Two Peas in a Pod: Play the Prisoner's Dilemma with Your "New Twin"

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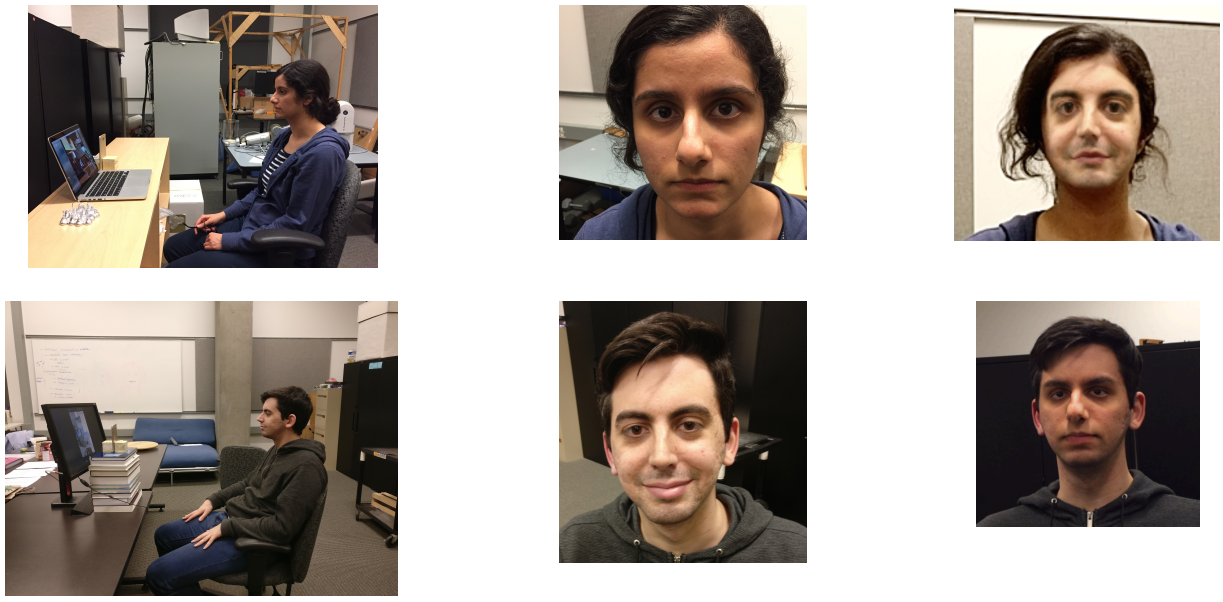

Figure 1: Experiment set up and twin effect.

ABSTRACT

The virtual self of one person is an entity that looks exactly like the person. The manner in which a person interacts with their virtual self can be in many types, and people have explored the cases when the person ignores, watches, controls, or communicates with the virtual self. However, the case when people cooperate with their virtual self has yet to be investigated. Cooperation in non-relatives is difficult to achieve or foster because of a lack of closeness and mutual understanding. In the presented work, we use the cooperation between one person and their virtual self to improve cooperation between two non-relatives. This is achieved by making a pair of individuals perceive one another as their identical twin. This is called the twin case. There are two cases in the experiment, and the other one is the non-twin case. The cooperation in the presented work is evaluated in the Prisoner's Dilemma game which is a classic model that has been used for decades to investigate cooperation in human society.

We ran experiments within subjects in both the twin case and non-twin case. We evaluated the proportion of cooperative acts and

final payoffs. We came to the conclusion that participants cooperated more frequently and thus gained more payoffs in the twin case. In addition to this, we evaluated the level of closeness after the game, and found that the pair perceived a higher level of closeness in the twin case.

KEYWORDS

Self; Cooperation; Game theory; Closeness

1 INTRODUCTION

Have you ever thought about what you really mean when you say "myself"? The word "self" has been taken for granted by everyone, but do you really know what it means and why you keep saying it? What is the relationship between you and "yourself"? Can "yourself" be outside of you?

The mirror test is a famous measure of self-awareness, and human beings start showing self-recognition when they are around 18 months old. The mirror is the most common way of seeing "ourselves" outside of us, while there are other uncommon ways which are not experienced by everyone. Olaf Blanke and Thomas Metzinger introduced three illusory self body perceptions: autoscopic hallucination, heautoscopy and out-of-body experience[1]. These three illusions are the phenomena of seeing a second version of your own body in extracorporeal space, and usually a result of damages at different brain locations.

Imagine "yourself" is outside of you, and you are looking at yourself right now, what kind of interactions would occur between you and your second self? You can ignore yourself, watch yourself, control yourself or communicate with yourself. These are the four types of interaction between two selves that have been explored. However, according to our current literature search, we have not found any research about cooperation between two selves, and the present project will fill this gap.

This project aims to explore cooperation between two selves. The "self" outside of one person is played by another person, i.e., turning the other person into the identical twin of the person. Hence, we also explore the cooperation and closeness between two persons, and the impact of turning them into identical twins on their cooperation and closeness. The participants' cooperation in this project will be evaluated playing the "Prisoner's Dilemma" game. Experiments are designed to answer two research questions:

1. Will altering the appearance of two people to look like one another increase cooperation between them?
2. Will altering the appearance of two people to look like one another help in increasing the closeness between them?

2 BACKGROUND AND RELATED WORK

2.1 The Self

There are many experiments that try to create illusions of seeing a second own body in extracorporeal space with digital technology. In 2007, H. Henrik Ehrsson conducted experiments to induce the out-of-body experience using visual perspective and multi sensory stimulation on the body[2]. One year later, Ehrsson and Valeria conducted another experiment to create the illusion of body swapping using the same technology[3].

Except for just seeing "the self", there are researches investigating the implications of controlling the self. In 2010, Jeremy Bailenson and Kathryn Segovia conducted an experiment to investigate virtual doppelgangers[4], and they investigated the implications of seeing the self in exercising, eating, advertisement and memory.

There are more relationships between the real self and the virtual self other than unidirectional watching and controlling. In 2011, Hal Hershfield and colleagues investigated how saving behaviours will be increased through age-progressed renderings of the future self[5]. In 2014, Sun Joo Ahn and Jeremy Bailenson investigated using the self to persuade customers in advertisements[6].

2.2 Avatar

Avatar is the representation of a user. An avatar can be an icon of figure in a video game, Internet forum, etc, and it can take either a 3D form[7] or a 2D form[8]. Avatars can be categorized into mainly two types: humanlike and non humanlike. Interesting avatars are those in novel human template and avatar of the self. In 2015, Jeremy Bailenson and Jaron Lanier investigated the appearance and task success in novel avatars[9], in which they analyzed the performance of avatar with 3 arms, one of which was controlled by rotating hands in a hitting target task. There are some video games that allow users to upload their photos to make the avatar look like the user such as [10].

The relationship between the user and the avatar can also be interesting, and the analysis of relationships between two selves in introduction can be translated to this relationship. Usually the user takes complete control of his/her avatar, but there are examples when the avatar is controlled by the algorithm or other users, such as the game World of Warcraft[11]. In this example, the user is just watching the avatar when the avatar is controlled by the algorithm or other users.

In this project, the user will cooperate with his/her avatar which looks exactly like him/her while it is controlled by another person, but not just watching or unidirectionally controlling the avatar.

2.3 Closeness

In 1983, Kelly gave a widely influential definition of closeness which was based on mutual influence, interdependence and degree of interconnectedness of activities[12]. In 1989, based on Kelly's definition, Berscheid and colleagues developed a measure of interpersonal closeness behaviour which focuses on time spent together, diversity of shared activities and perceived influence of the other over one's own decisions[13]. These two researches are based on behaviours, and there are researches of closeness based on cognitive significance of those behaviors. There are opinions claiming that people tend to act for the needs of the person that is

in a close relationship with him/her[14], and the empathy model developed by Clark and mills shows that people tend to help the person that he/she is in a close relationship with[15]. In 1980, Wegner claimed that empathy may "stem in part from a basic confusion between ourselves and others"[16]. Here comes the core idea of this project: turning another person into our own appearance and using this to increase the closeness between two persons. The idea of self/other merging has also been expressed by many theorists[17][18].

In 1992, Aron and colleagues investigated the structure of closeness and precise measures of closeness[19], and they mainly discussed the utility of Inclusion of the Other in the Self(IOS) Scale and their additional insights into other measures of closeness, especially the influential Relationship Closeness Inventory(RCI). According to the results of this research, IOS is a potentially widely useful measurement technique in research on close relationships, thus this project will use this technique to check the closeness between the two players of the same pair in the game.

2.4 Cooperation

In game theory, players are assumed as rational decision-makers, so the results of the game will only be determined by the two players' willingnesses for cooperation. The prisoner's dilemma is a game in which two players will struggle making decisions based on personal payoff and payoff of the other player in the same group, and it is a classic game which has been used for decades as a model for many real world situations involving cooperative behaviour, such as the cooperation between human and human-like computers[21], cooperation between different gender combinations[22], implications of the perception of the relationship and of an interaction with the other person in the cooperative responses[23]. In the influential book of cooperation "Evolution of Cooperation"[24], Axelrod used the Prisoner's Dilemma as a general representation of cooperation, and though this book was written to investigate how to promote cooperations between the East and the West during the Cold War, Axelrod found later that many people used his work, i.e., the analysis of the single model of Prisoner's Dilemma, in various applications such as understanding dynamics between foraging fish and between divorcing people[25]. It is the generality of this model that makes it the one that the experiment of this project will be based on.

3 MATERIAL AND METHODS

3.1 Experiment Design

Five pairs of students (4 male, 6 female) were selected to play the game over the course of a week. The first two pairs knew each other beforehand (Ex: coworkers in lab/friends) while the rest of the participants were complete strangers. In the case of the strangers, each individual was brought in at different times to ensure they did not see each other before conducting the experiment. They did not know the identity of the other and only interacted with each other while playing the game.

Before the experiment begins each participant has their picture taken (in order to be used by the face swapping software) and is given instructions on how to play the game. Each participant received the payoff-matrix as well 10 chocolates as their starting amount. A camera was placed in front of each individual in order to capture them in real-time. The players were separated from each and could only see each other through the monitor display. Each participant had a game administrator beside them who recorded each player's decision into a single synchronized document (Google Docs). This allowed the participants to be aware of the others choice at the end of each round as well as the current score of both players.

Prior to recording the results of the experiment, a number of participants were used to refine the experimental design. Based on their feedback several aspects of the experiment were modfied including the payoff matrix and interview questions which were altered extensively throughout the test runs. The final payoff matrix used in the experiment can be seen in Table 1.

Table 1: Payoff Matrix

Player A's move	Player B's move	
	Cooperate	Defect
Cooperate	2, 2	-2, 3
Defect	3, -2	-1, -1

Players begin the experiment with a starting amount of 10 in order to account for the negative payoffs. The game consisted of two rounds and the order of the rounds changed for one pair to another. In one round each player would see their face on the other person's body (face swapping). This was done to create the illusion of playing with ones twin. In the other round the players would see each other as they are (with no alterations).

The experiment started with player one picking one of two colours and indicating the choice to the game administrator, then holding up one of the colours to the camera to indicate their choice to the other participant. By showing the other player the same colour they picked they cooperated, otherwise showing a different colour meant defecting. After seeing the other player indicate the colour, player two indicates whether they choose to cooperate or not defect what the other participant is showing them by holding up a card with "Truth" (cooperate) or "Lie" (defect). Each administrator would then enter their participant's decision into the document where the pay-off of each interaction was calculated automatically. In the next iteration, the order switched where player two shows the colour and player one indicates if they think it is a "Truth" or "Lie".. After each iteration the administrator would distribute the payoff to their respective payoff by either adding chocolate pieces (positive payoff) or removing them (negative payoff).

Each round lasts for 14 iterations where the order goes back and forth between the players after each iteration, however the players are told that the end of the game is randomly determined and might occur after any interaction. The end of the game is kept ambiguous in order to not influence the participants decision making (players might decide to defect more often towards the games end). At the end of each round each participant fills out a form indicating their level of cooperation with the other player. When two rounds completed, the game ended and each the players had to fill in a questionnaire stating their age, sex and their knowledge of game theory (based on a scale). Finally each participant is interviewed separately on their thought process and

feelings throughout the game. The interview inquires about how the participants strategy evolved during the game and whether their perception of the other individual changed at any point.

3.2 Data Analysis

We consider the pair of players playing under either the twin condition or under the non-twin condition (n=5 in each condition) as the unit of analyses. Each pair of players played under both conditions. The proportion of cooperative acts, the average of players' total payoffs, and the average level of closeness between the two players were each separately considered as the dependent variables and were measured during the experiments. In order to investigate whether the order of test conditions (whether the pairs start the game under twin or non-twin condition) have any effect on the dependent variables, 2 pairs of participants start the experiment under twin condition and the other 3 start under non-twin condition. Each experiment were run for 14 iterations.

After collecting the data, in order to investigate whether the players used the optimum strategy or not, we counted the number of tit-for-tat (TFT) and Pavlovian moves in order to define the μ value (the probability of cooperation after oneself defected and the opponent cooperated, which equals 1 in TFT case and equals 0 for Pavlovian moves). The individual with $\mu \geq 2/3$ were considered as TFFT players and those with $\mu \leq 1/3$ as Pavlovian players.

Finally, the Analysis of Variance (ANOVA) were done on proportion of cooperative acts and the average level of closeness in order to highlight the significance of twin effect on these values.

4 RESULTS

4.1 Quantitative Results

Comparisons of proportions of cooperative acts are shown in Fig. 2. From the bar graph, the proportion of cooperative acts in twin case is higher than that in non-twin case no matter what order they are at, the difference is most obvious between cases when they both go first and there were no influence from previously run session. However, the difference between results of the two orders is obvious and interesting in the two conditions. POC is higher for twin case when it goes firstly than it goes secondly, while POC is lower for non-twin case when it goes firstly than it goes secondly. If we look at the POC of twin case under the first order and the POC of non-twin case under second order, we will find that the twin case in the first order leads to an increase of the POC in the non-twin case which is run at the second session. Under similar analysis, we also find that after the first session of non-twin case, the POC still increases in the second section of twin case.

Fig 4. shows the POCs of each iteration. POCs of each iteration are fluctuating, so does the relationship between POCs of the two cases. In all 14 iterations, there are 6 iterations when POC of twin case is higher than POC of non-twin case, while there are 4 iterations when POC of non-twin case is higher than POC of twin case, and POCs of the two cases are the same at the rest iterations. Contrast to other studies, we did not observe significant decrease in the POC across iterations in this graph.

Fig 3. shows the average payoffs in the two cases. The average payoff for twin case is 10 ± 3.07 while the average payoff for non-twin case is 8.5 ± 1.53. Different orders have significant impact on final payoffs of these two cases and twin case has higher payoffs in both orders while the difference is more obvious between the two cases when both of them go first. Payoffs of the two cases when they are in the second section are close and both of them are relatively low. While we did not observe the decrease of the POC across iterations, we observed the decrease of payoffs across iterations in this graph.

The probabilities of using Tit-for-Tat and Pavlov in the present study are not significant. The probability of TFT in twin case is 0.1071 while it is 0.1142 in non-twin case. The probability of Pavlov is 0.1214 in twin case while it is 0.1286 in non-twin case. There are not significant differences in the two cases in terms of strategies used.

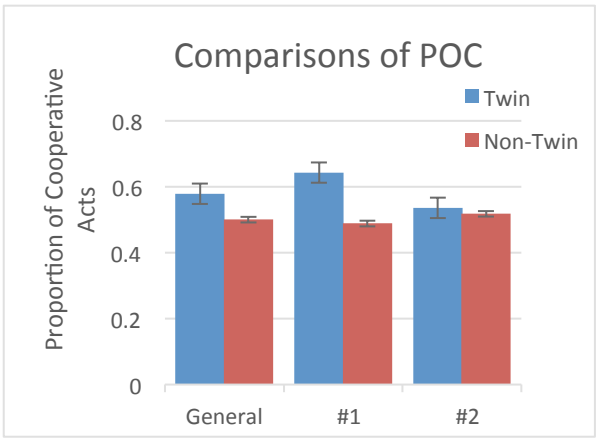

Figure 2: Comparison of proportions of cooperative acts in twin and non-twin cases. The cases when the condition tested firstly (#1) and when it is tested secondly (#2) are separately analyzed, and then they are combined as shown in the first two bars (general).

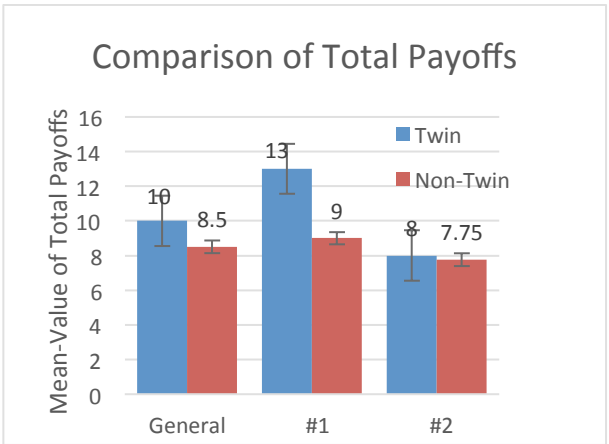

Figure 3: Comparisons of total payoffs after all iterations. The analysis process is the same as the comparisons of cooperative acts.

4.2 Qualitative Results

Overall, participants are highly engaged in the game, and we have observed their high desire to get high payoffs in the game. Though the pool of participants is not large enough, participants gave many interesting comments in the post-game interviews.

One participant commented that her decision making process was largely affected by the twinness in the second section, and it encouraged her to cooperate more every time she saw her own face, though she and her game partner did not cooperate well in the first session. Another participant commented that she paid more attention to her game partner in the second session of twin case. There is one participant, who gained relatively higher payoffs in the pair, who commented that she felt that she cooperated more in the second session of non-twin case, while the data showed that she cooperated more in the first session of twin case.

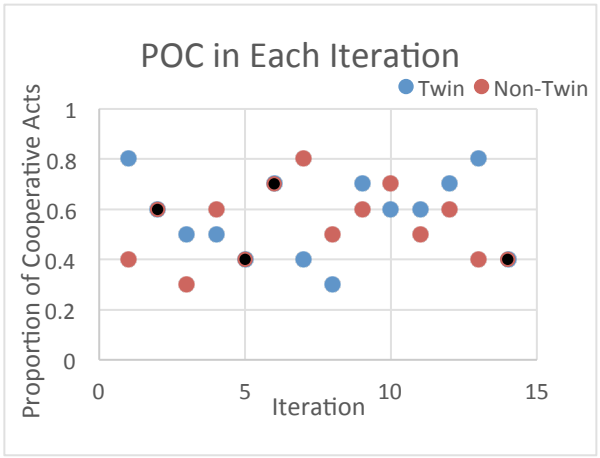

Figure 4: Proportions of cooperative acts in each iteration (14 iterations in total)

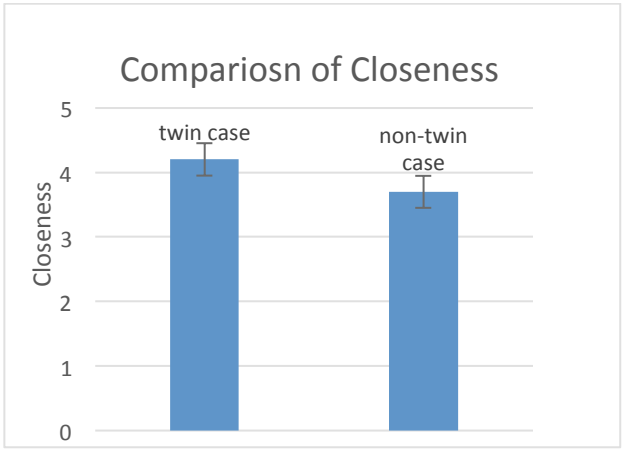

Figure 5: Comparison of closeness after the two conditions using IOS.

5 DISCCUSSION

We ran the experiment on 10 participants (5 pairs) to test our hypotheses and find answers to our research questions. Though the pool of participants is small, we obtained data from payoffs and proportions of cooperative acts which justify our hypotheses. At this moment, we can answer our research questions based on data we collected.

Turning two persons into the same appearance increases the proportion of cooperative acts, and this does not need to be aligned with the two persons' feelings. Due to the small number of participants, we ran the two conditions within-subjects, and we administered test conditions in different order to each group to reduce order effect. We also analyzed data for each order separately to maximize our understanding of the experiment results. Our hypothesis about the case of twin in the first order is that cooperative acts will increase significantly, while our hypothesis about the case of twin in the second order is that cooperative acts will not be affected too much. Our hypotheses are justified by the separate analyses described above, and to our surprise, the cooperative acts are increased even when the twin case is run in the second order. An interesting observation is that the participants were concerned about the increase of cooperative acts and there were cases when they felt that they defected more in the twin case but the data showed that there is no increase in defection compared to the non-twin case.

Turning two persons into the same appearance is helpful in increasing closeness between the two persons. The questionnaire of closeness was filled right after each session, and generally the level of closeness is not high, but closeness in twin case is relatively higher than non-twin case.

Though the results justified our hypothesis, we have to mention that according to our observations of the patterns in the data we have collected, we have not seen obvious difference between the two experimental conditions. From the ANOVA analyses of POC and closeness, we got p value of 0.389 for POC and p value of 0.639 for closeness. Besides, due to the small pool of participants, we are not confident enough to say that to what extent will turning two persons into the same appearance increase cooperation and closeness between two persons.

Besides, some participants reflected that the face swapping software is not natural enough, and it looks artificial. Ideally, the two persons will see each other having exactly the same appearance with themselves, including hair, face, body and cloths, while the body of "new twin" is acting naturally with natural facial expression.

6 CONCLUSIONS AND FUTURE WORK

This work examines how cooperation between two people changes when each person perceives the other as their twin. A game based on the Prisoner's Dilemma is used to evaluate the level of cooperation between the pair. The game consists of two rounds: one where they perceive each other as their twins, the other where they see each other normally. We designed and ran the experiment while focusing on our two research questions. Though there are limitations on the pool of participants and experiment environment, the results we obtained answered our research questions and justified our hypotheses.

The work of the experiment can be expanded upon as future work. For example, virtual reality can be used to create a more

immersive interaction with other participant. In this scenario each player would wear a virtual reality headset and only interact with the other participant through the virtual world. In the virtual world each player would see themselves projected onto the other participant's body. In this way it would create a 3D representation of playing with your twin.

In the virtual world each player would have a color above their heads that only the other one could see. Each player would have a virtual heap of gold coins beside them that represented their starting sum. The game would proceed with one player telling the other what their color is either telling the truth or lying, and the other player choosing to believe them or not. Based on the payoff the players receive, more gold coins would either appear (positive payoff) or their existing amount would decrease (negative payoff).

One case that was not covered in current experiment is when the two participants are different genders due to the limitations of the face swapping software. However with the use of 3D representations this is now possible. In addition to that the pool of participants grows larger because the face swapping software requires that people have similar facial structure and hairstyle.

The design of the payoff matrix can be improved to find the right balance between defection and cooperation. This would require more testing through trial and error to determine the final values. In addition to this, the questionnaire can be revised to obtain more relevant information from the users. The addition of open ended questions would allow us to explore a wider range of possible themes that arise from an issue.

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