In press at Social Psychological and Personality Science.

**This paper is not the copy of record and may not exactly replicate the final,
authoritative version of the article**

**Sharing money with humans versus computers:
On the role of Honesty-Humility and (non-)social preferences**

Yngwie Asbjørn Nielsen¹, Isabel Thielmann², Ingo Zettler^{3,4} & Stefan Pfattheicher¹

¹ Department of Psychology and Behavioral Sciences, Aarhus University, Denmark,

² Department of Psychology, University of Koblenz-Landau, Germany,

³ Department of Psychology, University of Copenhagen, Denmark

⁴ Copenhagen Center for Social Data Science (SODAS), University of Copenhagen, Denmark

Corresponding author:

Yngwie Asbjørn Nielsen

Aarhus University

Department of Psychology and Behavioral Sciences

8000 Aarhus C, Denmark

yan@psy.au.dk

Word count (excluding tables, figures, and references): 4980

Abstract

Does giving behavior in economic games reflect true prosocial preferences or is it due to confusion? Research showing that trait Honesty-Humility accounts for giving behavior suggests the former, whereas research showing that participants give money to a computer might suggest the latter. In three preregistered, well-powered studies, we examined the relation of Honesty-Humility with behavior in the Dictator Game (Study 1, $N = 468$) and Public Goods Game (Studies 2 and 3, each $N = 313$), while participants interacted either with humans (“social game”) or with a computer (“non-social game”). We found that (1) decisions in the non-social game predicted decisions in the social game, supporting the confusion hypothesis; (2) the effect of Honesty-Humility differed within and between games; and (3) participants who gave money to the computer reported acting *as if* they were playing with humans. Overall, the studies suggest that both prosocial preferences and confusion underlie giving behavior.

Word count: 150

Keywords: Confusion; Economic games; HEXACO Honesty-Humility; Social preferences;

Virtual player method

Introduction

A large body of research has shown that people behave prosocially towards others even when doing so is individually costly (Camerer, 2003; Engel, 2011). However, individuals differ considerably in their prosociality, which is commonly attributed to individual differences in social preferences (Fehr & Fischbacher, 2002) and to personality more generally (Thielmann et al., 2020). An alternative account of individual differences in prosocial behavior has, in turn, posited that prosociality additionally—or even exclusively—arises from confusion (Andreoni, 1995; Burton-Chellew et al., 2016). The present investigation is the first to merge these research streams, critically testing the two accounts against each other.

Economic games and social preferences

Economic games constitute a gold standard for studying prosociality (Thielmann et al., 2021a; van Dijk & De Dreu, 2020). In these games, participants make decisions that influence their own and others' (usually financial) outcomes. In the Dictator Game, for instance, a “dictator” can freely allocate an endowment between themselves and a “recipient” (Forsythe et al., 1994). In the Public Goods Game (Samuelson, 1954), each player in a group individually decides how much of an endowment to contribute to a group account. The sum of contributions is then multiplied by a constant larger than 1 and shared equally among all group members, irrespective of their individual contributions.

Although in both games players can attain the highest individual outcome by selfishly keeping their endowment, some players consistently act prosocially, thereby accepting individual costs to benefit others (Balliet et al., 2009). This heterogeneity in prosocial behavior has been accounted for by *social preferences*, defined as “concern for the payoffs allocated to other relevant reference agents in addition to the concern for one's own payoff” (Carpenter, 2010, p. 247).

Honesty-Humility

From the perspective of basic personality models, social preferences are best captured by dispositional levels in HEXACO Honesty-Humility,¹ which represents “the tendency to be fair and genuine in dealing with others, in the sense of cooperating with others even when one might exploit them without suffering retaliation” (Ashton & Lee, 2007, p. 156). Honesty-Humility appears to be the (basic) prosocial trait par excellence, predicting prosocial behavior across many situations (for overviews, see Ashton & Lee, 2020; Zettler et al., 2020). In particular, multiple studies have documented a positive relation between Honesty-Humility and sharing money with anonymous others (e.g., Hilbig & Zettler, 2009; Mischkowski et al., 2019; Thielmann & Hilbig, 2018; Zhao et al., 2016). Accordingly, Honesty-Humility was one of the best dispositional predictors of prosocial behavior in economic games in a recent meta-analysis (Thielmann et al., 2020) and shows strong links to Social Value Orientation (Hilbig et al., 2014; Zettler et al., 2020), a measure of dispositional social preferences (Murphy & Ackermann, 2014).

Confusion and the case against social preferences

Another line of research has proposed *confusion* as an alternative to prosocial preferences to account for prosocial behavior. Confusion refers to “subjects’ inability to discern the relationships between the choices made and the game’s incentives” (Ferraro & Vossler, 2010, p. 2). Thus, a confused participant’s actions might not express their true intention; instead, a confused participant might act prosocially due to misunderstanding that acting selfishly would increase their personal payoff. To disentangle confusion from social preferences, Andreoni (1995) suggested to “subtract off the social, cultural, and strategic incentives for subjects to cooperate, leaving confusion as the most reasonable explanation for cooperation” (p. 893). Thus, one needs to create a non-social situation and investigate whether “prosocial” behavior still occurs.

¹ The HEXACO model is a six-factorial variation and extension of the well-known Five Factor Model (McCrae & Costa, 2008) including the dimensions Honesty-Humility, Emotionality, Extraversion, Agreeableness vs. Anger, Conscientiousness, and Openness to Experience. For a detailed theoretical and empirical comparison of the two models, see Thielmann et al. (2021b).

The idea of removing social content from economic games is implemented in the *virtual player method* (Ferraro et al., 2003; Houser & Kurzban, 2002). In one condition (which we term the “social game”), participants play a standard Public Goods Game with other participants. In the other condition (the “non-social game”), participants knowingly play the same game with a computer that generates the responses of “virtual players.” Thereby, the social incentives to behave prosocially—and thus the influence of social preferences on behavior—are arguably removed. Any prosocial behavior in the non-social game is thus typically attributed to confusion, whereas higher mean-level prosociality in the social compared to the non-social game is attributed to social preferences (Ferraro & Vossler, 2010; Houser & Kurzban, 2002). Multiple studies have shown that “prosocial” behavior also occurs in the non-social game (e.g., Burton-Chellew et al., 2016; Ferraro & Vossler, 2010; Ferraro et al., 2003; Johnson et al., 2002), suggesting that a non-trivial amount of prosocial behavior in economic games is due to confusion.

In a striking demonstration, Burton-Chellew et al. (2016) had participants play both the social and the non-social game. Remarkably, behavior across the games were highly correlated ($r = .78$), and the difference in giving between games was non-significant. The authors therefore concluded that “a common assumption in behavioral economics experiments, that choices reveal [prosocial] motivations, will not necessarily hold” (Burton-Chellew et al., 2016, p. 216; see also Burton-Chellew & West, 2013, 2021).

Importantly, the logic applied by Burton-Chellew and colleagues (2016) relies on inferring confusion from non-social giving. Some findings support this inference, for instance by showing that clearer instructions reduce non-social giving (Ferraro & Vossler, 2010). Other findings, however, contradict this inference, for instance by showing that better comprehension does *not* eliminate non-social giving (Burton-Chellew et al., 2016). Non-social giving might thus be driven by factors other than confusion—which we investigate herein.

The present research

At face value, the social preferences and confusion accounts appear contradictory. Research on the impact of personality traits, such as Honesty-Humility, clearly implies that prosocial behavior is (to some extent) an expression of dispositional prosocial preferences (Thielmann et al., 2020). By contrast, research on the influence of confusion claims that prosocial behavior reflects, to a meaningful extent, something other than social preferences (Burton-Chellew et al., 2016). To critically test these competing hypotheses, we applied the virtual player method in three studies in a within-subjects design while also assessing trait Honesty-Humility. Indeed, if Honesty-Humility is associated with non-social giving, this would challenge the idea that the non-social game is devoid of social incentives.

Overall, the present research advances the literature in several ways. First, it is the first to integrate the literature on personality and prosocial behavior with the literature on confusion. Second, while confusion is traditionally studied in the Public Goods Game (Ferraro & Vossler, 2010), we also used the Dictator Game, thereby putting the confusion hypothesis to the most conservative test possible: Because the Dictator Game is the simplest economic game, confusion may only play a minor role therein. If confusion is, however, a key determinant of prosocial behavior (e.g., Burton-Chellew et al., 2016), non-social giving should occur even in the Dictator Game. Finally, the present research intends to replicate the findings by Burton-Chellew et al. (2016), which is an important endeavor in and of itself (Open Science Collaboration, 2015; Brandt et al., 2014).

Research ethics statement and data

The studies reported below were conducted in full accordance with the ethical guidelines of the American Psychological Association. Institutional review boards are not mandatory in the country (Denmark) where the responsible investigator (last author) is employed. There was no deception of participants. All participants gave informed consent. All studies were preregistered. Preregistrations, materials, data, syntax, and supplementary analyses are available on the Open Science Framework (OSF; <https://osf.io/hav5c/>).

Study 1

Methods

Materials and procedure. Participants first completed the English 60-item version of the HEXACO Personality Inventory-Revised (HEXACO-60; Ashton & Lee, 2009) to measure Honesty-Humility along with the remaining HEXACO dimensions with 10 items each. Sample items for Honesty-Humility are, “I would never accept a bribe, even if it were very large” and, “I think that I am entitled to more respect than the average person is” (reversed). Participants’ responses were collected on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). All HEXACO scales showed acceptable alpha coefficients ($\alpha \geq .77$).

Next, participants played the Dictator Game in two variants (in counterbalanced order). In both games, participants (dictators) received 10 monetary units (MU; 1 MU worth 0.03 US\$) of which they could allocate any amount to the recipient. In the social game, the recipient was another participant. In the non-social game, the recipient was a computer. Following Burton-Chellew et al. (2016), participants had to click a button reading, “I understand I am now playing with a real person” and “I understand I am now only playing with a computer” prior to playing the respective game. In the non-social game, they further read “You are the only real person in the game, and only you will receive any money.” Upon study completion, participants received a flat fee of 0.81 US\$ plus the bonus payment earned in the games ($M = 0.62$, $SD = 0.16$ US\$).

Participants. An *a priori* power analysis using G*Power (Faul et al., 2009) yielded a sample size of 460 to detect small effects of $r \geq .15$ at $\alpha = .05$ (two-tailed) with high statistical power ($1 - \beta = .90$). We therefore aimed at recruiting 470 participants (460 + 10 extra) through Prolific Academic. Participants were automatically excluded during the survey if they failed to correctly answer (i) one of two instructed attention checks (“This is an attention check. Please answer with ‘strongly agree’.”) embedded in the HEXACO-60 or (ii) one of two comprehension questions about the Dictator Game (e.g., “You can decide how much of your 10 MU endowment to transfer to the

recipient.” [correct/wrong]). We also included a control question to eliminate bots (“Write down in 1 sentence what you ate yesterday for lunch.”). In total, 40 participants were excluded based on these criteria or dropped out during participation, leaving 470 participants. After removal of two duplicate responses, the final sample comprised $N = 468$ participants (265 female, 205 male, 1 n.a.; age $M = 34.4$, $SD = 12.7$ years).

Results and discussion

Allocations. On average, participants allocated significantly more MU in the social game ($M = 3.85$, $SD = 2.39$) than in the non-social game ($M = 1.56$, $SD = 2.57$), $t(467) = 17.18$, $p < .001$, Cohen’s $d = 0.79$, 95% CI [0.68; 0.92]. Thus, similar to prior research (e.g., Ferraro & Vossler, 2010), participants on average gave twice as much in the social game compared to the non-social game. Allocations in the two games were significantly correlated, yielding a medium-sized effect, $r = .32$, $p < .001$ (Table 1).²

Honesty-Humility. As shown in Figure 1, Honesty-Humility was significantly related to allocations in both the social game ($r = .21$, $p < .001$) and the non-social game ($r = .11$, $p = .019$). Both relations remained significant when controlling for age, gender, and the remaining HEXACO dimensions (see Table S4 on the OSF). To test whether relations differed between games, we predicted allocations by Honesty-Humility (grand mean-centered), game type (dummy-coded; 0 = non-social game, 1 = social game), and their interaction using a hierarchical linear model with random intercept.³ This yielded a non-significant interaction between Honesty-Humility and game type ($B = 0.35$, $SE = 0.20$, 95% CI [-0.05; 0.74], $p = .088$).⁴

² In our preregistration, we focused on Honesty-Humility in particular; here we also test differences between the social and non-social games to assess the replicability of previous findings. An overview of the preregistrations is available on the OSF.

³ We preregistered a comparison of correlations; however, the reported model is more appropriate. A comparison of correlations using Williams’ test yielded a non-significant difference: $t(465) = 1.96$, $p = .051$.

⁴ There was a significant effect of game order on allocations in the non-social game (see OSF for details). This effect changed neither the main results nor the conclusions. We found no significant order effects in Studies 2 and 3.

Overall, Study 1 showed both similarities and differences in behavior between the social and the non-social Dictator Game. Although mean allocations differed significantly between games, behavior in the two games showed a medium-sized correlation. This correlation was, however, much smaller than the large effect ($r = .78$) reported by Burton-Chellew et al. (2016). We suspect that this might result from using the Dictator Game instead of the (more complex) Public Goods Game. In Study 2, we therefore used a Public Goods Game to test the generalizability of our findings.

Honesty-Humility was also positively related to allocations in both the social and the non-social games, although (descriptively) more strongly so in the former. One might therefore argue that Honesty-Humility is positively linked to confusion. In contrast to this reasoning, however, individuals high in Honesty-Humility do not cooperate indiscriminately when encountering a selfish interaction partner (Zettler et al., 2013), suggesting that they indeed understand the rules of economic games.

Table 1. Means, standard deviations, Cronbach's alphas (along the diagonal), and intercorrelations between all variables measured in Study 1 ($N = 468$).

	$M (SD)$	Correlation (Pearson's r)						
		H	E	X	A	C	O	DG social
H	3.47 (0.66)	(.77)						
E	3.32 (0.69)	-.06	(.81)					
		[-.15; .03]						
X	2.95 (0.77)	.03	-.21***	(.86)				
		[-.06; .12]	[-.29; -.12]					
A	3.16 (0.61)	.32***	-.23***	.20***	(.78)			
		[-.24; .40]	[-.32; -.15]	[.11; .29]				
C	3.65 (0.57)	.23***	-.07	.25***	.17***	(.78)		
		[-.14; .32]	[-.16; .02]	[.17; .34]	[.08; .26]			
O	3.66 (0.66)	.18***	.06	.20***	.10*	.17***	(.79)	
		[-.09; .27]	[-.03; .15]	[.11; .28]	[.01; .19]	[.08; .26]		
DG social	3.85 (2.39)	.21***	.07	.01	.05	-.00	.19***	
		[-.12; .30]	[-.02; .16]	[-.08; .10]	[-.04; .14]	[-.09; .09]	[.10; .28]	
DG non-social	1.56 (2.57)	.11*	.02	.03	-.01	.04	.02	.32***
		[.02; .20]	[-.07; .11]	[-.06; .12]	[-.10; .08]	[-.05; .13]	[-.07; .11]	[.24; .40]

Note. H = Honesty-Humility, E = Emotionality, X = Extraversion, A = Agreeableness vs. Anger, C = Conscientiousness, O = Openness to Experience, DG = Dictator Game. Range of measures: HEXACO = 1–5, DG = 0–10.

*** $p < .001$, * $p < .05$.

Figure 1. Distribution of Dictator Game allocations in the social and non-social game (right panel) and regression plot predicting allocations by Honesty-Humility (left panel) in Study 1. A jitter has been applied to the points for visual clarity.

But why does Honesty-Humility predict allocations in the non-social game? Prior research into social psychological aspects of decision making suggests that prosocial behavior may occur intuitively, that is, without conscious deliberation (Rand et al., 2012; Zaki & Mitchell, 2013; but see Bouwmeester et al., 2017). Relatedly, Nass and Moon (2000) posit that humans mindlessly apply social behavior when interacting with computers. It is thus conceivable that participants may to some extent intuitively act *as if* they are interacting with a human in the non-social game, triggering social preferences to affect behavior. In Study 2, we tested this possibility, hypothesizing that acting *as if* the computer is human moderates the relation between Honesty-Humility and giving in the non-social game. Although the possibility of participants generalizing social behavior to the non-social game has been discussed repeatedly (e.g., Burton-Chellew et al., 2016; Ferraro & Vossler, 2010), a direct test of this possibility is missing.

Study 2

Methods

Materials and procedure. Participants first completed the HEXACO-60. As in Study 1, all scales showed acceptable alpha coefficients ($\alpha \geq .77$). Next, they played the social and non-social versions of a two-player Public Goods Game in counterbalanced order. In each game, participants received 20 MU (each worth 0.01 US\$) and contributions to the group account were multiplied by 1.6. Thus, for every MU contributed, both players received 0.8 MU. In the non-social game, contributions of the virtual players were determined randomly, about which participants were informed. The procedure was otherwise identical to Study 1.

Following the games, participants were asked to indicate whether they played the non-social game *as if* they were playing with a human. To this end, we used three items (e.g., “When interacting with the computer, I acted as if the computer was human”), which showed high internal consistency ($\alpha = .98$). Participants responded on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Upon study completion, participants received a flat fee of 1.09 US\$ plus the bonus payment earned in the games ($M = 0.55$, $SD = 0.08$ US\$).

Participants. An *a priori* power analysis using G*Power (Faul et al., 2009) revealed a sample size of 314 to detect small to medium-sized effects of $r \geq .20$ with $\alpha = .05$ (two-tailed) and high statistical power ($1-\beta = .95$). Recruitment and exclusion criteria were identical to Study 1, except that we did not include a control question against bots. In total, 176 participants were excluded or dropped out during participation, leaving 314 participants. One participant informed the experimenter that they did not fully understand all items and was thus excluded. The final sample therefore comprised $N = 313$ participants (172 female, 137 male, 4 n.a.; age $M = 31.6$, $SD = 11.5$ years).

Results and discussion

Contributions. On average, participants contributed significantly more MU in the social game ($M = 10.56$, $SD = 6.67$) than in the non-social game ($M = 8.03$, $SD = 6.95$), $t(312) = 7.17$, $p < .001$, Cohen's $d = 0.41$, 95% CI [0.30; 0.51]. In turn, contributions in the social and the non-social game were significantly correlated, yielding a large effect, $r = .58$, $p < .001$ (Table 2).

Honesty-Humility. Contrary to previous findings, Honesty-Humility was not significantly related to contributions, neither in the social game ($r = .10$, $p = .085$), nor in the non-social game ($r = .04$, $p = .431$; Figure 2).⁵

Acting as if. As expected, acting *as if* the interaction partner in the non-social game was human was significantly related to contributions in the non-social game ($r = .35$, $p < .001$), but not in the social game ($r = -.06$, $p = .320$). To test whether social preferences may only influence non-social behavior if participants acted *as if*, we regressed contributions in the non-social game on Honesty-Humility, acting *as if* (both mean-centered), and their interaction. Contrary to our

⁵ A moderation analysis identical to that of Study 1 revealed no significant interaction between Honesty-Humility and game type ($B = 0.51$, $SE = 0.53$, 95% CI [-0.53; 1.55], $p = .336$).

expectations, there was no significant interaction ($B = 0.11$, $SE = 0.23$, 95% CI [-0.34; 0.56], $p = .629$).

Taken together, the findings from Study 2 differed somewhat from Study 1. First, the difference in contributions between the social and non-social game was smaller in Study 2, whereas the relation between contributions in the two games was larger. Second, Honesty-Humility was not significantly related to contributions in any game. Accordingly, the correlation observed in the social game ($r = .10$) was also smaller than a recent meta-analytic estimate ($r = .15$; Thielmann et al., 2020). In turn, acting *as if* the non-social game was played with a human was significantly related to contributions in the non-social game, suggesting that participants who give to computers do so partly because they misapply everyday social behavior in the non-social game.

Although Study 2 extended Study 1, several potential limitations remained, namely: (i) monetary incentives in the games were relatively small; (ii) Burton-Chellew et al. (2016) applied a four-player Public Goods Game, whereas we applied a two-player variant; (iii) a substantial number of participants were excluded based on comprehension checks; and (iv) we did not measure participants' game comprehension, which might constitute a more direct assessment of confusion. In Study 3, we aimed at replicating our findings while overcoming these limitations.

Table 2. Means, standard deviations, Cronbach's alphas (along the diagonal), and intercorrelations between all variables measured in Study 2 ($N = 313$).

	<i>M (SD)</i>	Correlation (Pearson's <i>r</i>)							
		H	E	X	A	C	O	As if	PGG social
H	3.46 (0.67)	(.77)							
E	3.46 (0.64)	-.03	(.78)						
		[-.14; .08]							
X	3.00 (0.71)	-.02	-.29***	(.82)					
		[-.13; .09]	[-.39; -.19]						
A	3.16 (0.66)	.26***	-.26***	.36***	(.81)				
		[-.15; .36]	[-.36; -.16]	[.26; .45]					
C	3.71 (0.59)	.26***	.02	.19***	.14*	(.81)			
		[-.15; .36]	[-.09; .13]	[.09; .30]	[.03; .25]				
O	3.65 (0.64)	.12*	.08	.06	.05	.20***	(.77)		
		[.01; .23]	[-.03; .19]	[-.06; .17]	[-.06; .16]	[.09; .30]			
As if	3.87 (2.37)	-.04	.08	.23***	.12*	.01	.04	(.98)	
		[-.15; .07]	[-.04; .18]	[.13; .34]	[.01; .22]	[-.10; .12]	[-.07; .15]		
PGG social	10.56 (6.67)	.10	-.13*	-.01	-.01	.02	.04	-.06	
		[-.01; .21]	[-.24; -.02]	[-.12; .10]	[-.12; .10]	[-.09; .13]	[-.07; .15]	[-.17; .05]	
PGG non-social	8.03 (6.95)	.04	-.08	.05	.08	-.03	.09	.35***	.58***
		[-.07; .15]	[-.18; .04]	[-.06; .16]	[-.03; .19]	[-.14; .09]	[-.02; .20]	[.25; .45]	[.50; .65]

Note. H = Honesty-Humility, E = Emotionality, X = Extraversion, A = Agreeableness vs. Anger, C = Conscientiousness, O = Openness to Experience, As if = acting *as if* the interaction partner in the non-social game was human, PGG = Public Goods Game. Range of measures: HEXACO = 1–5, As if = 1–7, PGG = 0–20.

*** $p < .001$, * $p < .05$.

Figure 2. Distribution of Public Goods Game contributions in the social and non-social games (right panel) and regression plot predicting contributions by Honesty-Humility (left panel) in Study 2. A jitter has been applied to the points for visual clarity

Study 3

Methods

Materials and procedure. Participants first completed the HEXACO-60, which showed acceptable alpha coefficients for all scales ($\alpha \geq .76$). Afterwards, they received detailed instructions on the four-player Public Goods Game. We used an initial endowment of 20 MU and a multiplier of 1.6 (i.e., for every MU contributed, all players received 0.4 MU). Following Burton-Chellew et al. (2016), participants were asked to complete 10 calculation questions (pretested in a pilot study and partly adapted based on the results) to check game comprehension (e.g., “Each group member has an endowment of 20 MU. Nobody (including yourself) contributes any MU to the project. What is *your* total income (in MU)?”). For each correct answer, participants received 0.01 US\$. To assist participants in their calculations, we provided them with four sliders (representing the contributions of the four players) and displayed their payoff for different hypothetical group contributions. We summed the number of correct answers as a measure of comprehension ($\alpha = .92$).

Next, participants played a social and a non-social variant of the Public Goods Game in counterbalanced order. To increase incentives compared to Studies 1 and 2, each MU was worth 0.05 US\$. Thus, participants could earn 2\$ by contributing nothing in either game, which exceeded the flat fee. Finally, for exploratory reasons, we measured participants’ prior experience with the game.⁶ The procedure was otherwise identical to Studies 1 and 2. Upon study completion, participants received a flat fee of 1.73 US\$ plus the bonus payment earned in the games ($M = 2.70$, $SD = 0.49$ US\$).

Participants. Power analyses and recruitment were identical to Study 2 with one exception; in order to allow investigation into the influence of comprehension on contributions, we did not exclude participants who failed a comprehension question. In total, 66 participants were excluded or dropped out during participation, leaving 314 participants. After removal of one duplicate

⁶ We found no significant main or interaction effects of prior game experience (see OSF).

response, the final sample comprised $N = 313$ participants (184 female, 123 male, 6 n.a.; age $M = 32.6$, $SD = 11.5$ years).

Results and discussion

Contributions. Replicating prior results, participants contributed significantly more MU in the social game ($M = 11.00$, $SD = 6.81$) than in the non-social game ($M = 8.02$, $SD = 6.52$), $t(312) = 7.99$, $p < .001$, Cohen's $d = 0.45$, 95% CI [0.36; 0.54]. Contributions in the games were once more strongly correlated, $r = .51$, $p < .001$ (Table 3).

Honesty-Humility. Honesty-Humility was significantly related to contributions in the social game ($r = .17$, $p = .003$), but not in the non-social game ($r = .01$, $p = .794$; Figure 3). The former relation remained significant when controlling for age, gender, and the remaining HEXACO dimensions (see Table S11 on the OSF). We again ran a hierarchical linear model to test for an interaction between Honesty-Humility (grand mean-centered) and game type (dummy-coded; 0 = non-social game, 1 = social game). This time, there was a significant interaction ($B = 1.53$, $SE = 0.54$, 95% CI [0.47; 2.60], $p = .005$).

Acting as if. Acting *as if* was again significantly related to contributions in the non-social game ($r = .28$, $p < .001$), but this time, it was also *negatively* correlated with contributions in the social game ($r = -.16$, $p = .005$).

Comprehension. In total, 43.8% of participants answered all comprehension questions correctly (in comparison to 22.2% in Burton-Chellew et al., 2016). Comprehension was positively related to contributions in the social game ($r = .13$, $p = .025$) and negatively to contributions in the non-social game ($r = -.16$, $p = .004$).⁷ Thus, with better comprehension, participants gave more to humans and less to computers. Moreover, comprehension was negatively related to acting *as if* the computer was human, ($r = -.38$, $p < .001$). Interestingly—and similar to Burton-Chellew et al. (2016)—among the 137 (43.8%) participants who answered *all* comprehension questions correctly,

⁷ By mistake, we preregistered a *positive* relation between comprehension and contributions in the non-social game.

87 (63.5%) contributed something (i.e., > 0 MU) in the non-social game, yielding a non-zero mean even among perfect comprehenders ($M = 6.96$, $SD = 6.98$).

Taken together, Study 3 extends the findings of Study 2 to a four-player Public Goods Game with higher incentives. Additionally, Study 3 showed that game comprehension is indeed related to contributions in both the social game (positively) and the non-social game (negatively), as well as to acting *as if* the computer was human (negatively). This latter finding suggests that low-comprehending participants are particularly likely to misapply everyday social behavior when playing with the computers.

Figure 3. Distribution of Public Goods Game contributions in the social and non-social games (right panel) and regression plot predicting contributions by Honesty-Humility (left panel) in Study 3. A jitter has been applied to the points for visual clarity.

Table 3. Means, standard deviations, Cronbach's alphas (along the diagonal), and intercorrelations between all variables measured in Study 3 ($N = 313$).

		Correlation (Pearson's <i>r</i>)									
	<i>M (SD)</i>	H	E	X	A	C	O	As if	Compre- hension	PGG social	
H	3.39 (0.68)	(0.76)									
E	3.41 (0.65)	-.03 [-.14; .08]	(0.78)								
X	2.99 (0.77)	-.07 [-.18; .04]	-.20*** [-.30; -.09]	(0.84)							
A	3.22 (0.64)	.19*** [.08; .29]	-.13* [-.24; -.02]	.24*** [.14; .34]	(0.79)						
C	3.69 (0.62)	.32*** [.22; .42]	.03 [-.08; .14]	.13* [.02; .24]	.12* [.01; .23]	(0.81)					
O	3.67 (0.63)	.11 [-.01; .21]	.11* [.00; .22]	.09 [-.02; .20]	.14* [.03; .24]	.19*** [.08; .30]	(0.77)				
As if	3.70 (2.24)	-.07 [-.18; .04]	-.03 [-.14; .08]	.23*** [.12; .33]	.05 [-.06; .16]	-.04 [-.15; .07]	-.08 [-.19; .03]	(0.95)			
Comprehension	7.16 (3.40)	.20*** [-.09; .30]	.10 [-.01; .21]	-.25*** [-.35; -.14]	-.16** [-.26; -.05]	.08 [-.04; .18]	.11* [.00; .22]	-.38*** [-.47; -.28]	(0.92)		
PGG social	11.00 (6.81)	.17** [.06; .27]	.07 [-.04; .18]	.00 [-.11; .12]	.12* [.01; .22]	-.04 [-.15; .07]	.07 [-.04; .18]	-.16** [-.27; -.05]	.13* [.02; .23]		
PGG non-social	8.02 (6.52)	.01 [-.10; .13]	-.05 [-.16; .06]	.12* [.01; .23]	.05 [-.06; .16]	-.00 [-.11; .11]	-.00 [-.11; .11]	.28*** [.17; .38]	-.16** [-.27; -.05]	.51*** [.43; .59]	

Note. H = Honesty-Humility, E = Emotionality, X = Extraversion, A = Agreeableness vs. Anger, C = Conscientiousness, O = Openness to Experience, As if = acting *as if* the interaction partner in the non-social game was human, PGG = Public Goods Game. Range of measures: HEXACO = 1–5, As if = 1–7, Comprehension = 0–10, PGG = 0–20.

*** $p < .001$, ** $p < .01$, * $p < .05$.

General Discussion

Humans behave prosocially for a variety of reasons. The present research examined two contradictory accounts of individual differences in prosocial behavior in the context of economic games, namely, that prosocial behavior is driven by a prosocial preferences versus confusion. In three high-powered, preregistered online studies, we assessed prosocial behavior in a social (i.e., playing with another person) and a non-social (i.e., playing with a computer) variant of the Dictator Game (Study 1) and the Public Goods Game (Studies 2 and 3). To conclusively pit social preferences against confusion, we investigated to what extent behavior converges across games and is related to (i) trait Honesty-Humility, (ii) acting *as if* the computer was human (Studies 2 and 3), and (iii) game comprehension (Study 3).

Supporting the social preferences account, participants gave more in the social games than in the non-social variants of the same games. Furthermore, the association between prosocial behavior and Honesty-Humility was descriptively larger in the social games, and significantly so in Study 3. Supporting the confusion hypothesis, better game comprehension was associated with lower contributions in the non-social game (Study 3). Further, behavior across the social and non-social game was positively correlated, although convergence was considerably smaller as observed by Burton-Chellew et al. (2016). Finally, convergence was larger in the Public Goods Game (Studies 2 and 3) than in the Dictator Game (Study 1). Overall, each account can explain parts of the findings.

Nonetheless, even in the Dictator Game—perhaps the simplest economic game—we found a significant correlation between allocations in the social and non-social game. How should this be interpreted? One might argue that confusion even plays a role in very simple (and presumably non-confusing) situations, suggesting that confusion has a robust effect on prosocial behavior in economic games. However, in Study 3, the majority of participants who demonstrated very high game comprehension still decided to contribute to a group of computers. Similarly, prior research

showed contributions in a non-social Public Goods Game even after 10 or 25 rounds of play (Houser & Kurzban; Ferraro & Vossler, 2010).

In light of these findings, one could argue that the virtual player method might capture something other than confusion. Specifically, we found a small but significant relation between Honesty-Humility and allocations in the non-social Dictator Game (Study 1). Thus, part of the variance in non-social allocations is attributable to a dispositional prosocial preference. Moreover, there was a moderate association between acting *as if* the non-social game was played with a human and contributions in the non-social Public Goods Game. In fact, acting *as if* was more strongly related to non-social contributions than was game comprehension. Both findings indicate that the “non-social” game is not devoid of social forces. By implication, the non-social game does not meet the requirements of a control condition that removes social incentives, as originally envisioned by Andreoni (1995).

Despite this, can behavior in the non-social game still be called “confused” to some extent? Following the definition of confusion—an inability to recognize the connection between choices and the game’s incentives—the answer is “yes.” Specifically, a non-social situation to which participants mistakenly attribute social incentives reflects what has been termed confusion. In fact, such an interpretation could explain the negative relation between comprehension and acting in the non-social game *as if* it was social.

Implications

The current work has important implications for research using economic games. First, researchers should be aware that the Public Goods Game may contain more “noise” resulting from confusion than the simpler Dictator Game. Indeed, Ferraro and Vossler (2010) found that presenting participants with highly detailed game instructions decreased confusion. Second, our findings for our *as if* measure imply that people (mis)apply social standards to non-human agents, such as computers (Nass & Moon, 2000; Nielsen et al., in press). Thus, the virtual player method may not

exclusively measure *non-social* behavior, as social motives seem to partly drive behavior. The close correspondence between giving to humans and computers might further suggest that giving behavior in economic games (toward humans and machines alike) occurs intuitively to a substantial extent (e.g., Zaki & Mitchell, 2013; Rand et al., 2012).

Another implication of the present findings is that estimates of the correlation between personality and prosocial behavior in economic games might be conservative. Specifically, if confusion adds noise to decisions, it thereby attenuates the relation between dispositional tendencies and behavior. Supporting this idea, effects of personality on prosocial behavior are generally larger in the Dictator Game than in more complex games, such as the Public Goods Game (Thielmann et al., 2020).

Limitations and outlook

Although our findings further illuminate the nature of confusion and individual differences in prosocial behavior, some limitations should be acknowledged. First, we only studied the influence of confusion in two economic games. Given that the influence of confusion seems to vary across games, future research is needed to investigate the generalizability of our findings to other games. Second, the present research neglects how behavior changes across multiple trials of the same game. Houser and Kurzban (2002) showed that contributions in the non-social game decay over time, indicating that confusion “wears off” (Burton-Chellew & West, 2013, 2021; Burton-Chellew et al., 2015; but see Bayer et al., 2013). That said, our findings are of direct relevance to research applying one-shot games, as most often used in research (Balliet et al., 2011; Thielmann et al., 2020). Finally, acting *as if* was measured by retrospective self-reports. Thus, the relation between acting *as if* and non-social contributions might partly reflect self-justification rather than a true relationship. Future research may pick up on this issue.

Conclusion

There are both differences and similarities in prosocial behavior across social and non-social contexts. Although similarities were previously interpreted as confusion, our results imply that these similarities also show that individuals tend to express their social preferences in non-social settings. Indeed, our paper highlights the potential of non-social settings as a method of inquiry into prosocial behavior (see Nielsen et al., in press). Overall, the current work is an initial step in bridging the gap between research on prosocial personality and confusion—in economic games and beyond.

References

- Andreoni, J. (1995). Cooperation in Public-Goods experiments: Kindness or confusion? *The American Economic Review*, 85(4), 891–904.
- Ashton, M. C., & Lee, K. (2007). Empirical, theoretical, and practical advantages of the HEXACO model of personality structure. *Personality and Social Psychology Review*, 11(2), 150–166. <https://doi.org/10.1177/1088868306294907>
- Ashton, M. C., & Lee, K. (2009). The HEXACO-60: A short measure of the major dimensions of personality. *Journal of Personality Assessment*, 91(4), 340–345. <https://doi.org/10.1080/00223890902935878>
- Ashton, M. C., and Lee, K. (2020) Objections to the HEXACO model of personality structure—and why those objections fail. *Eur. J. Pers.*, 34: 492– 510. <https://doi.org/10.1002/per.2242>
- Balliet, D., Mulder, L. B., & Van Lange, P. A. M. (2011). Reward, punishment, and cooperation: A meta-analysis. *Psychological Bulletin*, 137(4), 594–615. <https://doi.org/10.1037/a0023489>
- Balliet, D., Parks, C. D., & Joireman, J. A. (2009). Social value orientation and cooperation in social dilemmas: A meta-analysis. *Group Processes & Intergroup Relations*, 12(4), 533–547. <https://doi.org/10.1177/1368430209105040>
- Bayer, R. C., Renner, E., & Sausgruber, R. (2013). Confusion and learning in the voluntary contributions game. *Experimental Economic*, 16, 478–496. <https://doi.org/10.1007/s10683-012-9348-2>
- Bouwmeester, S., Verkoeijen, P., Aczel, B., Barbosa, F., Bègue, L., Brañas-Garza, P., Chmura, T., Cornelissen, G., Døssing, F. S., Espín, A. M., Evans, A. M., Ferreira-Santos, F., Fiedler, S., Flegr, J., Ghaffari, M., Glöckner, A., Goeschl, T., Guo, L., Hauser, O. P., Hernan-Gonzalez, R., ... Wollbrant, C. E. (2017). Registered replication report: Rand, Greene, and Nowak (2012). *Perspectives on Psychological Science*, 12(3), 527–542. <https://doi.org/10.1177/1745691617693624>
- Brandt, M. J., IJzerman, H., Dijksterhuis, A., Farach, F. J., Geller, J., Giner-Sorolla, R., Grange, J. A., Perugini, M., Spies, J. R., & van't Veer, A. (2014). The replication recipe: What makes

for a convincing replication? *Journal of Experimental Social Psychology*, 50, 217–224.

<https://doi.org/10.1016/j.jesp.2013.10.005>

Burton-Chellew M. N., Nax, H. H., & West, S. A. (2015). Payoff-based learning explains the decline in cooperation in public goods games. *Proceedings of the Royal Society B*, 282, Article 20142678. <http://doi.org/10.1098/rspb.2014.2678>

Burton-Chellew, M. N. & West, S. A. (2013). Prosocial preferences do not explain human cooperation in public-goods games. *Proceedings of the National Academy of Sciences*, 110(1), 216–221. <https://doi.org/10.1073/pnas.1210960110>

Burton-Chellew, M. N. & West, S. A. (2021). Payoff-based learning best explains the rate of decline in cooperation across 237 public-goods games. *Nature Human Behaviour*. Advance online publication. <https://doi.org/10.1038/s41562-021-01107-7>

Burton-Chellew, M. N., El Mouden, C., & West, S. A. (2016). Conditional cooperation and confusion in public-goods experiments. *Proceedings of the National Academy of Sciences*, 113(5), 1291–1296. <https://doi.org/10.1073/pnas.1509740113>

Camerer, C. F. (2003). *Behavioral game theory: Experiments in strategic interaction*. Russell Sage Foundation.

Carpenter, J. (2010). Social preferences. In Durlauf, S. N., & Blume, L. E. (Eds.), *Behavioural and experimental economics* (pp. 247–252). Palgrave Macmillan.

Engel, C. (2011). Dictator games: A meta study. *Experimental Economics*, 14(4), 583–610. <https://doi.org/10.1007/s10683-011-9283-7>

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41, 1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>

Fehr, E., & Fischbacher, U. (2002). Why social preferences matter – the impact of non-selfish motives on competition, Cooperation and Incentives. *The Economic Journal*, 112(478), C1–C33. <https://doi.org/10.1111/1468-0297.00027>

- Ferraro P. J., Rondeau, D., & Poe, G. L. (2003). Detecting other-regarding behavior with virtual players. *Journal of Economic Behavior and Organization*, 51, 99–109.
[https://doi.org/10.1016/S0167-2681\(02\)00137-3](https://doi.org/10.1016/S0167-2681(02)00137-3)
- Ferraro, P. & Vossler, C. (2010). The source and significance of confusion in Public Goods experiments. *The B.E. Journal of Economic Analysis & Policy*, 10(1), 1–42.
- Forsythe, R., Horowitz, J. L., Savin, N. E., & Sefton, M. (1994). Fairness in simple bargaining experiments. *Games and Economic Behavior*, 6, 347–369.
<http://dx.doi.org/10.1006/game.1994.1021>
- Hilbig, B. E., & Zettler, I. (2009). Pillars of cooperation: Honesty-humility, social value orientations, and economic behavior. *Journal of Research in Personality*, 43(3), 516–519.
<https://doi.org/10.1016/j.jrp.2009.01.003>
- Hilbig, B. E., Glöckner, A., & Zettler, I. (2014). Personality and prosocial behavior: Linking basic traits and social value orientations. *Journal of Personality and Social Psychology*, 107(3), 529–539. <https://doi.org/10.1037/a0036074>
- Houser, D., & Kurzban, R. (2002). Revisiting kindness and confusion in Public Goods experiments. *The American Economic Review*, 92(4), 1062–1069.
<https://doi.org/10.1257/00028280260344605>
- Johnson, E. J., Camerer, C., Sen, S., & Rymon, T. (2002). Detecting failures of backward induction: Monitoring information search in sequential bargaining. *Journal of Economic Theory*, 104(1), 16–47. <https://doi.org/10.1006/jeth.2001.2850>
- McCrae, R. R., & Costa, P. T. (2008). The five-factor theory of personality. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality psychology: Theory and research* (pp. 159–181). The Guilford Press.
- Mischkowski, D., Thielmann, I., & Glöckner, A. (2019). Minimizing inequality versus maximizing joint gains: On the relation between personality traits and different prosocial motivations. *Journal of Research in Personality*, 81, 153–157.
<https://doi.org/10.1016/j.jrp.2019.06.001>

- Murphy, R. O., & Ackermann, K. A. (2014). Social value orientation: Theoretical and measurement issues in the study of social preferences. *Personality and Social Psychology Review*, 18(1), 13–41.
<https://doi.org/10.1177/1088868313501745>
- Nass, C., & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. *Journal of Social Issues*, 56(1), 81–103. <https://doi.org/10.1111/0022-4537.00153>
- Nielsen, Y. A., Keijsers, M., & Pfattheicher, S. (in press). Prosocial behavior towards machines. *Current Opinion in Psychology*. Advance online publication.
<https://doi.org/10.1016/j.copsyc.2021.08.004>
- Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, 349(6251), 1–8. <https://doi.org/10.1126/science.aac4716>
- Rand, D., Greene, J., & Nowak, M. (2012). Spontaneous giving and calculated greed. *Nature*, 489, 427–430. <https://doi.org/10.1038/nature11467>
- Samuelson, P. A. (1954). The pure theory of public expenditure. *The Review of Economics and Statistics*, 36, 387–389. <http://dx.doi.org/10.2307/1925895>
- Thielmann, I., & Hilbig, B. E. (2018). Is it all about the money? A re-analysis of the link between Honesty-Humility and Dictator Game giving. *Journal of Research in Personality*, 76, 1–5.
<https://doi.org/10.1016/j.jrp.2018.07.002>
- Thielmann, I., Böhm, R., Ott, M., & Hilbig, B. E. (2021a). Economic games: An introduction and guide for research. *Collabra: Psychology*, 7(1), Article 19004.
<https://doi.org/10.1525/collabra.19004>
- Thielmann, I., Moshagen, M., Hilbig, B.E., & Zettler, I. (2021b). On the comparability of basic personality models: Meta-analytic correspondence, scope, and orthogonality of the Big Five and HEXACO dimensions. *European Journal of Personality*. Advance online publication. <https://doi.org/10.1177/08902070211026793>
- Thielmann, I., Spadaro, G., & Balliet, D. (2020). Personality and prosocial behavior: A theoretical framework and meta-analysis. *Psychological Bulletin*, 146(1), 30–90.
<https://doi.org/10.1037/bul0000217>

- Zaki, J., & Mitchell, J. P. (2013). Intuitive prosociality. *Current Directions in Psychological Science*, 22(6), 466–470. <https://doi.org/10.1177/0963721413492764>
- Zettler, I., Hilbig, B. E., & Heydasch, T. (2013). Two sides of one coin: Honesty–humility and situational factors mutually shape social dilemma decision making. *Journal of Research in Personality*, 47(4), 286–295. <https://doi.org/10.1016/j.jrp.2013.01.012>
- Zettler, I., Thielmann, I., Hilbig, B. E., & Moshagen, M. (2020). The nomological net of the HEXACO model of personality: A large-scale meta-analytic investigation. *Perspectives on Psychological Science*, 15(3), 723–760. <https://doi.org/10.1177/1745691619895036>
- Zhao, K., Ferguson, E., & Smillie, L. D. (2016). Prosocial personality traits differentially predict egalitarianism, generosity, and reciprocity in economic games. *Frontiers in Psychology*, 7, Article 1137. <https://doi.org/10.3389/fpsyg.2016.01137>