Chapter 1
Cooperators Are Faster but Not More Accurate in Social Exchange Decisions Compared to Defectors

Adam Karbowski, Jerzy Osiński, and Bartłomiej Wiśnicki

Abstract In this study, we focus on decision-making in social exchange. In particular, we test the effectiveness (measured by speed and accuracy of decisions) of the decision-making in social exchange. Experimental results show that persons who cooperate in a prisoner's dilemma game (cooperators) are faster but not more accurate at solving the social contract version of the Wason selection task compared to persons selecting in a prisoner's dilemma game a defection strategy (defectors). Differences between cooperators and defectors in speed or accuracy of decision-making have not been observed in the abstract version of the Wason selection task. The obtained results provide empirical support to the claim that the social exchange heuristic works as an optimizing tool of the human mind.

Keywords Social cooperation · Social exchange · Decision-making · Behavioral economics

1.1 Introduction

Social exchange (cf., e.g., cf., e.g., Kirchler et al., 1996; Kanazawa & Savage, 2009; Yamagishi & Mifune, 2009; Karbowski, 2012; Cook et al., 2013; Ohtsubo et al., 2014; Schilke et al., 2015; Bulbulia, 2017; Kim et al., 2019) is a phenomenon universal for the humankind. This behaviour is common in all cultures, including

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those that developed many years ago. Anthropological evidence to support the latter claim may be found, e.g., in Isaac (1978), Tooby and DeVore (1987), Cashdan (1989), McGrew and Feistner (1992), Sussman and Cloninger (2011) or Johnson (2016).

Cognitive psychology often assumes that the human mind consists of general rules of reasoning, independent from the object or the content of cognition (content-free rules; see, e.g., Fodor, 1983; Overton & Ricco, 2011). Evolutionary science challenges this assumption. According to evolutionary scientists, natural selection has led to the formation of many specific (content dependent) rules of reasoning, responsible for such areas of life as exchange, cooperation, danger or parenthood and care (Cosmides & Tooby, 1992; Overton & Ricco, 2011). Possessing these specific systems of reasoning has adaptive significance. Where, for example, two problems have different optimal solutions, a general principle for problem-solving would be worse off than two specific rules (Cosmides & Tooby, 1992).

Social exchange is the situation where the individuals are obliged to meet a particular requirement, usually at their costs, in exchange for which they acquire the right to gain a measurable benefit from another individual or a group (Cosmides & Tooby, 1992; Kim et al., 2019). The cost borne by the individual is always at least compensated by the received benefit. Social exchange is governed by the laws of interdependence, which makes it a form of a social contract. A failure to comply with the conditions of a social contract will be called "cheating".

According to Cosmides and Tooby (1992), social contracts have the logical structure of implication. This implication may be put down as follows: "If you have accepted a benefit from other persons, bear the cost for their account". While Cosmides and Tooby (1992) focused on the cheater detection device and its activation in the social context, Kiyonari et al. (2000) highlighted another fundamental precondition for the social exchange, i.e. willingness to cooperate. The ability to distinguish between defectors and cooperating persons is particularly useful to those who are going to cooperate (Kiyonari et al., 2000; Hiraishi & Hasegawa, 2001; Pothos et al., 2011; Barclay, 2013; Declerck et al., 2013; Reed et al., 2018). The effective social exchange module should then embrace both:

- a personal willingness (readiness) to cooperate and
- the cognitive ability to distinguish between defectors and cooperating persons (cheater detection device).

These two conditions may be described with the language of the theory proposed by Pruitt and Kimmel (1977). In the light of this theory, achieving cooperation in the social interaction requires: (1) a subjective transformation of the goal perception, from individual to common, and (2) a verification of the expectations that the common goal perception is shared by all the decision-makers involved. The social contract theory of Cosmides and Tooby concentrates on component (2), whereas the arguments of Kiyonari and others (2000) focus on component (1).

Let us now take a closer look at component (1). According to Kiyonari et al. (2000), in a social context, the subjective transformation involves a mental reshaping of the prisoner's dilemma game into the trust dilemma (assurance game). What is

particularly surprising, this also applies to one-off prisoner's dilemma game. There is abundant empirical evidence that shows that people perceive one-shot prisoner's dilemma as the trust dilemma (cf., e.g., Watabe et al., 1996; Kollock, 1997; Hayashi et al., 1999; Kiyonari et al., 2000; Yamagishi et al., 2007).

The personal willingness to cooperate works with the specialized cheater detection module. The ultimate purpose of this module is to limit cooperation to the cooperating individuals. So, on the one hand, the personal willingness to cooperate allows and initiates cooperative behaviour, and on the other hand, the cheater detection device supervises social interaction.

Kiyonari et al. (2000) explain social cooperation in terms of a social exchange heuristic. The Japanese researchers experimentally demonstrated the operation of this heuristic. Participants of the experiment committed a logical error in the direction of favouring cooperation as the situation involved more serious consequences. This suggests the operation of a domain-specific heuristic that encourages the pursuit of cooperation in social exchange (Kiyonari et al., 2000).

We further hypothesize: if such a heuristic works, it should streamline the decision-making process in social exchange. As a result, cooperators should be faster and at least not worse at solving social exchange tasks compared to defectors. Our objective is to test the latter claim experimentally.

Our research problem is then the effectiveness of cooperators' decision-making in social exchange in comparison to defectors' decision-making in such circumstances. We measure the effectiveness of decision-making by the accuracy and speed of decisions.

We hypothesize that cooperation-seeking persons solve the social contract version of the Wason selection task (cf., Cosmides & Tooby, 1992; Evans, 2016) faster and more accurately than defectors. As we noticed earlier, the effective social exchange mechanism (heuristic) entails subject's cooperative behaviour and the expectation that the other decision-makers share common goal perspective. As a result, in a prisoner's dilemma game, the cooperators should expect a higher degree of cooperation on the part of the other players compared to the defectors.

It should also be noted that social exchange heuristic works only in the relevant social context (cf., Yamagishi et al., 2007; Glowacki & Molleman, 2017). In solving the abstract version of the Wason selection task (Green & Larking, 1995), the heuristic remains dormant (Cosmides & Tooby, 1992). Therefore, there are no theoretical grounds to expect the directional differences in respect of accuracy and speed of decisions when the subjects solve the abstract version of the Wason selection task.

Finally, we formulate the following hypotheses.

Hypothesis 1 The persons who select cooperation strategy in a prisoner's dilemma game declare a higher percentage of cooperative decisions on the part of their partners compared to the persons selecting the defection strategy.

Hypothesis 2 In the social contract version of the Wason selection task, the solving time for the persons who cooperate in a prisoner's dilemma game is shorter than for the persons who decide to select the defection strategy.

Hypothesis 3 The rate of correct answers provided in the social contract version of the Wason selection task is higher among the persons who cooperate in a prisoner's dilemma game than among the persons who select the defection strategy.

Hypothesis 4 In the abstract version of the Wason selection task, the solving time for the persons who cooperate in a prisoner's dilemma game is equal to the solving time for the persons who decide to select the defection strategy.

Hypothesis 5 The rate of correct answers provided in the abstract version of the Wason selection task by the persons who cooperate in a prisoner's dilemma game is equal to the rate of correct answers provided by the persons who decide to select the defection strategy.

1.2 Material and Methods

1.2.1 Participants

The research was carried out with the participation of 126 university students (63 women and 63 men). Participants were between 19 and 26 years old (mean 21.7, standard deviation 2.11). They received a fixed remuneration (in national currency, ca. 13 USD).

1.2.2 Material

For the needs of the experiment, an appropriate computer programme (application) was prepared in JavaScript. The programme displayed a series of screens with instructions and fields to fill in by the subjects. The programme allowed us to collect information about the age and sex of the participants. Further, the application allowed to present a description of the prisoner's dilemma task for the subjects (in a task description, we referred to the research done by the Japanese scientists and used the payoff matrix proposed by Kiyonari et al. (2000), p. 421, though we changed the currency since yens in the country where the experiment was run are used less frequently compared with dollars). The participants were informed that they are going to play in pair with another student in the following game with hypothetical payoffs.

		The choice of the other player	
		K	P
Your choice	L	You get 10 USD; The other player gets 10 USD	You get 0 USD; The other player gets 15 USD
	S	You get 15 USD; The other player gets 0 USD	You get 5 USD; The other player gets 5 USD

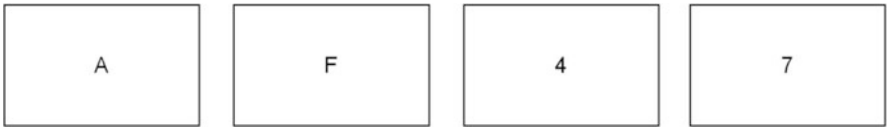

Fig. 1.1 Cards presented in the abstract version of the Wason selection task

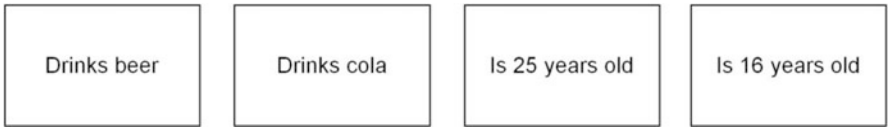

Fig. 1.2 Cards presented in the social contract version of the Wason selection task

> "Thus, if you select 'L' and the other player selects 'K', both of you will receive 10 USD. If you select 'L' and the other player selects 'P', you will not get the money, and the other player will receive 15 USD. If you select 'S' and the other player selects 'K', you will receive 15 USD, and the other player will not get the money. If you select 'S' and the other player selects 'P', both of you will receive 5 USD".

The participants were informed that the game is carried out once. Further, a computer application allowed the subjects to select "L" or "S". Then, the following question was addressed to the participants:

> "What do you think, how many people in the position of the second player would choose 'K'? Enter the estimated number in the box below: _ in 100 subjects".

The next screens presented the Wason selection task (in the abstract or the social contract version; the order depended on the experimental condition) preceded by appropriate instructions. These tasks offered the sets of cards like those shown in Figs. 1.1 and 1.2, respectively.

In the abstract task, the subject was asked to verify whether the logic rule—"if there is a vowel on one side of the card, there is an even number on the other side"—is violated for any of the four presented cards. For the task in the social contract version, the participant was asked to verify whether the rule—"if the person drinks beer, this person is more than twenty years old"—is violated for any of the four presented cards.

Finally, the programme allowed the subjects to select cards from those presented in the selection task.

1.2.3 Procedure

Before the beginning of the experiment, the experimenters indicated that they could assist if any part of the task were difficult to understand for the subjects. The subjects

Table 1.1 Experimental results concerning hypotheses 1, 2 and 4

Concerning hypothesis no.	Cooperators in a prisoner's dilemma (76 persons)	Defectors in a prisoner's dilemma (50 persons)
1	Declare 56.8 (mean value) per cent of cooperative decisions on the part of other players	Declare 44.7 (mean value) per cent of cooperative decisions on the part of other players
2	34.6 seconds (solving time; mean value)	48.7 seconds (solving time; mean value)
4	26.7 seconds (solving time; mean value)	33.1 seconds (solving time; mean value)

Source: Own calculations

were randomly assigned to one of the two experimental conditions. These conditions differed as regards the order in which the Wason selection task appeared on the screen, in its abstract or social contract version. The first task to solve for all subjects was a prisoner's dilemma game (exactly in the form given in the previous section). Then, they solved the selection task in the social contract version followed by the selection task in the abstract version (65 persons) or proceeded with the selection task in the abstract version followed by the selection task in the social contract version (61 persons). All the screens were displayed without a time limit, so the subjects decided by themselves when to proceed to the next screen. The time spent on solving the tasks by the subjects was automatically recorded (Table 1.1).

1.3 Results

Below are the results concerning hypotheses 1, 2 and 4. Next, the appropriate parametric tests are executed. In order to verify hypotheses 1, 2 and 4, we use Welch's t-test (which is a generalization of the standard t-test for unequal variances). The null hypothesis of the test is as follows:

$$H_0 : m_1 = m_2$$

where m_1 *and* m_2 are the means of cooperation declaration (for hypothesis 1) or solution time (hypotheses 2 and 4) for the participants who chose cooperation or defection in the prisoner's dilemma game, respectively. The alternative hypothesis is that the means are not equal (for hypothesis 4), or that $m_1 < m_2$ (for hypothesis 2) or that $m_1 > m_2$ (for hypothesis 1). The test uses t-statistic with calculated degrees of freedom. Table 1.2 provides the results with degrees of freedom and p-values for tested hypotheses. The decision to reject the null hypothesis (and thus declare rejection or no rejection of the research hypothesis) is made for the significance level of 0.05. Before the statistical procedure, the outliers (for which the answers lay above three times standard deviation value outside of mean of the respective groups of cooperators or defectors) were dismissed. By that, we lowered the sample

Table 1.2 Statistical testing of hypotheses 1, 2 and 4

Hypothesis no.	*t*-statistic value	Degrees of freedom	*p*-value	Decision concerning hypothesis
1	2.450	90.259	0.008	Not rejected
2	−2.003	71.752	0.024	Not rejected
4	−1.551	90.357	0.124	Not rejected

Source: Own calculations. Significance level: 0.05

size for hypothesis 2 by 2 (1 for each group) and hypothesis 4 by 3 (2 in the group that cooperated). Based on the statistical tests, research hypotheses 1, 2 and 4 cannot be rejected.

Next, let us present the experimental results concerning hypotheses 3 and 5 and the appropriate statistical testing. For that purpose, the following method was used. Hypotheses 3 and 5 concern the proportion of the sample that answered correctly in the Wason task. Thus, to verify the hypotheses, we use the two-proportion z-test (with Yates continuity correction) with the null hypothesis of the following form:

$$H_0 : p_1 = p_2$$

where $p_1$and p_2 are the fractions of persons who solved the Wason task correctly, given their cooperation or defection in the prisoner's dilemma game, respectively. The alternative hypothesis is $p_1 > p_2$ for hypothesis 3 and $p_1 \neq p_2$ for hypothesis 5. The test gives us a χ^2-statistic with 1 degree of freedom. We reject the null hypothesis with the significance level equal to 0.05. Based on the statistical tests, research hypothesis 5 cannot be rejected, but we reject research hypothesis 3 (Table 1.3).

The same procedure as in Table 1.4 can be used to statistically verify the significance of the difference in the accurate decisions in selecting a single card. For each card, the general population has a zero-one distribution; i.e., a correct decision may be taken, which involves inverting the card that needs to be inverted or leaving the card that need not be inverted. An incorrect decision involves inverting the card that does not allow checking the implication or leaving the card that should be inverted to check the implication. Next, we can make a comparison (between the group whose members decided to cooperate in a prisoner's dilemma game and the group whose members chose the defection strategy) of the fractions (or probabilities) of correct decisions concerning each card (Table 1.5).

Observe that in the social contract task, for three cards fraction differences are not significant, but for the card "drinks cola" significantly higher probability of making the correct decision occurred for the persons who chose to cooperate in a prisoner's dilemma game. In the abstract task, there are no significant differences in the fractions for all cards. Interestingly enough, the single card approach shows some evidence, which could be interpreted in line with the research hypothesis

Table 1.3 Experimental results concerning hypotheses 3 and 5

Type of Wason selection task	Percentage of correct answers by cooperators	Percentage of correct answers by defectors
Social contract	47.4%	40%
Abstract	35.5%	48%

Source: Own calculations

Table 1.4 Statistical testing of hypotheses 3 and 5

Hypothesis	χ^2-statistic value	Degrees of freedom	p-value	Decision concerning hypothesis
3	0.398	1	0.264	Rejected
5	1.464	1	0.226	Not rejected

Source: Own calculations. Significance level: 0.05

3, though the statistical testing (Table 1.4)—consistent with the formulation of hypothesis 3—leads to the rejection of this hypothesis.

1.4 Discussion

Hypothesis 1 was designed to check whether the subjects cooperating in a prisoner's dilemma game were to a greater extent than defectors expecting that the partners share a common goal perspective, as it is required by the effective social exchange mechanism (see Introduction). Note that the experimental results indicate that the subjects who decided to cooperate in a prisoner's dilemma game expected a higher degree of cooperation on the part of the partners compared to the persons who chose the defection strategy. Such a decision and revealed expectations of the cooperators are not consistent with the rational choice in a prisoner's dilemma game, but with the rational choice in a trust dilemma game, as Kiyonari et al. (2000) point out. As we remember, according to Kiyonari et al. (2000), in a social context, the subjective transformation of the goal perception involves a mental reshaping of the prisoner's dilemma into the trust dilemma (assurance game).

The purpose of the remaining hypotheses was to verify whether cooperators are better decision-makers in social exchange compared to defectors. To put it differently, the purpose of hypotheses 2–5 was to find out whether and what adaptive qualities are offered by the social exchange mechanism.

Biologists established criteria that allow determining which mechanisms are adaptive (Dawkins, 1982; Thornhill, 1991; Williams, 1966, 1985; Hauser et al., 2015). According to Williams (1985), adaptations are specially designed biological devices, which allow solving specific classes of problems (the special design problem-solving machinery). The criteria of evaluation are as follows: efficiency, precision, specialization and reliability (Williams, 1985).

Table 1.5 Statistical testing related to hypotheses 3—a single card approach

Type of Wason task	Card	Percentage of correct answers by cooperators	Percentage of correct answers by defectors	χ^2-statistic value	p-value
Social contract	"Drinks beer"	81.6%	86%	0.166	0.658
	"Drinks cola"	94.7%	84%	2.885	0.045
	"Is 25 years old"	77.6%	68%	0.992	0.160
	"Is 16 years old"	59.2%	56%	0.030	0.431
Abstract	"A"	84.2%	88%	0.111	0.738
	"F"	85.5%	92%	0.667	0.414
	"4"	61.8%	72%	0.969	0.325
	"7"	50%	56%	0.228	0.633

Source: Own calculations. Significance level: 0.05

Efficiency should be understood as the high speed and low cost associated with the functioning of the given mechanism. Precision should be seen as the high accuracy of the achieved solution. Specialization is the degree of the adjustment of the given mechanism to the requirements of the given class of social or biological problems. Reliability is the resistance of the given mechanism to errors.

The purpose of hypotheses 2–5 was to test the adaptive qualities of social exchange mechanism. We focused on the two dimensions stipulated by Williams, i.e. the efficiency of the mechanism (and specifically its speed) and its reliability. These qualities could be tested directly with the use of a properly designed experimental procedure.

The obtained results show that persons cooperating in a prisoner's dilemma game were faster and equally accurate at solving the social contract version of the Wason selection task compared to persons choosing in a prisoner's dilemma game the defection strategy. Intergroup differences in speed or accuracy of decision-making have not been observed in the abstract version of the Wason selection task.

These results provide empirical support to the claim that the social exchange mechanism works as an optimizing tool of the human mind. Such a device allows solving problems and takes decisions related to social cooperation more effectively (higher speed, not worse accuracy). Hence, such a mechanism has a measurable adaptive significance. The above results suggest that cooperators can respond faster than defectors to public policies based on social contract (e.g. redistributive policy, welfare policy, policy for sustainable development, cf., Benabou, 2000; Rhodes & Meny, 2016; Haagh, 2019).

The results presented in this paper are worth to be discussed in the light of another, more recent, experiment run by Karbowski and Wiśnicki (2021). The latter experiment shows that the social distance between players in games (i.e. social closeness to another player—from socially closest person to stranger) exerts a significant impact on prosocial/defection decisions made in the dictator and ultimatum games. Interestingly enough, for relatively close persons (up to no. 20 in the social distance scale), the participants were eager to accept a higher monetary loss from those persons than they transferred to them (Karbowski & Wiśnicki, 2021). For persons occupying further positions on the social distance scale (further than no. 20), participants were eager to transfer a higher monetary loss to them than they would accept from them. These findings show that prosocial/defection behaviour depends on social distance between players. Higher social distance between players makes subjects less cooperative.

Knowing that, we can reinterpret the results presented in the main body of the paper. The proportion of L/S decisions should depend on the perception of social distance to another student. If a decision-maker perceives other students as relatively close, the risk of obtaining LP outcome should be more tolerable compared with a decision-maker who feels socially detached from other students. The following is a speculation, but it is not excluded that decision-makers who perceive others as relatively close in general feel psychologically safe and are more eager to cooperate with others and perform it without deeper reflection (simply put, faster and with lower cognitive capacity use). The latter hypothesis needs a separate study.

1.5 Conclusion

In this study, we confirm the adaptive qualities of the social exchange heuristic. Persons who follow this cognitive and behavioural mechanism (and cooperate in the prisoner's dilemma game) turn out to be better decision-makers in the social version of the Wason selection task compared to defectors. The present study complements a work by Kiyonari et al. (2000) who presented the social exchange heuristic but did not test its adaptive qualities. A recent work by Karbowski and Wiśnicki (2021) sheds a new light on the incentives to launch a social exchange heuristic in decision-making. We hypothesize that the perception of a relatively small social distance to the other subject promotes social exchange heuristic and allows to optimize the process of decision-making in the social context. In turn, the relatively large social distance to another subject hampers the activation of social exchange heuristic, and as a result, defection rather than cooperation is expected. This hypothesis is important to environmental challenges (He et al., 2017) and sustainable development. Facing environmental challenges needs social cooperation, and now, we can add that such cooperation is—due to cognitive mechanisms—much easier to achieve in socially closer groups (where members perceive themselves as socially close or social distance to others is relatively small). It seems that solving global challenges starts locally.

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