



**RSGC**  
Royal St. George's College

# The Young Researcher

2021 Volume 5 | Issue 1

## Decision-Making and Rationality: Adults and Teenagers in the Prisoner's Dilemma

Kiana Kazemi

### Recommended Citation

Kazemi, K. (2021). Decision-making and rationality: Adults and teenagers in the prisoner's dilemma. *The Young Researcher*, 5 (1), 4-37. <http://www.theyoungresearcher.com/papers/kazemi.pdf>

ISSN: 2560-9815 (Print) 2560-9823 (Online) Journal homepage: <http://www.theyoungresearcher.com>

All articles appearing in *The Young Researcher* are licensed under CC BY-NC-ND 2.5 Canada License.

# Decision-Making and Rationality: Adults and Teenagers in the Prisoner's Dilemma

Kiana Kazemi

Human decision-making is largely analyzed by the field of behavioral game theory; however, little research has been done to compare adults' and teenagers' decision-making in game theory scenarios. A comparison of the two age groups could help future researchers better understand changes in decision-making with age. To do so, 146 participants (101 adults, 45 teenagers) from X County were surveyed on what their decision would be in the Prisoner's Dilemma and how much certain decision-making factors influenced their decision. Results showed that there is no significant relationship between age group and rational decision making. Additionally, it was found that "fairness" guided adult decision-making the most while "trust" guided teenage decision-making the most. Such results point towards little to no difference between adults' and teenagers' rationality, but it is clear that the two age groups are guided by different decision-making factors within the Prisoner's Dilemma.

*Keywords:* prisoner's dilemma, behavioral game theory, adult decision-making, teenage decision-making, rationality, decision-making factors

## I. Literature Review and Introduction

### Introduction

Game theory, the study of the behavior of decision-makers and the outcomes of those decisions (Aumann, 2008), has proven to be extremely useful in fields such as economy, warfare, and psychology. Certain branches of game theory often dive into different aspects of the games that are often played by two players. In recent decades, behavioral game theory, which describes actual human behavior by using empirical observation (Camerer, 1997), has become of interest for researchers who hope to use it as a key point of synthesis between game theory and cognitive science (Camerer, 2003). This paper aims to help further implement behavioral game theory in order to understand the differences in

rationality and decision making between adults (ages 18 and above) and teenagers (ages 13 to 17).

### The Basics of Game Theory

#### A Further Understanding of Behavioral Game Theory

When discussing behavioral game theory, there is an emphasis on describing the actual behavior of players through empirical observation (Camerer, 1997). Overarching game theory commonly uses mathematical principles with highly rational players, however, behavioral game theory focuses on how human beings, who are not often rational, behave in different strategic situations (Gächter, 2004). Research on this branch of game theory continues to help narrow down the limits of the rationality of human beings (Camerer & Ho, 2015).

## Game Theory Games

Within behavioral game theory, the Prisoner's Dilemma, Traveler's Dilemma, and the Dictator Game (see Appendix A for each) best represent some of the concepts that will be discussed in this study and that are key to behavioral game theory. The Prisoner's Dilemma, used in this study, where two players are offered two options (each with incentives), highlights issues of self-interest and rationality. Pairs who act on rational self-interest could end up worse off than a group who acts contrary to rational self-interest (Kuhn, 2019). This game highlights key principles rooted in behavior that are carefully studied as players attempt to use logic, strategy, and self-interest to make decisions.

## Decision Making Within Game Theory

The use of game theory with regard to decision making has become more appealing to researchers in recent years and can advance "the predictive accuracy of [behavioral] theoretical models" and knowledge on social decision making (Sanfey, 2007). To help better understand decision making, researchers have looked at the influential factors that lead a player to choose a certain option. Altruism, fairness, and even knowing the trustworthiness and social background of the opposing player can have a large impact on the rationality of participants (Van't Wout & Sanfey, 2008). This increased understanding of factors and changes in decision-making during game theory games can help with future advancements in the study of human behavior and strategic thinking.

## The Decision-Making Process

### Teenage and Adolescent Decision Making

Studies show that by the age of 15, children more carefully consider a course of action and the benefits and risks of the options that are provided to them (Mann et al., 1989). An adolescent's decisions are often influenced by the desire for sensation, their feelings on responsibility, their temperaments, and independence (Steinberg & Cauffman, 1996). Considering these factors and a teenager's competence when it

comes to decision making can further help in understanding their behavior and decision-making process in game theory.

### Adult Decision-Making

While adults can experience a cognitive decline in decision-making (Dietrich, 2010), aging grants the ability to use experience and wisdom that a younger person may not have yet acquired. Additionally, adults tend to use an organized form of thinking called model-based decision making, where they can weigh risks and benefits and better consider the factors in play in a decision (Worthy et al., 2011). These factors often include the impact the decision can have on the future and basic moral reasoning (Steinberg & Cauffman, 1996). With these ideas in mind, decision-making tendencies in adults during a game theory game can be more justified and studied.

### A Comparative Perspective

The differences in the decision-making of adults and adolescents should be noted. Adults tend to seek out advice and consider decisions for longer than adolescents (Halpern-Felsher & Cauffman, 2001), and when a decision capitalizes on emotions or experience, older adults tend to better assess a situation and make a proper choice (Bruine de Bruin et al., 2014). Additionally, adults regularly use less effortful strategies and tend to want to satisfy the decision rather than maximize it (Bruine de Bruin, 2016). This difference in approach to decisions between adults and teenagers should be largely highlighted in the context of behavioral game theory.

## Behavior and Decision Making in Game Theory Games

### Adolescents

The willingness of children to cooperate with an opposing player during a game and to be moral in their decision making is often guided by trust and theory of mind (Gummerum et al., 2008), which is the ability to understand someone else's motives and use empa-

thy (Dictionary, 2020). They evaluate theory of mind so they can win in a fair manner (Fan, 2000). Using trust and theory of mind is an indication that a person guides the decision-making process by emotions over rationality. One study shows that in younger children, emotions (such as guilt) and morality guide the way they allocate resources in the Dictator Game (Gummerum et al., 2010). This brings into question how rationally children approach decisions and what weight their emotions and views on morality truly have on their decision-making process.

### Adults

While there has been significant research done on adolescent behavior in game theory, the same cannot be said about older adults. Previous research with adults shows that those who are cooperative can predict the opposing player's decisions, and after communication, players are less likely to exploit their partner for their own benefit (Brosig, 2002). Furthermore, studies show that adults work for compromise instead in game theory scenarios (Camerer, 2011). Keeping track of the discussed cooperative, competitive, and fair behaviors during this study will help further clarify the motives and factors that adults consider in their decision-making during game theory games.

### Assumptions

As in much previous research, the Prisoner's Dilemma will be utilized for the study of the behavior and decision-making of adolescents and adults (Fan, 2000; Boone et al., 1999; Brosig, 2002; Camerer, 2011). This leads to the assumption that there are clear factors that influence the behavior and decision-making of both adolescents and adults while they are playing against an opponent in a game. These factors include age (Halpern-Felsher & Cauffman, 2001; Bruine de Bruin et al., 2014; Camerer, 2011), theory of mind (Gummerum et al., 2008; Fan, 2000), perception of fairness (Van't Wout & Sanfey, 2008; Fan, 2000), and trust (Van't Wout & Sanfey, 2008). These factors and others will be further studied in this paper.

## Justifications

### Justification for a Comparative Study on Decision-Making Processes

While there has been research conducted individually on adults (Boone et al., 1999; Camerer, 2011) and younger adolescents (Fan, 2000; Gummerum et al., 2008), a study that effectively contrasts adults and teenagers by looking into the differences in their decision-making process, decisions, and what influenced those decisions can help further understanding in behavioral game theory in humans and can be applied to the real world (Sanfey, 2007).

### Justification for a Comparative Study on Accuracy

This study will also focus on the difference in accuracy (see Appendix A) between adults and teenagers. By comparing the average accuracy of the two age groups, there can be inferences drawn about the development of strategic thinking in different age groups and whether or not there is a certain point in age where players become more or less apt to choose the best option for themselves.

## Research Question

These ideas from previous research and justifications for new research leads to this study's question: How do X County adults and teenagers compare when it comes to the accuracy of solving the Prisoner's Dilemma and the significance of certain psychological factors in decision-making during the Prisoner's Dilemma?

## II. Methodology

The researcher determined three main goals for this study and one sub-goal. The three main goals were: 1) to investigate the difference between adults' and teens' accuracy (and thus, rationality); 2) the difference between their most and least significant factors during decision-making; and 3) the difference between each

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

age group's individual factor significance ratings in the Prisoner's Dilemma. The impact of previous exposure to the game on participant accuracy was also of interest.

Three methods were initially considered for data collection. The first method was using focus groups. Chinn Fan used a large group of young children to study their behavior in the Prisoner's Dilemma game back in 2000 by breaking up the participants into focus groups (Fan, 2000). In addition, Colin Camerer has used focus groups with adults to pay attention to behavior during gameplay and to get immediate responses and feedback from participants (Camerer, 2011). However, this method was not chosen due to two reasons. The first was the risk of COVID-19 transmission and restrictions. The second was the potential lack of interest from the large population that was being studied. It was recognized that there was no need to be in direct contact with participants unlike other studies have done in the past (Fan, 2000; Camerer 2011).

Another method that was considered was interviews over a video conferencing platform which has not been done in previous studies. However, this was rejected due to it not being feasible for participants due to it potentially being tiresome and not intriguing to a large population.

Instead, the researcher proceeded with an embedded research design, featuring a focus on quantitative responses, by conducting a survey. Surveys have not been commonly used within the field, meaning it was not the ideal data collection method. However, a survey would allow the researcher to properly gain responses on quantitative questions. In order to ensure that there would be quality maintained in a few qualitative responses, participants were asked if they would be willing to participate in interviews if asked.

This combination of research design and data collection method allowed the researcher to be able to have a large number of participants from the target population play the game. In addition, it would help collect proper data to address the research question altogether without risking COVID-19 transmission.

### Study Procedure

Following full approval by the X High School IRB, the researcher drafted the following step-by-step pro-

cedure for the study. The aforementioned data in this study was collected through a survey on the platform, Google Forms (see Appendix B). This method was both efficient, participant-friendly, and low-risk. Initially, the survey (which had a universal link) was distributed through text messages, emails, and acquaintances. A large number of people were asked to take the survey and were offered a chance at a \$25 Amazon gift card as compensation. All survey responses were anonymous and were kept in a private Google Drive folder that only the researcher and project director had access to.

Participants who were asked to consent to completing the survey. If the participant was below the age of 18, they were asked to complete an informed consent section where they could receive approval from a guardian in order to participate in the study in order to comply with IRB guidelines.

Participants were then asked their age (in years) to help divide participants into the proper age groups for further data analysis. The lower bound for ages was 13 years old and there was no defined upper bound for ages, only 65+ years old.

Participants then read a rendition of the Prisoner's Dilemma (see Appendix B). Participants were not told that they were playing a game theory game or the name of the game in order to keep them from looking up the "correct" answer (though they were later debriefed on this). After participants read the scenario, they were asked to state how they would proceed in the game, meaning, whether they would "confess" or "remain silent."

Then they were asked questions on their decision-making process. Analysis of these questions is not featured in this study, however the questions can be viewed in Appendix B.

Following the decision-making process section of the survey, participants completed a section on influential factors. In this section, participants were asked how significant a factor was in their decision on a scale of 1 to 4 (1= Not a factor at all; 2= A minor factor; 3= A major factor; 4= Significant factor), and then were asked to elaborate on their rating. These factors included: "Maintaining a fair game," "Wellbeing of the other player," "Your own wellbeing," "Trust in the other player," "Being better off than the other player," and "Difference between the jail time of each outcome." At the end, they were asked which factor was most sig-

# ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

nificant in their final decision and which was the least significant in their final decision.

At the end of the survey, participants were asked for an email address if they wished to participate in a follow-up interview. Follow up interviews did not take place because the researcher determined that there was a better focus on quantitative responses rather than qualitative responses.

Participants were debriefed in order to comply with IRB guidelines to end the survey. They were then told that this study was also to help determine participant accuracy in the Prisoner's Dilemma, information that was previously withheld from the participants. Finally, participants were offered the link to the survey to share the survey with others in order for the study to gain more responses.

This procedure began January 11th, 2021, and ended February 19th, 2021, giving approximately 4 weeks for data collection to take place.

## Study Population

Participants in this study included teenagers and adults in X County. Of the 306 survey responses, 146 were complete and usable. The sample included 45 teenagers and 101 adults. This sample was used in the study because the age groups were in the target population, and the location allowed for a greater reach for participants.

Participants were recruited through multiple meth-

ods. This included direct text messages, emails to school districts, posts on social media platforms, and outreach through clubs and organizations.

## Results

The research question was broken down into the following sub-questions prior to the period of data collection:

**Age Groups:** Is there a difference between the accuracy (and thus, rationality) of the two age groups?

**Previous Exposure:** How did the accuracy of participants who have had exposure to the Prisoner's Dilemma compare to that of those who did not?

**Significant Factors:** Which factor(s) was most and least significant in the decision-making process of the participants, and how does that compare between the two age groups? And, how do the different factors rank in significance among each other and between each age group?

## III. Findings

### Demographic Information

Table 1 indicates the overall demographics of all 146 survey respondents. Teenagers were 13 to 17 years old while adults were 18 years old and older.

Age Group	Confessed	Remained Silent	Exposed	Non-Exposed
Teenagers	18	27	21	24
Adults	33	68	38	62

Note. n = 146. n(adults) = 101. n(teenagers) = 45. One adult respondent did not indicate whether they were exposed or not.

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Table 2			
Expected Frequencies for All Adults vs. Teenagers			
Decision	Age group		
	Teenagers	Adults	Total
Chose to remain silent	29.28	65.72	95
Chose to confess	15.72	35.28	51
Total	45	101	146

Note.  $n(\text{adults}) = 101$ .  $n(\text{teenagers}) = 45$ . Expected frequencies were calculated by the following formula:  $((\# \text{ in age group}) * (\# \text{ of all who chose the decision})) / (\text{total sample size of } 146)$ . Ex. for Teens who Remained Silent:  $((45) * (95)) / (146) = 29.28$ .

### Accuracy

To understand whether accuracy had any relation to age group, a chi-square test for independence was run. The null hypothesis was that there is no significant difference in accuracy between teenagers and adults. The alternative hypothesis was that there was a significant difference in accuracy between teenagers and adults. This was run at an alpha level of .05.

$f_e$  represents the expected frequencies of the data, which were calculated and are shown in Table 2, and  $f_o$  represents the observed frequencies of the data, which were obtained from Table 1.

After running the test, it was found that there was no significant difference in accuracy between the two age groups due to a p-value of .39137 (see Table 3).

Another chi-square test, excluding those who have been exposed to the Prisoner's Dilemma before, was deemed not significant. The observed frequencies were once again obtained from Table 1, and Table 4 shows the expected frequencies for the non-exposed participant data. However, the statistics show that the p-value of .07893 and alpha level of .05 were very close (See Table 5).

ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Table 3  
Chi-Squared Test for Independence for All Adults vs. Teenagers

Group	$f_e - f_o$	$(f_e - f_o)^2$	$\frac{[(f_e - f_o)^2]}{f_e}$	Result
Teenagers, Silent	(29.28-27)	(29.28-27) <sup>2</sup>	$\frac{[(29.28-27)^2]}{29.28}$	0.1775
Teenagers, Confessed	(15.72-18)	(15.72-18) <sup>2</sup>	$\frac{[(15.72-18)^2]}{15.72}$	0.330
Adults, Silent	(65.72-68)	(65.72-68) <sup>2</sup>	$\frac{[(65.72-68)^2]}{65.72}$	0.079
Adults, Confessed	(35.28-33)	(35.28-33) <sup>2</sup>	$\frac{[(35.28-33)^2]}{35.28}$	0.1473
p-value .39137	Chi-square statistic .73467			
Note. $X^2(1, N = 146) = .73467, p = .39137$ . Alpha level: .05.				

Table 4  
Expected Frequencies for Non-Exposed Adults vs. Teenagers

Decision	Age group		
	Teenagers	Adults	Total
Chose to remain silent	18.14	46.86	65
Chose to confess	5.86	15.14	21
Total	24	62	86

Note. n(adults) = 62. n(teenagers) = 24. Expected frequencies were calculated by the following formula: ((# in non-exposed in age group)\*(# of non-exposed who chose the decision)) / (total non-exposed sample size of 86). Ex. for Non-Exposed Teens who Remained Silent: ((24)\*(65))/(86) = 18.14.



ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Table 5

Chi-Squared Test for Independence for Non-Exposed Adults vs. Teenagers

Group	$f_e - f_o$	$(f_e - f_o)^2$	$\frac{[(f_e - f_o)^2]}{f_e}$	Result
Teenagers, Silent	(18.14-15)	(18.14-15) <sup>2</sup>	$\frac{[(18.14-15)^2]}{18.14}$	0.5435
Teenagers, Confessed	(5.86-9)	(5.86-9) <sup>2</sup>	$\frac{[(5.86-9)^2]}{5.86}$	1.6825
Adults, Silent	(46.86-50)	(46.86-50) <sup>2</sup>	$\frac{[(46.86-50)^2]}{46.86}$	0.2104
Adults, Confessed	(15.14-12)	(15.14-12) <sup>2</sup>	$\frac{[(15.14-12)^2]}{15.14}$	0.6512
p-value .07893	Chi-square statistic 3.0876			

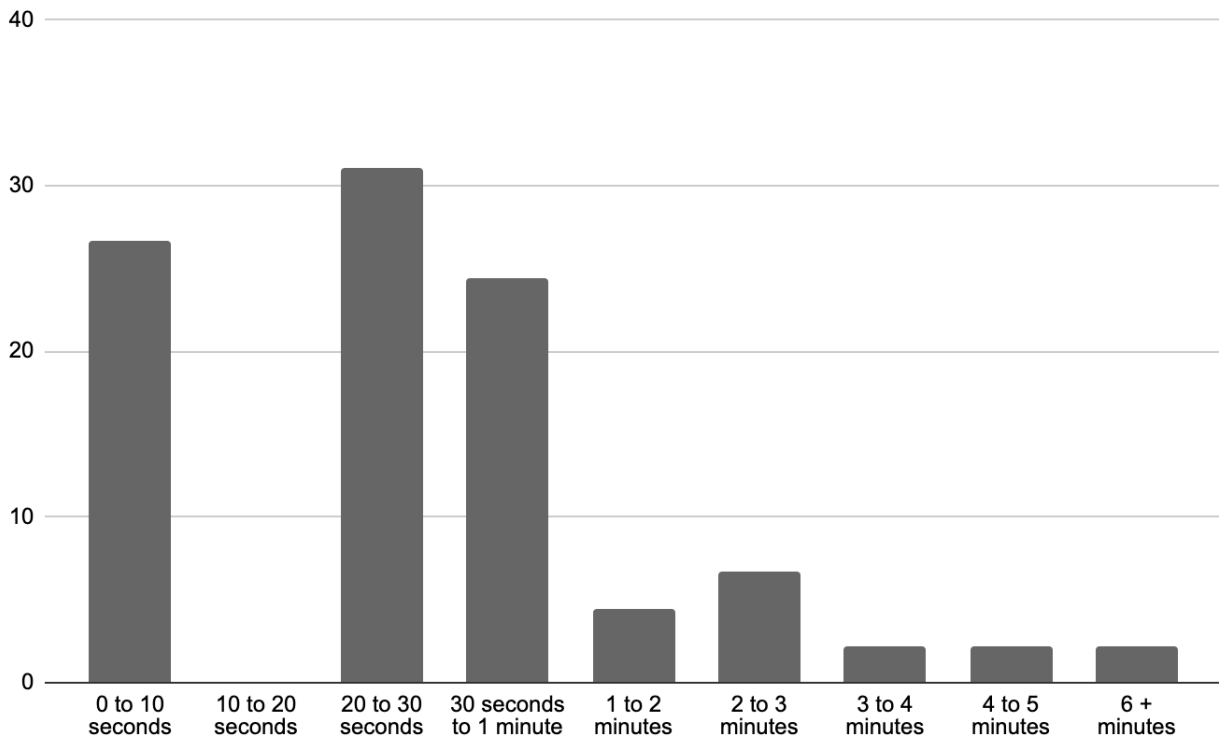
Note.  $X^2 (1, N = 86) = 3.0876, p = .07893$ . Alpha level: .05.

**Time to Make a Decision**

Participants were also asked how long they spent making their decision. Figures 1 and 2 show the distribution of relative frequencies of time taken for teenagers and adults to make their decision. The majority of teenagers, 82.2%, took between 1 second to 1 minute to make their choice (Figure 1), and there is a stronger relative frequency of adults, 13.9%, who took 2 to 3 minutes, than teenagers (Figure 2).

Figure 1

*Relative Frequencies for Amount of Time Taken to Make Decision for Teenagers*

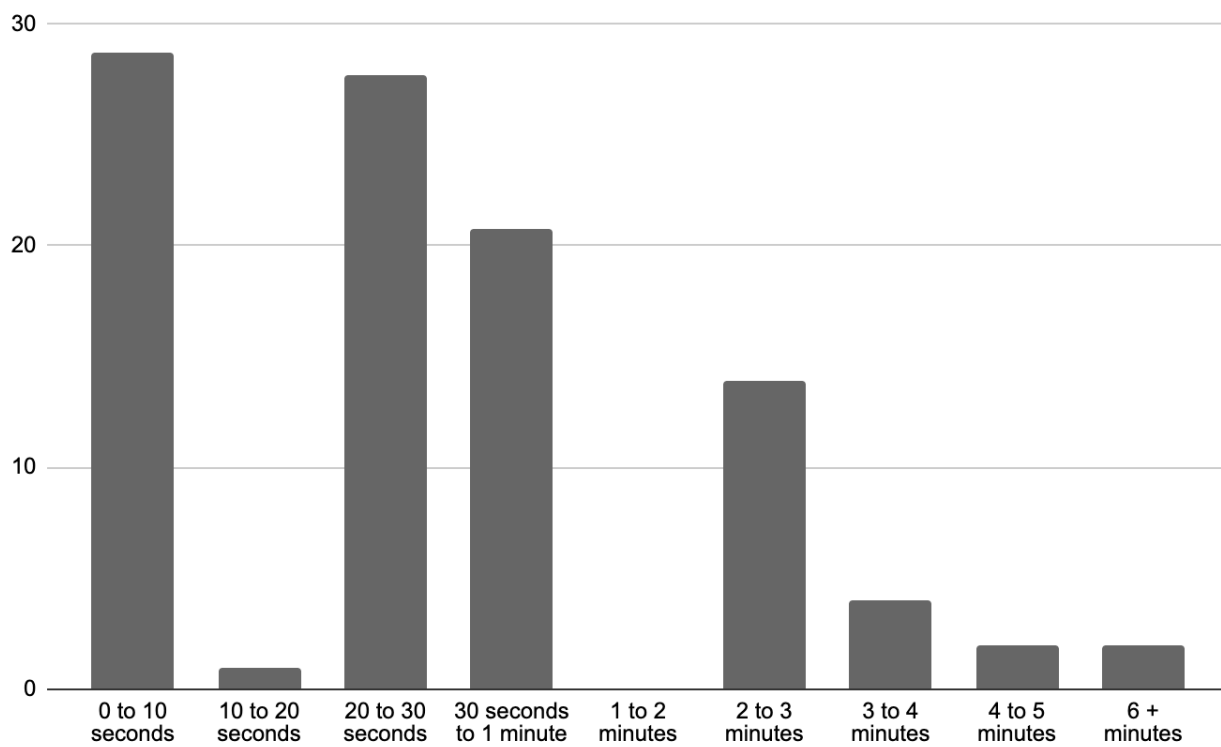


*Note.* n = 45.

# ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Figure 2

*Relative Frequencies for Amount of Time Taken to Make Decision for Adults*



*Note.* n = 101.

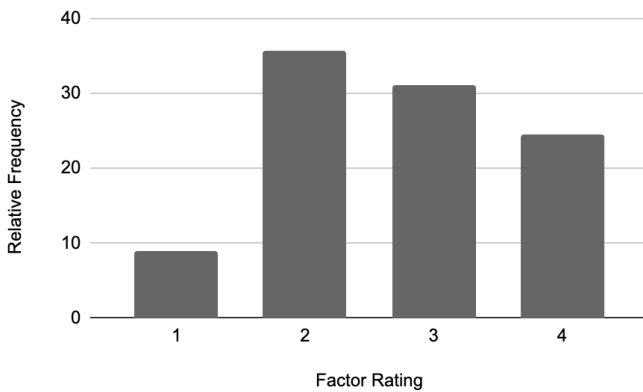
## Significant Factors

Participants were asked to rate, on a Likert scale (1= Not a factor at all, 4 = Significant factor), how much a specific factor impacted their decision. Factors included “Maintaining a fair game,” “Wellbeing of the other player,” “Your own wellbeing,” “Trust in the other player,” “Being better off than the other player,” and “Difference between the jail time of each outcome.”

In terms of fairness, the average rating was 2.71 for teenage respondents, indicating fairness was a somewhat significant factor in their decision-making (see Figure 3). For adult respondents, the average rating was a 2.89 (see Figure 4). However, unlike the teenage respondents, there is greater skew towards higher significance ratings among adults (see Figures 3 and 4).

Figure 3

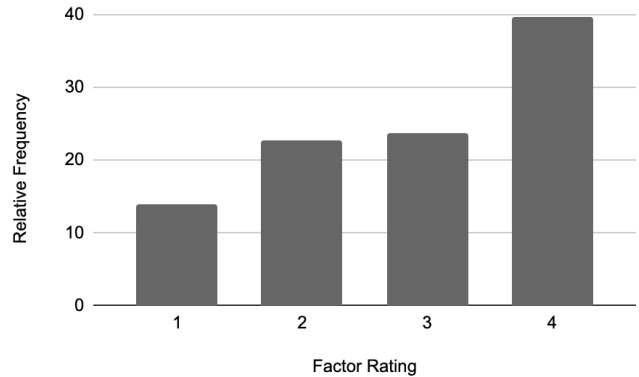
*Significance of Fairness: Relative Frequencies vs. Factor Rating of Teenagers*



Note. n = 45. Average of 2.71.

Figure 4

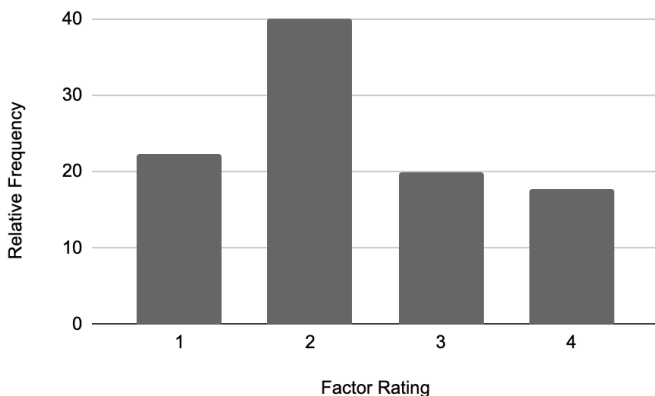
*Significance of Fairness: Relative Frequencies vs. Factor Rating of Adults*



Note. n = 101. Average of 2.89.

Figure 5

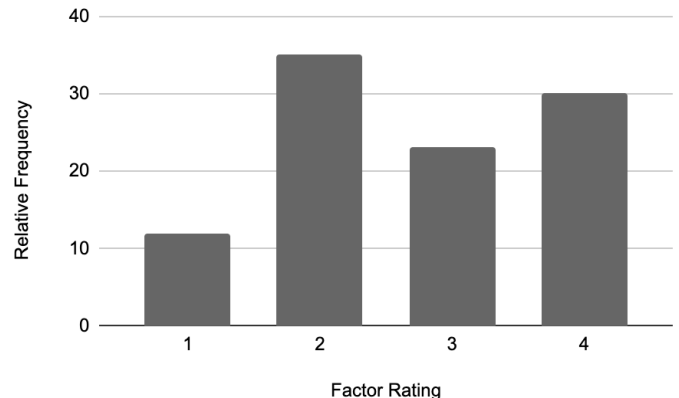
*Significance of Other Player's Wellbeing: Relative Frequencies vs. Factor Rating of Teenagers*



Note. n = 45. Average of 2.33.

Figure 6

*Significance of Other Player's Wellbeing: Relative Frequencies vs. Factor Rating of Adults*



Note. n = 100. Average of 2.71.

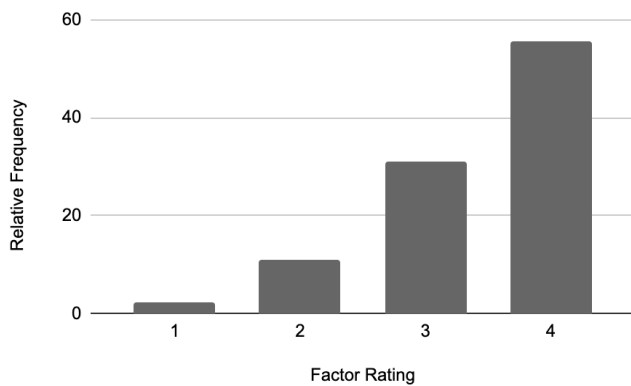
## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Figure 5 indicates the relative frequencies of significance ratings of other player's wellbeing for teenagers, and Figure 6 shows the same for adults. Teenagers more often rated other player's wellbeing as being less impactful (2.33). Adults rated this factor higher (2.71).

Figure 7 shows the relative frequencies of significance ratings of self-wellbeing of teenagers and Figure 8 shows the same for adults. Teenage respondents had a very similar average rating as adults, 3.4 and 3.28 respectively. Frequencies of 4's and 5's combined for each age group are also very similar.

Figure 7

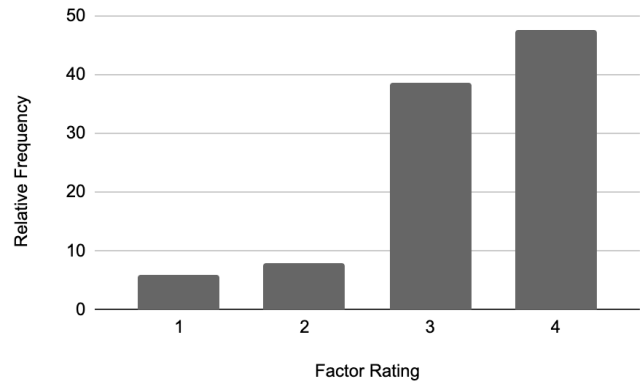
*Significance of Self Wellbeing: Relative Frequencies vs. Factor Rating of Teenagers*



*Note.* n = 45. Average of 3.4.

Figure 8

*Significance of Self Wellbeing: Relative Frequencies vs. Factor Rating of Adults*



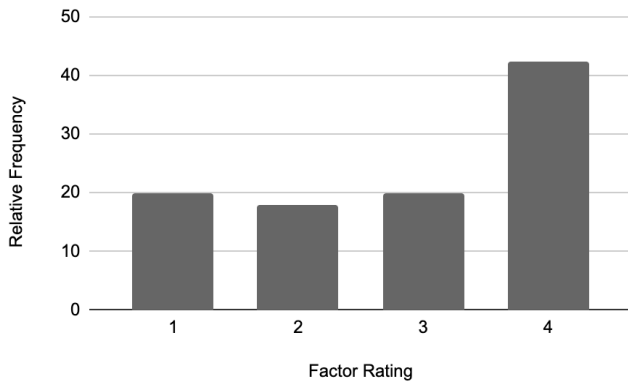
*Note.* n = 101. Average of 3.28.

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Figure 9 shows the relative frequencies of significance ratings of trust of teenagers, and Figure 10 shows the same for adults. Most respondents from both the adult (2.81) and teenager (2.84) groups reported trust in the other player as the most significant factor (see Figures 9 and 10).

Figure 9

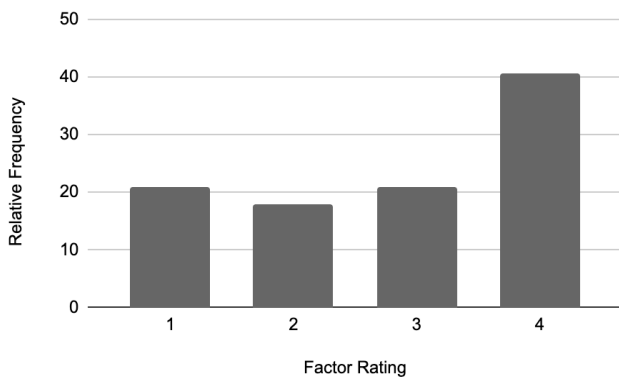
*Significance of Trust: Relative Frequencies vs. Factor Rating of Teenagers*



Note. n = 45. Average of 2.84.

Figure 10

*Significance of Trust: Relative Frequencies vs. Factor Rating of Adults*

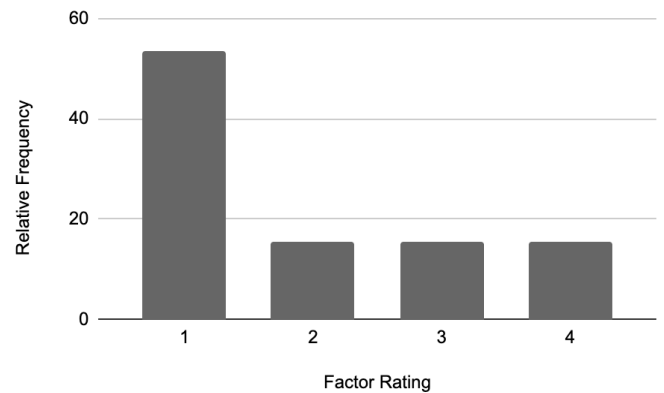


Note. n = 101. Average of 2.81.

Figure 11 shows the relative frequencies of significance ratings of the desire to be better off from teenagers, and Figure 12 shows the same for adults. While a majority on both sides chose the option that being better off was not a factor at all in their decision making (adult = 1.77, teenagers = 1.93), it is interesting to note that Significance Ratings of 2's-4's of teenagers were much more evenly distributed than the skew that can be seen in the Significance Ratings of 2's-4's of the adult sample.

Figure 11

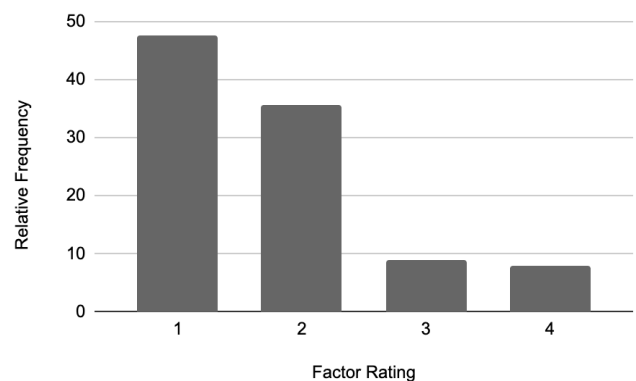
*Significance of Being Better Off: Relative Frequencies vs. Factor Rating of Teenagers*



Note. n = 45. Average of 1.93.

Figure 12

*Significance of Being Better Off: Relative Frequencies vs. Factor Rating of Adults*



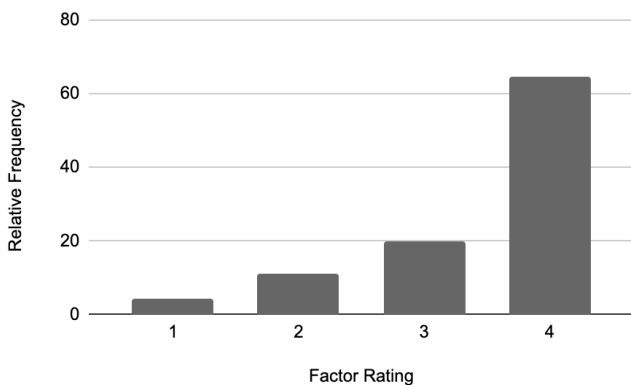
Note. n = 101. Average of 1.77.

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Figure 13 shows the relative frequencies of significance ratings of the difference in jail time of teenagers, and Figure 14 shows the same for adults. This factor had by far the greatest differences in averages, with teenagers having an average of 3.44, and adults having much lower average of 2.91. This can be seen in the graphs as well: teenagers had a much further skewed graph towards a high rating of 4, while adults had a more even distribution. It's clear a majority of both age groups considered difference in jail time a significant or most significant factor, but teenagers felt more strongly about the factor.

Figure 13

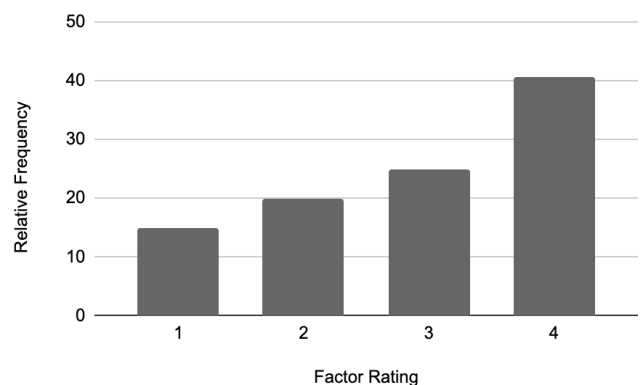
*Significance of Difference in Jail Time: Relative Frequencies vs. Factor Rating of Teenagers*



*Note.* n = 45. Average of 3.44.

Figure 14

*Significance of Difference in Jail Time: Relative Frequencies vs. Factor Rating of Adults*



*Note.* n = 101. Average of 2.91.

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Figure 15 shows the relative frequencies of the most significant factors of teens in blue and adults in red. It's clear from the graph that "Trust in the other player" and "Difference between the jail time of each outcome" were the most significant to teenagers (28.9%) compared to adults (18.8% and 23.8%, respectively). On the other hand, "Maintaining a fair game" was much more significant for adults (29.7%) than for teenagers (13.3%).

A chi-square test for independence was also run for the most significant factors for adults and teenagers (excluding write-in responses). The null hypothesis was that there is no significant difference in the most significant factor between teenagers and adults. The alternative hypothesis was that there was a significant difference in the most significant factor between teen-

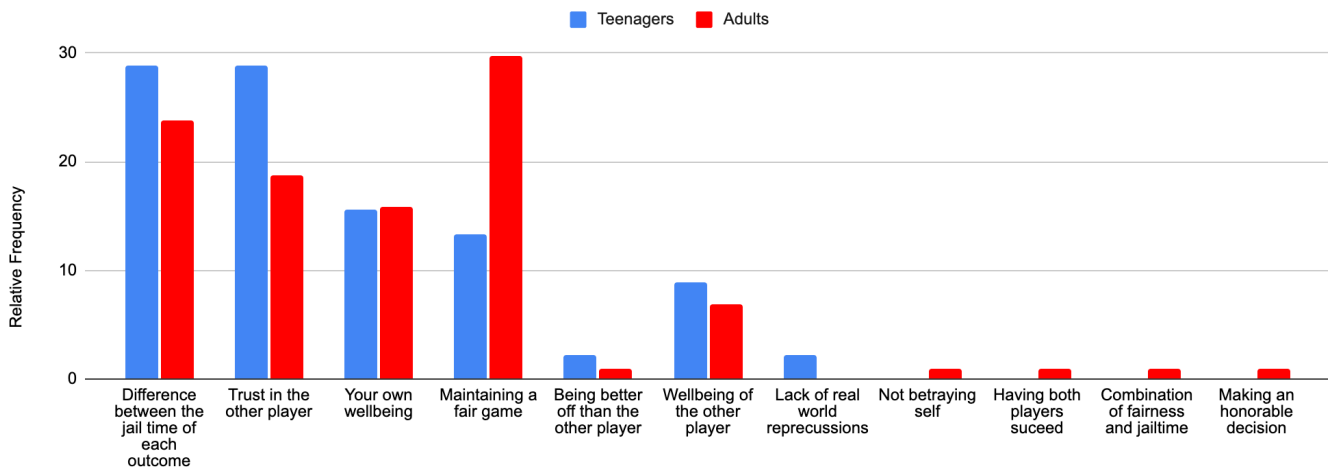
agers and adults. This was run at an alpha level of .05.

$f_e$  represents the expected frequencies of the data, which were calculated and are shown Table 7, and  $f_o$  represents the observed frequencies of the data, which are shown in Table 6.

After running the test, it was found that there was no significant difference in the most significant factor between the two age groups due to a p-value of .299706 (see Table 8). This is slightly contrary to what was found in Figure 15.

**Figure 15**

*Most Significant Factor: Relative Frequencies vs. Most Significant Factor of Adults and Teenagers*



*Note.* n(adults) = 101. n(teenagers) = 45. Blue columns represent teenagers, red columns represent adults.



ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Table 6			
Observed Frequencies for Most Significant Factors for Adults and Teenagers			
Most Significant Factor	Age group		
	Teenagers	Adults	Total
Difference between the jail time of each outcome	13	24	37
Trust in the other player	13	19	32
Your own wellbeing	7	16	23
Maintaining a fair game	6	30	36
Being better off than the other player	1	1	2
Wellbeing of the other player	4	7	11
Total	44	97	141
Note. n(adults) = 97. n(teenagers) = 44. Write-in responses were excluded.			

ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Table 7			
Expected Frequencies for Most Significant Factors for Adults and Teenagers			
Most Significant Factor	Age group		
	Teenagers	Adults	Total
Difference between the jail time of each outcome	11.55	25.45	37
Trust in the other player	9.99	22.01	32
Your own wellbeing	7.18	15.82	23
Maintaining a fair game	11.23	24.77	36
Being better off than the other player	0.62	1.38	2
Wellbeing of the other player	3.43	7.57	11
Total	44	97	141
Note. n(adults) = 97. n(teenagers) = 44. Write-in responses were excluded from calculation.			

Table 8

Chi-Squared Test for Independence for Most Significant Factors for Adults vs. Teenagers

Group	$f_e - f_o$	$(f_e - f_o)^2$	$\frac{[(f_e - f_o)^2]}{f_e}$	Result
Teenagers, Jail Time	(11.55-13)	(11.55-13) <sup>2</sup>	$\frac{[(11.55-13)^2]}{11.55}$	0.1820
Teenagers, Trust	(9.99-13)	(9.99-13) <sup>2</sup>	$\frac{[(9.99-13)^2]}{9.99}$	0.9069
Teenagers, Own Wellbeing	(7.18-7)	(7.18-7) <sup>2</sup>	$\frac{[(7.18-7)^2]}{7.18}$	0.0045
Teenagers, Fairness	(11.23-6)	(11.23-6) <sup>2</sup>	$\frac{[(11.23-6)^2]}{11.23}$	2.4357
Teenagers, Better Off	(0.62-1)	(0.62-1) <sup>2</sup>	$\frac{[(0.62-1)^2]}{0.62}$	0.2329
Teenagers, Other Player Wellbeing	(3.43-4)	(3.43-4) <sup>2</sup>	$\frac{[(3.43-4)^2]}{3.43}$	0.0947
Adults, Jail Time	(25.45-24)	(25.45-24) <sup>2</sup>	$\frac{[(25.45-24)^2]}{25.45}$	0.0826
Adults, Trust	(22.01-19)	(22.01-19) <sup>2</sup>	$\frac{[(22.01-19)^2]}{22.01}$	0.4116
Adults, Own Wellbeing	(15.82-16)	(15.82-16) <sup>2</sup>	$\frac{[(15.82-16)^2]}{15.82}$	0.0020
Adults, Fairness	(24.77-30)	(24.77-30) <sup>2</sup>	$\frac{[(24.77-30)^2]}{24.77}$	1.5669
Adults, Better Off	(1.38-1)	(1.38-1) <sup>2</sup>	$\frac{[(1.38-1)^2]}{1.38}$	0.1046
Adults, Other Player Wellbeing	(7.57-7)	(7.57-7) <sup>2</sup>	$\frac{[(7.57-7)^2]}{7.57}$	0.0429
p-value .2997	Chi-square statistic 6.0676			

Note.  $X^2(5, N = 141) = 6.067568, p = .299706$ . Alpha level: .05.

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

In terms of least significance, the relative frequency of being better off is much higher for adults (58%) than teenagers (42.2%). The relative frequency of the wellbeing of the other player is much higher for teenagers (20%) than adults (7%). The other relative frequencies of other factors tended to be much more similar (see Figure 16).

Finally, a chi-square test for independence was run for the least significant factors for adults and teenagers. The null hypothesis was that there is no significant difference in the least significant factor between teenagers and adults. The alternative hypothesis was that there was a significant difference in the least significant factor between teenagers and adults. This was run at an alpha level of .05.

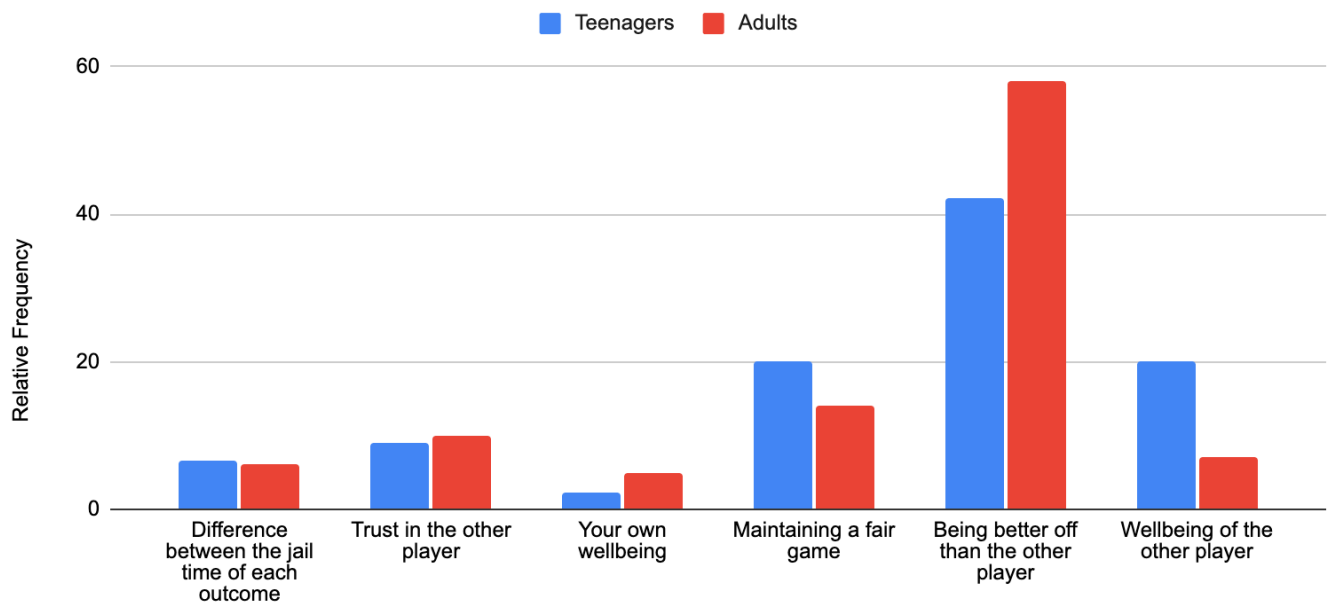
$f_e$  represents the expected frequencies of the data, which were calculated and are shown Table 10, and  $f_o$

represents the observed frequencies of the data, which are shown in Table 9.

After running the test, it was found that there was no significant difference in the least significant factor between the two age groups due to a p-value of .183641 (see Table 11). This agrees with the conclusion made from Figure 16.

Figure 16

*Least Significant Factor: Relative Frequencies vs. Least Significant Factor of Adults and Teenagers*



Note.  $n(\text{adults}) = 100$ .  $n(\text{teenagers}) = 45$ . Blue columns represent teenagers, red columns represent adults.

ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Table 9

Observed Frequencies for Least Significant Factors for Adults and Teenagers

Least Significant Factor	Age group		
	Teenagers	Adults	Total
Difference between the jail time of each outcome	3	6	9
Trust in the other player	4	10	14
Your own wellbeing	1	5	6
Maintaining a fair game	9	14	23
Being better off than the other player	19	58	77
Wellbeing of the other player	9	7	16
Total	45	100	145

Note. n(adults) = 100. n(teenagers) = 45. One teenage respondent did not choose a least significant factor.

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Table 10			
Expected Frequencies for Least Significant Factors for Adults and Teenagers			
Least Significant Factor	Age group		
	Teenagers	Adults	Total
Difference between the jail time of each outcome	2.79	6.21	9
Trust in the other player	4.34	9.66	14
Your own wellbeing	1.86	4.14	6
Maintaining a fair game	7.14	15.86	23
Being better off than the other player	23.9	53.1	77
Wellbeing of the other player	4.97	11.03	16
Total	45	100	145
Note. n(adults) = 97. n(teenagers) = 44. One teenage respondent did not choose a least significant factor and was not included in calculations.			

### IV. Discussion

This research shows that unlike children and adults, teenagers and adults have very similar decision-making tendencies. There was no significance in rationality, and only a few factors had significant differences between the two age groups.

These results can help bring up questions for further research on the difference in decision-making between adults and teenagers and help dispel misconceptions on teenage rationality.

#### Accuracy

As established by the chi-squared results, there was no significant difference between adults and teenagers (combined and non-exposed only) in their accuracy in the Prisoner's Dilemma, meaning there is no signif-

icant difference between their rationalities. Through these results, the question of whether or not accuracy varied between adults and teens has been answered. However, previous research disagrees with these results, stating that adults tend to make better, more well thought-out decisions than teenagers (Bruine de Bruin et al., 2014; Worthy et al., 2011). Despite these previous findings, it is clear that while there may be evidence that shows adults have the ability to make more rational decisions, in this study on the Prisoner's Dilemma, this is not the case. Teenagers and adults compare very similarly in terms of accuracy no matter their previous exposure.

#### Time for Response

Unlike what previous research suggests (Halpern-Felsher & Cauffman, 2001), adults on average did not

ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Table 11

Chi-Squared Test for Independence for Least Significant Factors for Adults vs. Teenagers

Group	$f_e - f_o$	$(f_e - f_o)^2$	$\frac{[(f_e - f_o)^2]}{f_e}$	Result
Teenagers, Jail Time	(2.79-3)	$(2.79-3)^2$	$\frac{[(2.79-3)^2]}{2.79}$	0.0158
Teenagers, Trust	(4.34-4)	$(4.34-4)^2$	$\frac{[(4.34-4)^2]}{4.34}$	0.0266
Teenagers, Own Wellbeing	(1.86-1)	$(1.86-1)^2$	$\frac{[(1.86-1)^2]}{1.86}$	0.3976
Teenagers, Fairness	(7.14-9)	$(7.14-9)^2$	$\frac{[(7.14-9)^2]}{7.14}$	0.4845
Teenagers, Better Off	(23.9-19)	$(23.9-19)^2$	$\frac{[(23.9-19)^2]}{23.9}$	1.0046
Teenagers, Other Player Wellbeing	(4.97-9)	$(4.97-9)^2$	$\frac{[(4.97-9)^2]}{4.97}$	3.267
Adults, Jail Time	(6.21-6)	$(6.21-6)^2$	$\frac{[(6.21-6)^2]}{6.21}$	0.0071
Adults, Trust	(9.66-10)	$(9.66-10)^2$	$\frac{[(9.66-10)^2]}{9.66}$	0.01
Adults, Own Wellbeing	(4.14-5)	$(4.14-5)^2$	$\frac{[(4.14-5)^2]}{4.14}$	0.1786
Adults, Fairness	(15.86-14)	$(15.86-14)^2$	$\frac{[(15.86-14)^2]}{15.86}$	0.2181
Adults, Better Off	(53.1-58)	$(53.1-58)^2$	$\frac{[(53.1-58)^2]}{53.1}$	0.4521
Adults, Other Player Wellbeing	(11.03-7)	$(11.03-7)^2$	$\frac{[(11.03-7)^2]}{11.03}$	1.4724
p-value .1836	Chi-square statistic 7.5374			

Note.  $X^2(5, N = 145) = 7.537449$ ,  $p = .183641$ . Alpha level: .05.

spend greater time than teens choosing their decision, and they had very similar relative frequencies for all time intervals. While this study did not aim to

address the matter of time for a decision to be made, this can largely affect the final decision made. Within that time, participants could have doubted their deci-

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

sion and decided to change their decision. In fact, a survey question revealed that 34.5% of all participants doubted and changed their answer (see Appendix B for question). Overall, results from this study's participants refute the idea that adults generally consider decisions more thoughtfully and for a greater amount of time.

### **Fairness**

Though both age groups had very similar average significance ratings, adults tended to consider fairness to be much more significant in their decision-making than teens (see Figures 3 and 4). Previous research does indicate that fairness can have a significant impact on whether or not players will cooperate during the Prisoner's Dilemma (Van't Wout & Sanfey, 2008), and that older teens and adults tend to aim for more strict equality and compromise, respectively (Camerer, 2011). Additionally, research does indicate that theory of mind tends to be a significant factor for children in the Prisoner's Dilemma (Fan, 2000), and this can hold true for teenagers as well. While the significance of fairness showed no statistically significant difference between adults and teenagers, it was still a somewhat significant factor in both age groups overall.

### **Altruism (Other Player's Wellbeing)**

When it came to the other player's wellbeing, and hence, altruism, adults tended to be more altruistically guided in their decision-making than teenagers. Studies with children have indicated that altruism did tend to be a significant factor in a child's decision-making (Van't Wout & Sanfey, 2008). However, it cannot be concluded that this is fully applicable to teenagers and adults as well. Unfortunately, altruism has not been commonly studied in the Prisoner's Dilemma with teens and adults. Despite this, data in this study indicate that adults may be more altruistically guided than teenagers.

### **Self-Preservation (Your Own Wellbeing)**

Self-preservation was one of the most significant decision-making factors among teenagers and adults, with no statistically significant difference in signifi-

cance ratings between age groups. Therefore, understanding self-preservation is key to understanding decision-making among teens and adults. Research affirms that decision-making is strongly guided by self-interest in early childhood, however, this hasn't been concluded for older ages (Camerer, 2011). While research did not uncover that self-interest may be a leading factor in decision-making in later ages, this data demonstrates that self-wellbeing is strongly considered by both age groups in game theory.

### **Trust**

Trust was by far the most similar factor between both age groups and somewhat significant. This significance of trust has tended to be a key concept in decision-making, in both the fields of behavioral game theory and psychology. Research indicates that trust can indeed be a guiding factor in decision-making for young children (Gummerum et al., 2008), though, there has been little research done on the significance of trust for adults and older teenagers in behavioral game theory. Nonetheless, this study indicates that adults and teenagers are both guided by trust in their decision-making to very similar extents.

### **Being Better Off**

Adults and teenagers did not consider being better off than the other player or deem it very significant in their decision-making. This does question whether the desire to be "better off," and therefore competitive against another person is ever truly significant in decision-making. There has not been much discussion within the field of behavioral game theory on how much adults, children, or teenagers care for being better off than another player or being competitive in a game such as the Prisoner's Dilemma. While there may be a greater difference in the significance of this factor among children and adults, this study concludes that being better off was not a very significant factor in decision-making for either adults or teenagers.

### **Jail Time**

Jail time was a very significant factor for both age groups; however, it should be noted that it may be more significant for teenagers than adults. Unfortu-



nately, there has been minimal research previously conducted on both age groups on the significance of jail time. This factor was added into this study because it is important to note that a great deal of decision-making can depend on the future outcomes of the decision and the extent of the consequences and benefits. While previous research shows that teenagers and adults are competent enough in weighing benefits and risks of their decisions (Mann et al., 1989; Worthy et al., 2011), there has not been much research done on the matter of the significance and consideration of outcome differences in decision-making in the Prisoner's Dilemma. Nonetheless, it is evident in prior research and this study that final outcomes and the aftermath of a scenario are well deliberated by both age groups. However, this study's data does indicate that teenagers were guided by outcomes in their decision-making to a greater extent than adults.

### Most and Least Significant Factors

Fairness tended to be one of the most significant guiding factors in decision making for adults, while trust and jail time were the most significant guiding factors in decision making for teenagers. On the other hand, being better off than the other player was rated as one of the least significant factors in decision making for both age groups, indicating that competitiveness was not a driving factor in participants. This can all be seen from the relative frequencies of each chart (Figures 15 and 16). However, while the chi-square test in Table 11 does affirm the conclusion made for the least significant factors of both age groups, the same cannot be said about the most significant factors. The chi-square test results in Table 8 for the most significant factors indicate no significant difference in the most significant factor between the two age groups. Despite there being no significant difference in the most significant factors, it can still be acknowledged that this study's sample size had strong frequencies of participants whose decision-making was guided by trust, difference in jail time, and fairness.

Additionally, previous research highlights fairness, altruism, and trust in both adults and children as significant in decision-making (Gummerum et al., 2008; Fan, 2000; Van't Wout & Sanfey, 2008). Those factors can be found as the most significant factors among participants of this study as well based on the

relative frequencies (excluding the factor of altruism for teenagers). While there has been no previous research conducted on least significant factors, it was included in this study as it may help eliminate factors that future research may want to study. Nonetheless, it can reasonably be said that teenagers within this study tended to be guided in their decision-making by their trust in another person and jail time (or consequences), while adults tend to be guided in their decision-making more often by the concept of fairness. The insignificant chi-square result for the most significant factors (Table 8) does prompt for more future research to be done on those factors with those age groups, however.

## V. Conclusions

### Limitations

This study was conducted through a Google Forms survey. Unfortunately, few to no studies in the field of behavioral game theory and the Prisoner's Dilemma have been conducted using a remote survey format. If there were no restrictions due to COVID-19, it would have been more desirable to hold focus groups with a few participants and have them play the Prisoner's Dilemma in real time against another participant. This would make the game seem more realistic to participants, and it would allow for the researcher to gain direct qualitative responses to help strengthen reasoning behind participants' quantitative results.

Additionally, the total sample size of this study was  $n=146$ . This is much less than the target sample size of 700 participants. This does make the data slightly less reliable and less representative of the population in X County. However, measures were taken to distribute the survey to the greatest extent possible (see Methodology). In the future, it would be recommended to use these same methods within a longer time period. In the end, this study did have to make use of snowball sampling by asking participants to share the survey with others who could qualify to take part in it. This limited the randomness of the sample size, and most importantly, the variety of backgrounds of participants. It is recommended in the future that a larger variety of people, groups, and organizations be

targeted and contacted in order to gain a more random sample to better justify data results.

## Conclusion

When it comes to the difference in accuracy, and hence rationality, between adults and teenagers who partake in the Prisoner's Dilemma, there is none. The chi-square statistic showed that there was no significance in the data that was obtained from the participants. However, on the matter of the difference between adults and teenagers for the most and least significant factor, two things can be stated. Based on the relative frequencies of both groups, adults felt fairness guided their decision-making the most strongly while teenagers felt that trust and jail time did. The "most significant factors" chi-square test did slightly refute this, however, and prompts for more research on these certain factors. On the other hand, a majority of both adults and teenagers felt that being better off was the least significant factor that guided their decision-making based on both the relative frequencies and the "least significant factors" chi-square test.

This poses two significant implications for the field of behavioral game theory and cognitive science. First, teenagers, ages 13 to 17, do not have significant differences in rationality than that of adults, ages 18 and up, have. For this reason, their decision-making can be regarded as much more similar to adults than that of children, ages 12 and under. However, teenagers and adults are driven to make the same choices due to different core decision-making factors in game theory situations. This can be due to a variety of both internal and external factors based on age groups and should be further researched in regard to cognitive science.

### Future Directions

There are some paths in this research topic that should be uncovered further. For example, future research should ask participants questions regarding their socioeconomic background and, potentially, their childhood background as these questions were not included in this study's survey. This data can potentially uncover why certain factors were either more or less significant to some participants and not others. Furthermore, it is highly recommended that any future research involving game theory games and un-

derstanding decision-making factor significance be done in a non-remote survey format. A survey format doesn't allow the researcher to fully understand the participants and further question them to gain valuable data.

These recommendations aim to help support future research within behavioral game theory on both adults and teenagers. Research on behavioral game theory in combination with cognitive science can truly lead to a better understanding of variations in human decision-making and rationality.

## VI. Works Cited

- Aumann R. (2008). Game Theory. In: Palgrave Macmillan (eds) *The New Palgrave Dictionary of Economics*. Palgrave Macmillan, London. [https://doi.org/10.1057/978-1-349-95121-5\\_942-2](https://doi.org/10.1057/978-1-349-95121-5_942-2)
- Basu, K. (2007). The Traveler's Dilemma. *Scientific American*. [https://www.cs.virginia.edu/~robins/The\\_Travelers\\_Dilemma.pdf](https://www.cs.virginia.edu/~robins/The_Travelers_Dilemma.pdf)
- Boone, C., De Brabander, B., & Van Witteloostuijn, A. (1999). The impact of personality on behavior in five Prisoner's Dilemma games. *Journal of Economic Psychology*, 20(3), 343-377. [https://doi.org/10.1016/S0167-4870\(99\)00012-4](https://doi.org/10.1016/S0167-4870(99)00012-4)
- Brosig, J. (2002). Identifying cooperative behavior: some experimental results in a prisoner's dilemma game. *Journal of Economic Behavior & Organization*, 47(3), 275-290. [https://doi.org/10.1016/S0167-2681\(01\)00211-6](https://doi.org/10.1016/S0167-2681(01)00211-6)
- Bruine de Bruin, W.B. (2016). Aging and Decision-Making Competence.
- Bruine de Bruin, W.B., Strough, J., & Parker, A. M. (2014). Getting older isn't all that bad: better decisions and coping when facing "sunk costs". *Psychology and aging*, 29(3), 642-647. <https://doi.org/10.1037/a0036308>
- Camerer, C. F. (1997). Progress in Behavioral Game Theory. *The Journal of Economic Perspectives*, 11(4), 167-188. <https://doi.org/10.1257/jep.11.4.167>
- Camerer, C. F. (2003). Behavioural studies of strategic thinking in games. *Trends in cognitive sciences*, 7(5), 225-231. [https://doi.org/10.1016/S1364-6613\(03\)00094-9](https://doi.org/10.1016/S1364-6613(03)00094-9)
- Camerer, C. F. (2011). Behavioral game theory: Experiments in strategic interaction.
- Camerer, C. F., & Ho, T. H. (2015). Behavioral game theory experiments and modeling. In *Handbook of game theory with economic applications* (Vol. 4, pp. 517-573). Elsevier. <https://doi.org/10.1016/B978-0-444-53766-9.00010-0>

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

- Definition of theory of mind | Dictionary.com. (2020).  
Www.Dictionary.com. <https://www.dictionary.com/browse/theory-of-mind>
- Dietrich, C. (2010). "Decision Making: Factors that Influence Decision Making, Heuristics Used, and Decision Outcomes." *Inquiries Journal/Student Pulse*, 2(02). Retrieved from <http://www.inquiriesjournal.com/a?id=180>
- Fan, Chinn. (2000). Teaching children cooperation -- An application of experimental game theory. *Journal of Economic Behavior & Organization*. 41. 191-209. [https://doi.org/10.1016/S0167-2681\(99\)00072-4](https://doi.org/10.1016/S0167-2681(99)00072-4)
- Gächter, S. (2004). Behavioral game theory. *Blackwell handbook of judgment and decision making*, 485-503.
- Gummerum, M., Hanoch, Y., Keller, M., Parsons, K., & Hummel, A. (2010). Preschoolers' allocations in the dictator game: The role of moral emotions. *Journal of Economic Psychology*, 31(1), 25-34.
- Gummerum, M., Hanoch, Y., & Keller, M. (2008). When Child Development Meets Economic Game Theory: An Interdisciplinary Approach to Investigating Social Development. *Human Development*, 51(4), 235-261. doi:10.2307/26764864
- Halpern-Felsher, B. L., & Cauffman, E. (2001). Costs and benefits of a decision: Decision-making competence in adolescents and adults. *Journal of Applied Developmental Psychology*, 22(3), 257-273. <https://www.sciencedirect.com/science/article/abs/pii/S0193397301000831> (from abstract)
- Kuhn, S. (2019). Prisoner's Dilemma (Stanford Encyclopedia of Philosophy). Stanford.Edu. <https://plato.stanford.edu/entries/prisoner-dilemma/>
- Leder, J., & Schütz, A. (2018). Dictator Game. *Encyclopedia of Personality and Individual Differences*, 1-4. [https://doi.org/10.1007/978-3-319-28099-8\\_652-1](https://doi.org/10.1007/978-3-319-28099-8_652-1)
- Mann, L., Harmoni, R., & Power, C. (1989). Adolescent decision-making: The development of competence. *Journal of adolescence*, 12(3), 265-278. [https://doi.org/10.1016/0140-1971\(89\)90077-8](https://doi.org/10.1016/0140-1971(89)90077-8)
- Sanfey, A. G. (2007). Social decision-making: insights from game theory and neuroscience. *Science*, 318(5850), 598-602. <https://doi.org/10.1126/science.1142996>
- Steinberg, L., & Cauffman, E. (1996). Maturity of judgment in adolescence: Psychosocial factors in adolescent decision making. *Law and Human Behavior*, 20(3), 249-272. <https://doi.org/10.1007/BF01499023>
- Van't Wout, M., & Sanfey, A. G. (2008). Friend or foe: The effect of implicit trustworthiness judgments in social decision-making. *Cognition*, 108(3), 796-803. <https://doi.org/10.1016/j.cognition.2008.07.002>
- Worthy, D. A., Gorlick, M. A., Pacheco, J. L., Schnyer, D. M., & Maddox, W. T. (2011). With age comes wisdom: decision making in younger and older adults. *Psychological science*, 22(11), 1375-1380. <https://doi.org/10.1177/0956797611420301>

## Appendix A

*Prisoner's Dilemma:* The Prisoner's Dilemma consists of two players who are considered "prisoners". They are given the option to,

- 1) remain silent or
- 2) confess against the other player to get them in trouble.

However, the two players are not allowed to converse with each other. There are four potential results.

- 1) Neither player confesses, and both face a short jail time,
- 2) player 1 confesses and player 2 does not, so player 1 goes free and player 2 faces a long sentence,
- 3) player 2 confesses and player 1 does not, so player 2 goes free and player 1 faces a long sentence, and
- 4) both players confess and face a medium-length sentence (Kuhn, 2019).

*Traveler's Dilemma:* The Traveler's Dilemma consists of two players who are considered "travelers". The two travelers' luggage has been lost, each with an identical antique. The airline manager says he will compensate them for the loss, but through a specific technique to guarantee there isn't inflation of prices. The players are instructed to write down a monetary value between \$2-\$100, but they are not allowed to discuss the numbers they write down with each other. If they both write the same numbers, the manager will pay them both that same price. If one player writes a higher number than the other, they will each be paid the lower value. However, the player with the lower value will receive a \$2 bonus and the player with the higher value will be penalized \$2 (Basu, 2007).

*Dictator Game:* The Dictator Game consists of two players, one who is the "dictator" and the other who is the anonymous "recipient". The dictator is given a certain amount of endowment, and it is up to them whether they would like to give a portion of that en-

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

dowment to the recipient. They can give the recipient absolutely nothing to the entirety of the endowment they get for that round (Leder & Schütz, 2018).

*Accuracy:* The ability for a participant to be able to choose the option which is deemed by game theory experts to be the best option for the participant within the game.

## Appendix B

### BEGINNING OF SURVEY

#### Decision-Making in Games

##### Section 1:

##### Decision-Making in Games Survey Consent Form

You are being asked to take part in a research study of how and why adults and teens make decisions in different games. We are asking you to take part because you are in the target group of participants.

You must be 13 years old or older AND live in [REDACTED] to complete this survey.

Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

##### What the study is about:

The purpose of this study is to learn how you approach a game against another player and what factors influence your decision-making process during the game.

##### What we will ask you to do:

If you agree to be in this study, you will complete a survey. The survey will include questions about your age and level of education, as well as the decision you make in a game and the factors that influenced your decision. The survey will take approximately 5 to 10 minutes to complete depending on how much time you spend on each question.

##### Risks and benefits:

I do not anticipate any risks to you participating in this study other than those encountered in day-to-day life. Additionally, there are no benefits to you. We hope to learn more about the decision-making process of teens and adults in games to benefit cognitive and social behavior sciences.

##### Compensation:

For compensation, you will be entered into a raffle for a \$25 Amazon gift card.

##### Your answers will be confidential:

The records of this study will be kept private. In any sort of report we make public we will not include any information that will make it possible to identify you. All research materials will be stored in a Google Drive folder that only the researcher and the project director have access to.

##### Taking part is voluntary:

Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide not to take part or to skip some of the questions, it will not affect your current or future relationship with [REDACTED] or their teachers. If you decide to take part, you are free to withdraw at any time.

##### If you have questions:

The researcher conducting this study is [REDACTED]. Please ask any questions you have now. If you have questions later, you may contact [REDACTED] at [REDACTED]. If you have any questions or concerns regarding your rights as a subject in this study, you may contact the [REDACTED] Institutional Review Board (IRB) at [REDACTED].

##### Question 1 [Required]:

If you are above the age of 18, have you read understood the above information and consent to participate in this study?

Yes, I am over 18 and consent to participate in this study [Go to Section 3]

No, I am not over 18 [Go to Section 2 - Teen Consent Form]

No, I do not consent to participate in this study [Go to Section 14 - Thank you...]

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

### Section 2:

#### Teen Consent Form

#### Decision-Making Processes in Games Parental Consent Form

You are being asked to take part in a research study of how adults and teens make decisions for their benefit in different games. We are asking you to take part because you are in the target group of participants.

You must be 13 years old or older AND live in [REDACTED] to complete this survey.

Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

#### What the study is about:

The purpose of this study is to learn how you approach a game against another player and what factors influence your decision-making process during the game.

#### What we will ask you to do:

If you agree to be in this study, you will complete a survey. The survey will include questions about your age and level of education, as well as the decision you make in a game and the factors that influenced your decision. The survey will take approximately 5 to 10 minutes to complete depending on how much time you spend on each question.

#### Risks and benefits:

I do not anticipate any risks to you participating in this study other than those encountered in day-to-day life. Additionally, there are no benefits to you. We hope to learn more about the decision-making process of teens and adults in games to benefit cognitive and social behavior sciences.

#### Compensation:

For compensation, you will be entered into a raffle for a \$25 Amazon gift card.

#### Your answers will be confidential:

The records of this study will be kept private. In any sort of report we make public we will not include any

information that will make it possible to identify you. All research materials will be stored in a Google Drive folder that only the researcher and the project director have access to. All of your answers will be destroyed following the completion of the study.

#### Taking part is voluntary:

Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide not to take part or to skip some of the questions, it will not affect your current or future relationship with [REDACTED] or their teachers. If you decide to take part, you are free to withdraw at any time.

#### If you have questions:

The researcher conducting this study is [REDACTED]. Please ask any questions you have now. If you have questions later, you may contact [REDACTED] at [REDACTED]. If you have any questions or concerns regarding your rights as a subject in this study, you may contact the [REDACTED] Institutional Review Board (IRB) at [REDACTED].

If you are under the age 18, you must receive parental consent to participate in this survey

#### Question 2 [Required]:

I have read the above information and give consent for my child to take part in this study  
Yes [Go to Section 3]  
No [Go to Section 14 - Thank you...]

#### Question 3 [Required]:

By writing my initials below I verify that I am the parent/guardian of the respondent  
[Write-in Answer]

#### Section 3:

#### Question 4 [Required]:

Do you live in [REDACTED] AND are 13+ years old?  
Yes [Go to Section 4 - Demographics]  
No [Go to Section 14 - Thank you...]

#### Section 4:

Demographics

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

### Question 5:

How old are you? (NOTE: You must be 13 or older to complete this survey)

[Multiple-choice answers from 13 to 65+ years old in whole numbers]

### Question 6:

What is the highest degree or level of school you have completed? (If currently enrolled, highest degree received.)

Some high school, no diploma

High school graduate, diploma or the equivalent (for example: GED)

Some college credit, no degree

Trade/technical/vocational training

Associate degree

Bachelor's degree

Master's degree

Professional degree

Doctorate degree

[After Section 4, continue to Section 5]

### Section 5:

#### Instructions

In the following section, you will be given an overview about the game, your situation, and the options you have in the game.

Please carefully consider the options you are given and make the choice that YOU want. Afterwards, you will be asked a few questions on the process you took to make your decision and the factors that influenced your choice.

[After Section 5, continue to Section 6]

### Section 6:

#### The Game

Instructions: In this game, please imagine you are in the following scenario. You are playing against another player who is an imaginary person, but please proceed to answer any questions as if they are a real person. You are not allowed to talk to or communicate with the other player in any way. Both of you will be

offered the same options.

Scenario: You and another member (the other player in the game) in a crime gang are arrested by the police. You are both placed in solitary confinement so there is no possible way for you both to communicate with one another. The police don't have substantial evidence to convict you both with a heavy charge, so they opt to give you both a lesser charge. You are each offered the same 2 options as a bargain.

Option 1) You can betray the other person and confess that the other person committed the crime.

Option 2) You can remain silent and not confess.

Once again, you do not have the option to communicate with the other person and discuss a deal between the both of you.

Here are your potential outcomes based on the option you choose (Keep in mind that the other player will choose from the same options as well):

Outcome A) You both decide to betray one another. You will both serve 5 years in jail.

Outcome B) You betray the other player, HOWEVER, the other player remains silent. You will be set free and the other player will serve 10 years in jail.

Outcome C) You remain silent, HOWEVER, the other player betrays you. You will serve 10 years in jail and the other player will be set free.

Outcome D) You both decide to remain silent. You will both serve 3 years in jail.

### Question 7:

Which option would you choose in this scenario?

I will betray and testify that the other member committed the crime

I will remain silent and not confess

[After Section 6, Continue to Section 7]

### Section 7:

#### Decision-Making Process in the Game

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

Instructions: The following questions are about your decisions in the game you just played. Please read the following questions and respond to the best of your ability.

[Scenario is given again for reference]

Question 8:

Approximately how long did it take for you to come to your final decision?

0 to 10 seconds

20 to 30 seconds

30 seconds to 1 minute

1 to 2 minutes

2 to 3 minutes

3 to 4 minutes

4 to 5 minutes

6 + minutes

Other [Write-in]

Question 9:

What was the first thing you thought about when you were trying to make your decision?

[Long answer text box]

Question 10:

Was there any point, while you were thinking, where you changed your decision from your original one?

Yes

No

Question 11:

If you answered yes to the previous question, please explain what made you change your decision:

[Long answer text box]

Question 12:

Was there anything that made you deliberate your answer for a longer period of time?

Yes

No

Question 13: If you answered yes to the previous question, please explain what it was that made you deliberate for longer:

[Long answer text box]

Question 14:

Would you change your answer if you had the option to communicate with the other player?

Yes

No

Maybe

Question 15:

Why did you choose your answer from the previous question?

[Long answer text box]

[After Section 7, continue to Section 8]

*Section 8:*

Influential Factors in the Game

Instructions: The following questions are about what factors helped you and influenced you to make a decision in the game you just played. Please read the following questions and respond to the best of your ability.

IMPORTANT: As you read these questions, please think about playing the game and that the other player is not an imaginary person.

[Scenario is given again for reference]

When asked about how much of a factor something was in the decision you made, please think about how much of an impact it had in helping you make a decision.

Question 16:

On a scale of 1 to 4, how much would you say your desire to be fair with the other player was a factor in the decision you made? (1= Not a factor at all, 2= A minor factor, 3= Major factor, 4= Significant factor)

[Linear scale from 1 to 4]

Question 17:

Why have you chosen the above rating?

[Long answer text box]

Question 18:

On a scale of 1 to 4, how much would you say your

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

desire for the other player's wellbeing was a factor in the decision you made?(To elaborate, "wellbeing" means how well-off/comfortable/happy/safe/etc. the player would be in that game's scenario. 1= Not a factor at all, 2= A minor factor, 3= Major factor, 4= Significant factor)

[Linear scale from 1 to 4]

Question 19:

Why have you chosen the above rating?

[Long answer text box]

Question 20:

On a scale of 1 to 4, how much would you say your desire for your own wellbeing was a factor in the decision you made? (To elaborate, "wellbeing" means how well-off/comfortable/happy/safe/etc. you would be in the game's scenario. 1= Not a factor at all, 2= A minor factor, 3= Major factor, 4= Significant factor)

[Linear scale from 1 to 4]

Question 21:

Why have you chosen the above rating?

[Long answer text box]

Question 22:

On a scale of 1 to 4, how much would you say that your trust in the other player was a factor in the decision you made? (1= Not a factor at all, 2= A minor factor, 3= Major factor, 4= Significant factor)

[Linear scale from 1 to 4]

Question 23:

Why have you chosen the above rating?

[Long answer text box]

Question 24:

On a scale of 1 to 4, how much would you say your desire to be better off than the other player was a factor in the decision you made? (To elaborate, "desire to be better off" means that you wanted to serve less time than the other player does. 1= Not a factor at all, 2= A minor factor, 3= Major factor, 4= Significant factor)

[Linear scale from 1 to 4]

Question 25:

Why have you chosen the above rating?

[Long answer text box]

Question 26:

On a scale of 1 to 4, how much would you say that the difference between the jail time of each outcome was a factor in the decision you made? (Ex. In Outcome A you would serve 5 years and in Outcome D you would serve 3 years. If you chose the decision that would potentially give you Outcome D rather than Outcome A specifically because Outcome D had less jail time, then the difference between the jail time of each outcome could be considered a significant factor in your decision. 1= Not a factor at all, 2= A minor factor, 3= Major factor, 4= Significant factor)

[Linear scale from 1 to 4]

Question 27:

Why have you chosen the above rating?

[Long answer text box]

Question 28:

Which of the following factors would you say was the most significant factor in the decision you made?

Maintaining a fair game

Wellbeing of the other player

Your own wellbeing

Trust in the other player

Being better off than the other player

Difference between the jail time of each outcome

Other [Write-in]

Question 29:

Why have you chosen the above factor?

[Long answer text box]

Question 30:

Which of the following factors would you say was the least significant factor in the decision you made?

Maintaining a fair game

Wellbeing of the other player

Your own wellbeing

Trust in the other player

Being better off than the other player

Difference between the jail time of each outcome

Question 31:

Why have you chosen the above factor?

[Long answer text box]



## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

[After Section 8, continue to Section 9]

### Section 9:

Previous Exposure

#### Question 32:

Have you been exposed to the Prisoner's Dilemma in a previous class or anywhere else?

Yes

No

[After Section 9, continue to Section 10]

### Section 10:

Further Discussion

Thank you for completing the survey thus far. To help further support the study and elaborate on some answers, you have the option of potentially having a 5-20 minute interview with the researcher sometime in the near future.

#### Question 33 [Required]:

Would you be interested in completing an interview to further elaborate on some of your responses?

Yes [Go to Section 11 - Contact Information]

No [Go to Section 12 - Debriefing]

### Section 11:

Contact Information

#### Question 34 [Required]:

To be able to get in touch with you and schedule and interview time, please write an email address we can reach you at:

[Short answer text box]

[After Section 11, continue to Section 12]

### Section 12:

Debriefing

Decision-Making in Games Debriefing Form

Thank you for participating in this study. In order to get the information we were looking for, we withheld some information/or provided you with incorrect information about some aspects of this study.

Now that the experiment is over, I will describe the deception to you, answer any of your questions, and provide you with the opportunity to make a decision on whether you would like to have your data included in this study.

What the study really is about:

The true purpose of this study was to understand if adults or teenagers would be better at choosing the best option in a game theory game, which in this case was the Prisoner's Dilemma, and what factors influenced both age groups to choose their decision. In addition, the full name of this study is "Decision-Making in the Prisoner's Dilemma". All parts of the study were real. The benefit of this study was to help researchers in behavioral game theory, as well as cognitive and social sciences, to understand the differences between the decision-making process of teenagers and adults. There are no benefits to you. I do not anticipate any risks to you participating in this study other than those encountered in day-to-day life. If you give permission, the only data from you that will be used in this study are your age, your education level, the option you chose, details on your decision-making process, and how and why you ranked certain influential factors. None of this information will be presented in a way to make you identifiable.

Taking part is voluntary:

Although you have already completed the survey, your involvement is still voluntary, and you may choose to withdraw the data you provided prior to debriefing, without penalty or loss of compensation offered to you. Withdrawing your submission will not adversely affect your relationship with [REDACTED], the researchers, or any of our affiliates.

Privacy/Confidentiality:

If you agree to allow us to use your data, here is how we will maintain confidentiality of the information: All survey data collected through Google Forms will be stored away in Google Drive folder which only the researcher and the project director have access to. Promptly following the completion of the study, your survey response will be destroyed so there is no possibility of distribution.

The main researcher conducting this study is [RE-

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA

DACTED], a student at [REDACTED].

If you have questions later, or would like to know about the results of the study, you may contact [REDACTED] at [REDACTED] or at [REDACTED]. Or their faculty advisor, [REDACTED], at [REDACTED].

If you have any questions or concerns regarding your rights as a subject in this study, you may contact the Institutional Review Board (IRB) for Human Participants at [REDACTED].

Question 35 [Required]:

After reading the above, please indicate if you do, or do not, give permission to have your data included in the study, below:

I have been debriefed by the researcher, and I understand the true intent of and the purpose of my participation in the study title "Decision-Making Processes in Games". I agree that the data collected during the study may be included for the purpose of the study.

I have been debriefed by the researcher, and I understand the true intent of and the purpose of my participation in the study title "Decision-Making Processes in Games". I DO NOT give permission for the data collected during the study to be included for the purposes of the study

[After Section 12, continue to Section 13]

*Section 13:*

Amazon Gift Card Raffle

We truly appreciate your participation in this study.

If you would like to be entered into a raffle for a \$25 Amazon gift card, please enter your email address below. We will notify you if you win.

Question 36:

Email address:

[Short answer text box]

*Section 14:*

Thank you so much for your time. If you know anyone else who may be interested in participating in this

study, please share the link below with them.

<http://bit.do/GameStudy>

END OF SURVEY

## ADULTS AND TEENAGERS IN THE PRISONER'S DILEMMA