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Application of Game Theory in a Social Experiment Based on Hawk-Dove Model

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ABSTRACT
Based on the Hawk-dove model, the game was designed to examine people's decision-making strategy factors. By analyzing vast scale of data from 8 games, which were conducted among high school students and college students, our assumptions were disproved that people with additional information and a chance to communicate can earn higher credits among all players. Within the communication, candidates are prone to lie, which affects the type 1(have complete information and allowed communicate with opponents) player's ability to judge. However, extra information caused players to consider more and to make more identity turnover within the game. In the game without communication, players' decisions mostly rely on the information. As a variable between America education system high school students and college students, age did not significantly affect the game. Gender, from the perspective of psychology, asserting the effect that causes vast imbalance among players of different genders' decision of making an agreement. The reason behind the imbalance among players is the difference in treating the relationship between males and females.

Keywords: *Game theory, social experiment, Hawk-Dove Model*

1. INTRODUCTION

The experiment designer chose the most exciting and feasible Hawk-Dove game model among the many game theory models and designed the experiment based on it. One team member was inspired by a wargame (a game in which a sample of people play one-on-one against each other) and used it to determine the experiment's final results. Based on the Hawk-Dove game model, the experiment will simulate markets and represent the changing number of strong and weak players in the market.

This paper studies the factors that influenced people's economic decision-making, which can apply to real-life situations. The experimental data can contribute a bit of international students' perspectives and strength to experimental as well as behavioral economics after testing the hypothesis.

According to the variables set in the experiment: Given information and communication-allowed. Players are classified into four types; the first type: having information about the game and communicating with their opponents. The second type: do not have the information about the game, but they can communicate with their opponents. The third type: Having the information about the game, and they are not allowed to communicate. The fourth type: do not have information and not allowed to communicate. Hence, under these situations, here are the following hypotheses. Firstly, the first type of players will score better get higher marks than others, and they may have many turnovers. Secondly, there will be a positive correlation between players' performance and their age. Thirdly, when female players meet with a female, they tend to have agreements with their opponents (each other). Fourthly, males have the greater possibility to lie when they met with a male opponent. Fifthly, it tends to have more agreements when different genders of players meet.

2. METHODS

2.1. Participants

The participants in this study were 45 students from senior 2, RDFZ Xishan School AP Center. They are undergraduate students and graduate students from Capital University of Economics and Business. High school participants are volunteers interested in our game, who fill out the volunteer questionnaire we assigned.

College students were randomly selected from The School of Finance and Taxation, The School of Economics, and The School of foreign languages in CUEB. The participants came from different classes, took different AP courses and different majors. It can ensure our research's comprehension and validity

2.2. Design and procedure

2.2.1. Introduction to Hawk-dove game

The Hawk-dove game is a game theory model developed by biologist John Maynard Smith, which is relevant to the Chicken Game within game theory models [1]. The model is used to illustrate evolution and coexistence between hawks and doves in nature. The occurrence of a mixed strategy is always used to study Nash Equilibrium [2].

2.2.2. Game design

During the research stage, the author refer Bayesian Game game theory, a complex version of the Hawk-Dove game that focuses on mixed strategies and incomplete information. In the model the author designed, there are two animals that are capable of choosing from two strategies when in conflict with one another [3]. The animal can choose to be a "hawk" and escalate to a fight, or the animal can choose to be a "dove" and peacefully back down. Hawks are always willing to fight, and so if two hawks meet, they will both lose 2 points. Doves flee never involved in a fight. There was no cost to be a dove, only the possibility of receiving no payoff. Winners receive the benefit, while losers face the cost of the fight. The specific credit changing during the game as shown in table 1. Ten players can have two optional identities- whether E, eagle or P, pigeon.

Table 1. Original Payoff Matrix.

	E	P
E	-2, -2	+0, +2
P	+2, +0	+1, +1

According to table 1: original Payoff Matrix, players will combat randomly with each other in each round. Also, the experiment conductors give players two points first, and then after each round, two guarantee credits will give out to the players, the final credit changing as shown in table 2.

Table 2. Payoff Matrix with Guarantee money.

	E	P
E	+0, +0	+2, +4
P	+4, +2	+3, +3

Moreover, the players can change their ID. Before revealing the combat result, players will have 1 minute to communicate, during the period they are free to change their ID. They can, whether lying or telling the truth, agreeing with their opponents. However, if they changed their ID during the communication, they will have one credit deducted by the end of the round. During the design stage, the gaming site arrangement and the ID gadget can prevent cheating when players sitting face to face are both designed, as shown in figure 1.

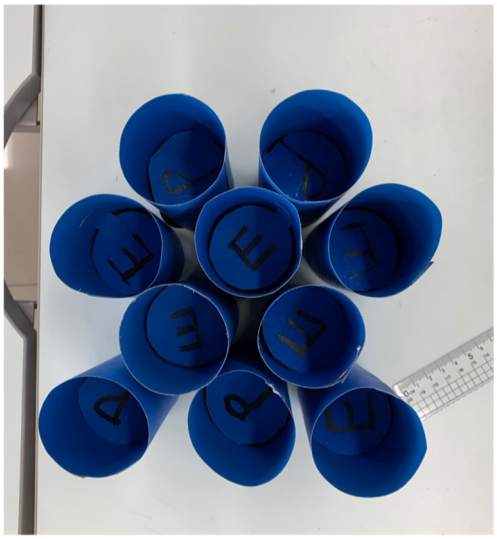

Figure 1. Designed ID gadget.

The gaming site arrangement consists of one outer circle and an inner zone, as shown in figure 2. In the outer zone, experimenters divide the participants into experimental groups and control groups, and each player has a unique serial number. After players informed the person who they will combat, the individual player will come to the inside zone, communicate with opponents, and decide if they change their game identity. At the end of the combat, they should be left their decision on the table in the inner zone and go back to their assigned seat in the outer circle. When players back to the outer zone, they will receive guarantee credits, gain or lose credits from the last combat. At this point, their decisions are potentially deliberate because of the actual monetary gains or losses present.

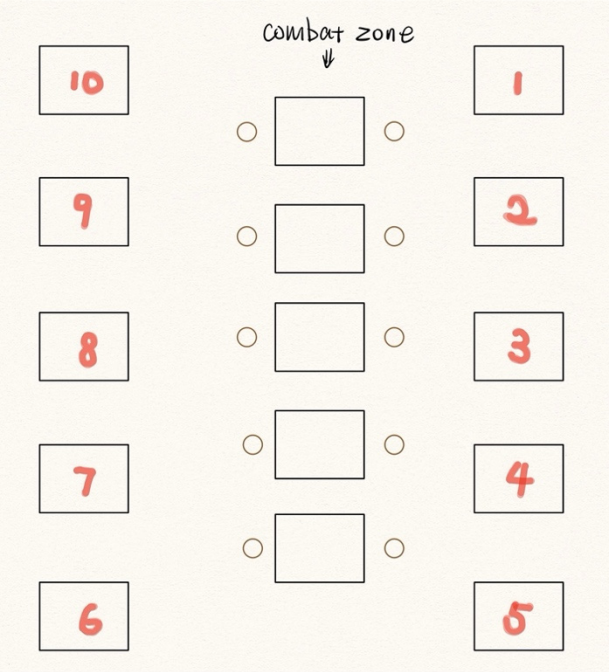

Figure 2. Gaming site arrangement.

The experimenter initially wants to create a matrix with no Nash Equilibrium to let players be competitive and set ID changing cost to remind players to make deliberate-careful decisions. However, the ID changing fee and original payoff matrix create a solid payoff matrix for players: their dominant strategy is to decide to be Eagle, as shown in table 3 and 4.

Table 3. Actual Payoff Matrix with Guaranteed money and ID changing (E to P).

	E	P
E	+0, +0	+1, +4
P	+4, +2	+2, +3

Table 4. Actual Payoff Matrix with Guaranteed money and ID changing (P to E).

	E	P
E	-1, +0	+2, +4
P	+3, +2	+3, +3

2.2.3. Measures

The author used each player's final score to measure how well they performed in the experiment. The scores will come up with a ranking, and the top three players can receive rewards from us.

2.2.4. Variables

The variables in our experiment include whether they received information about the game situation and whether they can or cannot communicate with their opponent.

3. RESULTS

From the statistics we collected, as shown in figure3, the total points that type 3 players (have information but no communication allowed) get are the highest, which contradict our hypothesis.

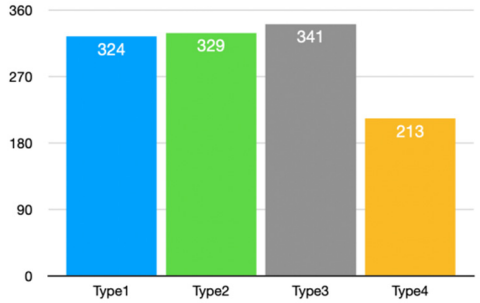

Figure 3. Visuals of total score each type of players gets.

Due to type 1 players hold much more information than other types of players. So, they tend to set their hearts upon the situation of the game and negotiate with others. They devoted all their energy to the information they hold. As a result, they reached the highest identity ID changing rate in the whole game, as shown in the figure 4.

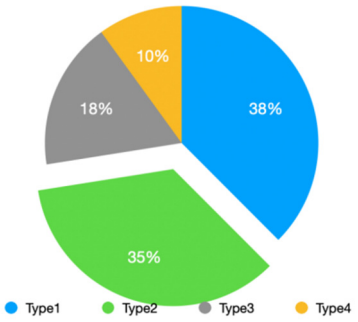

Figure 4. Percentage of each type of players' ID changing rate.

A scatterplot displays data about two variables as a set of points in the xy-plane and it is a helpful tool for determining a correlation between the variables. We

collected sixty valid data of players in 6 games; they are in the range of sixteen to twenty-five, as shown in figure 5. As a result, we discovered there is no relationship between the values of players' performance and age by using a scatterplot.

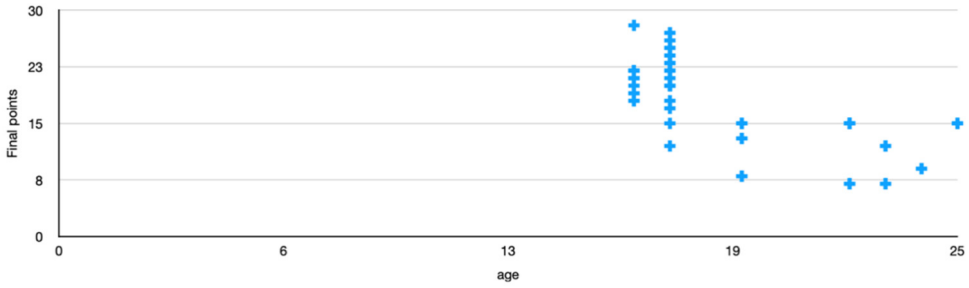

Figure 5. The relationship between players' final points and age.

There are 28 female-female, 25 male-male, 61 female-male combats in all three games with communication. The percentage of the agreement making were 53.57%, 36%, and 34.42%, which provide evidence for our first and second hypotheses. As shown in figure 6, the game result of AP volunteer group 1, in which game the agreement-making rate among female players is over 70 percent, while males are lower than 15 percent.

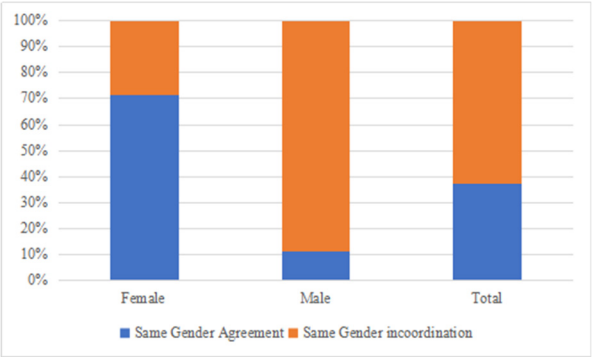

Figure 6. Gender related to Agreement (Jun-9th).

4. DISCUSSION

The incentives stimulate players to be more competitive [4]. Players' decisions are potentially deliberate because of the actual monetary gains or losses present. Due to the incentives set for the top three ranking players, they are many different kinds of snacks and beverages that the school does not sell in the cafeteria. Hence, in some ways, they are considered special treats.

Risk aversion is the participants' first behavior due to the incentives. Because they desire to be top three of the game and get rewards, this surprising discovery is because of one mistake I made during the experiment on June 21st. The unintended action is that the author deducted eagle two points when they met with pigeons, making most players who chose eagle almost reach bankrupt. According to the dominant strategy, players should decide to be an eagle and convince their opponent to choose pigeon. In this way, they can easily go on the podium, reach the top three. However, in the wrong game, this is the worst way. Because of the risk & loss aversion behaviors on humans, people who get no harm with choosing pigeons will decide to be straight pigeons. They are comfortable when they meet with any identity; pigeons avoid the risk and loss. Nevertheless, the situation turns totally different with eagles. They will get points deducted from meet with pigeons, plus the identity changing cost, and they will lose one credit every time they changed their identity. However, players want to take a chance on it; "what if I met a pigeon? I can get my points back." However, when they realize they are may bankrupt, they do not have the chance to change ID or go straight forward to zero points in the end. Therefore, the results in this particular game are upside down compared to previous experiments we conducted. - the player who decided to be a pigeon in all eight rounds reaches the top one. After this game, the author realized the mistakes, so the author experimented with the same group of people in the same game. The results of players deciding their identities are dramatically different. As shown in figure 7 and 8, the option they considered with less risk and loss, the pigeon, increased 19%, had exceeded half of the choices. The comparison of the results means players have learned from last time.

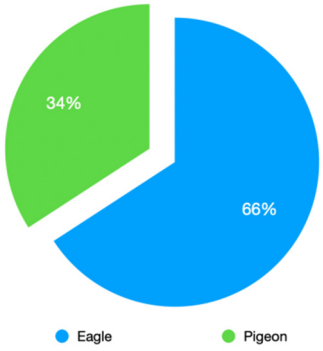

Figure 7. Percentage of players' decision in the first wrong game.

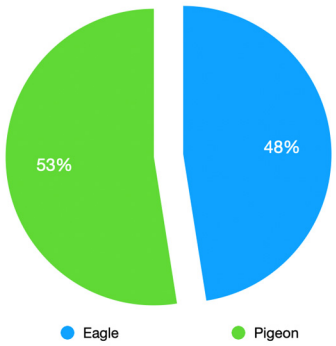

Figure 8. Percentage of players' decision in the corrected game.

Everyone wanted to choose the less risky and less rewarding option because choosing to become an eagle was extremely risky. Perhaps it will head for the worst possible outcome, while conservatively choosing the pigeon would allow them to get the monetary incentive in the end.

After data analysis, the first hypothesis is not valid, while the second hypothesis is valid. Type 1 players did not get the highest marks in the game, while the type 3 players scored the highest. However, the difference between these two categories of players is the presence or absence of communication. The possible reason for this result is the effective or helpful communication in games is encouraged or allowed, in games that communication is allowed. According to the observation, cheating happens a lot in games when the communication is allowed. Players used their negotiation skills to cheat their opponents or to exchange information with other groups of players. In conclusion, the presence of communication can interfere with the player's judgment of who has the information, causing them to lose points. Conversely, in the absence of communication, players with information rely more on making their decisions carefully.

The third hypothesis is also invalid, because there is no relationship between players' performance and their age.

According to Bates Duford, "the type of relationship appears to differ between male and female relationships" [2]. A female relationship requires face-to-face communication and other maintenance, but a male would consider someone whom he does not contact much as his friend easier. In addition, "Women require more frequent contact with someone they consider to be a friend; Men are more likely to use humor to taunt a friend while viewing this as innocent fun; Women are more likely to refrain from taunting and humor out of fear it may hurt their friends' feelings··· Although these differences do not apply to all male-male and female-female friendships, this provides a general idea of how male-male friendships differ from female-female friendshi." [2,5,6]. From this sense, the author investigated the agreement and incoordination among pure-female and pure-male combats to illustrate the effect of different genders' ways of dealing with their schoolmates of the same sex in their decision-making. The author made a hypothesis: it is easier to reach an agreement between females, for they care more about other's feelings; it is hard to reach an agreement between males, for they can lie to their friends less stressfully for winning higher credits; we consider that in a male-to-female match, the probability of agreement will be high, in the factor of male modesty to female and mutual courtesy.

5. CONCLUSION

Under tight time pressure, the author bodily accomplished the experimental goal of mathematically explaining the impact of each variable on consensus and decision-making by analyzing a large amount of recorded data. However, there were still vulnerabilities in the execution of the experiment. Many players' spontaneous behaviors (whether neutral or harmful) could not be effectively regulated in the chaotic game scenario. During the experimental phase, the program used to generate player matchup sequences occasionally created vulnerabilities by generating consecutive matches of the same players. However, the experiment conductors prepared alternate sequences; these sequences sometimes duplicated sequences that did not need to be replaced, leading to a small number of players who had no choice but to reach win-win or lose-lose outcomes in such cases.

In the future, the author expected to apply these research results into reality in the following aspects:.

Firstly, incentives in the experiment represent the motivations presents in real life. Since in real life, incentives act as excellent stimulator or motivator because it encourages people to improve their efficiency level and reach the target, maximizing their ability. In order to reach the top three in the game, players will act more aggressively, potentially affects their identity decisions which are closely related to their gain or loss.

Secondly, the information in our experiment represents the understanding of the whole game. We want to inform our audiences that people can perform better when they have a relatively full understanding of the task they will complete. Once people understand one thing, they will act confidently, which greatly influenced their identity decision.

Thirdly, Communication has two sides. It will give the player more comprehensive information about the whole field situation, which is the side that is beneficial to the player. The other bad side of communication is that it is the main reason for cheating, and in this case,

communication can have the opposite effect of confusing the player's judgment.

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