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The Structure of Human Prosociality Revisited: Corrigendum and Addendum to Böckler, Tusche, and Singer (2016)

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Abstract

In a recent publication, we employed factor analyses to integrate 14 measures of prosocial behavior, proposing four subcomponents of human prosociality: altruistically motivated, norm motivated, strategically motivated, and self-reported prosocial behavior. However, the reported confirmatory factor analysis (CFA) yielded standardized regression weights above 1, resulting from an improper solution (Heywood cases), which precludes straightforward interpretation of results. Here, we present two adjusted CFA models that rectify this problem. Model 1 resolves the issue of Heywood cases by implementing equality constraints, yielding a four-factor structure that is largely similar to the original model. Model 2 accommodates additional methodological considerations and presents a revised structure of prosociality with three subcomponents: altruistically motivated, norm motivated, and self-reported prosocial behavior. We also report minor corrections of descriptive results, none of which alter the pattern of results and interpretations of the original publication.

Keywords

behavioral economics, helping/prosocial behavior, social cognition, structural equation modeling, norms

Much to our regret, we have identified inaccuracies in the article *The Structure of Human Prosociality: Differentiating Altruistically Motivated, Norm Motivated, Strategically Motivated and Self-Reported Prosocial Behavior* (Böckler, Tusche, & Singer, 2016) which we would like to correct. Primarily, the confirmatory factor analysis (CFA) in our article yielded standardized regression weights above 1 (see Figure 1 in Böckler, Tusche, & Singer, 2016), resulting from an improper solution (*Heywood cases* that lead to negative error variances and inflated standardized factor loadings; Brown, 2014). We present two adjusted CFA models that rectify this problem. In addition, we report corrections of minor inaccuracies in the descriptive results detected during reanalyses.

CFA

To address the issue of Heywood cases in our original CFA, we specified two modified CFA models: The first model (Model 1) aimed at resolving the issue of improper solutions while being maximally similar to the CFA in the original publication. A second model (Model 2) built on Model 1 while accommodating additional methodological considerations. Indeed, Model 1 successfully eliminated the problem of Heywood cases while proposing the same four factors of human prosociality described in the original article: altruistically motivated, norm motivated, strategically motivated, and self-reported prosocial behavior. Based on results of this model and accommodating stricter methodological and statistical standards (e.g., Brown, 2014), Model 2 presents a revised structure of prosociality with only three subcomponents: altruistically motivated, norm motivated, and self-reported prosocial behavior. We identified minor inaccuracies in the descriptive results presented in the original publication, all of which are corrected in the present article. Please note that both adjusted CFA models rely on corrected descriptive values of prosocial measures (for details, see the second section *Descriptive Results* as well as revised correlation matrices in Table 1).

Model 1

The original CFA was based on results of an exploratory principle component analysis (PCA) in participant Sample 1 and was applied on data of an independent participant Sample 2.

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Table 1. Correlation Coefficients for the First Sample (Upper Half) and the Second Sample (Lower Half).

	Correlations													
Variables	DG	TG–RG	2nd PPG-DG	2nd PPG, B	3rd PPG, B	ZPG-help	ZPG-reci.	ZPG-cost	Donate	*k*	SVO	IRI	Prosoc.	Machia.
DG (given MUs)		.14	−.51**	−.12	.12	.32**	.11	−.15*	.16*	**−.26****	.32	.09	.14	−.04
TG–RG (MUs)	−.01		.00	−.03	.01	.13	.11	.04	.28**	**−.04**	.18*	.04	.11	−.10
2nd PPG, A—DG	−.44**	−.07		−.03	.03	−.00	−.07	.24**	−.00	**.17***	−.04	−.07	−.07	−.09
2nd PPG, B	.06	−.04	.16		.58**	−.26**	.08	.05	−.18*	**.17***	−.11	.08	.02	.09
3rd PPG, C	.13	−.08	.06	.64**		−.02	.05	−.01	−.14	**−.01**	.07	.16*	.12	−.03
ZPG—helping	.27**	.09	−.07	−.17*	−.04		−.01	.03	.08	**−.16**	.26**	−.10	−.02	−.05
ZPG—reci. effect	−.08	−.13	.10	.07	.02	−.22**		−.05	.04	**.02**	.01	−.04	−.00	.04
ZPG—cost effect	−.12	.02	−.22*	−.09	−.09	−.05	−.07		.07	**−.05**	−.04	−.05	.01	.05
Donation task	.11	−.01	−.06	−.03	.08	.17*	−.20*	.00		**−.16**	.14	.03	.19**	−.16*
Soc. Disc. (*k*) (log)	**−.22***	**−.09**	**−.10**	**.10**	**.03**	**−.21***	**−.02**	**.12**	**−.05**		**−.35****	**.08**	**−.12**	**.36****
SVO (prosocial)	.37**	−.04	.02	−.08	.02	.31**	.10	−.15	.05	**−.32****		.09	.13	−.10
IRI	−.01	−.11	−.14	−.14	−.05	−.01	.14	.03	−.00	**−.12**	.12		.41**	−.14
Prosoc. Scale	.00	−.01	.04	.06	.01	.02	.15	.02	.07	**−.31****	.13	.40**		−.18*
Machiavelli index	−.13	−.06	−.01	.12	.01	−.01	−.04	−.00	−.15	**.36****	−.22**	−.14	−.26**	
Sample 1														
Mean	32.3	6.3	9.8	28.9	31.9	61.8	13.2	9.6	55.8	−2.0	6.2	22.6	3.3	2.9
SD	17.8	25.4	23.1	22.0	23.0	25.7	27.9	30.7	28.2	0.4	3.5	2.3	0.5	2.5
n	187	187	187	187	187	184	184	184	185	151	185	188	185	185
Sample 2														
Mean	36.6	4.1	4.1	31.5	33.2	68.5	16.5	7.0	56.2	−1.9	5.6	22.5	3.5	3.0
SD	16.5	24.3	18.0	22.4	22.6	23.5	26.9	31.1	27.7	0.4	3.9	2.4	0.6	2.8
n	140	140	140	140	140	142	142	142	140	125	137	137	137	137

Note. Corrected coefficients for the log-transformed values of the social discounting variable (*k*) are displayed in **bold font**. Descriptive results (means and standard deviations [*SD*] and the amount of data available for each variable (*n*) for Sample 1 and Sample 2 are displayed below. DG = dictator game; PPG = party punishment game; ZPG = Zurich prosocial game; TG = trust game; RG = risk game; SVO = social value orientation; IRI = Interpersonal Reactivity Index; MU = monetary unit.

**Indicates significant correlations at $p < .01$ (two-tailed). *$p < .05$ (two-tailed).

This sample was comparatively small ($n = 142$) and the included latent factors contained few observed variables and entailed theoretically derived but empirically invalid a priori constraints. These features have been suggested to precipitate Heywood cases (Brown, 2014; Chen, Bollen, Paxton, Curran, & Kirby, 2001; Dillon, Kumar, & Mulani, 1987). We therefore modified our CFA in two ways (Model 1; Figure 1, left panel): First, factor loadings of the variables second party and third party punishment (2nd PPG and 3rd PPG) were constrained to be equal, a possible respecification of the model when factors are measured by few variables that is justified by high correlation and conceptual similarity of the variables (Brown, 2014). In addition, we removed the cross loading of the variable dictator game (DG) on the factor strategically motivated prosocial behavior because the DG does not conceptually belong to this latent factor. In fact, the observed relation between the DG and strategically motivated prosocial behavior is driven by the analytical dependency between the variables DG and strategic giving (i.e., a difference score that draws on DG). To accommodate this fact, the covariance between the residuals of the variables DG and strategic giving was specified as a free parameter, a specification that is conceptually different from the cross loading of the DG on the factor strategically motivated prosocial behavior. Conforming to the original CFA, we used standardized input variables. The adjusted Model 1 revealed a satisfying model fit, with root mean square error of approximation (RMSEA) = .049, $\chi^2 = 95.5$ ($df = 71$), and the comparative fit index (CFI) of .89 approaching suggested cutoff values (Hu & Bentler, 1999; West, Taylor, & Wu, 2012). Crucially, all estimated standardized regression weights

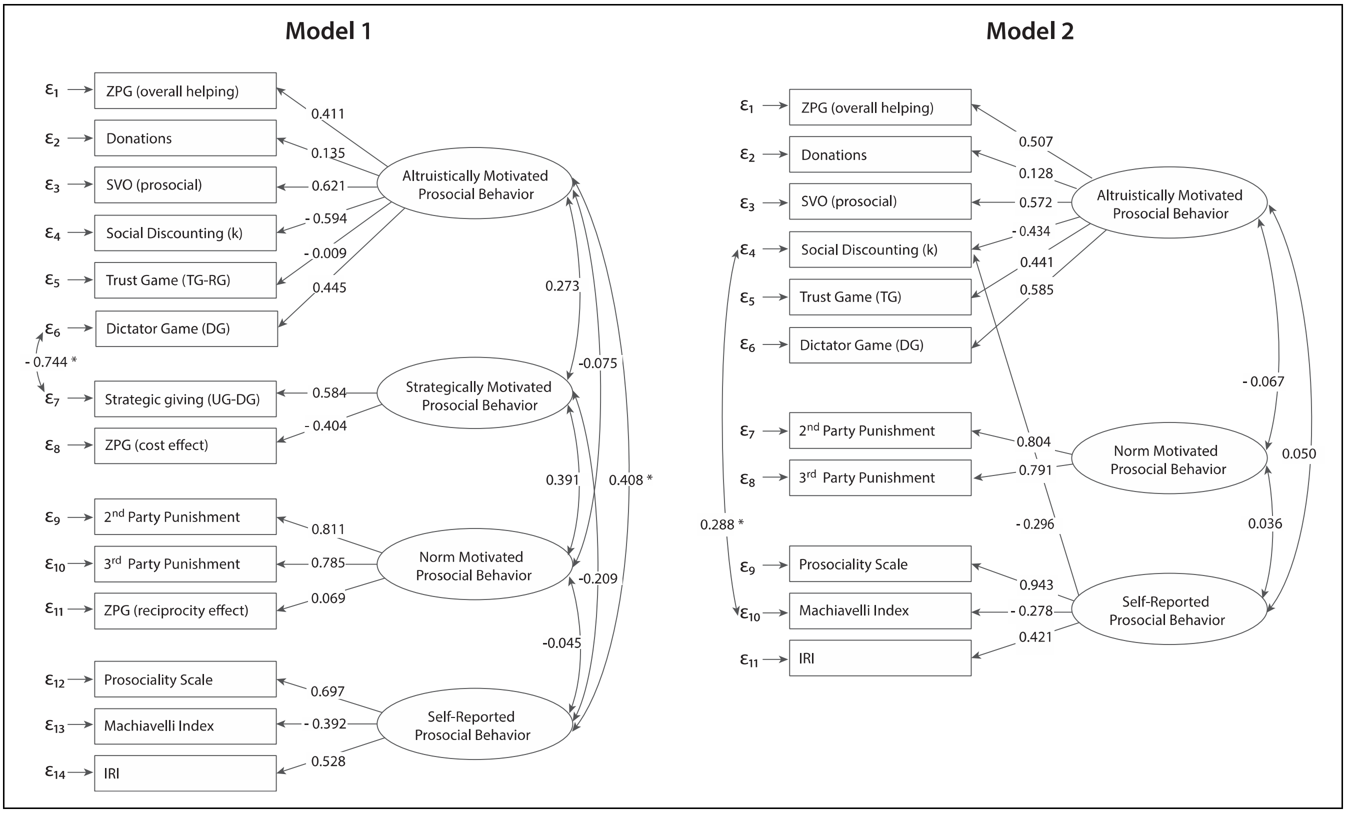

Figure 1. Confirmatory factor analyses. Models 1 (left panel) and 2 (right panel) are displayed with standardized regression weights and coefficients for error correlations and factor correlations.

were below 1 and no improper solution occurred after the minimization procedure (Figure 1, left panel). The factor structure and loadings were widely consistent with those reported in the original article. Hence, our respecifications of the original model successfully solved the issue of Heywood cases (for a discussion of model misspecifications and their identification as cause of Heywood cases, see Kolenikov & Bollen, 2012). Note that the variable Zurich prosocial game (ZPG) cost effect was *positively* linked to the variable strategic giving and the factor strategically motivated prosocial behavior in Sample 1 but showed *negative* correlations with both in Sample 2, revealing a discrepancy across samples.

Model 2

A second CFA (Model 2; Figure 1, right panel) built on the adjusted Model 1 and accommodated stricter methodological and statistical standards. Model 2 addressed four additional issues in particular. First, Model 2 used unstandardized raw data of observed measures of prosociality instead of standardized values as input (see Schafer & Graham, 2002; for discussions of potential issues regarding standardized input variables, see Brown, 2014; Cudeck, 1989; Kline, 2012). Second, we removed the variable ZPG reciprocity effect due to its non-significant and near-zero factor loadings (Brown, 2014). Third, Model 2 used the variable trust game (TG; mean: 41.8; *SD*: 31.1) instead of the difference score between TG and risk game (RG; for discussion of potential concerns about difference scores, see Edwards, 1994; Rogosa, Brandt, & Zimowski, 1982; see Table 2 for respective correlation coefficients). Finally, the factor strategically motivated prosocial behavior

Table 2. Correlation Coefficients for the Variable Trust Game (Mean: 41.8; *SD*: 31.1) With All Other Measures of Prosociality in Sample 2.

Variables	*n*	Correlation With TG (*n* = 140)
DG (given MUs)	140	.31**
TG–RG (MUs)	140	.43**
2nd PPG, A–DG	140	−.07
2nd PPG	140	−.10
3rd PPG	140	−.03
ZPG—helping	142	.20*
ZPG—reci. effect	142	−.14
ZPG—cost effect	142	.02
Donation task	140	−.06
Soc. Disc. (*k*) (log)	125	−.23*
SVO (prosocial)	137	.18*
IRI	137	−.22**
Prosoc. Scale	137	−.11
Machiavelli Index	137	.01

Note. n refers to the overall number of participants in the second sample who completed the respective measure. DG = dictator game; PPG = party punishment game; ZPG = Zurich prosocial game; TG = trust game; RG = risk game; SVO = social value orientation; IRI = Interpersonal Reactivity Index; MU = monetary unit. **Indicates significant correlations at $p < .01$ (two-tailed). *$p < .05$ (two-tailed).

was removed from the model because it contained only two variables, one of which suffered analytical dependencies (strategic giving) and the other showed qualitative differences across samples (ZPG cost effect). Similar to Model 1, factor loadings of the items 2nd PPG and 3rd PPG were constrained to be equal. Model modification indices suggested that an additional cross loading and an additional residual covariance were required. We therefore modeled the variable social discounting to also load on the factor self-reported prosocial behavior and included residual covariance between the variables social discounting and Machiavelli index. As for the adjusted Model 1, no improper solution occurred after the minimization procedure. Results also revealed an adequate fit of Model 2 (CFI = .91, RMSEA = .055, $\chi^2 = 57.0$ with 40 degrees of freedom). Besides one significant error correlation and one cross loading, no other significant error correlations were found (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Overall, while both models bear many similarities to the model proposed in our original publication, Model 2 shows some discrepancies to the original model that necessitate further investigation. First, the factor strategically motivated prosocial behavior was removed in Model 2, yielding a three-factor rather than a four-factor structure of prosociality. This decision was entirely based on methodological considerations (e.g., statistical dependencies) and future research employing larger participant samples and additional measures of prosociality will need to investigate strategic motivations for prosocial behavior and their role in models of human prosociality. Second, in contrast to the original model and Model 1, the factor norm motivated prosocial behavior in Model 2 entailed two rather than three variables that both assess behavioral tendencies to enforce and strengthen social norms at a cost to oneself (e.g., Fehr & Fischbacher, 2004). Identifying additional measures that can be subsumed under this latent factor will help to further clarify the motivational basis that underlies this component of prosocial behavior. Third, for methodological reasons, Model 2 considered the variable TG instead of its difference score with the RG (e.g., Bohnet & Zeckhauser, 2004). This variable showed a substantially increased loading on the factor altruistically motivated prosocial behavior, addressing potential concerns of low standardized parameter estimates in Model 1. This result suggests that interindividual variance in the TG is more strongly related to variations in altruistically motivated prosocial behavior than the difference score. In light of recent debates on the link of trust and altruism (e.g., Cox, 2004; Yamagishi et al., 2013), more research is required to settle the issue of raw versus difference scores of trust measures. Fourth, the relationship between the variable social discounting and self-report measures, especially the Machiavelli index, that was specified in Model 2 may originate from similarities between hypothetical measures of altruistic behavior (i.e., measures without monetary consequences for participants) and those derived from self-reports. Given that this relation was added in a data-driven manner, future investigations are required to verify and better understand this link.

Table 3. Principal Component Analysis. Corrected Factor Loadings of the 14 Measures of Human Prosociality (Pattern Matrix) and Communalities (Com).

Measures	F1	F2	F3	F4	Com.
Factor 1: altruistically motivated prosocial behavior (17% variance)					
Overall helping in Zurich prosocial game (ZPG)	.625	−.075	−.024	−.306	.459
Prosocial social value orientation (SVO)	.626	.098	−.081	.047	.415
Social discounting (*k*)	−.547	.119	.090	−.099	.347
Given money in dictator game (DG)	.553	.094	−.626	.006	.736
Given money in trust game (TG) > risk game (RG)	.499	.104	.191	.076	.295
Donations to charity (donation game)	.442	−234	.132	.242	.365
Factor 2: norm motivated prosocial behavior (13% variance)					
3rd party punishment (3rd PPG)	.073	.865	.065	.180	.758
2nd party punishment (2nd PPG)	−.234	.841	.119	.097	.768
Reciprocity effect in ZPG	.159	.253	−.099	−.160	.130
Factor 3: strategically motivated prosocial behavior (11% variance)					
Strategic giving (second PPG-DG)	−.077	−.011	.823	−.028	.688
Cost effect in ZPG	.168	.106	.616	−.106	.400
Factor 4: self-reported prosocial behavior (9% variance)					
Prosociality Scale	.123	.080	−.082	.752	.596
Interpersonal Reactivity Index	−.125	.143	−.166	.763	.604
Machiavelli Index	−.285	.134	−.150	−.460	.375

In summary, both adjusted models resolve the issue of Heywood cases and bear considerable similarity to the original model. They also confirm previous evidence that points toward a distinction between altruistic behaviors and those based on norms and punishment (Peysakhovich, Nowak, & Rand, 2014) and between behavioral measures of prosociality and self-reports (Hubbard, Harbaugh, Srivastava, Degras, & Mayr, 2016). Our models significantly extend prior research by proposing a conceptual framework of motivation based subcomponents of human prosociality that integrates a variety of distinct assessment methods from different research disciplines.

Descriptive Results

In the process of reanalyzing the original data, we became aware of some minor inaccuracies in the reported descriptive results. None of the main results and interpretations of the original publication are affected by these corrections. We list corrections in the order of appearance in the article and highlight changed values in the main body in **bold font**.

Page 4: Participants gave **less** (not more) monetary units in the DG than in the 2nd PPG. Degrees of freedom for game theoretical paradigms in Sample 2 were **139** (rather than 140). Numerical and statistical values in figures, tables, and the text are accurate.

Table 4. Corrected Correlation Coefficients With Factor Scores on the Factors of Prosociality for Sample 1.

Variables	Factor 1	Factor 2	Factor 3	Factor 4
Socioeconomic status				
Age	−.27*[a] [−.43 −.11]	.03 [−.14 .19]	−.15 [−.31 .01]	.05 [−.12 .21]
Gender (*female* = 1, *male* = 0)	−.21*[a] [−.37 −.05]	−.01 [−.17 .16]	.10 [−.06 .27]	.31*[a] [.15 .45]
Married (*yes* = 1, 0 = *no*)	.19* [.02 .34]	.01 [−.16 .18]	−.07 [−.24 .10]	.18* [.01 .33]
Children (*yes* = 1, 0 = *no*)	−.30*[a] [−.45 −.13]	.04 [−.13 .21]	.03 [−.14 .20]	−.04 [−.20 .13]
Monthly income (in Euros)	−.23*[a] [−.38 −.06]	.17 [−.00 .32]	.02 [−.15 .19]	−.16 [−.31 .01]
Affective dispositions (factor scores)				
Positive affect	.01 [−.15 .18]	−.03 [−.19 .14]	.02 [−.14 .19]	.23*[a] [.06 .37]
Negative affect	−.19* [−.38 −.02]	.20*[a] [.04 .38]	.05 [−.12 .23]	.03 [−.14 .20]
Serenity	−.09 [−.26 .08]	−.11 [−.27 .06]	−.02 [−.18 .15]	−.04 [−.20 .13]
Cognitive skills				
CFT-R20	.18* [.01 .34]	−.14 [−.31 .02]	−.02 [−.18 .15]	−.09 [−.25 .08]
Cued Flanker task—Flanker effect log RTs	−.21*[a] [−.66 −.06]	.02 [−.28 .34]	−.01 [−.32 .30]	−.01 [−.33 .29]
Cued Flanker task—Flanker effect log errors	.12 [−.08 .38]	−.02 [−.26 .19]	.05 [−.17 .29]	.11 [−.08 .37]
Stop signal RT task—log SSRTm	−.24*[a] [−.42 −.08]	.11 [−.06 .27]	−.03 [−.20 .14]	.06 [−.10 .22]
Working memory task—load effect log RTs	−.08 [−.24 .09]	−.04 [−.20 .13]	.08 [−.09 .25]	−.08 [−.24 .08]
Working memory task—load effect log errors	−.21*[a] [−.36 −.04]	−.01 [−.17 .15]	−.05 [−.21 .11]	.02 [−.14 .17]

Note. 95% confidence intervals are provided in brackets [lower bound, upper bound]. Of data of n = 187 participants, correlations are only reported for participants who completed all measures of prosociality (hence, have factor scores based on full information), yielding a sample of n = 144 participants. CFT-R20 = Culture Fair Test (Scale 2, Revised); SSRTm = Stop signal response time (estimated by the mean approach).
[a]Surviving Benjamini–Hochberg correction for multiple comparisons.
*p < .05 (two-tailed).
Qualitatively similar results were obtained when factor scores for altruistically motivated prosocial behavior and norm motivated prosocial behavior were estimated based on Model 2 (i.e., including TG rather than TG–RG and excluding ZPG reciprocity effect).

Page 5: The experimental factors cost and reciprocity did **not** interact in Sample 2, $\boldsymbol{F(1, 141) < 1}$. The reported interaction in Sample 1 is correct, and the interaction also holds in the overall sample, $F(1, 325) = 6.0$, $p < .05$, $\eta^2 = .018$, 95% CI [.001, .056].

Page 5: *PCA*. Contrary to the other variables, log- and subsequent z-transformation of the social discounting variable in the original analysis were performed on the overall sample rather than separately on the two samples. We have corrected this mistake and additionally removed outliers before transformation (see Jones & Rachlin, 2006; n = 151, mean = .055, *SD* = .094). Corrected correlation matrices (Table 1), the corrected PCA (Table 3), and corrected correlations with socioeconomic, affective, and cognitive variables (Table 4) revealed slightly different values. However, the overall pattern of results holds and is highly similar to those reported in the article.

Pages 5/6: *Relations to socioeconomic, affective*, and *cognitive variables*. Similar to results reported in the original article, the correlation between participants' scores on the factors negative affect and altruistically motivated prosocial behavior held when controlling for age and for cognitive skills **but not when controlling for gender**. Again, correlations between altruistic behavior and cognitive skills held when controlling for intelligence, for gender and for negative affect and when controlling for age, except for response inhibition ($\boldsymbol{p = .15}$). Similar to results reported in the article, women scored higher on self-reported prosocial behavior, $\boldsymbol{t(142) = 3.9}$, $p < .001$; mean women = **.41**, mean men **= −.21** but lower on altruistically motivated prosocial behavior, $\boldsymbol{t(142) = 2.5}$, $p < .01$; mean women = **−.09**, mean men = **.39**. Again, altruistically motivated prosocial behavior was negatively correlated with age and income and was reduced in participants with children. Because both income and having children were correlated with age (ρs > **.47**, *p*s < .001), partial correlations were performed. Results showed that neither income nor having children were significantly correlated with altruistic behavior when we controlled for age (*p*s > **.07**).

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Declaration of Conflicting Interests

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