

Erasmus University
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Master Thesis

Prisoner's dilemma in different contexts



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Abstract

In my thesis I examine if and how context influences the decisions in the prisoner's dilemma game. I have set up an experiment with two cases. In one case the participants are faced with a prisoner's dilemma game when their counterpart is their mother and in the other case the counterpart is a criminal. I have found that participants in the case mother significantly more cooperated. When the connection with the counterpart in the prisoner's dilemma is warmer/stronger, the participant is more likely to cooperate than when the connection is loose/cold. This result is also in line with findings in the theory. In my theoretical research I have found that there are a lot of processes influencing the behavior in the prisoner's dilemma game: biological elements, personality, emotions, social elements, image of the counterpart, trust and the connection with the other person. In my experiment I also examined the effect of an image of the situation (a photograph of a mother-child relationship and a photograph of a criminal). I've found that the participants who were faced with an image need less time to make a decision. Though, the decision of the participants who were faced with a photograph is not different than the decision of the participants that didn't face a photograph.

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1. Preface

In December I had to choose for a thesis supervisor. I chose Dr. Prof. Willem Verbeke as my supervisor because his specialization area, neuroeconomics, interested me. This was a field in economics I didn't know much about and therefore wanted to know more about. In the months March and April we had the opportunity to follow a course given by Verbeke, Knowledge-Based Marketing, where we were learned everything about entrepreneurship, knowledge, networking and a lot more. In the second class of this course Verbeke told us he was very interested in game theory. In that college I realized that this subject was something I was interested in and wanted to do my Master thesis about. I replaced my previous subject by the prisoner's dilemma in different contexts. There has been written a lot about the prisoner's dilemma and there has been done much research to which aspects influence the outcome of the prisoner's dilemma. But there hasn't been done research to the effect of a prisoner's dilemma game played when the counterpart is your mother and on the other hand a prisoner's dilemma game played with a criminal as counterpart. In this research I would like to take a closer look to the effect of the context on the decisions made in the prisoner's dilemma.

First of all I would like to thank my family and friends for their support during difficult moments of the writing part of the thesis. It is great to have people in my close environment that keep me motivated. It was a tough period but I am proud of the result. I would also like to thank the members of my table tennis club for their willingness to participate in my research. Last but not least, I would like to thank Prof. Dr. Willem J.M.I. Verbeke in special for being my supervisor, giving me the idea for this research, his support and his enthusiasm.

2. Introduction

2.1 Introduction

As an economy student you are learned dozens of economic models during the first years of the study. A popular game theory is the prisoner's dilemma. The prisoner's dilemma is a very often used model to explain social and economic behavior. In the classic example of the prisoner's dilemma two persons committed a crime together and are caught by the police. The police don't have enough evidence for a conviction. The two suspects are separated from each other and the police offer both of them the same deal. The two persons are not able to communicate with each other and have to make a decision independently: stay silent or betray the other person. The best solution for both persons is that both persons stay silent so they will both receive a low punishment. The problem is that two suspects cannot be sure that the other person will stay silent as well. If you would be silent while the other person betrays you, you will be in prison for a long time. Otherwise, if you betray the other person while he/she stays silent you will not have to go to prison and he/she will stay in prison for a long time. The dominant strategy for both persons in this model is to betray the other person. Regardless of the choice of the other person, it is the best thing for you to betray. The two suspects do not want to take the risk that the other person will betray him so he will be set free while you will be fully punished for the crime. Therefore the persons will chose to betray the other person. But what will happen if the persons in the prisoner's dilemma know each other very well? Will they still follow the dominant strategy? Does the choice in a prisoner's dilemma game depend on the context under which the decision has to be made? Will persons act differently when they are dealing with someone they know very well than when they are dealing with a criminal they don't know at all?

2.2 Research questions and hypothesis

In this research I hope to learn how context effects the decision in the prisoner's dilemma game. If you have to make the choice independently of someone you know very well or a criminal, will it influence the decision? The main question in my thesis is:

Does the context have an effect on the decision in the prisoner's dilemma game? If yes, which factors have an effect?

The main hypothesis in my thesis is:

When the connection between the two persons gets warmer/stronger you are less likely to betray the other person than when the connection is weak.

2.3 Objective

The prisoner's dilemma is a very well known game theory and is often used to explain behavior in daily situations. There has been done a lot of research to the prisoner's dilemma game and which factors has effect on the behavior in this game. But there hasn't been done a lot of research to what happens if the game is played with a family member. In this research I would like to know which factors have effect on the decision making process in the prisoner's dilemma game and I want to know if people behave differently when they are dealing with a family member. I want to know more about why the decisions are made the way they are made and the processes that are underlying the decision making process. At the end of this thesis I would like to know in which way the context affects the behavior during the prisoner's dilemma game.

2.4 Relevance

In the previous paragraph I have already described that there hasn't been done a lot of research to the effect of two family members playing the prisoner's dilemma game. The theoretical concept of the prisoner's dilemma game is that people tend to follow the dominant strategy which results in not the best net position. In this thesis I want to examine what the effect is if the game is played between persons that have a strong connection with each other.

2.5 Structure

To be able to answer the research questions and test the hypothesis as formulated in paragraph 2.2, the core of the thesis exists of three chapters. In chapter 3 I am going to explain the prisoner's dilemma in detail and will describe different papers. In the second part, chapter 4, I will describe the subject trust. The importance of trust on the decision making process will be described and I am going to describe some articles dealing with trust. In the second part of chapter four I will describe work of Wilson and Eckel to the effect of photographs in games.

The final part of my research is the most interesting part. In chapter five I am describing my own experiment. For this experiment I will ask participants to make a decision in the prisoner's dilemma game. In one case they have to make the decision to cooperate or defect while their counterpart is their mother and in the other case their counterpart is a criminal. With this experiment I am testing if context has an effect on the behavior of the participants.

After the core of the thesis, I will end my thesis by answering the research question and sum up the results in the conclusion and give implications for further research.

3. Prisoner's dilemma

3.1 Prisoner's dilemma in detail

3.1.1 Prisoner's dilemma explained

The prisoner's dilemma game is very often used to explain economic and social behavior. The prisoner's dilemma is a type of game theory. In game theory the participants have to make individual decisions and receive a pay-off based on the decisions the different participants make. In the prisoner's dilemma there are two parties involved. In the classic example of the prisoner's dilemma two people committed a crime and got caught by the police. The police have strong indications that a serious crime has been committed but they don't have enough evidence to prove that the two suspects committed the crime. They do have enough evidence to prove they have committed a smaller crime. Therefore the police decide to ask the two suspects separately if they have committed the crime. The suspects have two options; confess or remain silent. In the next table you can see the payoffs given the decisions of the two persons:

	The other person remain silent	The other person confess
You remain silent	Both will get 1 month prison	The other person will go free; you will be in prison for 1 year
You confess	You will go free; the other person will be in prison for 1 year	Both will get 3 months prison

The absolute pay-offs in the matrix can be anything. It doesn't matter how high the punishments are as it is about the relative punishments. When both persons remain silent the police only have enough evidence to give the persons a low punishment. When one of the persons confesses and the other remains silent, the police will give the person who remains silent the full punishment while the other person goes free. When both persons confess, both persons will be convicted for the big crime but will get a lower punishment because they are honest to the police.

This is the classic example of the prisoner's dilemma but there are a lot of situations in daily life where you have to make decisions under uncertainty with certain payoffs; for example when you are travelling to school. Imagine you have two options to go to school: by car or by public transport. It takes on average 15 minutes to walk to the metro station and to wait for the metro to leave and the average time of travelling is the same for travelling by metro or by car. People will then choose to go by car. If everyone will reason this way there will be traffic jams everywhere in the future. Another example of a prisoner's dilemma is not buying a ticket for a tram. Obviously it is cheaper (it is free) to not pay for a ticket but on the other hand if everyone decides to not pay for the use of public transport the prices of the public transport will go up or even worse. In daily life there are constant decisions to be made with different outcomes. The best option to choose on an individual basis isn't always the best option for the community.

3.1.2 Dominant strategy and Nash equilibrium

In the prisoner's dilemma there is a dominant strategy for both persons. For both persons the dominant strategy is to confess. No matter what strategy the other person chooses; confess produce better results than remain silent. If the other person remain silent it is better for you to confess (you will go free in stead of 1 month prison) and if the other person confess it is better for you to confess (you will get 3 months prison in stead of 1 year). It is the same story for the other person. If you remain silent it is better for the other person to confess (the other person will go free in stead of 1 month prison) and if you confess it is the best thing to confess (the other person will get 3 month prison in stead of 1 year prison). The result when both persons follow the dominant strategy, which is thus confessing, is the Nash equilibrium. The Nash equilibrium in this case is that both persons have to go to prison for 3 months.

Although the dominant strategy for both persons is to confess, this is not the best net solution. The net best solution is that both persons remain silent. In this case both persons will get a low punishment, just one month (two months in total). In the other situations the net punishments is six months or one year.

3.2. Prisoner's dilemma from different perspectives

In this paragraph I am going to describe different papers about the prisoner's dilemma and try to find out which factors have effect on the prisoner's dilemma game and if there are some common findings in the papers.

In a lot of articles, for example in the article "The absent-minded prisoner" (written by Alexander Dilger), researchers conclude that in a one-shot prisoner's dilemma game prisoners will not cooperate. In the article Prisoner's mistrust, written by Erin I. Kelly and Lionel K. McPherson, the researchers argue the standard prisoner's dilemma. Kelly and McPherson argue that it is not always rational to choose to remain silent, which is the best net solution. They make a distinction between individual and collective rationality. If the persons have a reason to trust each other it would be rational to follow the joint strategy and when the persons have no reason to trust each other it would be rational to follow the individual strategy. Kelly and McPherson see trust as something that exists when both persons have strong concern and believe that none of the persons advance his own interest or goals above the goals of the other person. The researchers don't see the prisoner's dilemma as a dilemma but an outcome of the persons trust in each other. When a person thinks he is able to trust the other person, he will follow the collective rationality and when he thinks he is not able to trust the other person he will follow the individual rationality. In chapter four I am going to describe more papers dealing with the effect of trust.

Hirsch and Peterson (2009) did research to the effect of personality and individual differences on the outcome of the prisoner's dilemma. They have found that personality and individual differences predict the likelihood of cooperation in the prisoner's dilemma. Individuals who score higher on fear and insecurity are more likely to cooperate. The explanation the researchers give is that these persons are more afraid of the consequences of their behavior. This motivation is supported by the work of the behavioral economists Fehr & Gächter (2000) and Hirschleifer & Rasmusen (1989) wherein they have found that fear of punishment can play a substantial role in cooperation. Hirsch and Peterson also found that enthusiasm has an effect on the chance of cooperation. People who are more enthusiastic tend to experience more positive emotions and are more sensitive to rewards. Enthusiastic persons might reward the benefits from cooperate behavior more and therefore have a higher chance to cooperate.

Hirsch and Peterson also noticed that positivism may be playing an important role in the prisoner's dilemma. Individuals that are in a good mood are more likely to cooperate.

James K. Rilling and other researchers examined the effect of playing two games, the prisoner's dilemma and the ultimatum game, in the brains. In these two games there are two situations: in one situation they were dealing with a computer partner and in the other position they were dealing with a human partner. The researchers found a high degree of overlap in the two situations. In both situations there was activation in two ToM (Theory of Mind) areas, the anterior paracingulate cortex and posterior STS. When the persons were faced with a human partner, the activation in these two brain areas was stronger than for computer partners. The stronger brain activity for human partners is consistent with the data that unfair offers from human partners were more frequently rejected and cooperating offers more frequently accepted. In the article "Theory of Mind broad and narrow: Reasoning about social exchange engages ToM areas, precautionary reasoning does not", the researchers used a MRI study to see which parts in the brain is activated and when. With this MRI study they found that when people are reasoning about social context the anterior and posterior temporal cortex is activated. So with these two papers we have seen that when persons are dealing with the prisoner's dilemma, the anterior and posterior temporal cortex are activated in the brain and when participants are dealing with a human there is more brain activity than in the situation of a computer partner.

Evgenia Hristova and Maurice Grinberg investigated the effect of the context on the prisoner's dilemma game in their research "Investigation of Context Effects in Iterated Prisoner's Dilemma Game". Hristova and Grinbergs claim that cooperation in the prisoner's dilemma depends on the pay-offs. The ratio between the pay-offs, the Cooperation Index (CI), has theoretical and empirical support as a reliable predictor of the cooperation rate in the prisoner's dilemma game. In work of Vlaev and Chater and earlier work of themselves, Hristova and Grinberg find support that the context of the prisoner's dilemma game has effect on the Cooperation Index. The cooperation rate depend on the current game pay-offs and CI but also on the CI's of other games in the game set. When a prisoner's dilemma game is given with a given CI in the context with higher CI values, the probability that people cooperate is significantly higher than in the other experimental conditions. Hristova and Grinberg also made a model to test the sensitivity of the context. The sensitivity is tested by using the utility

theory. The result is that the probability to cooperate depends on previous experiences and current payoffs. Based on the results of the experiments in this research, Hristova and Grinberg found support for their claim that context has a significant effect on the behavior in the prisoner's dilemma game.

Todd Sandler and Daniel G. Arce M. did research to different types of prisoner's dilemmas in their research "The Dilemma of the Prisoners' Dilemmas". Sandler and Arce first spend some words about the importance of the prisoner's dilemma in social, economic and political situations. In social and economic problems the prisoner's dilemma is a very often used model. The researchers had four faces of the prisoner's dilemma games: provision game, commons game, altruism game and selfish game. They found that group size is more important for the provision and commons games than the altruism and selfish games. Action (cooperate) is desirable in the provision and altruism game and inaction (defect) is better in the selfish and commons game. Besides the 2 by 2 prisoner's dilemma games, the researchers also combined the four prisoner's dilemma games with 3 options. They want to examine how people choose amongst three strategies. The result in these 3x3 games is the least desirable of the two embedded 2 by 2 game. Finally, Sandler and Arce claim that the choice to cooperate in the prisoner's dilemma games depend on internal relations, biology and environment.

A lot of researchers claim that rationality is the basis to make a decision in the prisoner's dilemma. Hauert and Stenfull don't agree that rational thinking is the most important factor in their paper "Simple Adaptive Strategy Wins the Prisoner's Dilemma". Emotions are more important than rational thinking. The actions in the past are summarized in the internal state of a person and this determines the behavior in the future. This concept is called "Adaptor". The Adaptor strategy can be seen as a constant learning curve. The researchers have found that the concept of Adaptor leads to patterns that are highly cooperative when playing the prisoner's dilemma game with relatives, robust for environmental changes and is superior in performance to most strategies in the literature. In the article "Neuroeconomics and Rationality", written by Chorvat and McCabe, the researchers wanted to learn more about the decision making process. In economics rationality is very often the assumption. Chorvat and McCabe claim that individuals are not behaving rationally but when persons behave irrationally the persons behave consistent irrational. In their paper Chorvat and McCabe did an interesting experiment. They were testing the effect of two cases on the brain. In the first

case a train is coming down a track and if they do nothing it will hit a car on the track and five people will be killed. If they would press a button the train will switch to a side track and only one person will be killed. The participants have two options: press the button or don't. In the second case the subject has to push the person next to him on the track with the consequence that he will get be dead. The options in this case are push or don't. The decisions made in these two cases are totally different although in both cases one person dies. In the first case almost all subjects chose to push the button and in the second case the subject didn't want to push the person. The study shows that parts of the brain are activated with fear in the case of pushing the person on the track. The emotional reactions are significantly less in the case of pushing a button to switch the track although still one person dies. The persons that decide to push the other person onto the track need significantly more time to make the decision. Moral and personal dilemma's are playing a big role in the decision making process.

Paul J. Zack has found that the generalized trust is highly correlated with happiness. The nature has designed us to be cooperative because it feels good. The Nash equilibrium in the prisoner's dilemma game is not obtained because the assumptions of the prisoner's dilemma game are not consistent with human nature. Zack describes a research of Rilling in which he found that cooperation itself is rewarding. The women who were participating in a prisoner's dilemma game and were playing against a human had more neural activity in dopamine regions than the women who were playing against a computer. Dopamine is a neurotransmitter that plays an important role in feeling happiness and satisfaction.

Constance J. Seidner reflected the prisoner's dilemma in his work "Prisoner's Dilemma: Reflections and Recollections". Seidner goes back in time to the 1800's where Cournot described his Duopoly Model. In this model there are two firms which are producing the same product. Cournot claims that when each firm optimizes his own profit it will be worse off than when the two firms would maximize their joint profit. In 1947 Seidner published an article himself which led to the same results; when each person behaves individually rationally both parties will be worse off than when they behave collectively rationally. In 1955 Seidner joined the Mental Health Research Institute at the University of Michigan. One of the experiments he did was a long lasting game of 36 hours without sleep in which three persons were asked to make a decision in four rounds. In many experiments with two person prisoner's dilemma games was found that when people had to make more decisions over time with the same

persons the willingness to cooperate increases. Seidner wanted to test if stress has effect on the decision but he didn't find a significant effect. He did find something else which is very interesting. After a lunch break where the three persons were lunching in a cafeteria together the level of cooperation increased significantly. The explanation has to found in the physical contact between the players. In later experiments he observed the same phenomenon under controlled conditions. Thus, when players in a prisoner's dilemma game have physical contact together, the willingness of cooperation increases.

3.3 Conclusion

In the first paragraph of this chapter I have explained the theoretical concept of the prisoner's dilemma and spend some words about the dominant strategy and Nash equilibrium. In the second paragraph I have described different papers dealing with the prisoner's dilemma. Based on the papers I have described in the previous paragraph, we can conclude that a lot of processes have effect on the decision making process in the prisoner's dilemma game. A few of these processes are: biological elements, personality, emotions, social elements, connection with the other person, trust in the other person.

In the next chapter I am going to describe the phenomenon trust and I will describe more papers about trust and papers on the effect of an image in experiments.

4. The importance of trust

4.1 Introduction

The decision of the two persons in the prisoner's dilemma has to be made separately. In the previous chapter I have talked about the dominant strategy in the prisoner's dilemma, confess, and that the best net solution is that both persons remain silent. The best net solution is not always the outcome of the prisoner's dilemma and that is exactly what makes game theory interesting. There are some processes underlying that influence the decision-making process as I have reported in the previous chapter. An important underlying process is the trust that the two persons have in each other. If the two persons know each other very well and have a lot of trust in each other, they will probably be more likely to cooperate. If the two persons don't know each other very well they will probably be more likely to have less trust in the other person. If two persons are not able to trust each other will the persons then think more on an individual basis and thus be more likely to choose to confess? In this chapter I will describe some papers on the ability to trust a person and how the connection between two persons affects the trust in the other person.

4.2 Trust in prior research

There has been done quite some research to the concept trust. In this paragraph I will describe some findings of researchers. In the research "Kinds of Third-Party Effects on Trust", of Ronald S. Burt and Marc Knez of the University of Chicago, the researchers examined the types of third party effects on trust. The researchers looked at network data and how third parties affect trust. One of their main conclusions is that trust is associated with the strength of the relationship. When the relation strength is stronger, the persons are able to trust each other more.

Glaeser, Laibson, Scheinkman and Soutter have described their experiments to measure trust and trustworthiness in their paper "Measuring Trust" (2000). They have found that trusting behavior can be predicted by past trusting behavior. When the connection with the person is stronger, both trust and trustworthiness rise. When the connection with the other person is weak or when the person is from another nationality or race, the trustworthiness strongly decreases. In the article "The Dyadic Trust Scale: Towards Understanding Interpersonal Trust

in Close Relationships” Huston and Larzelere examined the interpersonal trust. They have found similar results as the researchers in the previous two articles I described. When persons love each other and are living together (and thus has a close relationship), the level of trust is very high. When persons have a loose connection or have no connection at all, there is not much trust. Stevens and Hauser (2004) also found that when persons or other animals have no connection with each other there is rarely cooperation. In case there is cooperation there is cooperation because of selfish or indirect benefits via helping relatives for example.

4.3 The effect of an image

In paragraph 3.2 I described the work of Seidner. He found that when persons had physical contact with the counterpart, they are more likely to cooperate. If people don't have a connection with the counterpart they are still trying to get a view of the person they are playing the game with. Rilling found that participants are more willing to cooperate when they are dealing with a human partner than a computer partner. Apparently participants would like to get a picture in their head of the type of person they are dealing with in the prisoner's dilemma game.

There has been done some interesting research to the impact of a photograph of the counterpart on the behavior in prisoner's dilemma games. In the paper “Judging a Book by its Cover: Beauty and Expectations in the Trust Game”, Wilson and Eckel did an experiment to measure the effect of attractiveness on trust. They have tested if an attractive person gets a premium in a game involving trust and reciprocity. Attractive persons are found to be more trusted in the first round of the experiment and earn more in this round. The participants see attractive persons as more trustworthy. However when the expectations are not met, the attractive persons will get a beauty penalty in the second round of the experiment. To assess if persons are trustworthy depends on knowing how trustworthy the person has been in the past and trust that the person will be trustworthy in the future. Wilson and Eckel claim that when persons are dealing with someone they don't know they are still able to “read” how trustworthy the person is by signals of the counterpart. The researchers did an experiment where they were doing trust games and they also showed the participants photographs of the other player. The participants then had to rate how trusting, cooperative, honest, respectful

and complaining they think the person on the picture is. The participants rated the pictures of women higher than the pictures of men and people trust attractive counterparts more. Wilson and Eckel have thus found that attractiveness of the other person increases the trustworthiness. Wilson and Eckel also published a paper together with Scharlemann and Kacelnik. In this paper, “The value of a smile: Game theory with a human face”, they argue that facial expression of a counterpart contains information that is used by the person to make their decision. Cooperation in the prisoner’s dilemma game has the best outcome and therefore the persons in such a game always try to estimate if the person is trustworthy. In this paper two questions are addressed: does smiling elicit trust among strangers and is there a difference between the sexes in assessing trust? The results are that smiling increases the trustworthiness of a stranger, facial features can affect cooperation (with and without a smile) and both males and females have more trust in people of the opposite sex. In the paper “The Human Face of Game Theory” Eckel and Wilson examined the effect of the presence of a human face on game theory. Although the experiment wasn’t a big success (more than 1/3 of the participants didn’t understand the experiment) Eckel and Wilson concluded that an image of the counterpart in a game has effect on the decision. In chapter five I am going to set up my own experiment to test what the effect of an image is on the behavior of participants.

4.4 Stronger connection, more trust

In the introduction of this chapter I described that trust is a very important factor in the prisoner’s dilemma. Based on the conclusions in chapter three and the three papers I have described in chapter 4.2, there is enough evidence to assume that the connection between the participants in the prisoner’s dilemma has an effect on the trust between the two persons. When the connection between two persons is stronger, there will be more trust between the two persons. The probability that the two persons are cooperating is higher when the connection gets stronger.

If a prisoner’s dilemma game is played with two persons that don’t know each other, the persons try to make a picture of the behavior of the other person before making a decision. If participants in the game get to see a photograph of the other person they make assumptions about the behavior of the other person. A photograph has impact on the decision the participants make. Attractive and smiling persons are seen as more trustworthy.

5. Experiment

5.1 Introduction

In this chapter I will describe the experiment I have done to the effect of the context on the decision people make in the prisoner's dilemma. I have done this experiment to extend my thesis and to learn more about how the context influences the decision of the participants. In chapter three I have explained how the prisoner's dilemma theoretically works, the two options that both persons in the dilemma have and spend some words about the dominant strategy and the Nash equilibrium. The dominant strategy in the prisoner's dilemma is for both persons to confess. The Nash equilibrium is the position in the prisoner's dilemma when both persons follow the dominant strategy, and thus when both confess.

To test the effect of the context in the prisoner's dilemma I have made two cases; in one case the participant has to make the decision when the other person in the prisoner's dilemma is their mother and in the other case the participant has to make the decision when the other person is a criminal. I have attached the two cases in the appendix. In the rest of the research I will name the cases respectively "case mother" and "case criminal". In the case mother the participant will feel a more warm, strong (mother-child) connection where in the case of the criminal the participant will feel a more loose/cold connection. The experiment consists of two parts. In the first part I am testing if there are differences in the decision the participants make in the two cases. I am also interested to see how much time the participants need to make a decision and if there is a difference in the time the participant need in the two cases. To measure how much time the participants need I am using a stopwatch. In the second part of the experiment I am extending the first part and will include a photograph with the two cases. In chapter four I described the research of Eckel and Wilson where they found that images have a clear effect on the outcomes of experiments. I am interested to see if the presence of a photograph will influence the decision participants make and if it has an effect on the time the participants need to make their decision.

In the next paragraph I will explain clearly what the goals of the experiment are. In paragraph 5.3 I will set the research question and the hypothesis and in paragraph 5.4 I will spend some word about the sample description. After these two paragraphs I will test the hypothesis and

give the results of my experiment. In the final paragraph of this chapter I will answer the research question and give the conclusions of my experiment.

5.2 Goal

In the previous paragraph I have already explained what I was hoping to achieve with the experiment. To have a good overview I am summing up shortly what the goals of the experiment are. By having two totally different contexts I hope to get more detailed information about the influence of the context to the decision the participants make in the prisoner's dilemma. The theoretical concept of the prisoner's dilemma is that both persons will act individually and choose for the dominant strategy. I am curious to see if the participants will act differently (higher level of cooperation) when they are faced with the situation where they have a strong connection with the other person.

Besides the decisions the participants make in the two cases, I am also interested in the time the participants need to make their decision. Do people need less time when they are faced with a criminal?

At third, I am also interested in the effect of a photograph on the decision making process. Will it have an effect on the decision and are the participants able to make a decision in less time?

5.3 Research question and hypothesis

To be able to achieve the goals I have set in the previous paragraph, it is needed to have research question and hypothesis. In the introduction of my thesis I have set the following research question:

R. Does the context have an effect on the decision in the prisoner's dilemma game?

This research question can and will be answered with the hypothesis I set in this paragraph. In the introduction I have set the main hypothesis for my research. This hypothesis is also the most important one in my experiment. I am setting null hypotheses and alternative hypotheses to have a good overview.

Null hypothesis 1: The connection between two persons doesn't have effect on the decision made in the prisoner's dilemma

Alternative hypothesis 1: When the connection between the two persons gets warmer/stronger you are less likely to betray the other person than when the connection is weak.

The second hypothesis I have set is dealing with the article written by Eckel and Wilson I described in chapter four. They found that images have a big impact on the outcome of decisions. A famous phrase is that an image says more than 1000 words. With this hypothesis I am testing if the presence of a picture has an effect on the choice the participants make and if the presence of a picture give

Null hypothesis 2: The presence of a picture doesn't have effect the decision of the participant.

Alternative hypothesis 2: With the presence of a picture you are more likely to choose for the dominant strategy when the connection is colder/looser than when there is no picture and you are more likely to choose for the cooperative strategy when the connection is warmer/stronger.

The third hypothesis is dealing with the time the participants need to make their decision. With hypothesis 3a I am testing if there is a difference in the time the participants need to answer the two cases. With hypothesis 3b I am testing the effect of a photograph in making a decision. I am interested to see if the presence of a photograph makes it easier for participants to make a decision.

Null hypothesis 3a: The participants who are making their decision in the case mother need the same amount of time as the participants who are making their decision in the case of the criminal.

Alternative hypothesis 3a: In the case of the mother people will need more time to make their decision then in the case of the criminal.

Null hypothesis 3b: The presence of a photograph doesn't have effect on the time participants need to make their decision

Alternative hypothesis 3b: With the presence of a photograph participants will need less time to make their decision

With the hypotheses I have set in this paragraph I am able to give an answer on the research question. In the next paragraph I will in detail describe the sample I am using in my experiment.

5.4 Sample description

To be able to answer the research question and to test the hypothesis as formulated in paragraph 5.3, some participants are needed. I am a member of a table tennis club and I asked on four evenings different people to participate. The experiment exists of two parts. For the first stage I have been able to get 32 persons and for the second stage I have got 36 persons. In the first stage I have 16 people who made the case mother and 16 who made the case criminal. In the second stage 18 persons made the case mother and 18 persons made the case criminal. The fact that the size of the two stages isn't the same doesn't matter for my research. As all the players on my table tennis club are speaking Dutch I have translated the case in Dutch and let them make the case in Dutch. I have attached the two cases in English and in Dutch in the Appendix (page 35-38).

5.5 Results

5.5.1 Independent Samples T-Test

In my experiment I am comparing group means and proportions between groups to test if there are differences between the groups and proportions. To test if the means and proportions between groups are significant different I am using the independent sample T-test. The reason I chose for the independent sample T-test in stead of the pooled sample test is that the two variables are independent as I have been asking different people to answer the cases. By using the independent sample T-test I am able to test the hypotheses. In the following sub paragraphs I am testing the hypotheses by using the independent samples T-test. In the final sub paragraph I will come back to the research question.

5.5.2 Hypothesis 1

The first hypothesis as formulated in paragraph 5.3 is:

Null hypothesis 1: The connection between the two persons doesn't have effect on the decision made in the prisoner's dilemma.

Alternative hypothesis 1: When the connection between the two persons gets warmer/stronger you are less likely to betray the other person than when the connection is weak.

To test if the connection between two persons has effect on the decision they make in the prisoner's dilemma, I am comparing the proportion of the people that choose to confess in both cases. In the case mother 9 persons confessed (6 in the case without a photograph and 3 in the case with a photograph) and 25 persons decided to remain silent. So 9/34 decided to confess. In the case of the criminal 23 persons confessed (11 in the case without a photograph and 12 in the case with a photograph) and 11 persons remained silent. So in the case of the criminal 23/34 decided to confess. The proportion of the participants that confessed in both cases can be seen in the table below (table 2).

Table 2: Proportion of the participants that confessed in both cases

Case	Number of observations	Proportion that confessed
Case Mother	34	0.26
Case Criminal	34	0.68

To test if there is a significant difference in two proportions I am using the independent sample T-test. The result of this test can be seen in table 3.

Table 3: Test of Null hypothesis 1

Test of hypothesis H1	T-value	Significance
	3.679	0.000

Based on a significance level of 5%, the hypothesis that the proportion that confessed in both cases is equal and thus that the connection between two persons has no effect on the decision the participant make can be rejected. So there is evidence for the alternative hypothesis 1. If the connection with the other person is looser/colder you are more likely to choose for the dominant strategy. You are thus less likely to betray the other person when the connection with the other person gets warmer/stronger than when the connection is weak.

5.5.3 Hypothesis 2

The second null hypothesis and alternative hypothesis as formulated in paragraph 5.3 are:

Null hypothesis 2: The presence of a picture doesn't have effect the decision of the participant.

Alternative hypothesis 2: With the presence of a picture you are more likely to choose for the dominant strategy when the connection is colder/looser than when there is no picture. And you are more likely to choose for the cooperative strategy when the connection is warmer/stronger.

To test if the presence of a picture has a significant effect on the decision the participants make, I am comparing the proportions in the cases without a picture with the proportions in the cases with the presence of a picture. First I am comparing the case mother without a picture with the case mother with a picture (hypothesis 2a) and then I am comparing the case criminal without a picture with the case criminal with a picture (hypothesis 2b).

In the case mother 6 of the 16 persons confessed, while 3 of the 18 persons confessed in the case of the mother with the presence of a picture. The results can be seen in table below (table 4).

Table 4: Proportion of the participants that confessed in the case mother with and without a photograph

Case Mother	Number of observations	Proportion that confessed
No photograph	16	0.375

With photograph	18	0.17
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To test if the proportion of the participants that confessed is equal in the case mother without photograph and the case mother with photograph I am using the independent samples T-test. In the table below the result of this test is summarized.

Table 5: Test of Null hypothesis 2a

Test of hypothesis H2a	T-value	Significance
	1.351	0.188

Based on a 5% significance level the null hypothesis can not be rejected. So there is no evidence that the presence of a photograph has a significant effect on the decision of the participants in the case mother.

Now I am going to test if the proportion of the participants that confessed in the case criminal without photograph is equal to the case criminal with a photograph. In the case criminal without a picture 11 of the 16 persons confessed, while 12 of the 18 persons confessed in the case with a picture. These results can be seen in the table below (table 6).

Table 6: Proportion of the participants that confessed in the case criminal with and without a photograph

Case Criminal	Number of observations	Proportion that confessed
No photograph	16	0.69
With photograph	18	0.67

To test if the proportion between these two groups is equal I am doing an independent sample T-test. The result can be seen in table 7.

Table 7: Test of null hypothesis 2b

Test of hypothesis H2b	T-value	Significance
	0.126	0.901

The null hypothesis can not be rejected so there is no evidence that the presence of a photograph has significant effect on the decision in the case criminal. Null hypothesis 2a and 2b are not rejected so the null hypothesis 2 can not be rejected. The presence of a photograph doesn't have a significant effect on the decision of the participant.

5.5.4 Hypothesis 3

The third hypothesis I have formulated in paragraph 5.3, consist of sub hypothesis 3a and 3b. First I will give the results of sub hypothesis 3a and then I will give the results of sub hypothesis 3b.

The null hypothesis 3a and alternative hypothesis 3a are:

Null hypothesis 3a: The participants who are making their decision in the case mother need the same amount of time as the participants who are making their decision in the case criminal.

Alternative hypothesis 3a: In the case mother people will need more time to make their decision than in the case criminal.

The average time a participant in the case mother needed was 2 minutes and 17 seconds (137 seconds), while the average time a participant who was dealing with the case criminal needed 2 minutes and 10 seconds (130 seconds). In the table below you can see the exact numbers.

Table 8: Average time participants needed in case mother and case criminal

Case	Number of observations	Mean Time
Case Mother	34	137.44 seconds
Case Criminal	34	129.91 seconds

To test if the average time the participants needed in the two cases is equal I am doing an independent sample T-test. In the table below are the results summarized.

Table 9: Test of null hypothesis 3a

Test of hypothesis 3a	T-value	Significance
	0.659	0.512

The significance level is 0,512 and thus the null hypothesis is not rejected on a 5% significance level. So there is no significant evidence that the participants need more time in the case mother.

To test the null hypothesis 3b (the presence of a photograph doesn't have effect on the time participants need to make their decision) I am dividing this hypothesis in 3 sub hypothesis (3ba, 3bb and 3bc). First I am testing if the presence of a photograph doesn't have effect on the time participants need for the total group. I am thus comparing the group of participants that didn't have a photograph while making the case with the group of participants that did have a photograph. Then I am going to compare the participants in the case mother without photograph with the participants in case mother with photograph and the participants in the case criminal without photograph with the participants in the case criminal with photograph.

So first I am testing the total group. The average time a participant needed when they were making the case without a photograph is 2 minutes and 32 seconds, while the average time a participant needed when a photograph was present is 1 minute and 57 seconds (see table 10).

Table 10: Average time participants needed without and with a photograph:

Both cases	Number of observations	Mean Time
Without photograph	32	151.97 seconds
With photograph	36	117.42 seconds

To test if the presence of a photograph doesn't have effect on the time participants need to make their decision I am doing an independent sample T-test. The results of this test are in the table below.

Table 11: Test of null hypothesis 3ba

Test of hypothesis H3ba	T-value	Significance
	3.177	0.002

Based on a 5% significance level, the null hypothesis 3ba can be rejected. There is significant evidence that the participants need less time to make their decision when a photograph is attached. Now I have compared the participants who had to make the case without a photograph with the average participant with a photograph. I am also interested to see if in the case mother and in the case criminal a photograph has a significant effect on the time the participants need and therefore I am doing to more test (3bb and 3bc).

The average time the participants needed to make a decision in the case mother was 2 minutes and 28 seconds when they had to make the case without a photograph and 2 minutes and 8 seconds when a photograph was included in the case.

Table 12: Average time participants needed in the case mother with and without a photograph

Case Mother	Number of observations	Mean Time
Without photograph	16	148.38 seconds
With photograph	18	127.72 seconds

To test if the time participants needed in the case mother without a photograph is equal to the time participants needed in the case mother with a photograph I am doing an independent sample T-test. In the table below you can see the result.

Table 13: Test of null hypothesis 3bb

Test of hypothesis 3bb	T-value	Significance
	1.262	0.216

There is no significant difference in the time participants needed in the group participants that were making the case mother without a photograph and the group participants making the case mother with a photograph.

Now I am going to test if the time participants needed in the case criminal with and without a photograph is equal. The average time a participant needed in the case criminal without photograph is 2 minutes and 36 seconds and the average time a participant needed in the case criminal with a photograph is 1 minute and 47 seconds (see table 14).

Table 14: Average time participants needed in the case criminal with and without a photograph

Case Criminal	Number of observations	Mean Time
Without photograph	16	155.56 seconds
With photograph	18	107.11 seconds

To test if the time participants needed in the case criminal is equal for the group participants that didn't have a photograph of a criminal and the group of participants that were faced with a photograph of a criminal, I am running an independent samples T-test. The result can be seen in table 15.

Table 15: Test of null hypothesis 3bc

Test of hypothesis 3bc	T-value	Significance
	3.549	0.001

So the null hypothesis 3bc, the time the group of participants need in the case criminal without a photograph is equal to the time the participants need in the case criminal with the presence of a photograph, can be rejected. There is a significant difference between the two

groups. The participants that were faced with a photograph of a criminal needed significantly less time to make a decision.

We can conclude that the null hypothesis of 3b is rejected and thus that we have found evidence that a photograph make participants need less time to make their decision.

5.5.5 All results

To have a good overview of the results, I have summarized all the results of the hypotheses in my experiment in the table below.

Table 16: Summary of all tests

Test of hypothesis	T-value	Significance
Test of hypothesis 1	3.679	0.000
Test of hypothesis 2a	1.351	0.188
Test of hypothesis 2b	0.126	0.901
Test of hypothesis 3a	0.659	0.512
Test of hypothesis 3ba	3.177	0.002
Test of hypothesis 3bb	1.262	0.216
Test of hypothesis 3bc	3.549	0.001

5.6 Conclusion

The research question for my experiment was: does the context in which the people are in have an influence on the outcome of the prisoner's model? With the results in the previous paragraph I am able to answer this question and give the conclusions of my experiment.

I have found that the context has a significant effect on the choice the participant makes. In the case mother significantly more people decide to remain silent. So when the connection with the other person in the prisoner's dilemma is warmer/stronger, the participant will be

more likely to choose to remain silent than when the connection is loose. Apparently the participants don't want to risk that their mother has to go in jail for a long time and the participant also trust the mother to remain silent so both persons will be best of in this dilemma. In the case of the criminal the participants significantly choose more to confess than in the case mother. The participants clearly have less connection with the criminal and have less trust in the other person and therefore they don't want to risk that he or she has to be in jail for a long time because of the criminal. The participants also don't want to risk that the criminal gets less time in prison then they do. The participant makes a more egoistic decision in the case criminal.

I have also found that the presence of an image overall has significant effect on the time participants need to make a decision in the prisoner's dilemma. The participants need less time to make a decision when they are faced with a photograph of a criminal or a photograph of a mother-child relationship. Apparently the presence of an image makes the case more clear and abstract with the consequence that participants need less time to make a decision. When the participant sees an image of a criminal they will immediately get a certain feeling that is stronger than the feeling the participant gets in the case criminal when they are not faced with a picture. In the case mother the participants didn't make a decision in less time when a picture was attached. Apparently the presence of a picture of a mother-child relationship doesn't have effect on the way of thinking and the behavior of the participant. I have also compared the time the participants need to make a decision in both cases. The time they need is in both cases about equal (no significant difference).

The presence of a photograph in the case makes it easier for the participants to make a decision (they make their decision in less time), but the decision the participants make is not significantly different. So a photograph will make it easier for the participant to have a good image of the situation they are dealing with but it doesn't effect the decision they make.

6. Conclusion

The goal of my thesis was to learn more about how context influences the prisoner's dilemma game and which factors have an effect on the decision making process. Now, at the end of my thesis, I am able to give a good answer to the research question I have set in the introduction. Context has an effect on the decision in the prisoner's dilemma game. In the theoretical research I have found that there are a lot of processes influencing the behavior of people playing the prisoner's dilemma game. Factors that have an effect are: biological elements, personality of the players, emotions, social elements, images of the counterpart, connection with the other person and trust in the other person. There are probably even more processes playing a role.

In my experiment I examined if two totally different types of context has effect on the decisions made in the prisoner's dilemma game. I have found similar results as previous researchers have found: context has significantly effect on the behavior in the prisoner's dilemma. Participants in the case mother significantly more cooperated than the participants in the case criminal. When the connection with the counterpart in the prisoner's dilemma is warmer/stronger, the participant is more likely to cooperate than when the connection is loose/cold. This result is also in line with findings in the theory. If people have a connection and have trust in the other person, they care more about the consequences for the other person. In my experiment I also examined if there is a difference in the time participants need to make a decision when they are faced with an image of the situation they are dealing with. The participants need less time to make a decision when they are faced with an image. In the theoretical part I described papers of Eckel and Wilson. I didn't find significant differences in the behavior of the persons who are faced with an image but adding an image did make the participants need less time to make a decision. In the literature we have also seen that people try to simulate in their mind to what situation they are dealing with. Apparently by adding a photograph people understand right away the situation they are in and therefore are able to make the decision in less time.

Based on the theoretical part and my experiment I can conclude that context matters!

7. Feedback and recommendations for further research

In my thesis I examined if context has effect on the behavior in the prisoner's dilemma game. I have found that context matters. People that have a strong connection are more willing to cooperate than persons that have a loose connection. There are also a lot of other factors underlying the decision making process like biological elements, personality, emotions, social elements, images of the counterpart and trust. I am satisfied I am able to answer the research question and I am happy with the result of my thesis.

Although I have reached my goals, there are still some things I am curious about. It would be very interesting to extend this research by observing more closely behavior while the participants are confronted with the case; for example by testing on hormonal levels. Are there differences in the hormonal levels in the different cases? Paul J. Zack for example found that people who are cooperating produce higher level of dopamine. Will people who are confronted with the case mother have higher level of dopamine than the people in the case criminal? And will people who are confronted with the case criminal have higher level of the stress hormone cortisol? By besting on hormonal levels we will learn more about the processes in the body when you have to make decisions with someone you feel very involved with or with someone you don't have any connection with.

I am convinced that in the upcoming years there will be done more and intensive research to all processes that are going on in the body. Neuroeconomics is a quite young but very interesting and promising field in the economics and I am sure that in the upcoming years and decennia we will learn a lot more from ourselves and processes that are going on in the body. With these finding we will be able to better understand ourselves and are able to better explain behavior in economic and social situations.

8. References

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9. Appendix

9.1 Prisoner's dilemma – case mother

Situation:

You've committed a crime together with your mother. You are both caught by the police and are now in jail. The police don't have enough evidence about the crime and therefore they do not know exactly what have happened and who had which part in committing the crime. Therefore the officer decides to ask you and your mother separately if you have committed the crime. You and your mother both have two options: **confess** that you committed the crime or **remain silent**. You have to make the decision in another room and you do not know what the decision of your mother will be. Your mother also doesn't know your decision.

In the matrix table you can find the punishments offered by the police given the outcome of the answer of your mother/good friend/someone else:

	Your mother remain silent	Your mother confess
You remain silent	1. Both will get 1 month prison	2. – Your mother will go free - You will be in prison for 1 year
You confess	3. - You will go free - Your mother will be in prison for 1 year	4. Both will get 3 months prison

Situation 1: The police don't know what your role and your mother's role in the crime is but they do know that a crime has been committed and therefore both persons will get a low punishment.

Situation 2: You deny and will be fully punished; your mother will go free.

Situation 3: You will tell the police everything and will go free; your mother will be punished.

Situation 4: You will both tell the police everything and will both be punished.

What will you do given the punishments in the matrix? Will you **confess** or will you **remain silent** given the punishments in the matrix?

9.2 Prisoner's dilemma – case criminal

Situation:

You've committed a crime together with a criminal you don't know very well. You are both caught by the police and are now in jail. The police don't have enough evidence about the crime and therefore they do not know exactly what have happened and who had which part in committing the crime. Therefore the officer decides to ask you and the criminal separately if you have committed the crime. You both have two options: **confess** that you committed the crime or **remain silent**. You have to make the decision in another room and you do not know what the decision of the criminal will be. He will also not know your decision.

In the table below you can find the punishments offered by the police given the outcome of the answer of your mother and your criminal friend:

	The criminal remains silent	The criminal confesses
You remain silent	1. Both will get 1 month prison	2. – The criminal will go free - You will be in prison for 1 year
You confess	3. - You will go free - The criminal will be in prison for 1 year	4. Both will get 3 months prison

Situation 1: The police don't know what your role and the role of the criminal in the crime is but they do know that a crime has been committed and therefore both persons will get a low punishment.

Situation 2: You deny and will be fully punished; the criminal will go free.

Situation 3: You will tell the police everything and will go free; the criminal will be fully punished.

Situation 4: You will both tell the police everything and will both be punished.

What will you do given the punishments in the matrix? Will you **confess** or will you **remain silent** given the punishments in the matrix?

9.3 Prisoner's dilemma – case mother (Dutch)

Situatie:

Samen met je moeder heb je een misdaad gepleegd. Jullie zijn beide opgepakt door de politie en zitten nu vast in de gevangenis. De politie heeft niet genoeg bewijs van de misdaad om jullie er beide volledig voor te veroordelen en besluit daarom jou en je moeder in een aparte ruimte te vragen of jullie een aandeel hebben in de misdaad. Jij en je moeder hebben allebei twee opties: **toegeven** dat je de misdaad heb gepleegd of **zwijgen**. Je moet de keuze maken in een andere kamer dan je moeder en je weet niet wat de beslissing van je moeder is. Je moeder weet ook niet wat jouw beslissing is.

In onderstaande tabel staan de gevangenisstraffen die de politie oplegt gegeven de antwoorden die jij en je moeder geven:

	Je moeder zwijgt	Je moeder geeft toe
Jij zwijgt	1. Jullie krijgen allebei 1 maand gevangenisstraf	2. – Je moeder gaat vrijuit - Jij krijgt 1 jaar gevangenisstraf
Jij geeft toe	3. – Jij gaat vrijuit - Je moeder krijgt 1 jaar gevangenisstraf	4. Jullie krijgen allebei 3 maanden gevangenisstraf

Situatie 1: De politie weet niet precies wat jouw rol en de rol van je moeder in de misdaad is, maar ze weten wel dat de misdaad is gepleegd en daarom krijgen jij en je moeder allebei een lage straf.

Situatie 2: Jij ontkent en krijgt de volledige straf; je moeder gaat vrijuit.

Situatie 3: Jij vertelt de politie alles en gaat vrijuit; je moeder krijgt de volledige straf.

Situatie 4: Jij en je moeder vertellen de politie alles en worden allebei gestraft voor de misdaad.

Wat doe je gegeven de strafmaten in de matrix? **Geef je toe** de misdaad te hebben gepleegd of **zwijg je**?

9.4 Prisoner's dilemma – case criminal (Dutch)

Situatie:

Samen met een crimineel die je slecht kent heb je een misdaad gepleegd. Jullie zijn beide opgepakt door de politie en zitten nu vast in de gevangenis. De politie heeft niet genoeg bewijs van de misdaad om jullie er beide volledig voor te veroordelen en besluit daarom jou en de crimineel in een aparte ruimte te vragen of jullie een aandeel hebben in de misdaad. Jullie hebben allebei twee opties: **toegeven** dat je de misdaad heb gepleegd of **zwijgen**. Je moet de keuze maken in een andere kamer dan de crimineel en je weet niet wat de beslissing van hem is. Hij weet ook niet wat jouw beslissing is.

In onderstaande tabel staan de gevangenisstraffen die de politie oplegt gegeven de antwoorden die jij en je moeder geven:

	De crimineel zwijgt	De crimineel geeft toe
Jij zwijgt	1. Jullie krijgen allebei 1 maand gevangenisstraf	2. – De crimineel gaat vrijuit - Jij krijgt 1 jaar gevangenisstraf
Jij geeft toe	3. – Jij gaat vrijuit - De crimineel krijgt 1 jaar gevangenisstraf	4. Jullie krijgen allebei 3 maanden gevangenisstraf

Situatie 1: De politie weet niet precies wat jouw rol en de rol van de crimineel in de misdaad is, maar ze weten wel dat de misdaad is gepleegd en daarom krijgen jullie allebei een lage straf.

Situatie 2: Jij ontkent en krijgt de volledige straf; de crimineel gaat vrijuit.

Situatie 3: Jij vertelt de politie alles en gaat vrijuit; de crimineel krijgt de volledige straf.

Situatie 4: Jullie vertellen de politie alles en worden allebei gestraft voor de misdaad.

Wat doe je gegeven de strafmaten in de matrix? **Geef je toe** de misdaad te hebben gepleegd of **zwijg je**?

9.5 Photograph - case mother

The photograph of the mother-child relationship I have shown the participants in stage two of my experiment:



9.6 Photograph – case criminal

The photograph of the criminal I have shown the participants in stage two of my experiment:

