. J. Savage (1948). “The Utility Analysis of Choices Involving Risk”. In: *Journal of Political Economy* 56.4, pp. 279–304. ISSN: 00223808, 1537534X. URL: http://www.jstor.org/stable/1826045.

Gettinger, Maribeth (1984). “Individual differences in time needed for learning: A review of literature”. In: *Educational Psychologist* 19.1, pp. 15–29. DOI: 10.1080/00461528409529278. eprint: https://doi.org/10.1080/00461528409529278. URL: https://doi.org/10.1080/00461528409529278.

Gill, David and Victoria Prowse (2016). “Cognitive Ability, Character Skills, and Learning to Play Equilibrium: A Level-k Analysis”. In: *Journal of Political Economy* 124.6, pp. 1619–1676. DOI: 10.1086/688849. eprint: https://doi.org/10.1086/688849. URL: https://doi.org/10.1086/688849.

Hamel, Ronald and Verena D. Schmittmann (2006). “The 20-Minute Version as a Predictor of the Raven Advanced Progressive Matrices Test”. In: *Educational and Psychological Measurement* 66.6, pp. 1039–1046. DOI: 10.1177/0013164406288169. eprint: https://doi.org/10.1177/0013164406288169. URL: https://doi.org/10.1177/0013164406288169.

Hartshorne, Joshua K. and Laura T. Germine (2015). “When Does Cognitive Functioning Peak? The Asynchronous Rise and Fall of Different Cognitive Abilities Across the Life Span”. In: *Psychological Science* 26.4. PMID: 25770099, pp. 433–443. DOI: 10.1177/0956797614567339. eprint: https://doi.org/10.1177/0956797614567339. URL: https://doi.org/10.1177/0956797614567339.

Heckman, James J., Jora Stixrud, and Sergio Urzua (2006). “The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior”. In: *Journal of Labor Economics* 24.3, pp. 411–482. DOI: 10.1086/504455. eprint: https://doi.org/10.1086/504455. URL: https://doi.org/10.1086/504455.

Heinström, Jannica (2012). “Personality Effects on Learning”. In: *Encyclopedia of the Sciences of Learning*. Ed. by Norbert M. Seel. Boston, MA: Springer US, pp. 2588–2591. ISBN: 978-1-4419-1428-6. DOI: 10.1007/978-1-4419-1428-6_735. URL: https://doi.org/10.1007/978-1-4419-1428-6_735.

Jensen, Arthur R. (1989). “The relationship between learning and intelligence”. In: *Learning and Individual Differences* 1.1, pp. 37–62. ISSN: 1041-6080. DOI: https://doi.org/10.

1016/1041-6080(89)90009-5. URL: https://www.sciencedirect.com/science/article/pii/1041608089900095.

John, O. and S. Srivastava (1999). "The Big Five Trait taxonomy: History, measurement, and theoretical perspectives." In:

Kahneman, Daniel (2000). *Choices, Values, and Frames*. Cambridge University Press. DOI: 10.1017/CBO9780511803475.

Kleibeuker, Sietske W. et al. (2013). "Prefrontal cortex involvement in creative problem solving in middle adolescence and adulthood". In: *Developmental Cognitive Neuroscience* 5, pp. 197–206. ISSN: 1878-9293. DOI: https://doi.org/10.1016/j.dcn.2013.03.003. URL: https://www.sciencedirect.com/science/article/pii/S1878929313000236.

Komarraju, Meera et al. (2011). "The Big Five personality traits, learning styles, and academic achievement". In: *Personality and Individual Differences* 51.4. Digit Ratio (2D:4D) and Individual Differences Research, pp. 472–477. ISSN: 0191-8869. DOI: https://doi.org/10.1016/j.paid.2011.04.019. URL: https://www.sciencedirect.com/science/article/pii/S0191886911002194.

Kyllonen, P.C. (1986). "Theory based cognitive assessment (AFHRL-TP-85330)". In: *Brooks AFB, TX: Manpower and Personnel Division, Air Force Human Resources Laboratory.*

Lounsbury, John W et al. (2003). "Intelligence, "Big Five" personality traits, and work drive as predictors of course grade". In: *Personality and Individual Differences* 35.6, pp. 1231–1239. ISSN: 0191-8869. DOI: https://doi.org/10.1016/S0191-8869(02)00330-6. URL: https://www.sciencedirect.com/science/article/pii/S0191886902003306.

Martin, C. F. et al. (2014). "Chimpanzee choice rates in competitive games match equilibrium game theory predictions". In: *Scientific Reports* 4.

McGraw-Hunter, M, G Faw, and P Davis (Oct. 2006). "The use of video self-modelling and feedback to teach cooking skills to individuals with traumatic brain injury: A pilot study". In: *Brain injury : [BI]* 20, pp. 1061–8. DOI: 10.1080/02699050600912163.

Mortensen, Karoline and Taylor Hughes (Jan. 2018). "Comparing Amazon's Mechanical Turk Platform to Conventional Data Collection Methods in the Health and Medical Research Literature". In: *Journal of General Internal Medicine* 33. DOI: 10.1007/s11606-017-4246-0.

Nagel, Rosemarie (1995). "Unraveling in Guessing Games: An Experimental Study". In: *The American Economic Review* 85.5, pp. 1313–1326. ISSN: 00028282. URL: http://www.jstor.org/stable/2950991.

Nagel, Rosemarie, Christoph Bühren, and Björn Frank (2017). "Inspired and inspiring: Hervé Moulin and the discovery of the beauty contest game". In: *Mathematical Social Sciences* 90. In honor of Hervé Moulin, pp. 191–207. ISSN: 0165-4896. DOI: https://doi.org/10.1016/j.mathsocsci.2016.09.001. URL: https://www.sciencedirect.com/science/article/pii/S0165489616300804.

Pauwels, Lisa, Sima Chalavi, and Stephan Swinnen (Aug. 2018). "Aging and brain plasticity". In: *Aging* 10. DOI: 10.18632/aging.101514.

Rubinstein, Ariel (Feb. 2016). "A Typology of Players: Between Instinctive and Contemplative". In: *The Quarterly Journal of Economics* 131, qjw008. DOI: 10.1093/qje/qjw008.

Spearman, Charles (1904). ""General intelligence," objectively determined and measured". In: *American Journal of Psychology* 15, pp. 201–293.

Spearman, Charles (1927). *The Abilities of Man: Their Nature and Measurement*. Macmillan. URL: https://books.google.se/books?id=m4ORAAAAIAAJ.

Stahl, Dale and Paul Wilson (1994). "Experimental evidence on players' models of other players". In: *Journal of Economic Behavior & Organization* 25.3, pp. 309–327. URL: https://EconPapers.repec.org/RePEc:eee:jeborg:v:25:y:1994:i:3:p:309-327.

Stahl, Dale and Paul Wilson (1995). "On Players' Models of Other Players: Theory and Experimental Evidence". In: *Games and Economic Behavior* 10.1, pp. 218–254. URL: https://EconPapers.repec.org/RePEc:eee:gamebe:v:10:y:1995:i:1:p:218-254.

Stankov, Lazar (2018). "Low Correlations between Intelligence and Big Five Personality Traits: Need to Broaden the Domain of Personality". In: *Journal of Intelligence* 6.2. ISSN: 2079-3200. DOI: 10.3390/jintelligence6020026. URL: https://www.mdpi.com/2079-3200/6/2/26.

Statistics Finland (June 2017). In: URL: https://www.stat.fi/tietotrendit/artikkelit/2017/peruskoulun-paattaneista-yha-useampi-saa-jatko-opiskelupaikan/.

Statistics Finland (2021). In: URL: https://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__kou__khak/statfin_khak_pxt_11gf.px/table/tableViewLayout1/.

Stern, Elsbeth (Dec. 2017). "Individual differences in the learning potential of human beings". In: *npj Science of Learning* 2. DOI: 10.1038/s41539-016-0003-0.

Sutter, Matthias, Claudia Zoller, and Daniela Glätzle-Rützler (2019). "Economic behavior of children and adolescents – A first survey of experimental economics results". In: *European Economic Review* 111, pp. 98–121. ISSN: 0014-2921. DOI: https://doi.org/10.1016/j.euroecorev.2018.09.004. URL: https://www.sciencedirect.com/science/article/pii/S001429211830165X.

Thorndike, R.L. (1984). "Intelligence as information processing: The mind and the computer". In: Bloomington, IN: Center on Evaluation. Development and Research.

Tsai, Claire, Joshua Klayman, and Reid Hastie (Nov. 2008). "Effects of amount of information on judgment accuracy and confidence". In: *Organizational Behavior and Human Decision Processes* 107, pp. 97–105. DOI: 10.1016/j.obhdp.2008.01.005.

Vermetten, Yvonne J., Hans G. Lodewijks, and Jan D. Vermunt (2001). "The Role of Personality Traits and Goal Orientations in Strategy Use". In: *Contemporary Educational Psychology* 26.2, pp. 149–170. ISSN: 0361-476X. DOI: https://doi.org/10.1006/ceps.1999.1042. URL: https://www.sciencedirect.com/science/article/pii/S0361476X99910421.

Warne, Russell and Cassidy Burningham (Jan. 2019). "Spearman's g Found in 31 Non-Western Nations: Strong Evidence That g Is a Universal Phenomenon". In: *Psychological Bulletin* 145. DOI: 10.1037/bul0000184.

Warner, John T. and Saul Pleeter (Mar. 2001). "The Personal Discount Rate: Evidence from Military Downsizing Programs". In: *American Economic Review* 91.1, pp. 33–53. DOI: 10.1257/aer.91.1.33. URL: https://www.aeaweb.org/articles?id=10.1257/aer.91.1.33.

Waterhouse, Lynn (Dec. 2006). "Inadequate Evidence for Multiple Intelligences, Mozart Effect, and Emotional Intelligence Theories". In: *Educational Psychologist - EDUC PSYCHOL* 41, pp. 247–255. DOI: 10.1207/s15326985ep4104_5.

Winfred Arthur, JR. and David V. Day (1994). "Development of a Short form for the Raven Advanced Progressive Matrices Test". In: *Educational and Psychological Measurement* 54.2, pp. 394–403. DOI: 10.1177/0013164494054002013. eprint: https://doi.org/10.1177/0013164494054002013. URL: https://doi.org/10.1177/0013164494054002013.

Zerr, Christopher et al. (June 2018). "Learning Efficiency: Identifying Individual Differences in Learning Rate and Retention in Healthy Adults". In: *Psychological Science* 29, p. 095679761877254. DOI: 10.1177/0956797618772540.

Zheng, Min et al. (Dec. 2020). "How causal information affects decisions". In: *Cognitive Research: Principles and Implications* 5. DOI: 10.1186/s41235-020-0206-z.

A. Appendix

A.1 Data

After nine years of elementary school, students continue to either vocational schooling or high school. On average, vocational schooling has lower requirements what comes to school grades. After primary school 52% of students continued to high school and 42% to vocational school year 2015 (Statistics Finland 2017). Students in vocational education do not have matriculation examinations, and their path to university is significantly harder. However, by choosing a vocational school, students get a profession, and some of them continue to the polytechnic.

Test subjects in this thesis are Finnish high school students who are at least 18 years old. The test subjects are not a random population of Finnish students but students who aim for academic education. In 2015, 93% of Finnish university students had high school as their previous education dominated the vocational education (Statistics Finland 2021).

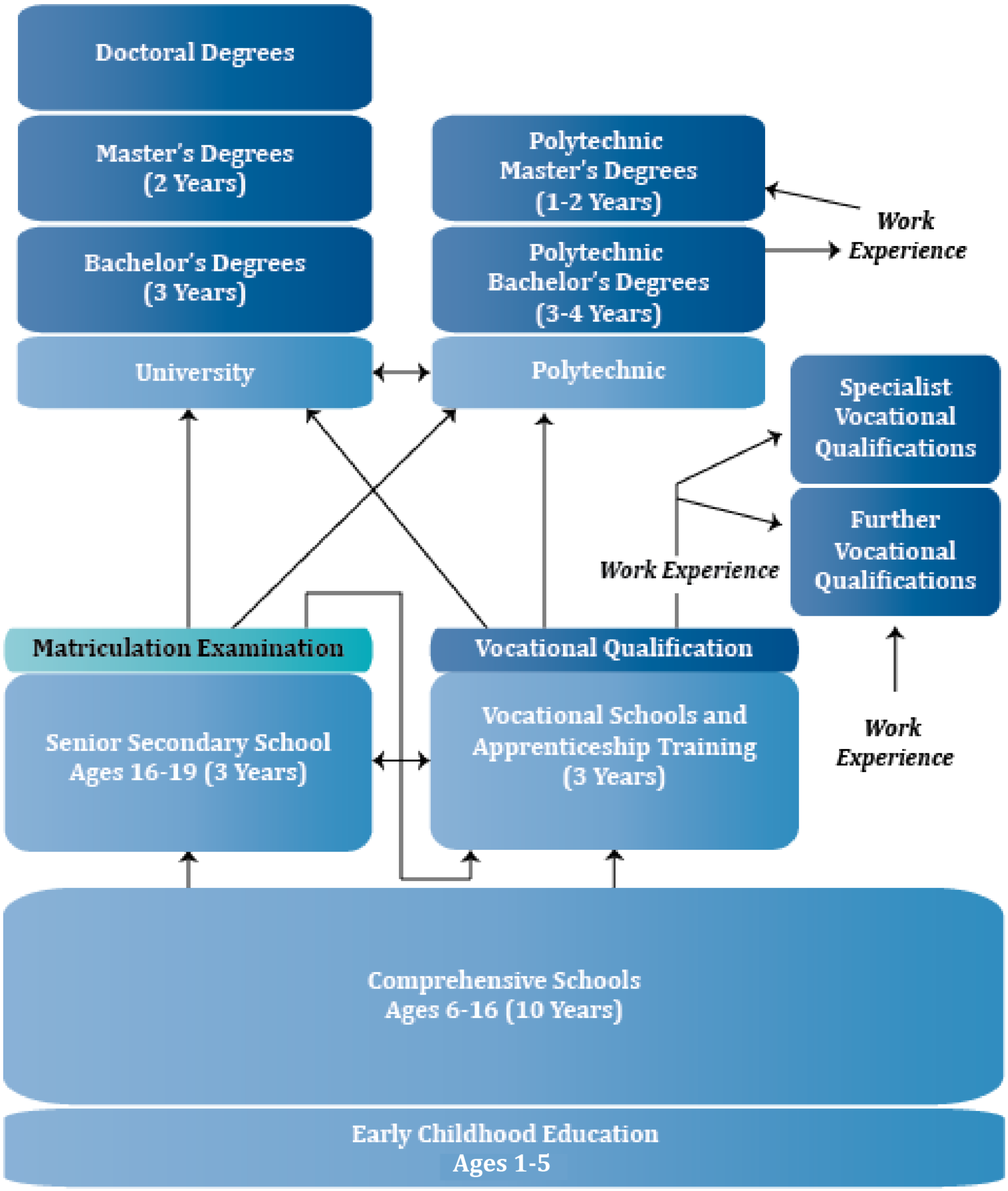


Figure A.1: Finnish School System

Variable Name	Definition	Potential Values
Basic BCG	Answer in the basic BCG	0-100
Theoretical equilibrium BCG	Answer in the theoretical equilibrium BCG	0-100
Theoretical equilibrium BCG correct	Answer NE	1 if definition true, else 0
Row B in variable-sum game	Answer row B in variable-sum game	1 if definition true, else 0
Total payoff	Total payoff in all games	2-16.2
Conscientiousness	Conscientiousness score in personality test	9-45
Openness	Openness score in personality test	10-50
Agreeableness	Agreeableness score in personality test	9-45
Age	Current age	≥ 18
Sex	Biological sex	1 if female, 0 if male
Not graduated from high school	Highest education is below high school	1 if definition true, else 0
High school or equivalent	Highest achieved education level is high school	1 if definition true, else 0
Bachelor's degree or equivalent	Highest achieved education level is bachelor's degree	1 if definition true, else 0
Master's degree or equivalent	Highest achieved education level is master's degree	1 if definition true, else 0
Doctoral degree or equivalent	Highest achieved education level is 'doctoral degree	1 if definition true, else 0
Strong math background	Self-assessed mathematical background is strong	1 if definition true, else 0
High-school class	Current high school class	1-3
Advanced math	Studies advanced math in high school	0-1
Game theory knowledge	Previous knowledge on game theory	0-1

Table A.1: Variables with definitions and ranges

Table A.2: HSS summary statistics

	Control group		Test group	
Variable	Mean	SD	Mean	SD
Basic BCG	44.32	28.39	57.84	23.49
Theoretical equilibrium BCG	45.57	27.13	47.45	29.29
Theoretical equilibrium BCG correct	0.00	0.00	0.00	0.00
Row B in variable-sum game	0.44	0.51	0.53	0.51
Total payoff	3.94	3.45	4.06	3.42
Cognitive ability	7.25	1.57	5.82	2.40
Conscientiousness	31.38	4.87	30.71	6.72
Openness	36.50	6.01	35.29	4.91
Agreeableness	33.44	5.46	34.76	3.78
Age	18.44	0.51	18.18	0.39
Sex	0.88	0.34	0.41	0.51
Education level	2.62	0.62	2.35	0.49
Strong math background	0.38	0.50	0.35	0.49
Game theory knowledge	0.00	0.00	0.18	0.39
N	16		17	

A.2 Distribution of answers

Figure A.2: MTurkers theoretical equilibrium BCG answer distribution

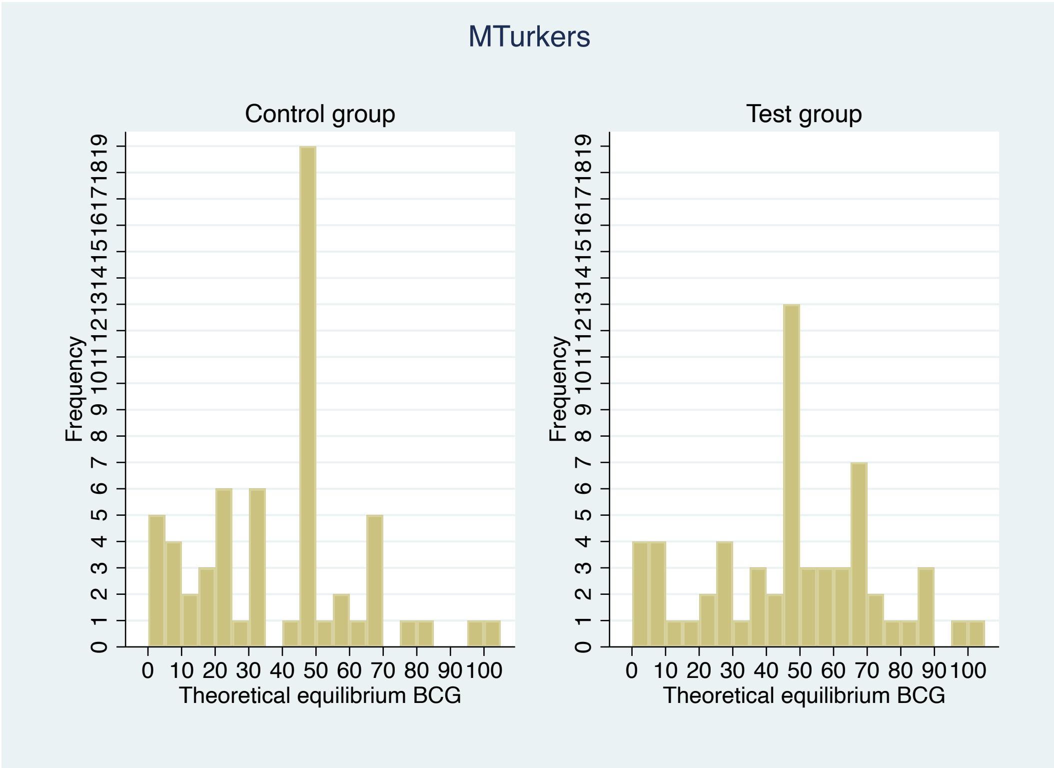


Figure A.3: HSS basic BCG answer distribution

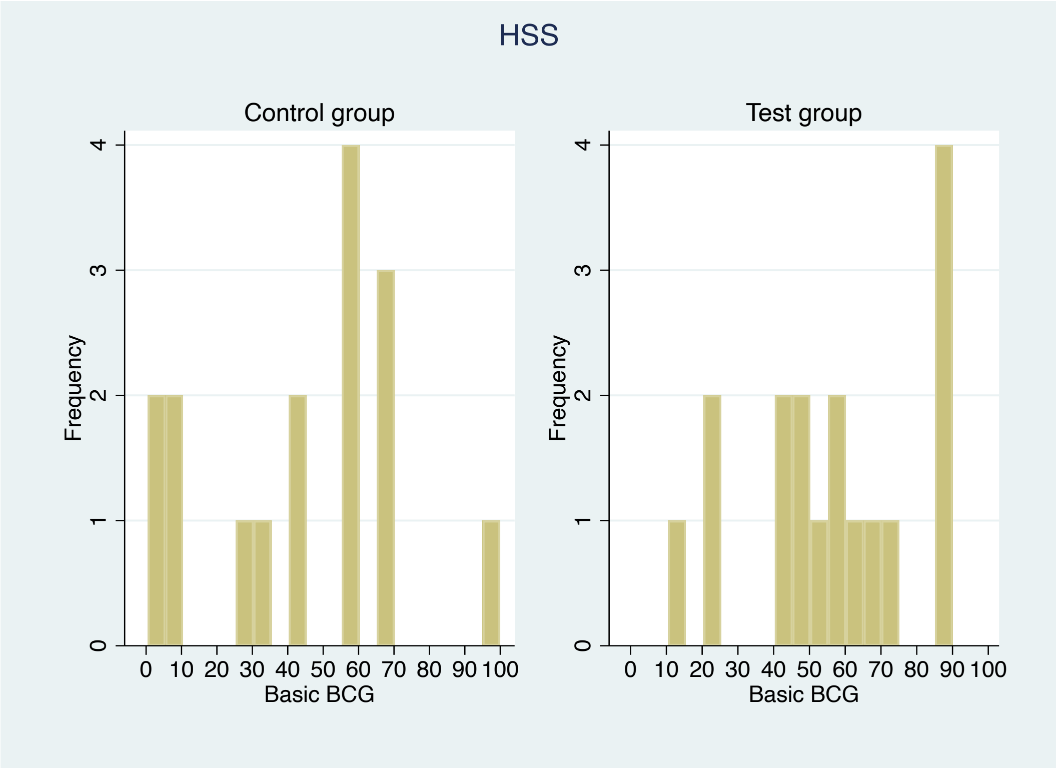
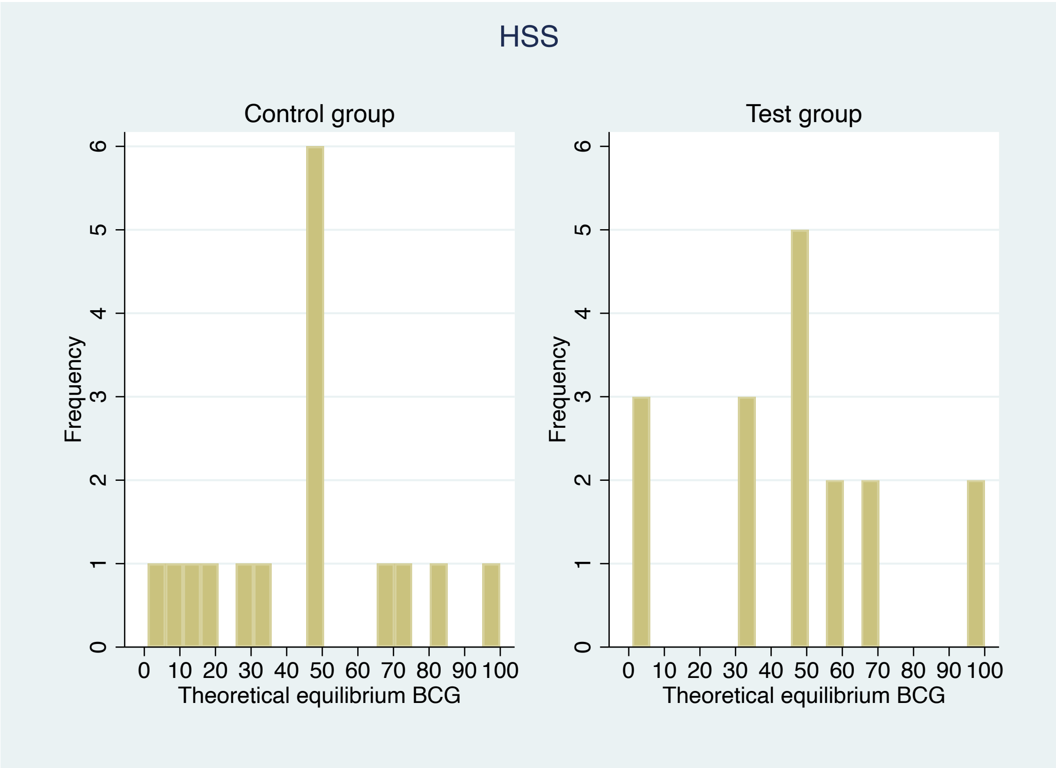


Figure A.4: HSS theoretical equilibrium BCG answer distribution



A.3 Non-linearities

Figure A.5: MTurkers basic BCG answers and cognitive ability

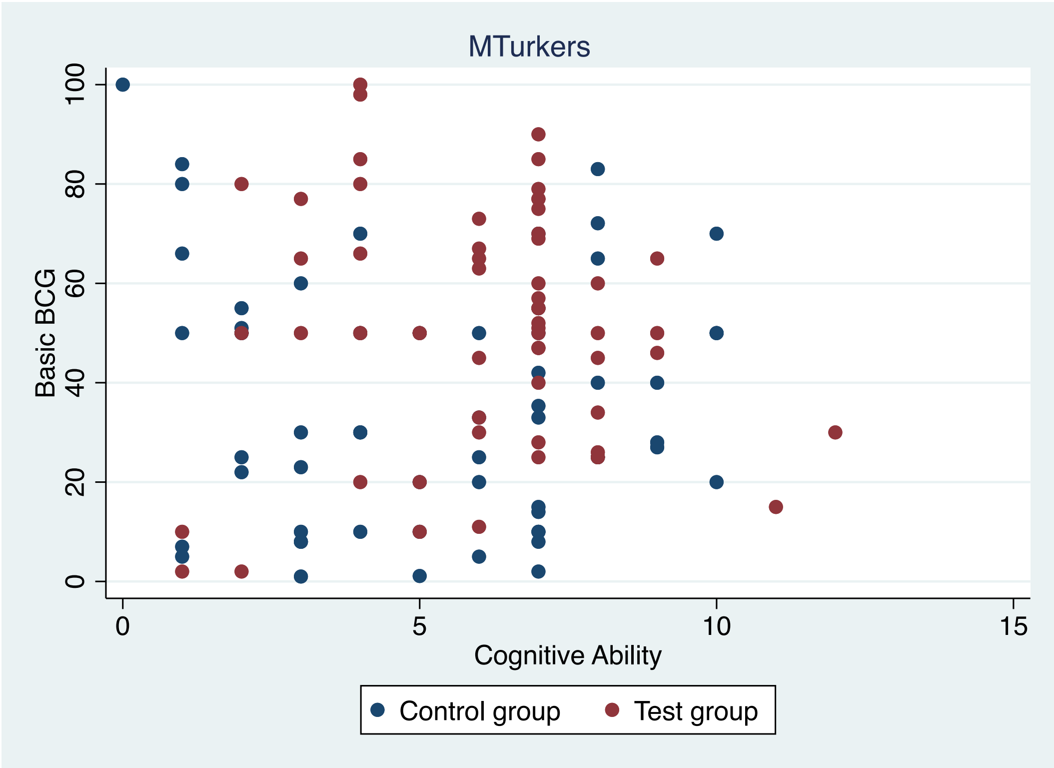


Figure A.6: MTurkers basic BCG answers and conscientiousness

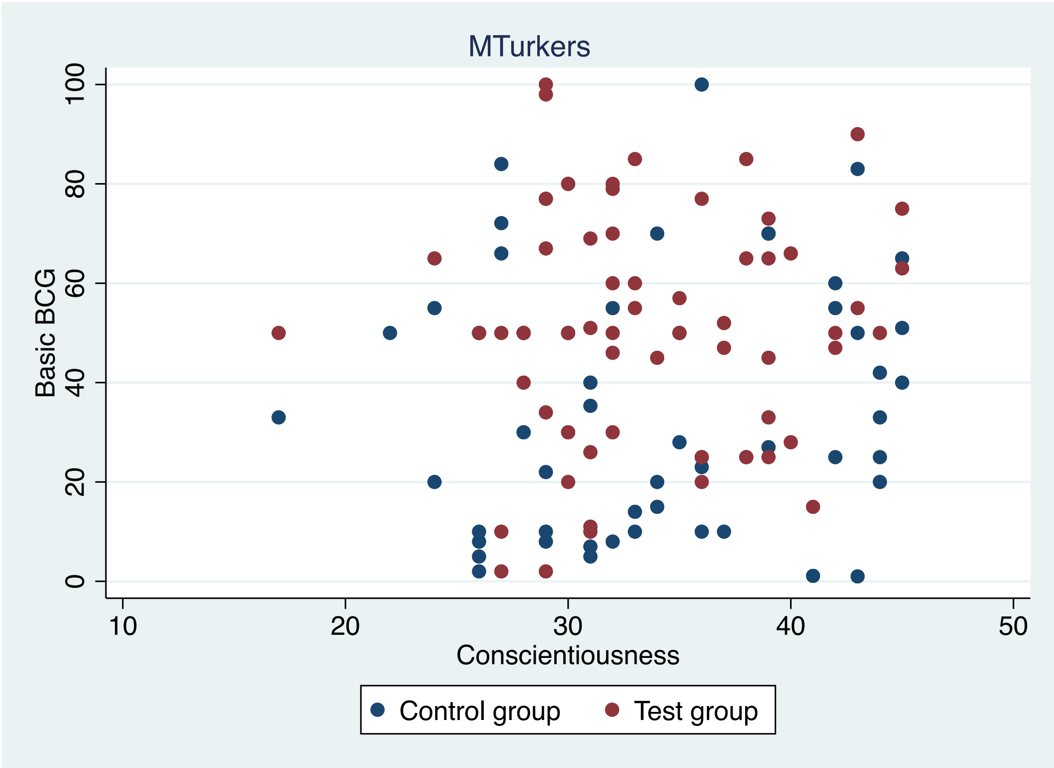


Figure A.7: MTurkers basic BCG answers and openness

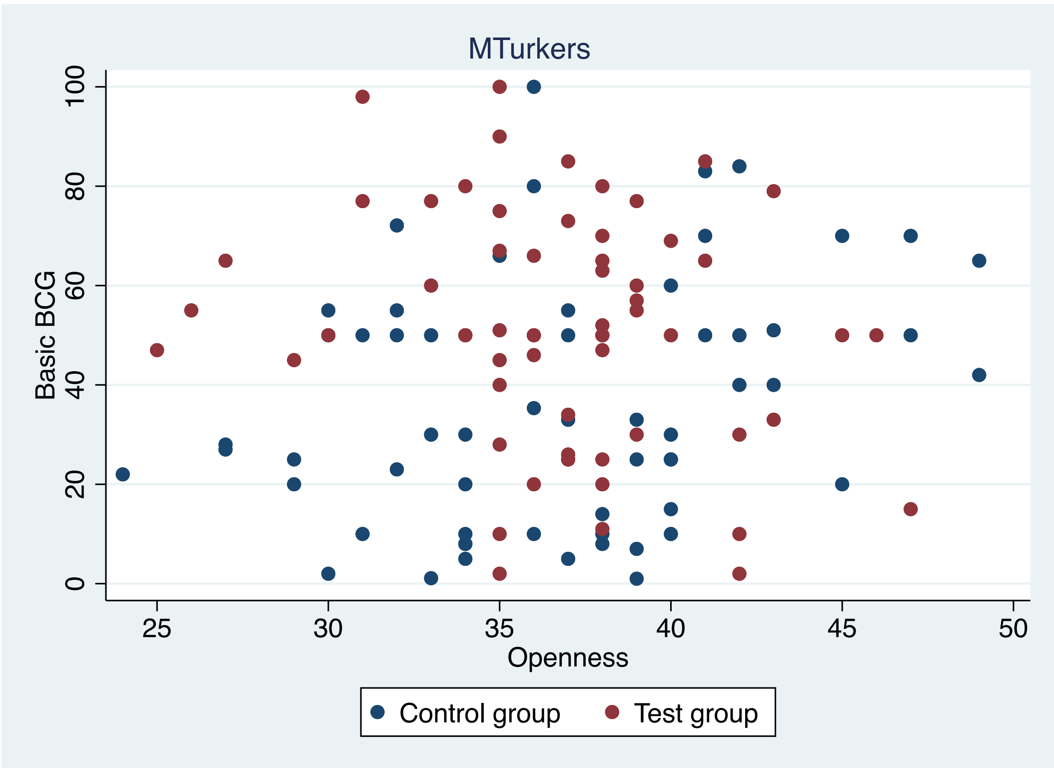


Figure A.8: MTurkers basic BCG answers and agreeableness

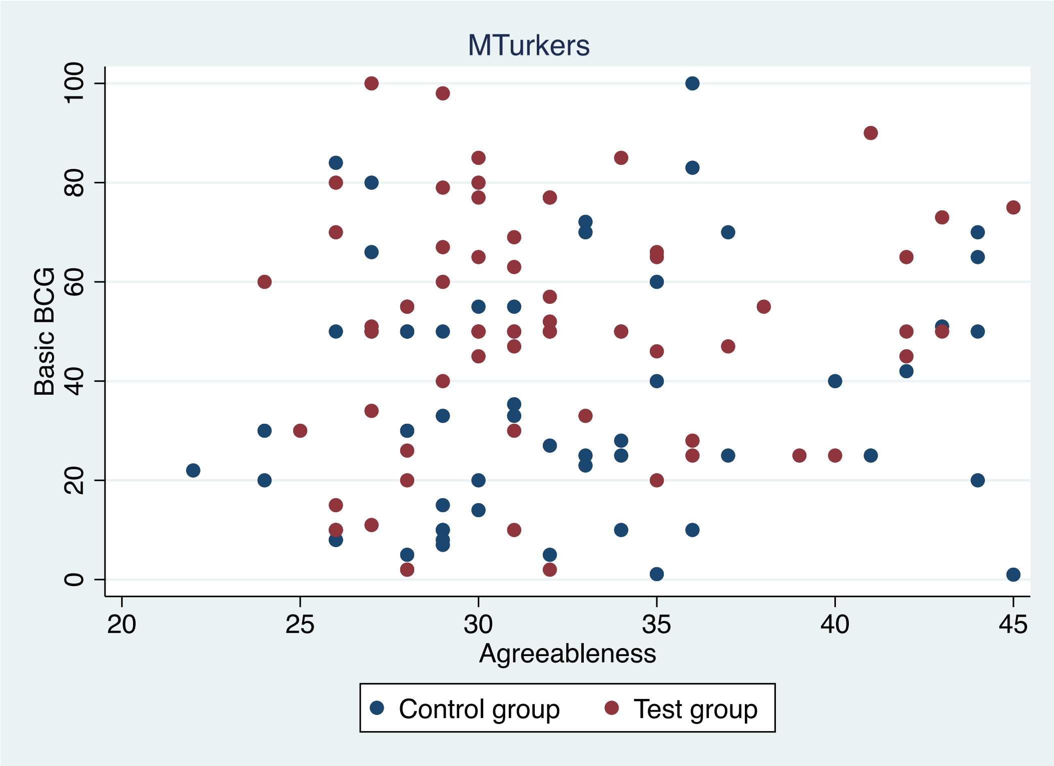


Figure A.9: MTurkers basic BCG answers and education

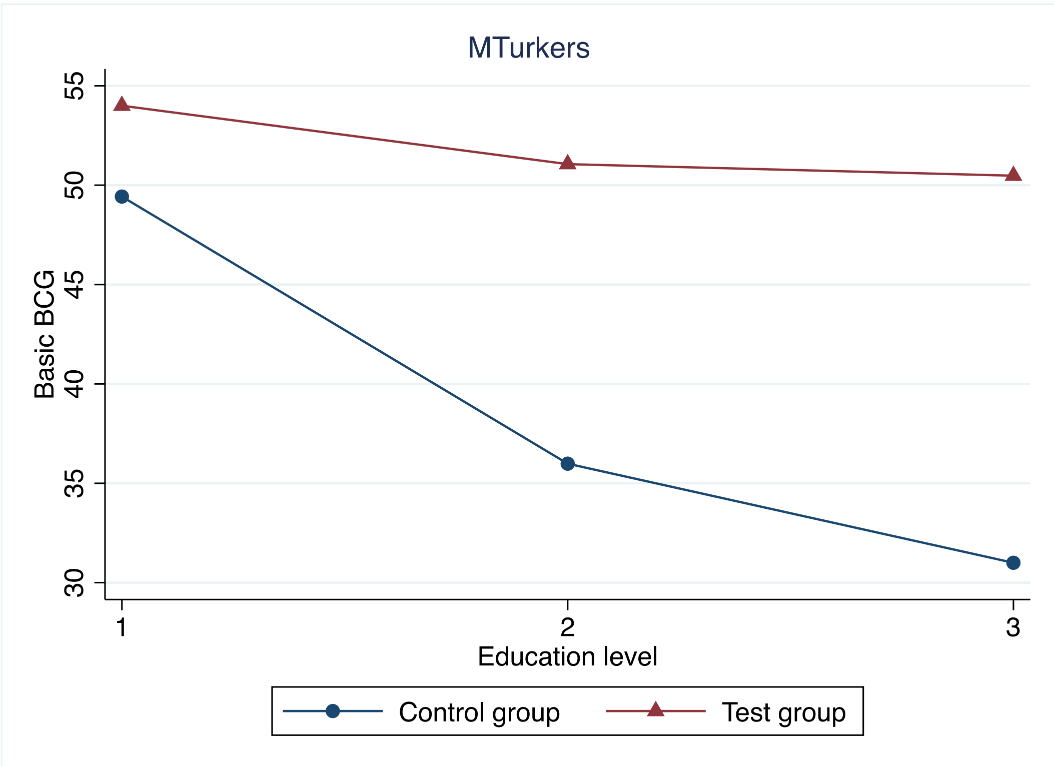


Figure A.10: Education level value 1 is high school, value 2 bachelor's degree and value 3 master's degree.

A.4 Randomization

Table A.3: Logistic regressions of treatment assignment

	(1) Test group	(2) Test group
Cognitive ability	0.123 (0.081)	-0.213 (0.308)
Conscientiousness	-0.002 (0.046)	-0.249 (0.149)
Openness	-0.007 (0.042)	0.002 (0.097)
Agreeableness	0.019 (0.052)	0.244 (0.195)
Bachelor's degree or equivalent	0.108 (0.761)	
Master's degree or equivalent	0.374 (0.817)	
Game theory knowledge	0.252 (0.492)	
Strong math background	0.762 (0.551)	0.680 (1.220)
Age	-0.007 (0.019)	-1.519 (1.323)
Sex	0.427 (0.426)	-3.410* (1.656)
Advanced math		0.851 (1.101)
Constant	-1.783 (2.218)	28.520 (24.551)
Observations	120	33

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

A.5 Experiment content for HSS

Note: text in *italics* describes actions by the experimenter or comments to clarify the procedure, and normal text is what the experimenter says to the test subjects. Note that the text for HSS was in Finnish. The Finnish version is available upon request.

Welcome to this experiment! If you have any questions during the experiment, send me a private message, and I will answer you personally. When you open the chat, you can click on the drop-down next to "To" and choose to send a message to the host, which is me, Verneri

Sirva. Can you find it? You can say this in the public chat if further clarifications are needed.

At each step, I will give clear instructions on what to do and how to proceed with the experiments.

The questions are divided into sections. After you have completed answering a question within the given time restriction, it is prohibited to change answers. If you do so, the answers will be deleted, and you will not be paid.

Besides the 5€ basic compensation for attending the experiment, you will be paid based on how you answer some of the questions. You have information of the payoff in each question, or alternatively, I tell the information before you answer.

Remember that all your answers are anonymous.

You will soon receive a Google forms link in the chat, where you answer all the questions. Be careful that you will not close the tab or your browser during the experiment, because in that case, we may lose your answers. Any form of cooperation during the experiment is prohibited; you need to answer the questions individually.

Each question has a time limit. I will always tell when the time is up, and then you need to stop answering and submit the answer for the question and listen to further instructions. In some of the questions, you can get additional time if you need it to answer carefully in all of the questions. I provide information regarding the time in each question.
I sent a link for the google forms in the chat. Open the Google forms now. You should see a Google forms page with the text "welcome". If you succeeded in that, wait for further instructions. I will give you some time to do it. Send me a message if you need help.

30 seconds is waited and help with technical difficulties provided if needed.

Now, we proceed to the experiment.

A.5.1 Treatment and games

For test group the treatment below was provided on the screen

I will show you a short text from my screen, and you will have one minute to read it. After that, you will see a picture with text, which you will have two minutes to look. I will show both in a row without pauses. Try to do your best to understand the provided content. Now we begin.

> "Game theory is a mathematical system for analyzing and predicting how people behave in strategic situations. A person making decisions based on game-theoretic thinking must anticipate what other people will do and the outcomes in possible scenarios."

"Think about the following example. You are a football goalie, and the team you are playing against gets a penalty kick. The kicker is a person you used to play in the same team with for a long time. You remember that he never kicked in the middle, and approximately seven out of ten times, he kicked to the right side of the goal. Because he is known for his hard kick, you need to decide which side you try to save before he kicks. You think strategically and try to save the right side because the probability of saving the ball is higher. However, the kicker knows that you know his tendency to kick right. Thus, he decides to kick the left side instead of the typical right side. Furthermore, the reasoning does not have to stop there..."

A.5.2 Games

Now we move forward. Next, you are going to answer three questions one at a time.

Now we proceed to the first question. You will have two minutes to answer it. When I give you permission to begin answering the question, press ”continue” and start answering the question. After the time is up, or you have answered, press continue, and you proceed to a page where you see a text “wait for further instructions”. Start answering the question.

> *Question below will be on google forms*
>
> “All participants in this experiment, including you, will choose a number between 0 and 100 with any number of decimals wanted. The target is to guess two-thirds ($\frac{2}{3}$) of the average chosen number by the participants. 10% of the answers closest to the target win 10€. Give the number you chose below.”

Now we proceed to the second question. You will have two minutes to answer it. When I give you permission to begin answering the question, press ”continue” and start answering the question. After the time is up, or you have answered, press continue, and you proceed to a page where you see a text “wait for further instructions”. Start answering the question.

> *Question below were on google forms*
>
> This game is the same as the previous one, but you will base your answer on theory.
>
> “All participants in this experiment, including you, will choose a number between 0 and 100 with any number of decimals wanted. The target is to guess two-thirds ($\frac{2}{3}$) of the average chosen number by the participants. 10% of the answers closest to the target win 10€.
>
> What do you think is the game theoretically correct answer if everybody was perfectly rational? Give the number you chose below.

Now we proceed to the third question. You will have two minutes to answer it. When I give you permission to begin answering the question, press “continue” and start answering the question.

After the time is up, or you have answered, press continue, and you proceed to a page where you see a text "wait for further instructions". Start answering the question.

Question were on google forms

		Player 2 L	Player 2 R
Player 1	T	4,0	2,2
Player 1	B	2,2	3,1

You are player 1. You need to choose to play either row T or B. The payoffs you have as player 1 are always the blue ones and player 2 gets the payoffs in red. Let's assume you play row T. If player 2 plays column L, you get 4€, and if player 2 plays column R, you get 2€. Let's assume you play row B. If player 2 plays column L, you get 2€, and if player 2 plays column R, you get 3€.

Now imagine that player 2 is a random anonymous player. Which row you choose to play?

A.5.3 Tests for cognitive ability and personality

Now we begin the first set of questions, where you have 12 questions and 8 minutes to answer in all of the questions. You answer all questions on the same page without any pauses. Your task is to choose the missing object on the right bottom corner of the matrix out of the eight suggestions below the figure. If you do not answer a question, it is counted as a false answer. You will receive 10 cents for each correct answer.

When I give you permission to begin answering the question, press "continue" and start answering the question. After the time is up, or you have answered, press continue, and you proceed to a page where you see a text "wait for further instructions". Start answering the question.
This raven's test is on google forms

Now we begin the second set of questions, where you have 28 questions and 15 minutes to answer all of the questions. You answer all questions on the same page without any pauses. It is important that you answer all of the questions; if you have not answered all of the questions when the time is over, send me a message, and you will get some extra time.

When I give you permission to begin answering the question, press "continue" and start answering the question. After the time is up, or you have answered, press continue, and you proceed to a page where you see a text "wait for further instructions". Start answering the question.
This big five inventory test will be on google forms. However, the non-relevant questions for conscientiousness, openness, and agreeableness are not included

A.5.4 Basic background information and

Now we begin the last section. You will answer some basic questions about yourself. You will have three minutes of time. It is important that you answer all of the questions, if you have not answered all of the questions when the time is over, send me a message, and you will get some extra time.

When I give you permission to begin answering the question, press “continue” and start answering the question. After the time is up, or you have answered, press continue, and you proceed to a page where you see a text “wait for further instructions”. Start answering the question.
Question were on google forms

How old are you? *They answer with an integer*
What is your sex? *Male/Female*
Which high school class? *1.,2. or 3.*
What is your math level? *Advanced/intermediate*
Have you familiarized with game theory before? *Yes or no*

Now, we are virtually done with the experiment. Before the last question, I want to say thanks to everyone in this experiment. I hope you do not talk about the content of this experiment until next week. Otherwise, somebody who is going to attend one of the following sessions may hear.

Next, you need to press continue in the google forms, and write your MobilePay number for the payment and submit the form. Note that it is important that you also submit the form. If you do not do it, the answers will not be registered, and you will not receive the payment. Payments will be made in the near future. After submitting, you are free to leave the Zoom meeting. Now press continue.

A.6 Experiment content for MTurkers

You can find the questions with treatment from this link. MTurkers had the same time limits as with the HSS.

A.7 Experiment expected payoffs

Below the potential and approximated average payoffs are calculated.

In the basic BCG, 10% of the closest answers receive a 10€/$ payoff. In the theoretical equilibrium BCG, for a correct answer 1€/$ player receives 1€/$ payoff. In the average payoff calculations, it is assumed that around 60% of test subjects give a correct answer.

For variable-sum-game, answers for Player 2 were collected from 10 random players before the experiments. Out of those 10 answers, a random answer for Player 2 was drawn for each player in the experiment. 9 out of 10 players answered R and 1 L. The exact payoff depends on the test subjects' strategies, but it will likely be around 2.6/$. This is based on the payoff 2.66€/$ if the test subjects play based on theory. In the cognitive ability test, it was assumed that players get on average 8 out of 12 questions correct.

The average payment for a player was 5€/$ + 1€/$ + $\sim$0.6€/$ + $\sim$2.6€/$ $\sim$0.8€/$ $\approx$ 10€/$. The maximum payoff was 21.2€/$.

A.8 Results

A.8.1 Hypothesis 1

Table A.4: HSS Mann-Whitney U-test

	(1) Observations	(2) Mean	(3) Rank sum	(4) Expected Rank sum	(5) Exact p-value
Basic BCG					
Control group	16	44.32	233	272	0.1645
Test group	17	57.84	328	289	0.1645
Play Row B					
Control group	16	0.44	259.5	272	0.8580
Test group	17	0.53	301.5	289	0.8580
Total payoff					
Control group	16	3.94	263.5	272	0.7684
Test group	17	4.06	297.5	289	0.7684

Note: Statistical significance in p-values is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.5: MTurkers Regressions of first hypothesis using binary values for Cognitive Ability and Personality Characteristics based on median

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	15.784**	0.405	0.019
	(4.705)	(0.522)	(0.594)
Cognitive ability med	2.858	0.926	0.442
	(4.923)	(0.541)	(0.622)
Conscientiousness med	-2.132	0.916	0.450
	(6.511)	(0.718)	(0.822)
Openness med	-0.865	0.585	0.382
	(4.791)	(0.539)	(0.605)
Agreeableness med	4.021	-0.850	0.227
	(5.915)	(0.678)	(0.747)
Bachelor's degree or equivalent	-7.595	-1.154	-0.054
	(8.885)	(0.878)	(1.122)
Master's degree or equivalent	-7.771	-3.083**	-0.375
	(9.550)	(1.086)	(1.206)
Game theory knowledge	-8.925	-0.812	0.550
	(5.927)	(0.653)	(0.749)
Strong math background	4.189	0.687	0.541
	(6.527)	(0.665)	(0.824)
Age	0.321	0.088***	0.037
	(0.226)	(0.026)	(0.029)
Sex	2.319	-1.764**	-0.639
	(5.022)	(0.661)	(0.634)
Constant	31.338*	-2.945*	1.660
	(13.674)	(1.434)	(1.727)
Observations	120	120	120

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.6: HSS Regressions of first hypothesis

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	16.912	0.545	-0.661
	(12.083)	(0.926)	(1.599)
Cognitive ability med	-17.136	-1.081	-0.788
	(13.694)	(1.036)	(1.813)
Conscientiousness med	-4.506	-0.231	-0.215
	(11.056)	(0.838)	(1.463)
Openness med	-6.357	0.444	0.610
	(10.983)	(0.828)	(1.454)
Agreeableness med	-11.780	-0.474	-1.829
	(12.033)	(0.935)	(1.593)
Education level	-0.793	-1.173	-1.739
	(13.139)	(1.073)	(1.739)
Strong math background	-0.691	0.210	1.323
	(11.681)	(0.883)	(1.546)
Age	-1.844	0.685	0.029
	(16.398)	(1.248)	(2.171)
Sex	12.573	0.624	-1.060
	(14.414)	(1.106)	(1.908)
Constant	88.073	-9.855	9.595
	(285.371)	(21.575)	(37.773)
Observations	33	33	33

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

MTurkers Regressions of first hypothesis using nominal values for Cognitive Ability and Personality Characteristics

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	16.330***	0.320	-0.130
	(4.730)	(0.512)	(0.589)
Cognitive Ability	-0.553	0.075	0.195
	(0.953)	(0.103)	(0.119)
Conscientiousness	-0.198	0.092	0.107
	(0.536)	(0.056)	(0.067)
Openness	0.234	0.011	-0.012
	(0.488)	(0.051)	(0.061)
Agreeableness	0.510	-0.096	-0.089
	(0.599)	(0.065)	(0.075)
Bachelor's degree or equivalent	-7.465	-1.151	-0.006
	(8.872)	(0.867)	(1.105)
Master's degree or equivalent	-8.146	-2.879**	-0.294
	(9.569)	(1.058)	(1.192)
Game theory knowledge	-9.134	-1.221*	0.665
	(5.813)	(0.616)	(0.724)
Strong math background	5.618	0.829	0.371
	(6.448)	(0.643)	(0.803)
Age	0.274	0.087***	0.037
	(0.228)	(0.025)	(0.028)
Sex	1.979	-1.699**	-0.545
	(4.997)	(0.660)	(0.622)
Constant	18.457	-2.930	1.019
	(25.693)	(2.575)	(3.200)
Observations	120	120	120

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Nominal values for cognitive ability and personality characteristics were used.

A.8.2 Hypothesis 2

Table A.7: HSS Regressions of second hypothesis using binary values for Cognitive Ability and Personality Characteristics based on median

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	37.644 (18.486)	0.754 (1.498)	0.936 (2.524)
Cognitive ability med	-6.806 (15.136)	-0.983 (1.168)	0.008 (2.066)
Cognitive ability med × Test group	-34.296 (23.543)	-0.346 (1.929)	-2.642 (3.214)
Conscientiousness med	-5.647 (10.824)	-0.239 (0.839)	-0.303 (1.478)
Openness med	-9.119 (10.890)	0.419 (0.838)	0.398 (1.487)
Agreeableness med	-14.712 (11.921)	-0.500 (0.948)	-2.055 (1.627)
Education level	0.397 (12.856)	-1.160 (1.074)	-1.647 (1.755)
Strong math background	-4.043 (11.636)	0.190 (0.889)	1.064 (1.589)
Age	-6.106 (16.277)	0.639 (1.270)	-0.299 (2.222)
Sex	25.413 (16.607)	0.766 (1.374)	-0.070 (2.267)
Constant	150.606 (281.941)	-9.185 (21.827)	14.413 (38.491)
Observations	33	33	33

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.8: MTurkers Regressions of second hypothesis using nominal values for Cognitive Ability and Personality Characteristics

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	13.542	-0.116	-2.506
	(11.722)	(1.289)	(1.439)
Cognitive Ability	-0.749	0.046	0.028
	(1.219)	(0.129)	(0.150)
Cognitive Ability × Test group	0.485	0.075	0.414
	(1.865)	(0.205)	(0.229)
Conscientiousness	-0.200	0.092	0.105
	(0.538)	(0.056)	(0.066)
Openness	0.228	0.011	-0.017
	(0.491)	(0.051)	(0.060)
Agreeableness	0.513	-0.095	-0.087
	(0.601)	(0.065)	(0.074)
Bachelor's degree or equivalent	-7.736	-1.187	-0.237
	(8.971)	(0.872)	(1.101)
Master's degree or equivalent	-8.328	-2.882**	-0.449
	(9.636)	(1.053)	(1.183)
Game theory knowledge	-9.225	-1.231*	0.587
	(5.848)	(0.617)	(0.718)
Strong math background	5.780	0.852	0.509
	(6.506)	(0.647)	(0.799)
Age	0.273	0.086***	0.036
	(0.229)	(0.025)	(0.028)
Sex	1.882	-1.688*	-0.628
	(5.033)	(0.658)	(0.618)
Constant	19.939	-2.741	2.283
	(26.426)	(2.621)	(3.243)
Observations	120	120	120

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Nominal values for cognitive ability and personality characteristics were used.

A.8.3 Hypothesis 3

Table A.9: HSS Regressions of third hypothesis using binary values for Cognitive Ability and Personality Characteristics based on median

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	2.934	0.806	-0.011
	(21.970)	(1.749)	(2.888)
Cognitive ability med	-15.216	-1.154	-0.719
	(14.792)	(1.127)	(1.944)
Conscientiousness med	-11.810	1.043	0.425
	(16.791)	(1.388)	(2.207)
Openness med	-16.014	0.627	1.860
	(18.348)	(1.468)	(2.412)
Agreeableness med	-10.932	-2.236	-3.408
	(18.701)	(1.781)	(2.458)
Conscientiousness med × Test group	12.650	-2.734	-1.214
	(23.565)	(1.946)	(3.097)
Openness med × Test group	17.210	0.240	-2.104
	(27.612)	(2.135)	(3.629)
Agreeableness med × Test group	1.496	2.789	2.427
	(23.427)	(2.022)	(3.079)
Education level	0.823	-1.452	-2.061
	(14.124)	(1.083)	(1.857)
Strong math background	-3.545	-0.306	1.716
	(14.535)	(1.118)	(1.910)
Age	-0.337	1.025	0.121
	(17.752)	(1.390)	(2.333)
Sex	12.154	0.119	-1.215
	(15.858)	(1.153)	(2.084)
Constant	65.282	-15.179	8.066
	(307.965)	(24.115)	(40.480)
Observations	33	33	33

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.10: MTurkers Regressions of third hypothesis using nominal values for Cognitive Ability and Personality Characteristics

	(1) Basic BCG	(2) Row B	(3) Total payoff
Test group	71.797	0.788	-2.556
	(45.093)	(4.506)	(5.560)
Cognitive Ability	-0.450	0.049	0.183
	(0.955)	(0.105)	(0.118)
Conscientiousness	-0.304	0.243**	0.133
	(0.747)	(0.092)	(0.092)
Openness	1.138	0.061	-0.155
	(0.729)	(0.086)	(0.090)
Agreeableness	0.166	-0.282*	0.010
	(0.966)	(0.119)	(0.119)
Conscientiousness × Test group	0.449	-0.277*	-0.104
	(1.026)	(0.119)	(0.127)
Openness × Test group	-1.973	-0.034	0.251
	(1.083)	(0.114)	(0.133)
Agreeableness × Test group	0.053	0.315*	-0.103
	(1.284)	(0.150)	(0.158)
Bachelor's degree or equivalent	-3.493	-1.244	-0.454
	(9.165)	(0.980)	(1.130)
Master's degree or equivalent	-4.507	-3.511**	-0.584
	(9.829)	(1.246)	(1.212)
Game theory knowledge	-7.788	-1.465*	0.492
	(5.847)	(0.671)	(0.721)
Strong math background	4.203	1.214	0.552
	(6.486)	(0.713)	(0.800)
Age	0.207	0.086**	0.045
	(0.232)	(0.028)	(0.029)
Sex	2.105	-1.708*	-0.477
	(5.027)	(0.672)	(0.620)
Constant	-1.729	-3.710	2.328
	(29.493)	(3.086)	(3.636)
Observations	120	120	120

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Nominal values for cognitive ability and personality characteristics were used.

Table A.11: MTurkers Regressions of Row B with Cognitive Ability > 3 using nominal values for Cognitive Ability and Personality Characteristics

	(1) Row B
Test group	5.478 (5.764)
Cognitive Ability	0.340 (0.200)
Conscientiousness	0.194 (0.115)
Openness	0.119 (0.110)
Agreeableness	-0.209 (0.153)
Conscientiousness × Test group	-0.278 (0.154)
Openness × Test group	-0.147 (0.146)
Agreeableness × Test group	0.308 (0.189)
Bachelor's degree or equivalent	-1.487 (1.280)
Master's degree or equivalent	-4.433* (1.849)
Game theory knowledge	-1.309 (0.890)
Strong math background	1.057 (0.965)
Age	0.124** (0.040)
Sex	-2.307* (0.977)
Constant	-9.638* (4.499)
Observations	92

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Nominal values for cognitive ability and personality characteristics were used.

Table A.12: MTurkers Regressions of first hypothesis with Cognitive Ability > 3 using binary values for Cognitive Ability and Personality Characteristics based on median

	(1) Basic BCG
Test group	18.491***
	(4.988)
Cognitive ability med	3.698
	(5.313)
Conscientiousness med	-3.029
	(6.887)
Openness med	3.299
	(5.363)
Agreeableness med	4.960
	(6.132)
Bachelor's degree or equivalent	-8.363
	(9.524)
Master's degree or equivalent	-12.265
	(10.349)
Game theory knowledge	-4.452
	(6.922)
Strong math background	4.026
	(7.460)
Age	0.365
	(0.235)
Sex	0.953
	(5.531)
Constant	25.933
	(14.151)
Observations	92

Note: Standard errors are reported in parentheses and significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.