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Modifying the Iterated Prisoner's Dilemma

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The present experiment introduces a modification of the iterated prisoner's dilemma (PD). In contrast to classical dilemma situations with only one interaction partner, participants ($N = 120$) interacted with five fictitious interaction partners within one game, either in a random order (change condition) or against each of the interaction partners in succession (block condition). The authors assume that the change condition simulates the social interactions of a real environment more accurately and that individual memory skills are more important in the change condition as compared to the block condition. As dependent variables, the participants' score in the game was recorded, as well as the participants' memory performance concerning information about their interaction partners. Results show that good memory performance with respect to biographical information leads to higher scores only in the condition with changing interaction partners, but not in the block condition.

Keywords: *cooperation; social interaction; prisoner's dilemma game; episodic memory*

It is a poor sort of memory that only works backward.
—Lewis Carroll (1871/1983)

In the traditional and frequently studied iterated prisoner's dilemma paradigm (PD), two persons—who know each other to a greater or lesser extent—interact repeatedly. Both individuals make independent decisions about cooperating with

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versus deceiving their interaction partner. A deception has a more favorable effect for the deceiver—but only if the partner cooperates. When both interaction partners deceive, however, the result (e.g., payoffs, prison punishments, and other reward or punishment incentives) is worse for both persons as compared to mutual cooperation (for a summary, see Axelrod, 1984).

The PD is not merely a tool for use in social scientific investigations. Rather, we find ourselves in such situations on a daily basis. For example, imagine somebody asking you to lend him or her money. You then have the choice of complying with this request and trusting that you will receive the money back after a given time. You also may refuse the favor; however, you may then run at risk of not getting help when being in need at any point. It is only in retrospect that we know which one of the two alternatives had been the better one, namely, when we realize how our interaction partner behaved. Many other examples—from the individual level to situations of great societal relevance—are conceivable (e.g., see Dawkins, 1994).

It is evident that social skills, especially episodic memory capacity, should be helpful to make such—at times distinctly difficult—decisions with the greatest possible benefit for those involved. The present article has two goals: (a) We propose a modification of the PD game that captures such real-life situations more realistically, and (b) we analyze whether specific memory skills enhance performance in this revised version of the PD.

On the Ecological Validity of the Classical PD Game

The iterated PD has been the subject of numerous investigations with various different designs and research questions, particularly in the area of social psychology; Axelrod (1980) has described this paradigm as the "E.coli of social psychology" (p. 6). One of the most impressive findings in the history of the PD is a tournament held by Axelrod (1980) to determine the best play strategy in these situations (for an overview on these as well as more recent findings, see Komorita & Parks, 1999). Overall, a strategy named tit-for-tat turned out to be the most effective play strategy in most situations: Tit-for-tat cooperates at the beginning of each interaction and then behaves in exactly the same way as the game partner has just done previously. Hence, every attempt at deceiving is punished immediately, and offers of reconciliation by the opposing party fall on fertile ground without any resentful phase.

Although most studies of the PD have dealt with two-person games, recent analyses reveal that strict reciprocity becomes more difficult to sustain as the size of the social group increases (e.g., Boyd & Richerson, 1988; Enquist & Leimar, 1993; Joshi, 1987). With increasing group size, it is more difficult to remember the quality of the interactions a person had with every single interaction partner and therefore to choose the adequate reaction that fits the preceding behavior of the interaction partners.

Thus far, individual memory skills as a determinant of behavioral decisions in the PD have not been investigated. This is likely due to certain methodological aspects inherent in previous studies in this domain. To examine the extent to which episodic memory capacity may help the persons involved in social dilemma situations to achieve success, let us first analyze whether our everyday interpersonal interactions have been realistically depicted by the classical iterated PD (see also Boyd, 1995). As mentioned above, in the traditional PD, typically two persons interact with one another for several rounds of the game. Thus, these interaction partners have the possibility to get to know the respective interaction partners and have the opportunity to analyze carefully whether they can trust the other person.

In reality, however, we are confronted with several or even a multitude of different persons every day. Moreover, we often do not receive immediate feedback as to whether the other person is trustworthy or not, and we rarely have the opportunity for direct payback (in both a positive and negative sense). Rather, we often engage in similar reciprocal exchanges with other persons as well, until we eventually know whether our previous decisions regarding cooperation or refusal of cooperation were smart choices or put us at a disadvantage. Hence, in real life, it might not be as easy to follow the recommendation of Axelrod (1980) and engage in a tit-for-tat strategy as it seems to be in the traditional iterated PD. To react in exactly the same way as the interaction partners have done previously, it is necessary to recognize these persons and link them to their previous interactions. Thus, we should remember the quality of these relationships and the individual contacts to react accordingly—possibly after a protracted amount of time or despite other interactions in the interim.

In addition, social motives like the need for achievement, power, or affiliation (McClelland, 1961) play a key role in determining the actual strategies used by the interaction partners. For example, Kelley and Stahelski (1970) demonstrated that when playing with competitive participants, cooperative persons behaved in an equally competitive manner. Thus, persons analyze the information available about their social environment and use this information to accommodate their behaviors accordingly. In light of this evidence, we propose that memory skills of the respective interaction partners are crucial for making the best possible choices, especially within larger groups and in comparatively realistic settings.

When considering the highly developed human ability to recognize faces, to interpret the moods of others, to detect deceit, and to react accordingly, it seems likely that evolution has prepared us well for precisely these social exchange relationships (for a summary, see Dunbar, 1996). Likely, however, individual differences exist with respect to the memory skills of the persons participating in such interactions (see, e.g., Kihlstrom & Cantor, 2000). Thus, people will differ in their ability to remember their interaction partners and the specific interactions they had. To analyze the potential effects of such individual differences, we assessed the memory performance of our participants by a memory task concerning biographical information about the interaction partners and the respective interaction patterns within the game.

Moreover, we introduce a modification of the iterative PD game. Therefore, the participants will be confronted with several fictitious game partners simultaneously and interact with them in a random order. We assume that the demands on the memory skills of the participants are quite different when the players are confronted with constantly changing interaction partners, as compared to situations in which the participants are in a continuous reciprocal exchange with one single interaction partner (the classical PD game).

Hypotheses

The goal of the current investigation is to examine whether persons with better memory performance concerning biographical data of their game partners (i.e., faces, names, or occupations) and the actual interaction patterns achieve better results in a (revised) PD game. In addition, we examine whether the classical iterated PD paradigm differs from a more realistic variant with changing interaction partners. More precisely, the following two hypotheses will be examined:

Hypothesis 1: Participants in the classical iterated PD (block condition) will, on average, achieve better game results than the participants in a PD with changing interaction partners (change condition).

In the block condition, the participants play continuously with the same interaction partner and therefore have the opportunity to adapt themselves to the partner's behavior. As a consequence, higher scores should be obtained. In the change condition, by contrast, the participants are faced with constantly changing interaction partners. Accordingly, it will be more difficult to achieve a high score.

Hypothesis 2: Persons with a better memory regarding biographical information about their game partners and their actual interaction patterns will, on average, achieve better results in the PD game.

This is because it is highly useful to identify the interaction partners to react correspondingly. In a game situation with constantly changing interaction partners, these memory skills will be even more important and thus will distinguish more strongly between good and less good players as compared to the block condition.

Method

Sample

A total of 120 persons (80 female, 40 male) took part in the experiment. Participants were aged between sixteen and sixty-one years, with a mean age of twenty-four years.

Half of the participants were studying psychology, while the other half studied other subjects or were recruited from outside of the university. Participants were randomly assigned to one of the two experimental conditions.

Game Version of the PD

Participants' task was to play against five fictitious interaction partners, introduced on a computer screen by means of a photograph, their first name, occupation, and age. Each of these fictitious interaction partners was assigned a game strategy (without the knowledge of the participants), which was maintained for the complete duration of the game.

Five photographs were selected from a list of 20 passport-like photographs of male persons aged between twenty-five and thirty-five years. The facial expression of the pictured people was held constant, as all men showed a neutral but friendly smile. Only photographs of men were used to control for potential influences of gender. The selection of the photos was based on a pilot study ($N = 20$), aimed at achieving as comparable photographs as possible with regard to perceptions of attractiveness, age, intelligence, trustworthiness, and good nature. For the selection of the first names of the fictitious interaction partners, we referred to a study by Rudolph and Spörrle (1999; see also Rudolph, Böhm, and Lummer 2006), presenting word norms for German first names. Male first names with equivalent mean values for perceived attractiveness and perceived intelligence were selected. For the selection of the occupations assigned to the interaction partners, we referred to a study by Spörrle and Rudolph (2000) providing likability and prestige ratings for various occupations. The selected occupations had equivalent mean values with respect to likability and prestige. The allocation of the first names and occupations to the photographs was determined randomly. The fictitious age of the interaction partners presented to the participants resulted from the mean value of age estimations that had been assessed within our pilot study.

Each of the fictitious interaction partners was randomly allocated to one of the following game strategies: (1) "tit-for-tat," (2) "nasty," (3) "nice," (4) "mild tit-for-tat," and (5) "naïve prober." The strategy "tit-for-tat" begins the game with cooperation and then always does what the participant has done previously. The strategy "nasty" always deceives, while the strategy "nice" always cooperates. The game strategy "mild tit-for-tat" plays in the same way as "tit-for-tat" except that after three deceptions on its part, it always cooperates in the fourth round. Thus, longer sequences of deception are interrupted. The strategy "naïve prober" also plays like "tit-for-tat," apart from the fact that after a sequence of three instances of cooperation on its part, it always deceives in the fourth round. Therefore, longer sequences of cooperation are interrupted.

Procedure

The participants were randomly assigned to the block condition versus the change condition. In the block condition, the participants interacted with the same fictitious interaction partner for 30 rounds of the game; subsequently, another 30 rounds began with the next interaction partner, until the participant had played against all five interaction partners. In the change condition, the participants were also confronted 30 times with each of the five interaction partners. In contrast to the block condition, here, the interaction partner changed randomly after almost every round—with the exception of individual random doubles. The order of the total of 150 rounds of the game was set randomly.

At the beginning, participants were told that the fictitious interaction partners were real people and that their play behavior had been determined in several preliminary investigations and translated into a computer program. Before the beginning of the game, the interaction partners were introduced to the participants by means of their photograph, first name, occupation, and age. Participants were asked to imagine that they themselves and the interaction partners were traders who bury money or secret goods in separate places and then check out the hiding place of the other. Upon each round of the game, each of them—participant and interaction partner—had to decide anew whether to actually deposit the goods/money (i.e., to cooperate) or whether to deceive the other and not deposit anything in the hiding place. If both cooperated, both players received two points; if both players deceived, then both would go away empty-handed and receive no points. If however, one of the two players deceived while the other cooperated, the deceiver received four points, while the deceived person received a minus point (see Table 1 for the payoff matrix). Participants were told that the goal of the game was to achieve the highest possible total score.

Within each round, the participants were informed about which of the five interaction partners they were currently playing against (with the help of the photograph and the interaction partner data, that is, first name, occupation, age) and how often they were to interact with this player again. The participants then made a decision concerning their own cooperation or deception. The score achieved by the participant was revealed directly after each round of the game. At the end of the game, the total score achieved by the participant (with each interaction partner) and the respective scores of the interaction partners were presented on the screen.

After the PD game, the participants participated in a cued recall task; they were presented with the five interaction partner photographs and asked to freely recall the first names and occupations of these interaction partners. The amount of correctly remembered data served as a measure of the memory performance regarding biographical information about the interaction partners. We did not ask for the age of the interaction partners, because it is not an indicator for memory performance

Table 1
Payoff Matrix of the Present Prisoner's Dilemma Game

	Fictitious Interaction Partner	
Participant	Cooperates	Deceives
Cooperates	2 points (for participant) 2 points (for interaction partner)	−1 point (for participant) 4 points (for interaction partner)
Deceives	4 points (for participant) −1 point (for interaction partner)	0 points (for participant) 0 points (for interaction partner)

but merely a measurement of the ability to estimate the age by means of their pictures.

Finally, the participants were asked to estimate how often each of the interaction partners decided for cooperation within the 30 rounds of the game. The difference between the real amount of cooperation choices of the single interaction partners and the estimations of the participants served as a measure of the memory performance concerning the actual interaction patterns.

Results

First, an analysis of variance with gender of the participants as an independent variable reveals that there is neither an influence of the participants' gender on the game result nor an influence on the respective measures of memory performance, $F(1, 119)$ always < 2, p always $> .10$. We first compare the classical iterated PD with the new variant of the PD game with changing interaction partners to analyze whether the demands on the participants differ between these two variants of the game. Second, we analyze whether the respective memory skills of our participants have any effects on their performance in the respective experimental conditions.

Comparison of the Game Results for Block versus Change Condition

To compare the game results for the block versus change condition, we computed an analysis of variance with the experimental conditions (block and change) and the interaction partners (game strategy 1 to 5) as independent variables. The game results differ significantly between the two experimental conditions, $F(1,118) = 8.21$, $p = .005$, and for the five interaction partners, $F(1,118) = 225.35$, $p = .000$. There is no interaction effect between experimental condition and interaction partner. In line with our hypotheses, more points were obtained in the block condition ($M = 228$, $SD = 27$) as compared to the change condition ($M = 214$, $SD = 26$). Individual *t*-tests, however, reveal that significant differences are obtained for only

Table 2
Means and Standard Deviations for Recollections of Biographical Data and Actual Interaction Patterns

Recollection of	Change Condition *M* (*SD*)	Block Condition *M* (*SD*)
Biographical data	4.13 (2.10)	4.17 (2.03)
Interaction patterns	−3.47 (2.45)	−4.00 (2.55)

Note: For biographical data, higher mean values indicate better memory performance; for interaction patterns, mean values indicate the differences between estimated and actual cooperation frequencies.

two of the interaction partners, that is, for the strategies "nasty" and "nice." For the other, more complex strategies, no significant differences were found. This finding can be attributed to the fact that even in the block condition, it is quite difficult to correctly recognize the three more complex strategies (i.e., "tit-for-tat," "mild tit-for-tat," and "naïve prober") and to react correspondingly.

Memory Performance Concerning Biographical Information about the Interaction Partners

Mean values for recollections of biographical information and actual interaction patterns are given in Table 2. There is no effect of block versus change condition on any of these dependent variables, $F(1, 119)$ always < 2, p always $> .10$. To analyze the relationship between the obtained score and memory for biographical information (i.e., names and occupations of the interaction partners), we calculated a linear regression analysis. A significant effect of memory performance on game result is obtained only for the change condition, $R^2 = .23$, $t(60) = 1.80$, $p = .039$, while no significant effect is obtained in the block condition, $R^2 = .02$, $t(60) = -0.14$, $p = .889$. Thus, for the change condition, persons who are better able to memorize biographical data of their interaction partners obtain significantly better game results. In the comparatively easier block condition, however, it makes no difference for the success in the PD game whether participants remember biographical data of their interaction partners.

Memory Performance Concerning Actual Interaction Patterns

We calculated linear regression analyses to analyze the relationship between the game results and memory performance regarding the actual interaction patterns in the game with every single interaction partner (remembered number of cooperation choices of the interaction partners). A significant regression was obtained for both the block, $R^2 = .33$, $t(60) = 2.62$, $p = .011$, and the change condition, $R^2 = .42$,

$t(60) = 3.52$, $p = .001$. Thus, persons with a better memory performance for the interaction patterns achieved better results in the PD game.

Discussion

When analyzing the usefulness of memory skills within the iterated PD game, we need to analyze as to how typical everyday social interactions are realistically simulated in a PD game. It becomes clear now that both conditions (block versus change) impose different demands on the participants. We assume that the change condition simulates the social interactions of a real environment more accurately, because in everyday life we interact with many people, and we seldom find ourselves in a continuous reciprocal exchange with only one person.

First of all, the present findings show that memory skills (i.e., identifying the interaction partners) have a positive effect only within the change condition. In the block condition, when playing continuously against one player in the PD, it plays no role for the participants whether their memory performance concerning biographical information is better or worse to obtain good results. In the change condition, however, those persons who are able to better identify their interaction partners by making use of biographical features (i.e., name and occupation) obtain higher scores in the game.

This selective effect of memory skills on game performance in the block versus change condition, however, is restricted to the recollection of biographical information. That is, the recollection of actual interaction patterns turns out to be useful within both variants (block and change condition) of the PD game. Hence, the recollection of the actual interactions promotes the payoffs actually obtained, no matter whether a person participates in a game with constantly changing partners or whether a person plays continuously with the same interaction partner.

To summarize, our data suggest that the recollection of biographical information about interaction partners is especially helpful in an environment consisting of at least moderate numbers of interaction partners (i.e., five interaction partners instead of only one) and when being in random (rather than exclusive and continuous) contact to each of these interaction partners.

Thus far, only few mental capacities have been investigated that exert a direct influence on performance in the PD game, as was the case for the recollection of biographical information for the respective interaction partners in the present study. To conclude, we recommend that future studies in this area will (a) make use of more realistic implementations of the PD game reflecting everyday interactions more adequately and (b) investigate other mental and social skills related to these kinds of social interaction as well.

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