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Analyzing Factors Influencing Cooperativeness Using the Prisoner's Dilemma

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Abstract The authors analyzed the factors that can influence cooperativeness. Altogether 102 participants were asked to play the Prisoner's Dilemma game as a measurement of cooperativeness (those people who did not confess were considered cooperative). The participants were asked about their sex, age, education, and occupation. The results were analyzed using a Chi-square test. Probably due to the relatively small sample size, none of the investigated factors affected the participants' answer. However, for education and occupation clear tendencies were found showing that higher education and intellectual activity coincided with a higher tendency toward cooperation.

Keywords Prisoner's Dilemma, cooperative and competitive behaviour

Introduction

Cooperative and competitive (uncooperative) behaviour forms (strategies) can be found in all areas of everyday life. Some examples are given by Mérő (1996), from among which the story of Tosca (An Opera by Puccini) will probably raise the highest interest. In the story both protagonists (Scarpia and Tosca) try to cheat the other, but, as a consequence, neither gains any advantage (neither of them followed a cooperative strategy). The listed examples (Mérő, 1996) show that in most situations one can follow either a cooperative or a competitive strategy and the success or failure of the adapted behaviour (strategy) mainly depends on that of the other participant(s) in the situation. This phenomenon is one of the key problems of game theory - a relatively new disciple developed by von Neumann (1928); von Neumann and Morgenstern (1944) – named the "Prisoner's Dilemma" (Tucker, 1950).

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The dilemma is this: Two men are found near the scene of a bank robbery. Both men are found to be carrying concealed weapons and are taken into custody. Each man is interrogated separately and, because of a lack of evidence, the investigating officer offers to cut each man a deal. The officer to the first man: "If you confess to the robbery then we'll cut you a deal. Implicate your partner in the robbery and we'll let you go free, dropping the firearms charges we have against you." The man responds: "What will happen to my partner if I do?" The officer: "He'll be prosecuted to the full extent of the law. We'll have him up for the robbery and on firearms charges. But you will go free." The man responds: "And if my partner confesses too?" The officer: "Then you'll both be prosecuted but since you've both cooperated we'll only push for a lenient penalty" A similar conversation is carried out with the second man. Both men have a choice, to confess or stay silent. They are kept in isolation and can't discuss what they might do. We are to assume that both men will act rationally to get the mildest sentence for themselves. Firearms charges receive one year, bank robbery receives ten years, while the reduced charges will result in five years imprisonment. The outcomes can be summarized in table 1.

Table 1. The possible outcomes of the prisoners' dilemma:

	1st Man Confesses	1st Man Stays Silent
2nd Man Confesses	1st gets 5 years, 2nd get 5 years	1st gets 10 years, 2nd goes free
2nd Man Stays Silent	1st goes free, 2nd gets 10 years	1st gets 1 year, 2nd gets 1 year

As argued by Mérő (1996), logic requires each robber to confess, because if the other man stays silent then confession results in 0 years in prison (freedom) compared to 1 year. If the other man confesses then again it is better to confess and receive a 5 year sentence compared to a 10 year one. Yet if both men follow the same logic they both get 5 years instead of the 1 that they would have gotten had they both stayed silent. The question is whether this logic excludes meaningful cooperation between these men?

In past studies, numerous experiments have been carried out studying the prisoners' dilemma and varying the possible outcomes. In the present study, our objective was to analyze the possible environmental factors that could influence the chosen strategy in this dilemma.

Material and Methods

The study was carried out in April 2010. 102 people were asked to play the prisoners' dilemma following the outcomes provided in table 1. Besides, they were also asked about their sex (63 female, 39 male), age (42 14–18 y; 20 19–30 y; 24 31–40 y; 8 41–50 y; 3 51–60 y; 1 61–70y; 4 71–80y), education (47 primary school, 2 industrial school, 17 secondary school, 36 university), occupation (35 white-collar workers, 10 manual workers, 57 students). Because of the low number of observations, age classes over 40 years (15.7% of all cases) were pooled. For the same reason, the 2 participants finishing industrial school were merged with those of secondary school. The answers of the participants (0 = do not confess, 1 = confess) were analyzed by

Chi-square test using the Proc Freq procedure of SAS (SAS Institute Inc., 2002–2003). The participants were randomly sorted into pairs, but, because of the low sample size, the outcome (penalty) was only analyzed by descriptive statistics.

Results and discussion

The frequency distribution of the answers according to the sex, age, education and occupation of the participants is provided in tables 2-5. Altogether 44 out of 102 participants decided to confess; that is 43.1%. This percentage was 38.4% and 46% for males and females, respectively, and the difference between them was not significant (p=0.45) (table 2). The average age of the participants was not known precisely, but it could be estimated using the midpoint of the different age classes. According to this method, the average age of the participants was 28.5 years. In terms of the different age groups, the percentage of those participants who decided to confess was 42.8%, 40%, 45.8% and 56,2%, respectively, which was not significantly different (p=0.98). According to Mérő (1996) females tended to confess in a higher proportion (65%) than males (40%) especially when the penalty was increased for the participant who remained silent.

Table 2. Outcomes of the prisoners' dilemma according to sex

	Male	Female
Not confess	24	34
Confess	15	29

Table 3. Outcomes of the prisoners' dilemma according to age

	14-18 y	19-30 y	31-40 y	41- y
Not confess	24	12	13	9
Confess	18	8	11	7

Education also did not influence the willingness to confess (p=0.16) although its frequency was substantially lower (30%) among those who finished University than among those who stopped education after primary school (51%) or secondary (or industrial) school (47.3%) (table 4). This result shows that higher education tends to increase cooperation, although this result was not proven statistically.

Table 4. Outcomes of the prisoners' dilemma according to education

	Primary school	Secondary school	University
Not confess	23	10	25
Confess	24	9	11

Table 5. Outcomes of the prisoners' dilemma according to occupation

	White-collar worker	Manual worker	Student
Not confess	24	3	31
Confess	11	7	26

The results for occupation were very similar to those from education. This factor did not affect the proportion of those who showed cooperation (not confess). White collar workers confessed in a much lower percentage (31.4%) than manual workers (70%). This finding corroborates previous findings: those people whose work requires physical activity are less prone to collaboration. Despite the substantial difference, this could not be proven statistically due to the low frequency of (9.8%) of manual workers. That similar tendencies were found between the education and occupation is insignificant, because those who finished higher education were recorded as white-collar workers almost entirely (94%).

When the participants were randomly paired it was found that 17 pairs were cooperative (neither of them confessed), 10 pairs were competitive (both of them confessed) and 12 pairs were mixed (one of them confessed the other remained silent). Thus the average penalty was 3.67 which is closer to the possible maximum of 5 years (if everybody confessed) than to the possible minimum (if every participant kept silent). From the 44 participant who confessed (played for freedom) 54.5% were released and 45.5% jailed for 5 years. Almost the same percentages were recorded for those who did not confess (played for a 1 year penalty) 58.6% got 1 year while 41.4% got 10 years. Thus, those who confessed were jailed on average for 2.72 years, which was much shorter than the average sentence of those who did not confess: 4.72 years.

Mérő (1996) noted that generally, when the Prisoner's Dilemma game is played only once, the percentage of those who cooperate (not confess) is about 40%, which is substantially lower than in our experiment (56.8%). However, when the play is repeated many times the willingness to cooperate increases to about 60%. Repeated Prisoner's Dilemma games were investigated by Axelrod (1980 a,b), who organized a Prisoner's Dilemma competition where participants could compete with softwares developed for playing the dilemma many times. The participating programs were randomly sorted into pairs and the pairs had to play the game 200 times. The software that won both competitions was called "Tit for Tat" which was extremely simple: in step 1 it cooperates (not confess) and in all subsequent steps it plays the step that was played by the opponent in the previous round. The main characteristics of this program are friendliness and forgiveness. These features can be considered important in order to be successful in situations that manifest the prisoners' dilemma. In an experiment Milinski (1987) analyzed the behaviour of stickleback fishes and found that they closely followed the "Tit for" Tat strategy. Unfortunately, many times we find that, in Prisoner's Dilemma-type situations, animals show more rational behaviour than humans.

Conclusions

In the present study, no investigated factors influenced the percentage of the Prisoner's Dilemma results (confess vs. not confess), which was probably due to the relatively small sample size. Nevertheless, we received clear indications that higher education and intellectual activity increase subjects' willingness to cooperate.

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