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## Need for Conclusive Evidence that Positive and Negative Reciprocity are Unrelated

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The strong reciprocity model of the evolution of human cooperation [1] postulates that positive and negative reciprocity are associated. Recently in PNAS, Yamagishi et al. [2] reported results that challenged this proposition by showing that the tendency to reject unfair offers in the ultimatum game is *not* related to various indicators of positive reciprocity in other experimental games. This result was corroborated by a nonsignificant correlation between self-reported positive and negative reciprocity.

As much as we appreciate the elegant series of experiments reported by Yamagishi et al. [2], we see two methodological problems that challenge the conclusion drawn from the data (i.e., that positive and negative reciprocity are unrelated). First, the sample size is rather small ( $N = 86$ ), resulting in low power for detecting an effect if it is present. For example, if there was a true correlation of  $r = .20$  between positive and negative reciprocity in the population, then there was a chance of only 46% of finding a significant effect in the study by Yamagishi et al. [2]; for  $r = .10$ , the chance was even as low as 15%. Thus, in order to confirm the hypothesis that positive and negative reciprocity are unrelated, a sufficiently large sample size would be necessary. Second, measurement error due to the unreliability of behavioral variables derived from economic games enhances the probability of nonsignificant results, thus leaving the conclusion of unrelatedness of positive and negative reciprocity in muddy water.

Fortunately, data from the Socio-Economic Panel (SOEP; Version 28) of the German Institute for Economic Research allow for a thorough examination of the research question under scrutiny. The SOEP is an ongoing nationally representative longitudinal study of private households in Germany [3,4]. The sample comprises 18,646 German adults (52.3% female) from 18 to 100 years of age ( $M = 50.52$ ,  $SD = 17.64$ ), resulting in a power of 0.9999995 to detect an effect of  $r = .05$ .

Positive reciprocity was assessed by three items (1. If someone does me a favor, I am prepared to return it. 2. I go out of my way to help somebody who has been kind to me before. 3. I am ready to undergo personal costs to help somebody who has helped me before; Cronbach's  $\alpha = .61$ ), as was negative reciprocity (1. If I suffer a serious wrong, I will take revenge as soon as possible, no matter what the costs. 2. If somebody puts me in a difficult position, I will do the same to him/her. 3. If somebody offends me, I will offend him/her back; Cronbach's  $\alpha = .82$ ).

The correlation between positive and negative reciprocity was  $r = .002$ . Put differently, the two scales shared only 0.0004% of their variance (95% CI of the correlation:  $[-.012; .016]$ ; 95% CI corrected for measurement error:  $[-.018; .023]$ ). Thus, from only these data, it seems reasonably safe to conclude that positive and negative reciprocity vary independently from each other, providing a severe challenge to the strong reciprocity model of the evolution of human cooperation.

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