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Preliminary Version

Similarity Drives Cooperation in Social Dilemmas Above and Beyond the General Tendency to Cooperate and Beliefs

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Abstract

Cooperation is crucial for achieving mutually beneficial strategic interactions. However, since many interactions have the structure of social dilemmas, cooperation is not easily achieved and its attainment remains both a theoretical and a practical challenge. In three studies we test predictions derived from Subjective Expected Relative Similarity theory (SERS), a theory which predicts cooperation whenever the similarity among opponents exceeds the similarity threshold, derived from the expected payoffs. We show that similarity predicts cooperation in Prisoner's Dilemmas above and beyond the previously established factors general tendency to cooperate and beliefs. We show that similarity can be influenced by a minimal-group manipulation and that the direct effect of this manipulation on cooperation is mediated by changes in similarity. Furthermore, it is demonstrated that the tendency to cooperate is higher in environments with a lower similarity threshold, and hence depends on the game structure in the theoretically predicted manner. The results highlight the importance of similarity for cooperation in social dilemmas.

Introduction

Many situations have the structure of a social dilemma, which is characterized by the fact that optimizing ones' own outcome is detrimental for the outcome of the group as a whole. One standard paradigm for investigating such kinds of situation is the Prisoners Dilemma (PD), in which mutual cooperation would lead to a mutually beneficial and Pareto efficient outcome for both players (Rapoport & Chammah, 1965). However, each individual player would be better off by defecting, independent of the behavior of the other, making mutual defection the dominant strategy that should be chosen by rational agents that are purely selfish money-maximizing and interact only once (and the unique Nash-equilibrium).

In contrast to this prediction, it has been consistently shown that a considerable portion of individuals cooperates in PDs involving both repeated but also one-shot interactions (see Dawes, 1980; Sally, 1995; Van Lange, Joireman, Parks, & Van Dijk, 2013, for overviews). Several models have been developed to account for this cooperative behavior and to describe possible factors influencing peoples' tendency to cooperate in social dilemmas. Important classes of factors that have been suggested to drive cooperation are (i) generalized cooperativeness, social value orientation and social preferences (Fehr & Schmidt, 1999; McClintock & Liebrand, 1988; Van Lange, 1999), (ii) beliefs and social projection (Bogaert, Boone, & Declerck, 2008; Krueger, DiDonato, & Freestone, 2012; Pruitt & Kimmel, 1977), as well as (iii) perceived similarity, shared genes and kinship (Alexander, 1974; Fischer, 2009; Hamilton, 1964; Trivers, 1971). In the current work, we investigate the third class of factors and particularly the effects of perceived similarity in more detail.

Similarity and Cooperation

Models of kinship and shared genes assume that cooperation should increase for persons that are similar concerning genes that would increase the fitness of an allele (Hamilton, 1964). Nonetheless these models do not offer a behavioral mechanism that would allow participants to determine the necessary extent of similarity within each conflict situation. According to the Subjective Expected Relative Similarity (SERS) model (Fischer, 2009), individuals' tendency to cooperate is assumed to be a function of the perceived similarity and a similarity threshold that is derived from the payoff-matrix. SERS predicts that individuals cooperate with each other whenever their perception of similarity with the opponent is bigger than the similarity threshold calculated from the payoff matrix.

Several studies have demonstrated that induced similarity increases cooperation (Fischer, 2009, 2012; Krupp, Debruine, & Barclay, 2008; see also Simpson, 2006). Fischer (2009), for example, manipulated perceived similarity with another person by asking participants to coordinate their thoughts and experience their success in making identical choices (study 1) or by allowing participants to compare their ratings on an attitude questionnaire (study 2). The tendency to cooperate in a subsequent PD increased with similarity induced by both procedures. Krupp et al. (2008) manipulated kinship and similarity of the other player by morphing a picture of the own face with the picture of another person and found that cooperation increased for more similar opponents.

Nevertheless, a potential criticism to these studies is that they did not attempt to disentangle the effects of similarity, from the effects of the two other classes of models introduced above, that is, beliefs and social preferences. Specifically, it remained unclear whether the manipulation of similarity influenced peoples' tendency

to cooperate directly and perhaps even unconsciously or whether the effect of increased similarity is mediated by changes in beliefs or social preferences or both as could be expected based on belief-based approaches and preference models (Bogaert et al., 2008). Although it has been shown that effect of social preferences and beliefs on cooperation hold when controlling for similarity (Van Lange & Kuhlman, 1994), this is the first study that investigates the complement; namely whether the effect of similarity holds while controlling for the other two classes of factors.

The current investigation aims to empirically separate the influence of social preferences and beliefs from the pure effects of similarity. First, we investigate whether similarity is merely a more specific factor that can be conceptually subsumed under the factors specified in the former approaches by testing whether similarity predicts cooperation over and above beliefs and general cooperativeness. Importantly, we thereby also extend the well-studied 2 by 2 PD game paradigm and its SERS driven solution to the more ecologically valid paradigm of the continuous PD game, where participants may select a level of cooperation rather than choose whether they wish to cooperate (or to defect).

Based on the similarity approaches introduced above we hypothesize:

H1: Similarity predicts cooperation over and above beliefs and social preferences.

Furthermore, we test for interactions between similarity and social preferences and (in studies 2 and 3) also investigate whether similarity perception has a causal effect on cooperation behavior.

Study 1: Similarity and Cooperation

Method

Participants and design

Sixty-five students (*37* female, age *M*=24.5, *sd*=5.1) were recruited from the subject pool of the Max Planck Institute for Research on Collective Goods using the online recruitment platform ORSEE (Greiner, 2004) to participate in the study. The study did not involve any factorial manipulation but each participant indicated behavior towards all other (usually 11) participants in a session, which allows to capture natural variations in perceived similarity in comparison between and within persons in a repeated measurement approach. For two participants there were missing values on some of the variables, and therefore the total sample for analyses requiring these variables was reduced to 63. Participants' payments depended on the outcome in the experiment and could range from 0 Euro to 15 Euro (approx. USD 20.00).[1]

Material

In the continuous PD game a player chooses a degree of cooperation (Goerg & Walkowitz, 2010; Van Lange & Kuhlman, 1994) instead of the binary decision to cooperate or defect in the classical PD. Each player starts with an initial endowment of 100 Talers and then has the opportunity to transfer an integer part of the 100, nothing, or the whole 100 Talers to the opposite player. Both players decide simultaneously on the amount to be transferred. Each amount transferred to the other player is doubled, resulting in an efficiency gain. The players' final payoffs consist of the initial endowment, minus the transferred amount, plus the doubled amount transferred by the opposite player. As in the classical PD game, the rational individual money-maximizing solution is that a player does not cooperate (transfer nothing) and the social efficient outcome is that both players cooperate fully (transfer everything). In situations that only allow to select between two contribution levels, the standard rational approach predicts choosing the lowest possible amount.

[1] The study was run in combination with two unrelated studies involving a show-up fee and additional payments.

Nonetheless, according to the similarity approach suggested by the theory of Subjective Expected Relative Similarity (SERS) a player considering whether to transfer an amount x or a larger amount $x + \Delta$, will choose the higher amount if the perceived similarity is above a similarity threshold. Details on the calculation of the similarity thresholds are provided in Appendix A.

Procedure

Full translated instruction are available in Appendix B, original instruction in German are available at osf.io/96mjb.

Subjects were seated in separated cubicles and read the instructions for the continuous PD game. Afterwards, control questions were completed to ensure comprehension of the game. Before the actual game was played, subjects had to answer the question on the perceived similarity with the other subjects in their session. Therefore, each subject separately stood up in the cubicle, so that he/she was visible to the other subjects. Each of the other subjects guessed on an eleven-point scale how similar this participant would behave in the continuous PD game. Thereafter, subjects had to decide for each of the other subjects in the session on the amounts to transfer in the continuous PD. After all subjects had decided on their actual transfers they stated their beliefs on the other subjects' transfers if they were matched with each other. Then, participants assessed the other subjects concerning several control factors, specifically concerning how cooperative, attractive, friendly, sociable, and reliable they assume them to be. Again, each subject stood up separately to be visible to the other participants and individually written statements were given on an eleven-point scale for each of the attributes, which were named without any

further explanations.[2] Finally, subjects were paid contingent on their own transfers and the transfers of another random subject. Payments were made in cash and the earned Talers were converted into Euros with an exchange rate of 1 Taler being 5 EuroCent. Participants did not learn with whom they were matched for the final payoff; this was publicly announced prior to playing the game.

To test our first hypothesis, we predict individual contributions from each person to each other person (dependent variable) based on (i) similarity, (ii) beliefs concerning the others' contribution, and (iii) persons' general level of cooperativeness to control for interindividual differences concerning social value orientation and social preferences. Specifically, we include individuals' average transfer to all other players in the game, which captures all trait-like factors in the person that drive cooperation. We furthermore include control factors to check for alternative explanations and the general robustness of our findings.

Results

On average participants transferred 42.37 Taler (*sd*=12.27) to the other participants in this experiment and stated an average similarity of 5.55 (*sd*=0.91). Further descriptive statistics and zero-order correlations for all variables are summarized in Appendix C (Table C1).

[2] Control factors were selected taking into account previous findings as well as based on theoretical considerations. While the attributes cooperative, friendly, sociable, and reliable can be assumed to be related to cooperation on theoretical grounds (see also Van Lange & Kuhlman, 1994), it has empirically been shown that attractive persons are assumed to be more cooperative (Andreoni & Petrie, 2008).

Figure 1: Relationship between similarity level and transfers in Study 1 in the original data (left panel) and in the residuals after partialling out the influence of all other factors from Table 1 (right panel).

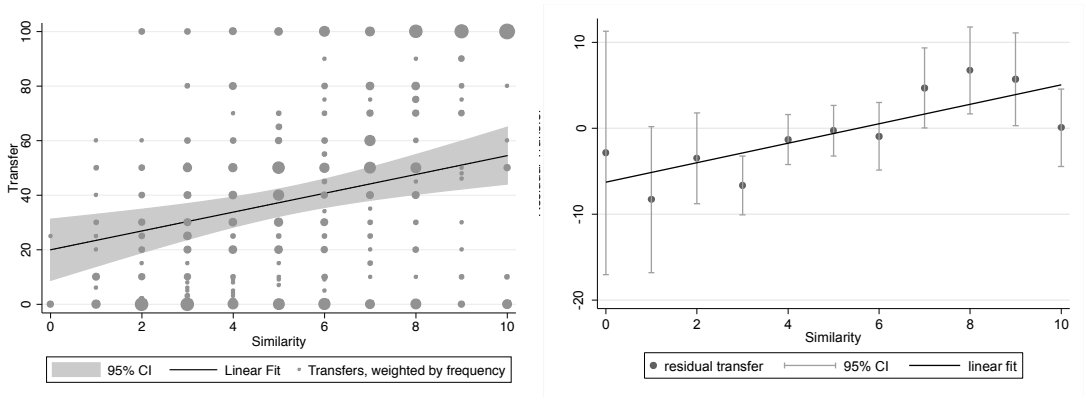


Figure 1 (left) illustrates the relation between transfers and similarity statements. Our data clearly exhibits a positive and significant relation between similarity statements and cooperative transfers, which is also apparent in the zero order correlations (Table C1). The higher the similarity rating the higher the transfer (r=.57, p<.001). Furthermore, transfers increase with beliefs (r=.80, p<.001) and thus subjects who think that matched participants are likely to exhibit more cooperation tend to cooperate more themselves. Finally, transfer increases with peoples' general cooperation tendency, measured as the average transfer to other participants (r=.75, p<.001).[3] The result suggests that subject's transfer to a matched participant are to a large degree determined by the subject's general cooperativeness reflecting social preferences.

[3] Formally speaking, we investigate how the transfer from participant i to a specific participant j (a_j^i) is correlated with the average transfer from participant i to all other matched participants $\frac{\sum_{k=1}^{N} a_k^i}{N-1}$ with $k \neq j$.

Table 1: Determinants of transfers in the continuous Prisoner's Dilemma games for Studies 1 and 2.

	Study 1		Study 2	
Transfer $_{(0\text{-}100)}$	*b*	*z*	*b*	*z*
Similarity $_{(0\text{-}10)}$	3.092***	(5.73)	1.410***	(4.52)
Belief $_{(0\text{-}100)}$	0.451***	(8.09)	0.495***	(15.23)
Cooperation $_{(0\text{-}100)}$	0.860***	(10.64)	1.067***	(21.88)
Ingroup $_{(yes=1)}$			1.777	(1.60)
Sim*Coop	0.0314	(1.63)	0.0313**	(2.87)
Sim*Ingroup			1.094*	(2.09)
Ingroup*Coop			0.0190	(0.44)
Sim*Ingroup*Coop			-0.0216	(-1.12)
Q: reliable	0.626	(0.84)	0.641	(1.52)
Q: friendly	0.320	(0.40)	1.062*	(2.23)
Q: attractive	0.569	(1.63)	1.943***	(5.79)
Q: sociable	0.557	(0.78)	0.0266	(0.05)
Q: cooperative	1.575+	(1.90)	0.791+	(1.72)
N (subjects)	528 (63)		1856 (195)	
BIC	3302.8		10772.91	

Note. Estimations are based on random-effects Tobit regressions taking the censored structure of the data into account (i.e., transfers cannot be below 0 or above 100). Variables marked with Q are from questionnaire ratings. Variables similarity, belief, cooperation and ingroup are centered. Constant and control factors gender, age and session are not reported. In Study 1 out of 528 observations 106 were left-censored (i.e., equal to zero) and 92 were right-censored (i.e., equal to 100). In Study 2 out of 1,856 observations 408 are left-censored and 351 are right-censored.
+ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

To control whether these three factors - similarity, beliefs, and general cooperativeness - are driving cooperation independently from each other, we conduct regression analyses with multiple predictors. Table 1 (first model) reports the results of random-effects Tobit regressions predicting transfer (i.e., cooperation) by

perceived similarity, participants' beliefs concerning others cooperation, their general cooperativeness, the interaction between similarity and cooperativeness and the assessments of matched participants' reliability, friendliness, attractiveness, sociability, and cooperativeness. Additional controls include gender, age, and session fixed-effects (not reported).[4]

If higher similarity results in higher cooperation, the regression should yield a positive and significant coefficient for similarity — regardless of additional control variables. This is, in line with hypothesis H1, confirmed. From the coefficient for similarity it follows that on average, keeping everything else constant, a one-point increase of perceived similarity leads to an increase in transfers by roughly 3.09 Talers. In addition, the previously reported positive effects of beliefs and general cooperativeness on cooperation in the PD remain significant. Further analyses show that the effect of similarity on cooperation is robust and also holds in a fixed-effects linear regression on the residual transfer after partialling out the effect of all other factors (Figure 1, right panel).

There is also a trend towards a two-way interaction of similarity and peoples own general cooperation tendency (p=.103). If we split participants according to cooperativeness at the midpoint of the scale (50) in pro-social and pro-self persons, the unique effects of similarity holds for both subgroups (both $p < .01$). The effect, however, tended to be stronger for pro-socials than for pro-selfs as indicated by the trend in the two-way interaction.

Discussion

[4] Throughout the paper we report estimates obtained with Tobit regressions taking the censored structure of the data into account, i.e. transfers cannot be below 0 and not above 100. Estimates without control variables for gender, age and session are in line with the reported ones.

The results indicate that the perceived similarity that persons generate from seeing their potential opponents once has a substantial effect on cooperation above and beyond beliefs, social preferences and other control factors and therefore fully support our first hypothesis. Importantly, we show that perceived similarity drives cooperation independently of beliefs, general cooperativeness as well as other reasonable control factors.

Due to the correlational design, results from the first study are, however, limited in that they do not allow for deriving conclusions concerning whether similarity drives persons willingness to cooperate or vice versa. In the second study we therefore aim to manipulate similarity and measure whether this manipulation carries over to cooperation behavior. We thereby rely on a minimal group paradigm in which group membership is randomly assigned. Importantly, in contrast to other paradigms that involve group formation based on (supposedly) real preferences (e.g., the group of persons that likes Klee vs. Kandinsky) or person properties (e.g., intelligence, personality) the minimal group paradigm excludes any confounding factors that could drive cooperation or beliefs beyond group membership.

In Study 2, aside from **H1**, we test the following additional hypotheses:

H2: A minimal-group manipulation of similarity influences cooperation.

H3: Similarity mediates the effect of the minimal-group manipulation on cooperation.

Study 2: Influencing similarity with group identity

Method

Participants and design

One hundred ninety-seven individuals participated in this study (122 female, age m=23.1, sd=4.6). Again, subjects were recruited from the Max Planck Institute

subject pool using the online recruitment platform ORSEE (Greiner, 2004). For two participants data was missing so that these person were excluded from the respective analyses and the analyses were run with the remaining subjects. Participants that took part in Study 1 were excluded from Study 2. Additionally to the repeated measurement approach from Study 1 capturing natural variations in perceived similarity, we implemented a minimal group manipulation of similarity. Specifically, participants were in equal shares randomly assigned to one of two color groups and indicated their behavior towards all other members of the own group and the other group in their session. Participants' payments depended on the outcome in the experiment and the variable part could range from 0 Euro to 15 Euro (approx. USD 20.00), which was paid in addition to a fixed show up fee of 5 Euro.

Procedure

The same procedures as in Study 1 were implemented except for an additional within-subjects manipulation of similarity by a minimal group paradigm with the respective manipulation checks.[5] Specifically, after the explanation of the game structure and the control questions participants were randomly assigned into group blue or group green. For the group assignment each participant drew a color card from a deck of cards, thereby, establishing common knowledge about the random group assignment. Furthermore, participants were explicitly informed that the group assignment would not influence the selection of the matched player in the incentivized game. Participants publicly indicated to which group they belonged. Finally, in each

[5] Assuming a small to medium effect of the minimal-group manipulation on similarity ($f = .20$), the study was first run with $N = 83$, which gives the test an excellent power $1-\beta > .95$ in the repeated measurement design (Faul et al., 2007). Nevertheless, we decided to extend the study to 200 subjects. Throughout the paper we report unadjusted two-sided test results. However, all reported results would remain on conventional significance levels when applying a very conservative Bonferroni correction.

assessments round (for similarity, action, belief, properties), participants were instructed to stand up and present both cabin number as well as color card. Finally, we added five exploratory control questions at the end of the questionnaire, which did not reveal further insights.

Results

First, we analyzed whether the minimal-group manipulation successfully induced differences in similarity ratings. Figure 2 gives the distribution of similarity ratings for participants from the in- and out-group. As expected, our manipulation was successful in that similarity ratings were higher for persons that belong to the in-group (*M=5.87, sd=1.12*) as compared to persons from the out-group (*M=5.59*, *sd*=1.10), *t*(196)= 2.73, *p*=.003, *d*=0.25.[6] The minimal group manipulation had a small effect on similarity ratings according to common conventions (Faul et al., 2007).

The descriptive statistics and zero-order correlations for all variables and split by our ingroup manipulation are reported in Appendix C (Tables C2 and C3).

Figure 2: Relationship between similarity level and transfers in Study 2 (dots with CI graph with the yaxis on the left side) and frequency of observed similarity levels (bar graph with yaxis on the right side) split by in- and outgroup (color).

[6] Note that calculations here and in the appendix are based on means per rated other subject. We can use all 197 participants in this analysis since no missing information are concerned.

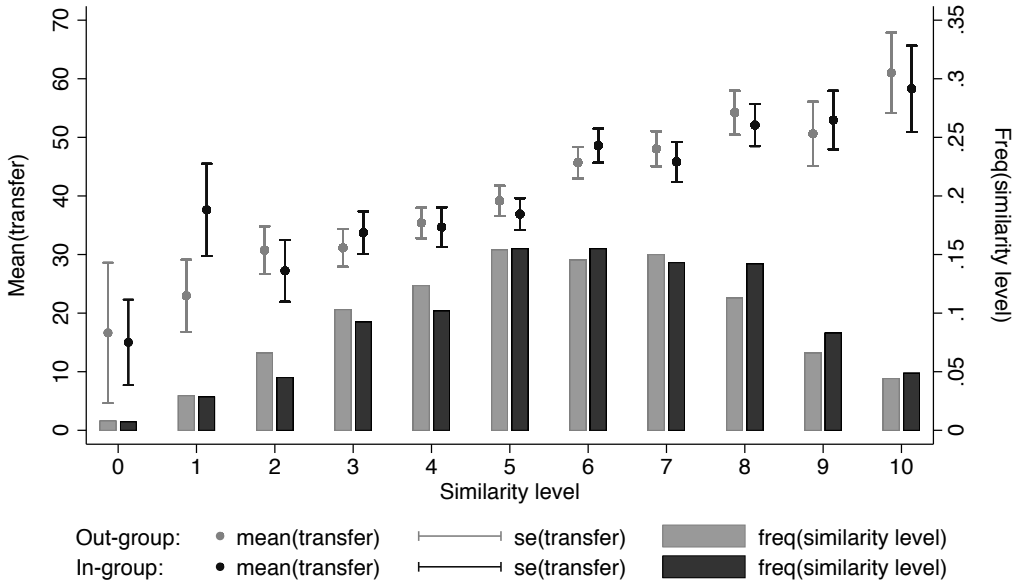


Figure 2 demonstrates that we are able to replicate the positive effect of similarity on transfers from Study 1 -- the higher the perceived similarity the higher the transfer. This relationship holds for in-group members (r=.32, p<.001) as well as for out-group members (r=.29, p<.001) and the zero-order correlations were of similar magnitude (although generally somewhat lower than in Study 1).

Furthermore, we again investigate whether the effect of similarity on cooperative transfers is robust when controlling for the other factors in this study, too. Table 1 (second model) gives the results of a random-effects Tobit regression predicting transfer by our minimal group manipulation, perceived similarity, participants' beliefs, their general cooperativeness, as well as interactions between these factors and the assessments of matched participants' reliability, friendliness, attractiveness, sociability, and cooperativeness, and in-group affiliation. The results provide further support for H1 as the coefficient for similarity is highly significant and implies that a one-unit increase in similarity results in an increase of transfers by 1.45 Taler. This effect of similarity on cooperation was again confirmed by a fixed effect linear regression approach on the residuals after partialling out the other factors

(b=1.51, t=7.6, p<.001).

The significant two-way interaction of ingroup and similarity indicates that the effect of similarity on cooperation was stronger for persons from the ingroup as compared to persons from the outgroup. Separate analyses for both conditions revealed that when taking into account control factors the effect of similarity only holds in the ingroup (b=1.81, z=4.03, p<.001) but not in the outgroup (b=0.65, z=1.57, p=.116). As mentioned above, no such difference was observed for zero-order correlations. Further analyses revealed that this divergence is due to the fact that for the outgroup the effect of similarity diminishes after controlling for beliefs and perceived cooperativeness (i.e. Q:cooperative). This indicates that for the two social identity conditions similarity influenced cooperation on different pathways: while for the outgroup the effect of similarity is solely driven by changes in beliefs, for the ingroup similarity effects on transfer go beyond beliefs. This effect nicely extends previous findings concerning the psychological differences between ingroup love and outgroup hate in that ingroup love is driven by the motive to help the own group which goes beyond mere beliefs (Halevy, Bornstein, & Sagiv, 2008).

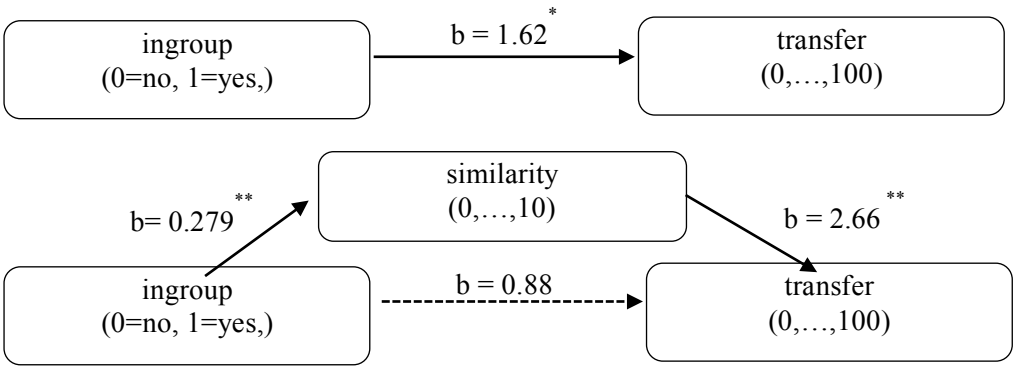
Similar to Study 1, we find some indication that pro-socials react differently on similarity than pro-selfs in that the respective two-way interaction between average contribution and similarity turned out significant. Separate analyses for person that contributed more than or equal to half (pro-socials) vs. less (pro-self) indicate that the effect of similarity holds for pro-socials only (b=2.43, z=4.17, p<.001) and is reduced to almost zero for pro-selfs (b=0.41, z=1.23, p=.218).

As suggested by H2, the group manipulation carries over into significantly higher transfers for in-group members (M=43.9) compared to out-group members (M=42.9) according to a random effects regression predicting transfer by ingroup and

all factors from the regression model (Table 1, model 2) except for beliefs, b=2.77, z= 2.10, p=.036. When including beliefs the effect is substantially reduced (Table 1, model 2), so that the evidence for H2 remains somewhat mixed.

In line with H3, the effect of the group manipulation on transfers is mediated by the previously described changes in similarity ratings and the indirect effect was significant, b=0.74, z=2.96, p=.003. Overall, similarity mediated 46% of the total effect of in-group on transfers. Figure 3 gives the results of a mediation analyses for multilevel data (Krull & MacKinnon, 2001).

Figure 3: Similarity mediates the effect of in-group on transfers. Reported are the results from a mediation analyses for multilevel data, coefficients and p-values are based on mixed-effects reduced maximum likelihood estimations. * p<.05, ** p < .01



Finally, based on finding that minimal group manipulations influence social preferences in that people become more prosocial towards the ingroup as compared to the outgroup (Billig & Tajfel, 1973; see Brewer, 1979, for a review; Chen & Li, 2009), it might be suspected that the remaining unique effects of similarity on cooperation is driven by just this more pro-social behavioral tendency towards the ingroup. We directly test this alternative hypothesis by repeating the regression model 2 (Table 1) with taking group specific social preferences into account. Specifically,

we replace the factor Cooperation (i.e. the average contribution level of each person) by Group-Specific-Cooperation which is the average contribution level of each person separately for the ingroup and the outgroup. The regression reveals a substantially reduced but still robust unique effect of similarity on cooperation, b=0.872, z=3.22, p=.001. Hence, the data replicate previous findings that minimal group manipulations influence social preferences and money allocation to groups, but – most importantly – there remains an additional and unique effect of similarity on cooperation.

Discussion

The results from Study 2 provide further support for the assumption that similarity is one of several drivers for cooperation in one-shot dilemma games. The unique effect of similarity on cooperation could be replicated and did again hold after controlling for beliefs and individuals general tendency to cooperate as a proxy for social preferences, even if differences in social preferences between ingroup and outgroup are taken into account. Additionally, the second study indicated that increasing similarity by a minimal group manipulation goes along with increased transfer.

Overall, these studies demonstrate robust effects of similarity on cooperation as well as the possibility to manipulate cooperation by manipulating perceived similarity in persons. Most importantly, they go beyond previous work (Fischer, 2009, 2012) by showing that the effect of similarity on cooperation also holds when controlling for beliefs and trait-like person factors such as social value orientation and social preferences. Still, since controlling for social value orientation / social preferences is crucial for our argument, both studies might be criticized for the operationalization of the construct. Specifically, one might speculate that measuring

social value orientation / social preferences by individuals' general tendency to cooperate might lead to imprecise measurement or uncontrolled confounds with strategic thoughts. We therefore conduced a third study in which we replaced this measure and included the SVO slider (Murphy & Ackermann, 2011) as a validated instrument for measuring social value orientation / social preferences.

Additionally, in Study 3 we aimed to investigate another prediction of the SERS model by manipulating the environment, that is, the payoff structure of a game. Specifically, SERS predicts that individuals' tendency to cooperate should decrease with increasing similarity threshold p_s, which follows mathematically from the structure of the game as described in Appendix A. In the continuous PD the threshold can be simply calculated by:

p_s = 1 / Multiplier of Money Transfered

We want to test whether the results by Fischer (2009) generalize to the continuous PD and hypothesize:

H4: Cooperation increases with a decreased similarity threshold p_s.

As previously discussed, aside from testing **H4**, in Study 3 we particularly aim to test **H1** once again using an improved measure for social value orientation / social preferences.

Study 3: Independent measurement of social preferences and manipulating the similarity threshold

Method

We recruited 102 individuals for the study according to the same procedure as before. For six of the persons data was partially missing, so that the core analyses were conducted on 96 participants (49 female, age M=24.7, SD=5.3). According to an

a priori power analysis, this sample should allow to identify medium effects of similarity threshold with sufficient power = .90 (assuming am medium effect size f = .25, for 11 repeated measurements with r = .5 in a repeated measurement ANOVA using GPower, Faul et al., 2009).

The study was in most parts identical to Study 1 with two exceptions. First, we manipulated similarity threshold in two levels between persons. The low threshold of p_s = .33 was implemented by multiplying the transferred money with a factor of 3, whereas the high threshold of p_s = .67 was implemented by multiplying the transferred money with a factor of 1.5 (while the previous studies used the factor 2 in between). Participants took part in sessions consisting of 7 to 12 persons and were session wise assigned to the conditions, with 47 participants completing the low threshold condition and the remaining the high threshold condition.

Second, in a pre-study that had to be completed at least 12 hours before the main session in the lab, participants answered an online survey, measuring social value orientation using the established SVO slider measure (Murphy & Ackermann, 2011). Thereby participants repeatedly indicated how they would prefer to allocate money between them and another person on slider containing a range of payoffs. The SVO slider is incentivized by paying out a randomly picked money allocation decision, which was added to the overall payment resulting in a (realized) total payment range of 5 to 23 €. The questionnaire also included a 60-item version of the general personality questionnaire HEXACO (Ashton & Lee, 2007; Moshagen, Hilbig, & Zettler, 2014), which is, however, not included in the current analysis.

Results

Participants transferred *M*= 38.78 Taler (*sd* =14.90) to other participants and stated an average perceived similarity of *M*=5.75 *(sd*=0.98). Transfer was higher for the low similarity threshold condition (*M*=46.5, *sd* =13.2) as compared to the high threshold condition (*M*=31.6, *sd*=12.70), $t(100) = 5.81$, $p < .001$, $d = 1.16$. These observations nicely replicate previous findings and support H4.

More importantly, we again find that transfer increased with perceived similarity, $r(100) = .58$, $p < .001$. The zero-order correlation was of similar magnitude as observed in Study 1 and the correlation was of similar magnitude in both environment conditions (see Appendix A for full descriptives and zero order correlations).

A regression analysis confirmed these findings and provided further important support for H1 in that perceived similarity predicts transfer independent of beliefs and social preferences (Table 2). The analysis shows that H1 also holds if social valur orientation / social preferences are measured using the SVO slider instead of average cooperation rates that were used in Studies 1 and 2.

Additionally, we replicate the finding from the previous studies that pro-socials react positively on similarity whereas pro-selfs don't as indicated by the again significant two-way interaction between SVO and similarity. There was also an unexpected three-way-interaction between SVO, similarity, and threshold indicating that this interaction was stronger for higher similarity thresholds. A robustness check again reveals that the effect of similarity on transfer also holds in a linear fixed effects regression on the residuals after partialling out all other factors (*b*=1.93, *t*=6.56, *p*<.001).

Table 2: Determinants of transfers in the continuous Prisoner's Dilemma games for Study 3.

	Study 3	
Transfer (0-100)	*b*	*z*
Similarity (0-10)	3.112***	(7.18)
Belief (0-100)	0.515***	(12.92)
SVO (-16-45)	0.847***	(4.50)
Threshold high (yes=1)	-12.50*	(-2.24)
Sim*SVO	0.0923***	(3.53)
Sim*Threshold	-0.221	(-0.27)
Threshold*SVO	-0.340	(-0.91)
Sim*Threshold*SVO	0.138**	(2.66)
Q: reliable	-0.195	(-0.34)
Q: friendly	1.696**	(2.61)
Q: attractive	0.262	(0.55)
Q: sociable	-0.784	(-1.44)
Q: cooperative	-0.0577	(-0.10)
N (subjects)	833 (96)	
BIC	5346.349	

Note. Estimations are based on random-effects Tobit regressions taking the censored structure of the data into account, (i.e., transfers cannot be below 0 or above 100). Variables marked with Q are from questionnaire ratings. Variables similarity, belief, cooperation and threshold are centered. Constant and control factors gender, and age are not reported. In Study 3 out of 833 observations 183 were left-censored (i.e., equal to zero) and 96 were right-censored (i.e., equal to 100).
** $p < .01$, *** $p < .001$

General Discussion

One of the theoretical challenges in strategic decision research is to explain why individuals cooperate in social dilemmas in which cooperation is irrational according to standard economic models. Besides the well explored factors social preferences and

beliefs, similarity has been suggested as possible explanation. Sufficient similarity may indicate that cooperation provides a higher expected payoff, as suggested by Subjective Expected Relative Similarity (SERS) Theory (Fischer, 2009); it might also function as an indicator for kinship and shared genes or group relatedness. Furthermore, similarity based strategies have been demonstrated to promote the evolution of cooperation (Fischer et al., 2013). Although it therefore seems both theoretical plausible and adaptive that similarity drives cooperation, the direct and independent effect of similarity has only rarely been tested empirically. Specifically, while previous studies have clearly shown that manipulations of similarity can induce cooperation (Fischer, 2009, 2012; Krupp et al., 2008), it remained unclear whether this effect is due to similarity per se or mediated by other factors that have been established to drive cooperation such as beliefs and social preferences. It is for example, reasonable that similarity increases expectations concerning the cooperation of the other player and that the effect of similarity is therefore not independent but mediated by beliefs.

Our data closes this gap by demonstrating a positive and significant relation between similarity and cooperation rates in one-shot prisoners' dilemma games. The higher the assessed similarity, the higher the willingness to cooperate. This relation is robust to added controls for general tendency to cooperate (reflecting social preferences) as well as standard social preference measures and beliefs on matched players' cooperation. Hence, similarity contributes above and beyond the established factors general cooperativeness due to social preferences and beliefs. This relation also holds when controlling for further factors such as attractiveness, and gender.

Also we provide further evidence that perceived similarity plays a causal role in driving cooperation by showing that similarity mediates the effect of a minimal-

group manipulation on cooperation. In addition, we show that a manipulation of the environment that increases the similarity threshold for cooperation according to SERS leads to a substantial decrease in cooperation.

Overall, our results demonstrate that similarity at least in parts drives cooperation also independent of beliefs and social preferences. The robust main effect of similarity renders pure social preferences- and belief-based models as clearly incomplete.

Complex interdependencies of beliefs, social preferences, and similarity

On top of these results demonstrating the important and independent role of similarity for cooperation, several interactions indicate that the interplay between the various influence factors is complex and that these factors are partially also interdependent. First, we find that the positive effects of similarity on cooperation increase with peoples' own cooperativeness. In line with social projection approaches (Krueger et al., 2012) but also with considerations that result from a utilitarian perspective (Dawes, 1980), perceived similarity concerning others is less effective in inducing cooperation if persons themselves are not particularly cooperative or are less engaged in comparisons with others that are necessary for the formation of similarity perceptions. Still, it is interesting to note, that we do not see a full reversal of the effect for pro-self persons, which would follow from both approaches. One possible explanation is that positive effects of similarity and negative effects of social projection cancel each other out, but this possibility would need to be investigated in future research.

Second, ingroup effects on cooperation are only partially mediated by similarity indicating that manipulations of social identity influence cooperation on

multiple pathways some of which include effects that are conveyed over other factors such as changes in social preferences (Chen & Li, 2009).

Third, and related to the previous point, we see that similarity effects are conveyed on different pathways for the ingroup as compared to the outgroup. While for the outgroup effects of similarity on cooperation are merely conveyed by changes in beliefs (i.e., one expects higher cooperation for more similar persons), for members of the ingroup similarity effects cooperation beyond changes in beliefs. In interaction with members from the ingroup, social identity causes people not only to increase cooperation due to increasing the beliefs that the partner will reciprocate cooperation. Additionally, people seem to give more value to establishing cooperation per se or might have more pro-social preferences concerning outcomes from the ingroup. This finding extends previous results supporting the view that effects of social identity on cooperation are mainly driven by motives of ingroup love instead of outgroup hate (De Dreu, 2010). More detailed investigations of these complex interactions are due to further research.

Authorship

All authors contributed to the study concept and to the study design. Testing and data collection for Experiments 1 and 2 were organized by A. Glöckner and for Experiment 3 by R. Schlegelmilch. S. Goerg and A. Glöckner performed the data analysis and interpretation for Experiments 1 and 2, and R. Schlegelmilch for Experiment 3. A. Glöckner and S. Goerg drafted the manuscript, and I. Fischer and R. Schlegelmilch provided critical revisions. All authors approved the final version of the manuscript for submission.

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Appendix A: Calculation of the similarity threshold

General case: x vs. $x + \Delta$

$$EV(x) = p_s(100 - x + 2x) + \sum_{\substack{n=0 \\ n \neq x}}^{100} p(100 - x + 2n)$$

$$EV(x + \Delta) = p_s(100 - (x + \Delta) + 2(x + \Delta)) + \sum_{\substack{n=0 \\ n \neq x+\Delta}}^{100} p(100 - (x + \Delta) + 2n)$$

Assumption that all outcomes with unequal decisions have the same probability: $p = p_n = p_{n-1},\ \forall\ n \in [1, ..., 100]$

Player is going to choose $x + \Delta$ over x if $EV(x + \Delta) > EV(x)$

$$\Leftrightarrow p_s(100+x+\Delta)+\sum_{\substack{n=0 \\ n \neq x}}^{100} p(100-(x+\Delta)+2n) > p_s(100+x)+\sum_{\substack{n=0 \\ n \neq x}}^{100} p(100-x+2n)$$

$$\Leftrightarrow \Delta p_s > p(100 - x + 2n) \sum_{\substack{n=0 \\ n \neq x}}^{100} p(100 - x + 2n) - \sum_{\substack{n=0 \\ n \neq x}}^{100} p(100 - (x + \Delta) + 2n)$$

$$\Leftrightarrow \Delta p_s > p(100 - x + 2(x + \Delta)) - p(100 - (x + \Delta) + 2x) + 99\Delta p$$

$$\Leftrightarrow \Delta p_s > 3\Delta p + 99\Delta p$$

$\Leftrightarrow p_s > 102p$, now we can use that $1 - p_s = 100p \Rightarrow p = \frac{1-p_s}{100}$

$$\Leftrightarrow p_s > 1.02 - 1.02p_s$$

$$\Leftrightarrow 2.02p_s > 1.02$$

$$\Rightarrow p_s > 0.50495$$

1st example – 100 vs. 50

$$EV(x_i = 100) = p_s(100 - 100 + 200) + \sum_{n=0}^{99} p_n(100 - 100 + 2n)$$
$$EV(x_i = 50) = p_s(100-50+100)+\sum_{n=0}^{49} p_n(100-50+2n)+\sum_{n=51}^{100} p_n(100-50+2n)$$

Player is going to choose 100 over 50 if $EV(x_i = 100) > EV(x_i = 50)$

$$200p_s + \sum_{n=0}^{99} p_n(2n) > 150p_s + \sum_{n=0}^{49} p_n(50 + 2n) + \sum_{n=51}^{100} p_n(50 + 2n)$$

Large overlap in $p_n 2n$, thus we can simplify the whole thing

$$200p_s + 100p_{50} > 150p_s + 250p_{100} + \sum_{n=0}^{49} 50p_n + \sum_{n=51}^{99} 50p_n$$
$$50p_s > 250p_{100} - 100p_{50} + \sum_{n=0}^{49} 50p_n + \sum_{n=51}^{99} 50p_n$$

Here I need an assumption on p_n. I assume they have the same probability

$$p = p_n = p_{n-1},\ \forall n \in [1, ..., 100]$$

$$50p_s > 150p + \sum_{n=0}^{49} 50p + \sum_{n=51}^{99} 50p$$
$$50p_s > 150p + 50(50p) + 49(50p)$$
$$p_s > 102p$$

Here I can use that the sum over the 100 p's must be $(1 - p_s)$

$$1 - p_s = 100p \Rightarrow p = \tfrac{1-p_s}{100}$$

$$p_s > 102\tfrac{1-p_s}{100}$$
$$p_s > 1.02 - 1.02p_s$$
$$2.02p_s > 1.02$$
$$p_s > 0.50495$$

2nd example – 100 vs. 0

$$EV(x_i = 100) = p_s(100 - 100 + 200) + \sum_{n=0}^{99} p_n(100 - 100 + 2n)$$
$$EV(x_i = 0) = p_s(100) + \sum_{n=1}^{100} p_n(100 + 2n)$$

Player is going to choose 100 over 0 if $EV(x_i = 100) > EV(x_i = 0)$

$$200p_s + \sum_{n=0}^{99} p_n(2n) > 100p_s + \sum_{n=1}^{100} p_n(100 + 2n)$$
$$100p_s + 0p_0 > 300p_{100} + \sum_{n=1}^{99} p_n(100)$$

Again, I assume that $p = p_n = p_{n-1},\ \forall n \in [1, ..., 100]$

$100p_s + 0p > 300p + 99p100$
$100p_s > 300p + 9900p$
$100p_s > 10200p$

Again: $1 - p_s = 100p \Rightarrow p = \frac{1-p_s}{100}$

$100p_s > 10200\frac{1-p_s}{100}$
$100p_s > \frac{10200-10200p_s}{100}$
$100p_s > 102 - 102p_s$
$202p_s > 102$
$p_s > 0.50495$

3rd example – 50 vs. 0

$$EV(x_i = 50) = p_s(100-50+100)+\sum_{n=0}^{49} p_n(100-50+2n)+\sum_{n=51}^{100} p_n(100-50+2n)$$
$$EV(x_i = 0) = p_s(100) + \sum_{n=1}^{100} p_n(100 + 2n)$$

Player is going to choose 50 over 0 if $EV(x_i = 50) > EV(x_i = 0)$

$$150p_s + \sum_{n=0}^{49} p_n(50 + 2n) + \sum_{n=51}^{100} p_n(50 + 2n) > 100p_s + \sum_{n=1}^{100} p_n(100 + 2n)$$
$$150p_s + p_0(50 + 2 * 0) + \sum_{n=1}^{49} p_n(50) + \sum_{n=51}^{100} p_n(50) > 100p_s + p_{50}(200 + 2 * 50) + \sum_{n=1}^{49} p_n(100) + \sum_{n=51}^{100} p_n(100)$$
$$50p_s > p_{50}(200) - p_0(50) + \sum_{n=1}^{49} p_n(50) + \sum_{n=51}^{100} p_n(50)$$

Again, I assume that $p = p_n = p_{n-1},\ \forall n \in [1, ..., 100]$

$50p_s > 200p - 50p + 99p50$
$50p_s > 5100p$

Again: $1 - p_s = 100p \Rightarrow p = \frac{1-p_s}{100}$

$50p_s > 5100\frac{1-p_s}{100}$
$50p_s > \frac{5100-5100p_s}{100}$
$50p_s > 51 - 51p_s$
$101p_s > 51$
$p_s > 0.50495$

Appendix B: Instructions

Experiment 1

Thank you for participating in our decision experiments.
In the following, we will explain the game, which is played in the present experiment. Please read the following rules of the game carefully. For the entire duration of the experiment, it is very important that you do not communicate with the other participants of the experiment. We therefore ask you not to talk to each other.
For the punctual appearance to the experiment you will receive a basic payoff of 5 Euros. You will also receive an individual payoff that is dependent on your decision-making behavior and the decision-making behavior of another person.

Rules of the game
You will be assigned to another participant of the experiment. You (player A) and the participant assigned to you (Player B) make the same decision at the same time.

Each player receives an initial endowment of 100 Taler (1 Taler = 5 cents).

Then you can transfer any amount of your initial endowment to player B. Thereby you can only transfer integer values, for example you can only choose one number from the set [0, 1, 2, 3, ..., 98, 99, 100]

The amount transferred to Player B will be doubled, so that Player B receives twice the amount you transferred.

The participant assigned to you (Player B) has the exact same choices. Player B can also transfer any amount of his initial endowment. Both players make their decisions simultaneously. During the experiment, both players are *not* informed about the decision of the respective other player.

Your individual payoff is determined as follows:

your initial endowment
- the amount transferred to Player B
+ the doubled amount that Player B transferred to you
= your individual payoff

Control questions
There are a few further questions. These questions will help you to understand the game properly. If you have trouble answering these questions, you are invited to read the rules again. Should any questions remain unanswered, please raise your hand and we will come to you.

1. How high is the payoff (in Taler) if Player A and Player B transfer an amount of 0 Taler?
Payoff Player A:
Payoff Player B:

2. How high is the payoff (in Taler) if Player A and Player B transfer an amount of 100 Taler?

Payoff Player A:
Payoff Player B:

3. How high is the payoff (in Taler) if Player A and Player B transfer an amount of 50 Taler?
Payoff Player A:
Payoff Player B:

4. How high is the payoff (in Taler) if Player A transfers an amount of 0 Taler and Player B transfers an amount of 100 Taler?
Payoff Player A:
Payoff Player B:

5. How high is the payoff (in Taler) if Player A transfers an amount of 100 Taler and Player B transfers an amount of 0 Taler?
Payoff Player A:
Payoff Player B:

Assessment of the other participants
Your task is to assess how similar to you the other participants of this experiment would behave in this game! For this purpose, every person will be asked to stand up. Then we ask you to assess the person standing up.

Please answer the question: How similar to you does the person behave in this game? Imagine that the other person plays the game for 10 rounds and you play the game for 10 rounds. How often will you behave similarly (not necessarily exact the same, but in a similar range)? Please use a scale from 0 to 10.

We then call the participants according to their cabin numbers. Please only assess the person standing up for evaluation. You do not have to assess yourself.

How similar to you does the person behave in this game?

Person	never the same 0	1	2	3	4	5	6	7	8	9	always the same 10
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Actual decision making

We ask you to decide which amount of your 100 Taler you would transfer, if you would actually play this game with another participant in this room.

For every participant please set the amount you would transfer, if you would play the game with this person. At the end of the experiment, we randomly select one interacting dyad. For this dyad, your decisions and those of the randomly assigned player will be implemented and paid out.

This means that each of your choices could be relevant for your payoff so you're your decisions should be considered carefully. If you have any questions, feel free to take a look in the game manual again.

This part of the experiment is also anonymous and we will not tell you which of the participants you have actually played the game with.

We now call on the participants sorted by cabin numbers. Please note the amount you want to transfer only for the person who stands up straight. You don`t have to transfer Taler to yourself.

Person	Transfer (x of 100 Taler)
1	Taler
2	Taler
3	Taler
4	Taler
5	Taler
6	Taler
7	Taler
8	Taler
9	Taler
10	Taler
11	Taler
12	Taler

Assessment of the behavior of the other players

We now want you to assess the behavior of the other participants. What do you think how much would the other participants transfer to you?

Again, we call on the participants sorted by cabin numbers. Please enter the amount of Taler you expect the person standing up transferring to you!

Person	Expected amount transferred (x of 100 Taler)
1	Taler
2	Taler
3	Taler
4	Taler
5	Taler
6	Taler
7	Taler
8	Taler
9	Taler
10	Taler
11	Taler
12	Taler

Assessment of the other participants

Finally, we want you to assess the other participants again. To this end, each person will stand up again shortly and we ask you to assess the respective person on the dimensions stated below.

Please only assess the person who stands up straight to be assessed. You don`t have to assess yourself.

Please rate the extent to which the attributes apply to the person. For this purpose, you should enter numbers between 0 = "does not apply at all" and 10 = "fully applies" in each box.

In the last column, please note if you have already known the person personally, before participating in the experiment.

Person	reliable	friendly	attractive	sociable	cooperative	I know the person (yes / no)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Demographic data

In the end we ask you to provide some data for statistics:

age: _____

nationality: _____

sex: o male o female

Experiment 2

The newly introduced group manipulation in Experiment 2 is provided here, the full instruction is available in the online supplement at osf.io/96mjb.

Division into groups

The participants of this study will be divided into two groups, the blue group and the green group. This division has no influence on the assignment of another participant to you during the determination of the payoff later on.

Please draw a card from the pile prepared by the experimenter to determine which group you belong to.

If you draw a card with the color blue, you belong to the group Blue.

If you draw a card with the color green, you belong to the group Green.

Please indicate the group you belong to by crossing the appropriate box!

I belong to the group Blue. O

I belong to the group Green. O