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Greater Male Variability in Cooperation: Meta-Analytic Evidence for an Evolutionary Perspective

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Abstract
Do men and women differ systematically in their cooperation behaviors? Researchers have long grappled with this question, and studies have returned equivocal results. We developed an evolutionary perspective according to which men are characterized by greater intrasex variability in cooperation as a result of sex-differentiated psychological adaptations. We tested our hypothesis in two meta-analyses. The first involved the raw data of 40 samples from 23 social-dilemma studies with 8,123 participants. Findings provided strong support for our perspective. Whereas we found that the two sexes do not differ in average cooperation levels, men are much more likely to behave either selfishly or altruistically, whereas women are more likely to be moderately cooperative. We confirmed our findings in a second meta-analytic study of 28 samples from 23 studies of organizational citizenship behavior with 13,985 participants. Our results highlight the importance of taking intrasex variability into consideration when studying sex differences in cooperation and suggest important future research directions.

Keywords
cooperation, sex differences, decision making, evolutionary psychology

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People's ability to cooperate with unrelated others is arguably the main driver for the success of modern human societies, which have relied on cooperation to survive and thrive (Bowles & Gintis, 2011). Cooperation is often studied in social-dilemma situations in which cooperative behavior is in the collective interest of all actors, but each individual has an incentive to "free-ride" on the cooperation of others (Kollock, 1998; Rand, 2016). The current COVID-19 pandemic provides many examples of social dilemmas. We all benefit if most of us behave cooperatively and follow recommendations from authorities to self-isolate and refrain from hoarding toilet paper, face masks, and hand sanitizer. However, each and every one of us has an incentive to free-ride on the cooperation of others by eschewing masks in public, meeting friends, and stockpiling Charmin.

An important question in the literature on social-dilemma cooperation is to what extent sex differences exist in the propensity to cooperate (e.g., Balliet, Li, Macfarlan, & van Vugt, 2011). According to social-role theory, sex differences in cooperation emerge mainly as a result of contextual factors and can exist in either direction depending on the presence of these factors (Eagly & Crowley, 1986). Social-role theory suggests that gender norms and stereotypes follow from the roles that are imposed on women and men by their social environment (Eagly & Wood, 2012). Women are oriented toward nurturing and caring in close interpersonal relationships and are more cooperative than men in such a context. In contrast, men are oriented toward chivalry and heroic behaviors, particularly in public situations that allow them to attain or assert their status, and are more cooperative than women in such a

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context (Becker & Eagly, 2004; Eagly & Crowley, 1986). Neither contextual factor is present in classic social-dilemma paradigms, such as the two-player prisoner's dilemma game or the multiplayer public-goods game, which are typically conducted in anonymous, minimally social, and largely impersonal settings. Because these settings are essentially private, they do not allow men to attain or assert status; because they are impersonal, they provide no opportunity for relational gain for women. Given the absence of contextual cues that activate gender-role stereotypes and gender-role-specific behaviors, social-role theory would suggest that the first moment (i.e., the mean) of the cooperation distribution in social dilemmas does not differ between men and women.

Although previous researchers have mainly relied on social-role theory to argue that sex differences in cooperation are primarily context- and social-role specific, there is also a complementary evolutionary perspective that suggests that there are also important context-independent sex differences in cooperation due to greater variability in heritable, sexually selected traits of males (Archer & Mehdikhani, 2003). This reasoning is used to support what has often been referred to as *greater male variability*. The greater-male-variability hypothesis, the origins of which lie with Charles Darwin, was that males are more likely to be found in both the upper and lower tails of the distribution of a number of physical, cognitive, and behavioral characteristics, because differentiation had survival value (Archer & Mehdikhani, 2003; Johnson, Carothers, & Deary, 2008). For example, Lehre, Lehre, Laake, and Danbolt (2009) showed that male adults had more intrasex variance in a wide range of characteristics, including weight (13% more variance), height (25%), 60-m-dash times (44%), and blood parameters such as cholesterol (50%) and triglycerides (55%). Similar differences have been found in measures of mathematical, verbal, and spatial performance (Hyde, 2014), intelligence (Arden & Plomin, 2006), and physical aggression (Pomiankowski & Møller, 1995), to name a few. Because greater male variability has been found to exist already at birth, explanations related to social context or role can be ruled out (Lehre et al., 2009).

Although sex differences in cooperation variability have not been a focus of previous social-dilemma research, results seem to support this perspective; public-goods-games studies have shown that females in same-sex groups are more conforming than males (Cadsby & Maynes, 1998). On the basis of this evolutionary perspective, we hypothesize that the second moment (i.e., the variance) of the cooperation distribution in social dilemmas will differ such that men will demonstrate more variance in cooperation behaviors than will women. Interestingly, given that this perspective does not predict sex differences in mean cooperation levels, it is in line with most previous social-dilemma research, which has failed to find systematic differences in average cooperation between the two sexes (Balliet et al., 2011; Croson & Gneezy, 2009; Eckel & Grossman, 2008). Instead, the greater-male-variability perspective predicts sex differences in the distribution of cooperation behaviors, which cannot be detected by focusing on mean cooperation levels alone. Published research on sex differences in cooperation has almost exclusively focused on differences in central tendency, a focus that would have caused previous researchers to overlook sex differences in the distribution of behaviors. An exception is the work of Poen and Gächter (2013), who study sex differences in dynamic public-goods games. Because greater male variability has not been the focus of previous social-dilemma research, variability indices are seldom reported separately for men and women. Therefore, in Study 1, we collected 40 raw data sets in order to conduct a meta-analysis of greater male variability in cooperation behaviors. In Study 2, we extended our inquiry into the domain of organizational citizenship behavior.

Statement of Relevance

Cooperation is essential in a large number of social situations, including voting, tax compliance, environmental protection, charitable giving, corruption, teamwork, organ donations, and (in the current COVID-19 pandemic) self-isolation, hoarding, and social distancing. An important question is what predicts cooperation in these and similar situations. One potential predictor is gender. In this research, we asked whether women and men behave differently when they are tasked to cooperate. To address this question, we examined the results of more than 40 studies of cooperation behavior in social dilemmas and organizational citizenship situations. Across more than 20,000 participants, women and men did not differ in terms of their average cooperation levels. However, men were more likely to behave either selfishly or altruistically, whereas women were more likely to be moderately cooperative. These findings highlight the importance of taking intrasex variability into account in considering whether women and men show important differences in their social behaviors.

Study 1

Method

Study context and cooperation measurement. In Study 1, we examined cooperation in public-goods games (e.g., Ledyard, 1995). The public-goods game is basically a prisoner's dilemma game, but unlike the traditional prisoner's dilemma game, it allows for more players and a continuous strategy space. In the standard public-goods game, two or more players (n) endowed with e monetary units simultaneously choose a contribution $g_i \in [0, e]$. Monetary payoffs are

$$\pi_i(g_i, g_{-i}) = e - g_i + a \sum_{j=1}^{n} g_j.$$

Participants' earnings are equal to their endowment minus their contribution plus the sum of all contributions multiplied by a, the marginal per capita return. For $\frac{1}{n} < a < 1$, this game is a social dilemma: Individual payoff maximization calls for zero contributions, whereas from the group's perspective, full contributions would be optimal. We studied three variants of this game: In the *one-shot* game (a), players interact only once and choose their contributions simultaneously; in the *dynamic game* (b), players play a series of consecutive public-goods games in stable groups and receive information about the contributions of the other players after every round of play; and in the *strategy-method* version of the game (c), players can condition their contribution on the average contribution of the $n - 1$ other players in the group. For dynamic games, we focus on the first-round contributions, as they measure participants' willingness to cooperate at the onset of a repeated interaction, when decisions are still independent of observed behavior. The strategy-method data are from studies adopting the experimental design introduced by Fischbacher, Gächter, and Fehr (2001). Unlike in the other variants of the game, this design removes the strategic uncertainty regarding the other participants' behavior and allows us to identify types of cooperative behaviors.

To answer our research question, we needed variability measures of cooperation behaviors, such as standard deviations, separately for men and women. However, after we carefully reviewed the literature, it became apparent that virtually all social-dilemma studies focus on mean cooperation levels and do not report separate variability measures for the two sexes. A traditional meta-analysis approach of collecting summary statistics from published articles was therefore not feasible. Instead, we had to conduct a meta-analysis of individual participant data, also referred to as *integrative data analysis*, which is uncommon in psychology but widely used in other fields, such as medicine (Curran & Hussong, 2009). An integrative data analysis is the pooled analysis of multiple individual data sets in one combined data set.

Given the sheer number of public-goods-games studies, it was not feasible to conduct a comprehensive individual-participant data analysis of the entire public-goods-games literature. To achieve a balance between what is desirable (i.e., sufficient statistical power for hypothesis testing) and what is feasible in terms of available data sets and cost of data collection, we conducted a power analysis to determine the number of observations required to test our hypotheses. The standard measure of the effect size for variability is the variance ratio—in our case, the ratio between male and female variance in contributions. To obtain information on expected effect sizes, we searched the literature for suitable variance ratios but could not identify studies reporting variance ratios for social-dilemma experiments. However, there is a sizeable literature on male:female variance ratios in mathematics as well as in verbal and spatial performance. A survey of this literature (Hyde, 2014, p. 391) found variance ratios within a relatively narrow range from 1.03 to 1.27. For our power analysis, we aimed for a middle ground in this range and calculated the required power to detect a variance ratio of 1.10. The power analysis for a two-sample variance test with a power of .80 and a Type I error rate of .05 requires a sample of 6,918 observations. We used this to guide our individual-participant-data search process.

Data sets. To achieve the required sample size, we went to great lengths and contacted a large number of authors of experimental public-goods-games studies. Studies were drawn from the extensive and homogeneous pool (i.e., standardized experimental procedures) of public-goods-games studies to achieve a "random sample of random samples," as recommended by Curran and Hussong (2009, p. 93). We continued data collection until we exceeded the required sample size by a comfortable amount. Ultimately, we were able to compile a unique data set consisting of the original raw data of 40 samples from 23 social-dilemma studies with a total sample size of 8,123 observations. All articles in our sample report data from public-goods-games experiments run under the methodological standards of experimental economics (incentivized decisions, randomized group assignment, anonymous decisions, and no deception). Table 1 provides an overview of the 40 samples included in our study. The table reports the location of the experiments, the number of observations, the sex ratio, and the game parameters.

The upper half of Table 1 shows the data sources of the one-shot version of the public-goods game.[1] The

Table 1. Overview of the Studies Included in the Study 1 Meta-Analysis

Article	Code	Country	Observations	DV	Percentage female	Sample	Medium	n	e	a
				One-shot game						
Abeler & Nosenzo (2015)	AN15	UK	174	Direct, strategy	43.7	Convenience	Computer	4	20	.4
Fischbacher & Gächter (2010)	FG10	Switzerland	140	Direct, strategy	32.1	Convenience	Computer	4	20	.4
Fischbacher et al. (2001)	FGF01	Switzerland	44	Direct, strategy	38.6	Convenience	Computer	4	20	.4
Fischbacher et al. (2012)	FGQ12	UK	136	Direct, strategy	50.0	Convenience	Computer	4	20	.4
Fischbacher et al. (2014)	FST14	Germany	228	Direct, strategy	53.5	Convenience	Computer	4	20	.4
Fosgaard et al. (2014)	FHW14	Denmark	676	Direct, strategy	47.2	Quasi-representative	Internet	4	50	.5
Gächter & Herrmann (2009)	GH09r	Russia	192	Direct	35.9	Convenience	Computer	3	20	.5
Gächter & Herrmann (2009)	GH09s	Switzerland	144	Direct	38.9	Convenience	Computer	3	20	.5
Gächter et al. (2004)	GHT04b	Belarus	127	Direct	37.0	Quasi-representative	Paper and pen	3	20	.5
Gächter et al. (2004)	GHT04r	Russia	181	Direct	56.4	Quasi-representative	Paper and pen	3	20	.5
Gächter & Thöni (2005)	GT05	Switzerland	180	Direct	24.4	Convenience	Computer	3	20	.6
Herrmann & Thöni (2009)	HT09	Russia	160	Direct, strategy	28.8	Convenience	Paper and pen	4	20	.4
Kamei (2012)	K12	US	350	Direct, strategy	49.4	Convenience	Computer	5	20	.3/.4
Kocher et al. (2008)	KCKNS08a	Austria	35	Strategy	34.3	Convenience	Paper and pen	3	20	.6
Kocher et al. (2008)	KCKNS08j	Japan	36	Strategy	16.7	Convenience	Paper and pen	3	20	.6
Kocher et al. (2008)	KCKNS08u	US	36	Strategy	47.2	Convenience	Paper and pen	3	20	.6
Kistler et al. (2017)	KTW17	Germany	252	Direct	55.6	Quasi-representative	Internet	2	100	.75
Makowsky et al. (2014)	MOP14	US	96	Direct, strategy	34.4	Convenience	Computer	4	10	.4
Thöni et al. (2012)	TTW12	Denmark	1488	Direct, strategy	48.3	Quasi-representative	Internet	4	50	.5
van Miltenburg et al. (2014)	VBBR14	Netherlands	164	Direct, strategy	64.0	Convenience	Computer	4	20	.4
Volk et al. (2012)	VTR12	Switzerland	72	Direct, strategy	29.2	Convenience	Computer	4	20	.4
Weber et al. (2018)	WWG18	UK	456	Strategy	59.2	Convenience	Computer	4	20	.4
New data	NDS1	Indonesia	320	Direct, strategy	58.4	Convenience	Paper and pen	2	20	.75
New data	NDS2	Germany	823	Direct	48.2	Convenience	Internet	2	100	.75
New data	NDS3	Germany	365	Direct	61.1	Convenience	Internet	4	100	.5
				Dynamic game						
Herrmann et al. (2008)	HTG08a	Australia	40	Direct	40.0	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08c	China	96	Direct	46.9	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08d	Denmark	68	Direct	27.9	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08g	Germany	60	Direct	55.0	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08gr	Greece	44	Direct	43.2	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08k	South Korea	84	Direct	46.4	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08o	Oman	52	Direct	36.5	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08r	Russia	80	Direct	50.0	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08s	Switzerland	96	Direct	34.4	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08s2	Switzerland	48	Direct	33.3	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08t	Turkey	64	Direct	31.3	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08u	Ukraine	44	Direct	31.8	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08uk	UK	56	Direct	51.8	Convenience	Computer	4	20	.4
Herrmann et al. (2008)	HTG08us	US	56	Direct	39.3	Convenience	Computer	4	20	.4
New data	NDS4	Switzerland	360	Direct	43.1	Convenience	Computer	4	20	.4
Total			8,123		47.2					

Note: The code for each study is constructed from the authors' initials and the year of publication. The "dependent variable" (DV) column shows whether the DV is a direct-response contribution, a contribution strategy, or both. The "sample" column indicates whether the study used a convenience sample (students) or quasi-representative samples, and the "medium" column indicates whether the study was a computerized laboratory experiment, an Internet experiment, or a paper-and-pen experiment. The three rightmost columns list group-size n, endowment e, and marginal per capita return a. For more information about the new data sets NDS1 to NDS4, see Section S1 in the Supplemental Material available online.

Fig. 1. Mean contribution in the (a) one-shot, (b) dynamic, and (c) strategy-method games, separately for male and female participants (Study 1). Means of the study are weighted by the number of observations. All contributions are rescaled to the interval [0, 1]. Error bars indicate bootstrapped 95% confidence intervals.

lower half shows studies that used the dynamic version of the public-goods game (i.e., games in which a stable group of participants play several repetitions of a public-goods game).[2] As indicated in Table 1, we also added four new data sets of our own to the sample. In Section S1 in the Supplemental Material available online, we provide information about the experimental procedures of these studies. In total, our sample contained individual observations of 8,123 participants. None of the studies included here (including our own) originally focused on sex differences, so experimenter demand effects or publication bias should not influence our inferences about sex differences. For the analysis, the contributions of all data sources were rescaled to the interval [0, 1]. In the following section, we discuss the findings of our meta-analysis in which we used restricted maximum-likelihood random-effects models (Raudenbush, 2009).

Results

Mean cooperative behavior. We first analyzed average cooperation levels, for which we expected no sex differences. The overall sample of contribution decisions (one-shot and dynamic) consisted of 7,560 participants from 36 samples (see Tables S1 and S3 in the Supplemental Material for details). In a first step, we calculated Cohen's d and bootstrapped standard errors for each individual sample separately (2,000 replications). The sample-size-weighted mean effect size for sex was small and nonsignificant, d = 0.021, 95% confidence interval (CI) = [−0.036, 0.078]. The heterogeneity measures of the model, $Q(35) = 48.37$, $p = .066$, $\tau^2 = 0.005$, suggest that, although there is some variation in the effect sizes across studies, it is small given conventional cutoffs for heterogeneity measures (see Fig. S3 in the Supplemental Material for a forest plot).

Figure 1 shows the results across all samples, separately for each sex and for the three strategic situations. Contributions in the one-shot game (Fig. 1a) were identical: Both female and male participants contributed 56.4% of their endowment. In the first period of the dynamic game (Fig. 1b), we observed slightly lower contributions by female than by male participants (52.3% vs. 54.9%, respectively), but the difference did not reach significance. Finally, Figure 1c shows the results of the strategy-method games. The strategy-method version of the game was used in 13 samples, with a total of 4,048 participants. Again, we observed very similar cooperation levels for men and women (female: 41.6%, male: 40.6 %; see Fig. S6 in the Supplemental Material for a forest plot).[3] Overall, and in line with most previous social-dilemma research and social-role theory, our results showed no evidence for differences in mean cooperation levels between the two sexes.

Variance in cooperative behavior. On the other hand, our meta-analytic results strongly supported our hypothesis of larger variance in male contributions. We calculated the log variance ratio, ln(VR), for each study and used bootstrapping to derive standard errors. A meta-analysis of the combined data set of one-shot and dynamic games with 7,560 participants from 36 samples demonstrated an ln(VR) significantly larger than zero, ln(VR) = 0.26, 95% CI = [0.20, 0.32]. This translates to a variance ratio of 1.30, which is larger than what has been found in the literatures on sex differences in variability of mathematics as well as in verbal and spatial performance (Hyde, 2014).[4] The heterogeneity measures do not suggest that the effect varies greatly between studies, $Q(35) = 41.56$, $p = .206$, $\tau^2 = 0.004$ (see Fig. S4 in the Supplemental Material for a forest plot).

To illustrate the magnitude of the effect, we show the ratio of the relative frequencies of male and female contributions in the combined sample (Fig. 2a). For expositional ease, we divided contributions into five bins: a bin for 0 (selfish), a bin for full contribution (altruist), and three equally sized bins for intermediate contributions. We treated the corner solutions (0 and 1) as separate cases because, as is usually the case with public-goods games, considerable fractions of the observations fall into these two categories (36% in the overall sample). We pooled the data of the one-shot and dynamic public-goods games (for histograms of the contributions, see Figs. S1 and S2 in the Supplemental Material). We observed selfish behavior (contribution of 0) in 14.5% of the cases for male participants and in 7.7% of the cases for female participants. In other words, the fraction of free riders is 1.88 times larger among male participants, or (to put it another way) for every 100 selfish female participants, there were 188 selfish male participants. For altruistic behavior (full contributions), we found 132 male participants for every 100 female participants. Conversely, for the three intermediate categories, we observed ratios below 1, indicating that these strategies were more popular among female participants.

We then calculated risk ratios for the relative frequency of extreme strategies. The *risk ratio* is the fraction of males opting for 0 or full contributions relative to all male participants, divided by the fraction of females opting for these contributions relative to all females. The overall risk ratio from a random-effects model for binary data was 1.52, 95% CI = [1.37, 1.68]. In contrast to the variance ratios, our data seem to indicate moderate heterogeneity for risk ratios across studies, $Q(35) = 65.34$, $p = .001$, $\tau^2 = 0.030$ (see Fig. S5 in the Supplemental Material for a forest plot). We therefore examined several potential moderators of sex differences in cooperation, as identified in previous research (Balliet et al., 2011): game parameters (group size, endowment, marginal per capita return), strategic situation (one-shot, dynamic, strategy method), sample type (convenience sample, representative), and location (lab, field; see Table 1 for details). The risk ratio was regressed onto this set of moderators, but none of the weights reached statistical significance.

Cultural variables have also been studied as moderators in the context of cooperation behaviors. Of particular relevance here is the cultural dimension of individualism-collectivism. Members of collectivistic cultures tend to emphasize harmonious relationships and to organize themselves into cohesive groups, for which they feel responsible; members of individualistic cultures expect individuals to look after themselves. Because culture is considered an important determinant of human behavior, it may be that sex differences, including differences in cooperation variance, would be nullified by the need for harmonious relationships and group well-being. Our data set contained 12 samples from collectivistic cultures and 24 samples from individualistic cultures. We found that participants from individualistic cultures were significantly more likely to contribute either none or all of their endowment (with no systematic effect on average contributions). However, individualism does not explain the variation in sex differences in our random-effects meta-regression for the risk ratio. Thus, although it seems that there is some cultural variation in the distribution of cooperation decisions, we did not find evidence for culture as a moderator of sex differences in the distribution of cooperation.

Types of cooperative behavior. The finding that men are substantially more likely to choose extreme strategies is not confined to games with strategic uncertainty. Using the standard classification (Fischbacher et al., 2001; Thöni & Volk, 2018), we distinguish between four types of cooperation preferences in our strategy method sample: (a) *free riders* never contribute, (b) *triangle cooperators* increase their contribution in response to the contribution of others up to some point and decrease it thereafter, (c) *conditional cooperators* contribute consistently more whenever others contribute more, and (d) *unconditional cooperators* make a constant contribution (usually the maximum contribution) irrespective of the contributions of others.

We identified these types in 17 samples with a total of 4,611 participants. Figure 2b shows the ratio of the relative frequencies of the four types and the residual category in the entire sample. The types are ordered by the average contribution observed in the respective schedules (numbers in parentheses). For free riders, this average is zero by definition. For the remaining types, we observed the highest average contribution for unconditional cooperators, followed by conditional cooperators. In the overall sample, 22.1% of male

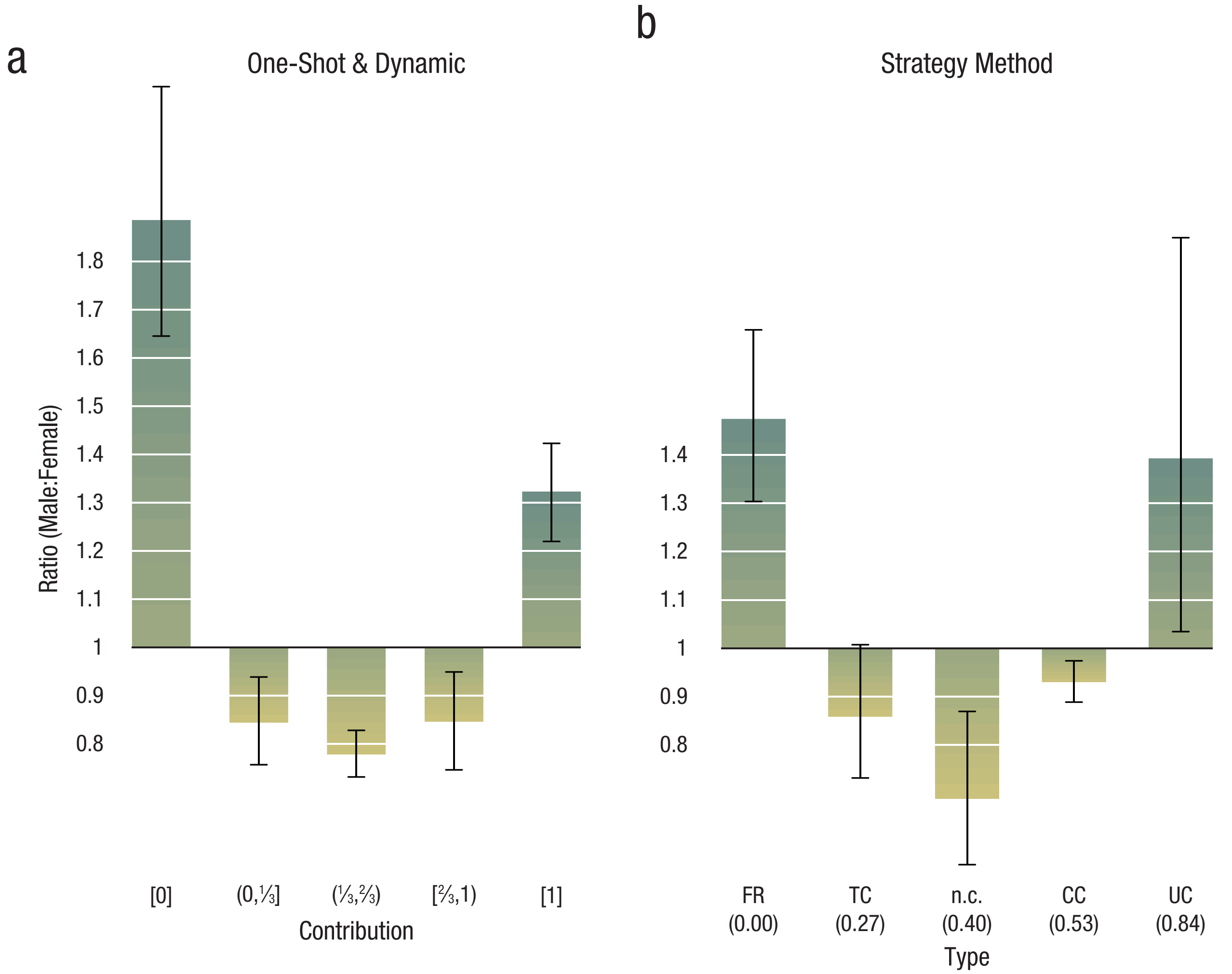

Fig. 2. Variance in contributions and types by gender (Study 1). The male:female ratio of the relative frequencies in a given range of contributions (a) is shown for the data of the one-shot and the dynamic game (pooled). Contributions are divided into five bins: 0 (no contribution), 1 (full contribution), and three equally sized bins for intermediate contributions. The male-to-female ratio of the relative frequencies of each type (b) is shown for the following types: free rider (FR), triangle cooperator (TR), conditional cooperator (CC), and unconditional cooperator (UC), as well as for those not classified (n.c.). Numbers in parentheses indicate the average contribution in the schedules of the respective type. Error bars indicate bootstrapped 95% confidence intervals.

participants fell into the category of free riders, whereas 15.0% of female participants did. Triangle cooperators and unclassified schedules were more frequent among female participants. The most frequent type, conditional cooperator, was also more prevalent among female participants. Finally, the most altruistic type, the unconditional cooperator, was more prevalent among male participants (see Table S5 in the Supplemental Material for an overview and Figs. S7–S10 for meta-analytic results on the types). Taken together, our findings provide strong support for our greater-male-variability hypothesis.

The finding that there were no systematic differences in average contributions but large differences in variability between the two sexes was reflected across the individual studies in our sample. Figure 3a shows the average effect of sex in the one-shot and dynamic experiments. Most studies found nonsignificant mean differences. Studies that found significant mean differences can be seen at both ends of the scale; the combined effect (indicated by the diamond) is close to zero and nonsignificant. On the other hand, the higher male inclination toward extreme strategies is confirmed in each data set. Figure 3b shows the differences in the percentage of extreme strategies (both selfish and altruistic). In the combined sample, 42.7% of the male participants behaved either selfishly or altruistically. Among female participants, the percentage was 29.0%, or 13.7 percentage points lower. Across the studies, the difference between male and female participants was always positive and ranged from 3 to 41 percentage points (see Tables S1 and S3 in the Supplemental Material for details, and see Tables S2 and S4 in the Supplemental Material for regression analyses).

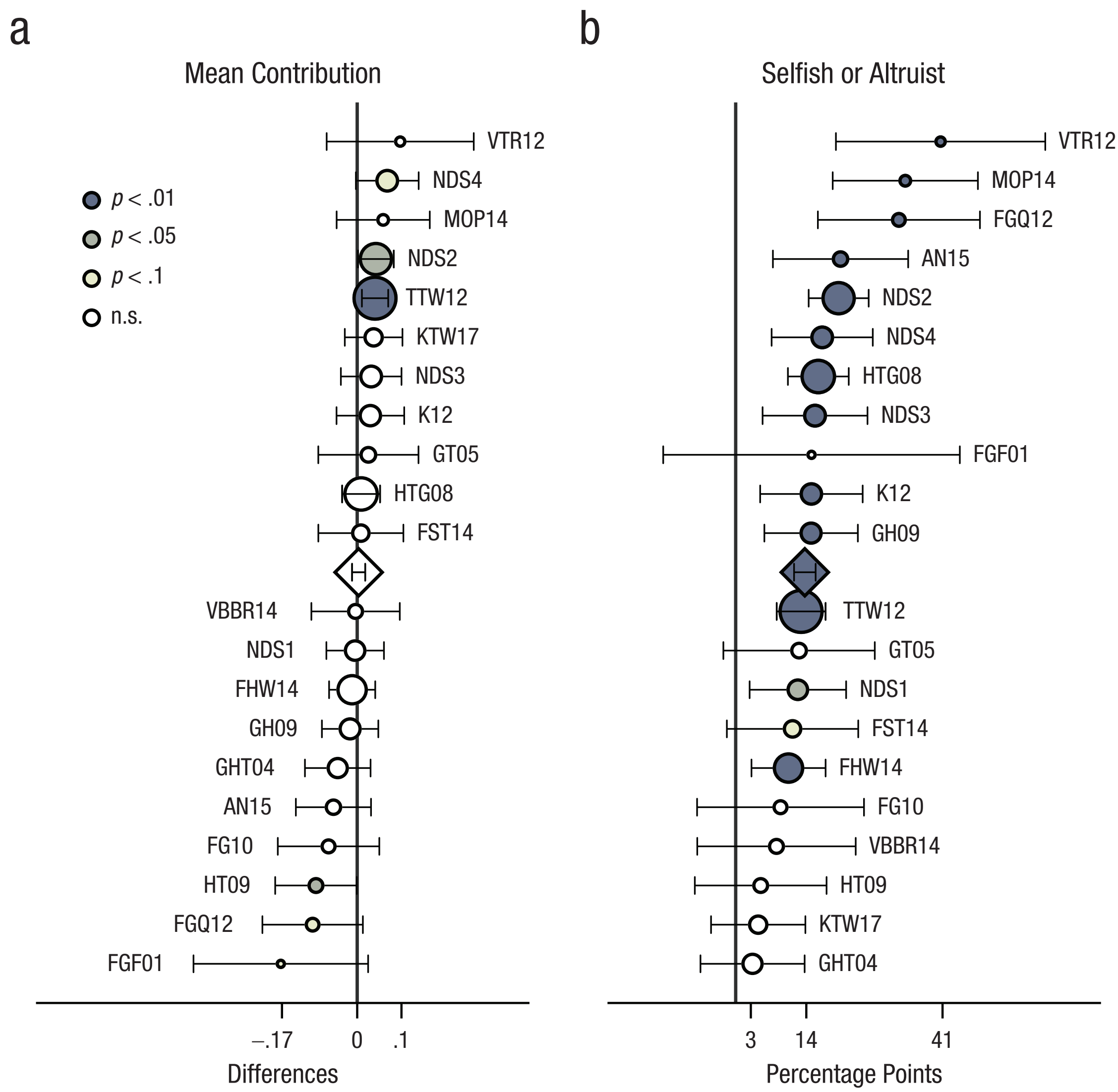

Fig. 3. Sex differences (Study 1). Differences between mean contributions of men and women are shown in (a) and differences in the percentage of extreme strategies (zero or maximum contribution) are shown in (b). Each dot represents a data set. Dot size is proportional to sample size, and error bars indicate bootstrapped 95% confidence intervals. Diamond-shaped symbols show the overall average (size not to scale). The color of the dots indicates significance levels when tested against zero. Codes for the study names are explained in Table 1.

Study 2

Method

Although our main focus is on social-dilemma cooperation, an important question is to what extent our findings generalize to a broader prosocial-behavior literature. To answer this question, we searched the organizational citizenship behavior (OCB) literature for gender-specific variance differences. OCB is often defined as the general tendency to be cooperative and helpful at work (LePine, Erez, & Johnson, 2002). Although OCB and cooperation are not isomorphic, much of the OCB literature focuses on its helping-related factors, one of which is cooperation. Given the interpersonal nature of cooperation, we focused on OCB toward individuals rather than organizations.

As a first step toward identifying relevant articles, we conducted a 6 × 6 keyword search across PsychINFO, Web of Science, Taylor and Francis, and Scopus using each possible combination of “organizational citizenship behavior,” “OCB,” “contextual performance,” “prosocial organizational behavior,” “extra-role behavior,” or “cooperation” with “sex,” “gender,” “female,” “male,” “men,” or “women” in the 50 highest-ranked business and management journals by the *Financial Times* (FT50) and in five other journals that publish work on OCB (*Journal of Organizational Behavior, Personnel Psychology, Leadership Quarterly, Journal of Occupational and Organizational*

Psychology, and *Journal of Vocational Behavior*). We included gender keywords because we were expecting studies with a focus on gender to be more likely to use gender-specific variability measures. As a second step, we searched the reference lists of three recent OCB meta-analyses (Carpenter, Berry, & Houston, 2014; Chiaburu, Oh, Berry, Li, & Gardner, 2011; Eatough, Chang, Miloslavic, & Johnson, 2011) and included all relevant studies in our search as well. In addition, we solicited published and unpublished studies using Academy of Management LISTSERVs, asking authors to send us information about gender-specific means and variances of their OCB measures. Finally, we conducted a free search in the above databases and in Google Scholar for studies reporting gender-specific means and variances for OCB measures.

These four steps returned 374 articles. We included all articles in which one of the above-listed OCB-related behaviors was studied, as long as they had a broad focus on individuals (i.e., interpersonal cooperation) rather than purely on organizations. However, as was the case with Study 1, we found very few articles that reported variability measures separately for men and women, even among articles that focused on gender differences. This demonstrates that variability measures have been largely neglected in previous OCB research. Nevertheless, we were still able to identify 28 pairs of variances from 23 articles. When articles reported gender-specific variances for multiple relevant outcomes, we selected the measure closest to standard, individually oriented OCB construct definitions. This resulted in a total sample of 13,985 independent participants (52.1% female), which exceeded the required sample size according to our power analysis (i.e., 6,918 observations) by a comfortable margin. Table 2 shows the means and variances for male and female respondents on the OCB measures reported in these articles.

Results

Our meta-analytic approach in Study 2 was identical to our approach in Study 1 with one exception. In Study 1, we were able to calculate bootstrapped standard errors from raw data, but in Study 2 we had access only to summary statistics. In Study 2, we therefore derived confidence intervals for the variance ratios using the standard deviations reported in the articles.[5]

The 28 samples included in our analysis provide consistent evidence for greater male variability in OCB. Table 2 provides an overview of the studies with the effect sizes for means (Cohen's *d*) and variability (variance ratio). For the majority of samples, the variance ratios are above 1, indicating that males exhibit more variability in citizenship-related behaviors than females do. Because the measures in these studies are of generalized cooperative behavior rather than the monetary allocations that are specific to public-goods games, they allay concerns that extreme male responses in public-goods games are due to the artificiality of the task.

The meta-analytical results are surprisingly similar to those of Study 1. We found no evidence for sex differences in means, $d = 0.10$, 95% CI = [−0.29, 0.49] (see Fig. S11 in the Supplemental Material), but highly significant sex differences in variability, ln(VR) = 0.20, 95% CI = [0.12, 0.28]. The overall variance ratio of 1.22 is slightly lower than in Study 1 but still substantial compared with the variance ratios reported in the broader literature (Hyde, 2014).[6] The heterogeneity measures for the variance ratios indicate some differences across studies, $Q(27) = 51.93$, $p = .003$, $\tau^2 = 0.020$ (see Fig. S12 in the Supplemental Material for a forest plot), which is not surprising given that the studies involved data from a wide variety of participants and cultural backgrounds.

As in Study 1, we examined the cultural dimension of individualism-collectivism as a potential moderator. Our data set in Study 2 contained 21 samples from individualist countries and seven samples from collectivist countries. We did not find evidence for culture as a moderator for the variance ratio in OCB.

Discussion

Our meta-analysis of social-dilemma studies based on 40 samples with 8,123 participants strongly supports our hypotheses and provides empirical evidence of greater male variability in cooperation. Our second meta-analysis of OCB studies based on 28 samples with 13,985 participants demonstrates that these findings are not restricted to experimentally measured behaviors. These results corroborate theories that explain sex differences not only from a social-role perspective but also from an evolutionary perspective, according to which one sex will display greater intrasex variability in phenotypes because of greater variability in heritable traits (Archer & Mehdikhani, 2003; Arden & Plomin, 2006; Wilcockson, Crean, & Day, 1995). This perspective builds on Bateman's principle (Bateman, 1948), according to which diversification of phenotypes is more adaptive for the sex that faces more intense intrasexual competition and more vetting by the other sex. According to parental-investment theory (Trivers, 1972), this is the male sex for most species because of lower parental investment and more chances to reproduce. Consistent with our hypotheses, results of our large-scale analyses indicate that this is indeed the case for cooperative behaviors: Greater male variability in cooperation was reflected across all studies and strategic

Table 2. Sex Differences in Organizational Citizenship Behavior in the Studies Included in the Study 2 Meta-Analysis

			Female			Male			Effect size	
Article	Code	Scale	Observations	*M*	*SD*	Observations	*M*	*SD*	*d*	VR
Ariani (2013)	A13	OCB	276	3.9	0.38	231	3.9	0.48	0.10	1.64
Belansky & Boggiano (1994)	BB94	Help, problem solving[a]	57	5.4	0.79	56	4.8	0.94	–0.75	1.42
Belansky & Boggiano (1994)	BB94	Help, nurturing	57	6.0	0.58	56	4.9	1.09	–1.81	3.53
Bellou et al. (2005)	BCB05	OCB[a]	82	3.9	0.52	58	4.0	0.52	0.13	1.00
Bellou et al. (2005)	BCB05	Helping	82	3.5	0.72	58	3.7	0.74	0.33	1.06
Berry et al. (2013)	Bea13a	CP supervisor	56	28.5	4.62	189	27.4	4.84	–0.22	1.10
Berry et al. (2013)	Bea13a	CP peer	58	28.1	3.30	203	27.5	3.26	–0.18	0.97
Berry et al. (2013)	Bea13a	CP subordinate[a]	49	31.2	4.27	177	30.7	4.55	–0.12	1.14
Berry et al. (2013)	Bea13b	CP supervisor	112	6.2	0.78	441	6.1	0.78	–0.04	1.00
Berry et al. (2013)	Bea13b	CP peer	125	6.2	0.61	509	6.2	0.58	0.04	0.92
Berry et al. (2013)	Bea13b	CP subordinate[a]	134	6.4	0.53	543	6.4	0.52	0.15	0.98
Bozkurt & Bal (2012)	BB12	OCB	45	4.3	0.40	32	4.1	0.49	–0.57	1.50
Cohen et al. (2014)	Cea14a	OCB	412	14.5	12.68	435	15.1	14.59	0.04	1.32
Cohen et al. (2014)	Cea14b	OCB	236	15.6	13.40	208	14.8	13.80	–0.06	1.06
El Badawy et al. (2017)	ETM17a	OCB	47	5.4	0.60	80	5.5	0.67	0.08	1.25
El Badawy et al. (2017)	ETM17b	OCB	57	5.8	0.52	59	5.7	0.76	–0.06	2.14
George et al. (1998)	GCKC98	Help	325	0.1	0.70	212	–0.2	0.75	–0.43	1.15
Golzari et al. (2012)	GMP12	OCB	100	99.8	4.42	100	132.5	6.76	7.40	2.34
Guzman & Espejo (2019)	GE19	Voice	118	5.3	1.39	215	5.5	1.48	0.13	1.13
Hafidz et al. (2012)	HHF12	OCB	194	4.7	0.42	71	4.5	0.46	–0.43	1.20
Kmec & Gorman (2010)	KG10a	DWE	1311	3.4	0.74	1263	3.4	0.76	-0.03	1.05
Kmec & Gorman (2010)	KG10b	DWE	1084	3.7	0.65	1107	3.5	0.73	–0.20	1.26
Kowal et al. (2019)	KKM19a	OCB-I	197	16.0	6.40	83	15.4	6.03	–0.08	0.89
Kowal et al. (2019)	KKM19b	OCB-I	41	18.5	7.47	39	17.9	8.58	–0.08	1.32
Lovell et al. (1999)	Lea99	OCB	55	67.7	8.34	41	64.1	10.14	–0.43	1.48
Raj et al. (2019)	RTR19	OCB	120	33.7	5.70	118	35.2	7.53	0.26	1.75
Roche & Haar (2013)	RH13	OCB-I	163	3.6	0.65	223	3.5	0.74	–0.24	1.28
Sackett et al. (2006)	SBWL06	OCB[a]	669	3.4	0.34	213	3.3	0.39	–0.22	1.35
Sackett et al. (2006)	SBWL06	OCB-I	669	3.6	0.36	213	3.6	0.39	–0.07	1.17
S. R. Singh & Padmanabhan (2017)	SP17	OCB	396	607.3	57.20	132	609.3	63.50	0.03	1.23
A. K. Singh & Singh (2010)	SS10	OCB-I	22	36.1	4.60	188	40.3	5.59	0.90	1.48
Tang et al. (2000)	TSR00	OCB	187	49.5	5.35	106	49.4	5.41	–0.02	1.02
Valentine et al. (2009)	VGPR09	Altruism	294	6.1	0.91	135	5.9	0.82	–0.16	0.81
Van Houwelingen and Van Dijke (2020)	VV20	OCB	70	5.3	0.81	144	5.2	0.79	–0.14	0.95
Wilkinson (2005)	W05	Personal support	539	0.1	0.77	436	–0.1	0.83	–0.35	1.16

Note: Some articles reported results from two separate samples, which are identified by a lowercase letter in the code. VR = variance ratio; CP = contextual performance; DWE = discretionary work effort; OCB = organizational citizenship behavior; OCB-I = OCB directed toward individuals.

[a]Some articles reported several OCB-related scales. The measure indicated here was used for our main specifications.

situations included in our analysis of social-dilemma studies and was equally present in the OCB studies we analyzed.

Our theories and findings provide important implications for future research on sex differences in cooperation. One important implication relates to the existence of sex differences in social-dilemma situations. Social-dilemma researchers have long grappled with the question of whether men and women differ systematically in their cooperation behaviors (Balliet et al., 2011; Croson & Gneezy, 2009; Eckel & Grossman, 2008). Similarly, OCB researchers have investigated sex differences but found no evidence for significant gender effects (Ng, Lam, & Feldman, 2016). By focusing on variability of behaviors rather than central tendencies, we were able to provide evidence for strong and systematic sex differences in the distribution of cooperation behaviors. This finding is important given that cooperation is not the only area in which the prevailing focus on central tendency may have masked important sex differences in the tails of the distribution. As a result, researchers may have underestimated the magnitude of gender differences in many areas, and future research should focus on the extent to which this might be the case for related topics, such as decision making under risk, attitudes toward competition, and trust and reciprocity. As of this writing, public-health officials are grappling with overreactors and underreactors to the COVID-19 pandemic. The overreactors engage in extensive hoarding (Barrett, 2020), and the underreactors make a point of poking the coronavirus bear (Kasabian, 2020). To our knowledge, efforts to understand these extremes have focused on personality and life-situation variables, but perhaps they should also focus on sex.

Our research also speaks to the role of environmental inputs and context for sex differences in cooperation as emphasized by social-role theory. Indeed, the most recent major analysis of sex differences in social dilemmas concluded that sex differences in cooperation emerge mainly as a result of contextual factors (Balliet et al., 2011). Our finding of no sex differences in mean cooperation levels is in line with the predictions of social-role theory, given that public-goods games provide no contextual cues that could trigger gender-role-specific behaviors. However, our finding of systematic sex differences in the variability of cooperation behaviors indicates that some sex differences in cooperation might exist that are not context or social-role specific.

In conclusion, although the main focus of our article was on sex differences in social-dilemma cooperation, we found similar results for OCBs. Overall, our results suggest that for the science of human cooperation and potentially many other areas—such as decision making under risk, attitudes toward competition, and trust and reciprocity—focusing on variability in behaviors (and evolutionary-evolved sex differences) may be just as illuminating as central tendencies (and socially primed sex differences).

Transparency

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Author Contributions
C. Thöni and S. Volk collected the data, performed the primary statistical analysis, and wrote the first draft of the manuscript. J. M. Cortina provided the meta-analytic methods. All authors contributed to the writing of the final draft and approved it for submission.
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Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797620956632

Notes

1. Many of these studies used the Fischbacher et al. (2001) design to elicit both a one-shot contribution and a vector of conditional contributions, whereas some are ordinary one-shot experiments. In this study, we did not distinguish between the unconditional contribution elicited by the Fischbacher et al. design and the contribution elicited in ordinary one-shot games, even though they are strategically different. They are different because in the Fischbacher et al. design, one player in the group can react to the contributions of others, whereas in the ordinary one-shot game, all contributions are chosen simultaneously. However, in our data, we observed no significant differences in contributions between the two strategic situations. But even if there were systematic differences, there is no reason to expect that these differences are relevant for our primary

research question regarding variance differences. For two studies (Kocher, Cherry, Kroll, Netzer, & Sutter, 2008; Weber, Weisel, & Gächter, 2018), we received the conditional contributions but not the unconditional contributions.

2. An important source of data is the cross-cultural study by Herrmann, Thöni, and Gächter (2008), who reported results from repeated public-goods games with participants from 16 subject pools with various cultural backgrounds. Table 1 shows data for 14 cities in which the study was conducted. We dropped two locations from the original study (Riyadh and Minsk) because the number of female participants was too low (< 5%) to draw meaningful inferences about gender differences. Furthermore, we used only the observations in which the standard public-goods game was played in the first sequence, leaving us with 888 observations from this study.

3. In the strategy method, participants complete a contribution schedule, specifying their desired contribution for all possible average contributions of the other participants in their group. In addition, the participants choose an unconditional contribution. A random device selects one member of the group as conditional contributor. The unconditional contributions of the other group members are used to calculate the average, and the contribution schedule of the selected participant is used to determine his or her contribution. To calculate an average contribution from these schedules, we determine each participant's contribution as the average of 10,000 random matches with other participants in the sample of the respective study.

4. In the main analysis, we treated each sample as an independent observation. In our view, this is justified because all experiments included were clearly separated by either time (if from the same lab) or geographical location. Nevertheless, we used robust variance estimations to account for possible dependencies (Hedges, Tipton, & Johnson, 2010). We considered two dependencies: (a) among samples from the same publication (e.g., all the studies with a code starting with HTG08), and (b) among samples stemming from the same laboratory (e.g., FGF01 and FG10). In both cases, our results remained highly significant, and the estimated variance ratios were very close to our main specification—ln(VR) = 0.24, 95% CI = [0.17, 0.30], VR = 1.27, and ln(VR) = 0.27, 95% CI = [0.20, 0.34], VR = 1.31.

5. We used the standard deviations for male and female OCB scores, s_m and s_f, to calculate the variance ratio s^2_m/s^2_f. Assuming normal distribution of the OCB measure, we can calculate the 95% CI for the variance ratio using the F distribution with $n_m - 1$ and $n_f - 1$ degrees of freedom:

$$\left[\frac{1}{F_{.025}}\frac{s_m^2}{s_f^2}, F_{.025}\frac{s_m^2}{s_f^2}\right].$$

6. Our results did not depend on the selection of the dependent variables (for the cases in which there were multiple OCB-like measures available). We found very similar results even when we selected the dependent variables least supportive for greater male variability, ln(VR) = 0.18, 95% CI = [0.09, 0.26], VR = 1.19, or when we included all variables reported in Table 2 using robust variance estimations, ln(VR) = 0.24, 95% CI = [0.15, 0.33], VR = 1.27.

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References marked with one asterisk report studies included in the Study 1 meta-analysis, and references marked with two asterisks report studies included in the Study 2 meta-analysis.

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