

### Original Article

#### Sex Differences in In-Group Cooperation Vary Dynamically with Competitive Conditions and Outcomes

Drew H. Bailey, Department of Psychological Sciences, University of Missouri, Columbia, USA. Email: [dhbd45@mail.missouri.edu](mailto:dhbd45@mail.missouri.edu) (Corresponding author).

Benjamin Winegard, Department of Psychological Sciences, University of Missouri, Columbia, USA.

Jon Oxford, Department of Psychological Sciences, University of Missouri, Columbia, USA.

David C. Geary, Department of Psychological Sciences, University of Missouri, Columbia, USA.

**Abstract:** Men's but not women's investment in a public goods game varied dynamically with the presence or absence of a perceived out-group. Three hundred fifty-four (167 male) young adults participated in multiple iterations of a public goods game under intergroup and individual competition conditions. Participants received feedback about whether their investments in the group were sufficient to earn a bonus to be shared among all in-group members. Results for the first trial confirm previous research in which men's but not women's investments were higher when there was a competing out-group. We extended these findings by showing that men's investment in the in-group varied dynamically by condition depending on the outcome of the previous trial: In the group condition, men, but not women, decreased spending following a win (i.e., earning an in-group bonus). In the individual condition, men, but not women, increased spending following a win. We hypothesize that these patterns reflect a male bias to calibrate their level of in-group investment such that they sacrifice only what is necessary for their group to successfully compete against a rival group.

**Keywords:** sex differences, cooperation, coalition, public goods game

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### Introduction

Intergroup male-male competition appears to have contributed to the evolution of sex differences in the ease of forming and maintaining same-sex coalitions and associated cognitions about in-groups and out-groups (Flinn, Geary, and Ward, 2005; Geary, 2010; Keeley, 1996; Leblanc and Register, 2003; Otterbein, 2004; Pratto and Hegarty, 2000; Pratto, Sidanius, Stallworth, and Malle, 1994; Wrangham, 1999). Boys and men form and

maintain large, well integrated groups more easily than do girls and women, especially when competing against other same-sex groups (Browne, 2007; Geary, Byrd-Craven, Hoard, Vigil, and Numtee, 2003; Lever, 1976). Men compete intensely for position within these groups, but once a dominance hierarchy is established, they typically maintain friendly relationships with all in-group members and become increasingly skilled at coordinating group behavior. (Parker and Seal, 1996; Rose and Rudolph, 2006; Savin-Williams, 1987). Men are also more sensitive than women to between-group hierarchies and possess stronger biases against out-groups, especially during conflict (Sidanius, Pratto, and Bobo, 1994; Sidanius, Pratto, Mitchell, 2001; Van Vugt, De Cremer, and Janssen, 2007). These sex differences have been implicated, at least indirectly, in many real world phenomena, ranging from sports fandom (Winegard and Deaner, 2010) to ethnic conflict (Thayer, 2009) and suicide terrorism (Atran, 2003; Ginges, Hansen, and Norenzayan, 2009).

To the extent that sex differences in ease of coalition formation and associated cognitions are related to an evolutionary history of male-male coalitional competition (Geary, 2010), they should be especially pronounced during competitions with other groups. Indeed, intergroup competition has been shown to increase cooperation in an economic game (Bornstein, Gneezy, and Nagel, 2002), and one proximate reason for this seems to be a motivation to help the in-group (rather than a motivation to harm the out-group; Halevy, Bornstein, and Sagiv, 2008). Van Vugt, De Cremer, and Janssen (2007) used a public goods game to experimentally study sex differences in in-group cooperation. As elaborated below, when men believed they were competing against a rival group, they made larger contributions to their group than they did when there was no rival group. Women's contribution to their group, in contrast, did not vary with cues indicating the presence or absence of a rival group. Van Vugt and colleagues' studies confirm that men's bias toward in-group cooperation is heightened during between-group competitions but they only tested this bias in a one-shot public goods game. The relative balance between selfish and altruistic decisions can change dynamically across iterations of these types of economic games, contingent on the outcomes of previous trials (Axelrod and Hamilton, 1981; Monterosso, Ainslie, Toppi, Mullen, and Gault, 2002). Thus, we extended Van Vugt et al.'s procedure to include multiple trials and experimentally manipulated trial outcomes, and explored potential mediators and moderators of individual and sex differences in level of in-group cooperation.

### *Intergroup vs. Intragroup Competition*

Social psychologists have documented the ease with which people demonstrate in-group favoritism and form biases against out-group members. (Billig and Tajfel, 2006; Diehl, 1990; Sidanius and Ekehammar, 1983). When in-group members are presented with an external threat, it may be especially important for them to cooperate with one another to deal effectively with the threat. Because men were more likely to be participants in intergroup conflict during hominid evolution (and during written history) (Geary, 2010; Pinker, 2011), they should exhibit stronger group biases than women. As noted, Van Vugt et al. (2007) tested and confirmed this hypothesis using a one-shot public goods game.

More precisely, in the Van Vugt et al. (2007) study, men and women were assigned to one of two conditions consisting of six-person, same-sex groups. Each individual began with an endowment of approximately four dollars, which could be kept or invested publicly

in the group. If the group of six individuals contributed approximately 16 dollars to the group, each individual would receive a bonus of approximately eight dollars. However, if the public investment failed to reach 16 dollars, each individual would lose the money they chose to invest publicly, while keeping the portion they kept for themselves. Participants in the individual condition were told the experiment was being conducted at 10 different universities in England and were told that researchers were interested in how well individuals performed. Instructions were the same in the group condition with one exception: participants were told that the researchers were interested in how well student *groups* performed relative to groups at *rival* universities. The authors hypothesized that this would induce a coalitional psychology among group members (i.e., they would perceive student groups at rival universities as an out-group). Results showed that men cooperated significantly more in the group condition than in the individual condition, whereas women's level of cooperation was similar across conditions. These results were robust whether individuals participated in a binary (i.e., invest all or none in the public domain) or continuous (i.e., invest any desired amount in the public domain) public goods game.

This evidence is consistent with the hypothesis that men's cooperative behaviors are more sensitive to group competition than are women's. However, Van Vugt et al. (2007) did not assess cooperative behavior across multiple trials. Given the temporal dynamics of between-group competition, a one-shot game is not likely to fully capture the real world temporal trade-offs involved in deciding whether to act altruistically or selfishly. In fact, given the unpredictability of these dynamics (Monterosso et al., 2002), economic games may never fully capture real life decision making. Nevertheless, an iterated public goods game provides a much needed extension of Van Vugt et al.'s experimental paradigm.

#### *Underlying Sociocognitive Differences*

Men in one of Van Vugt et al.'s (2007) group conditions reported heightened in-group identification that in turn mediated their increased in-group investment relative to the individual condition. There are also stable individual and sex differences in sociocognitive processes that may contribute to the sex difference in cooperative, group dynamics. (Geary, 2010). Women, for example, generally score higher on tests of empathy and religiosity than do men (Baron-Cohen, Knickmeyer, and Belmonte, 2005; Stark, 2002). This may bias women to consider the welfare of group members when competing both individually and against a group. Men, on the other hand, generally score higher on social dominance scales, which reflect sensitivity to dominance and competition (Levin, 2004). Especially relevant to coalitional psychology, Haidt and Graham (2007) have identified five dimensions of moral reasoning, three of which are directly linked to between group psychology. Specifically, the moral foundations of loyalty, authority, and purity define rules and obligations for treatment of in-group members and for maintaining group stability (see also Haidt, 2007). Two of the five dimensions, i.e., care and fairness, appear to reflect broader concerns, beyond the in-group, regarding the care and protection of the vulnerable and the equal distribution of resources and rights. We explored whether individual differences on measures of these five dimensions of morality mediated individual or sex differences in sensitivity to between group competition.

#### *Current Study*

The current study was designed to extend Van Vugt et al.'s (2007) finding that men cooperate relatively more in conditions of group threat whereas women's cooperation with other members of the in-group is not influenced by a perceived group threat. We extended their procedure in two ways. First, we used an iterated public goods game that allowed us to provide false feedback on the level of cooperation of other group members. Second, we administered a battery of sociocognitive measures designed to find potential moderators and mediators of individual and sex differences in cooperation and sensitivity to between group competition.

## **Materials and Methods**

The participants were 354 undergraduates (167 male) at a large Midwestern public university. They were recruited to participate in same-sex groups of six, but many scheduled participants did not keep their appointments, resulting in group sizes ranging between two and six ( $M = 4.3$ ,  $SD = 1.2$ , Table 1). Written consent was obtained from all participants.

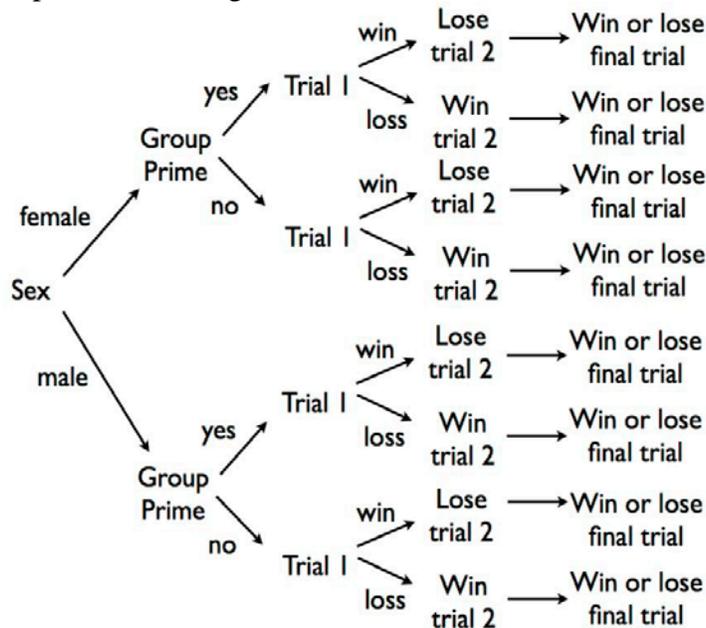
**Table 1.** Group Sizes

Group Size	Number of Groups (%)	Number of Participants (%)
2	5 (6)	10 (3)
3	20 (24)	60 (17)
4	23 (27)	92 (26)
5	22 (26)	110 (31)
6	14 (17)	84 (24)

### *Public Goods Game*

Each participant engaged in a computer-based public goods game. Participants were given \$3 and were instructed that they could keep this money or choose to invest some or all of it in the group. All participants made their investment to the group using a computer keyboard, with computers separated by dividers so that other participants would not be able to see how much they invested. If the group invested a total of \$12 or more, they would receive a \$5 bonus on top of whatever amount they chose not to invest into the group fund. If fewer than 6 individuals showed up for the experiment, participants were told that the unoccupied computers made contributions to the group based upon the average responses that previous participants had given. However, all participants, regardless of group size, were actually given predetermined feedback about whether or not the group had contributed enough money for the \$5 bonus. Participants underwent three trials of this game, following the experimental design shown in Figure 1; participants were informed that the third trial determined the amount of money the participant received (see appendix for full participant instructions).

**Figure 1.** Experimental design



### *Group Prime*

Participants were randomly assigned to either a group or an individual condition. In the former, participants were told that the study in which they were participating was part of a larger experiment that included all of the schools in their university’s athletic conference, including some of the university’s principle rivals. In this condition, as the participant played the public goods game, the logo of each university in the athletic conference remained visible at the top of the computer screen throughout. Participants were informed that the researchers were interested in how well student groups at this university performed at different tasks compared to groups of students at these other universities.

In the individual condition, participants were still informed that the study in which they were participating was part of a larger experiment that included all of the schools in their university’s athletic conference, but without mention of the university’s rivals or any visible university logos. Participants were informed that the experimenters were interested in how well students individually performed at different tasks.

### *Sociocognitive Measures*

The following scales were used to explore potential sociocognitive mediators or moderators of sex and individual differences in investment patterns. Participants filled out the scales in random order after completing the experimental portion of the study.

*Social dominance orientation scale.* This scale measures the extent to which an individual prefers inequality between social groups. The SDO contains 14 questions each of which are answered on a 1(very negative) to 7 (very positive) scale. Questions include, “Some groups are simply not the equals of others,” and “To get ahead in life, it is sometimes necessary to step on others.” (Pratto et al., 1994).

*Quest scale.* The 12 item Quest scale measures the degree to which an individual's religious beliefs involve an open ended view of the existential dilemmas of life. Each question ranges from strongly disagree (1) to strongly agree (9). Questions include, "As I grow and change, I expect my religion also to grow and change." (Batson and Schoenrade, 1991).

*Religious fundamentalism scale.* The 12 item scale measures the degree to which an individual believes his or her religious beliefs to be the intrinsic and inherent truth about humanity and god. Individuals who score highly on this scale tend to believe that there are forces opposed to their religious beliefs and that these forces must be vigorously fought and defeated. They also believe that those who act in accordance with the fundamentals of their religion have a special relationship with god. The scale ranges from strongly disagree (-4) to strongly agree (4). Items asked on the scale include, "God has given humanity a complete, unending guide to happiness and salvation, which must be totally followed." (Altemeyer and Hunsberger, 2004).

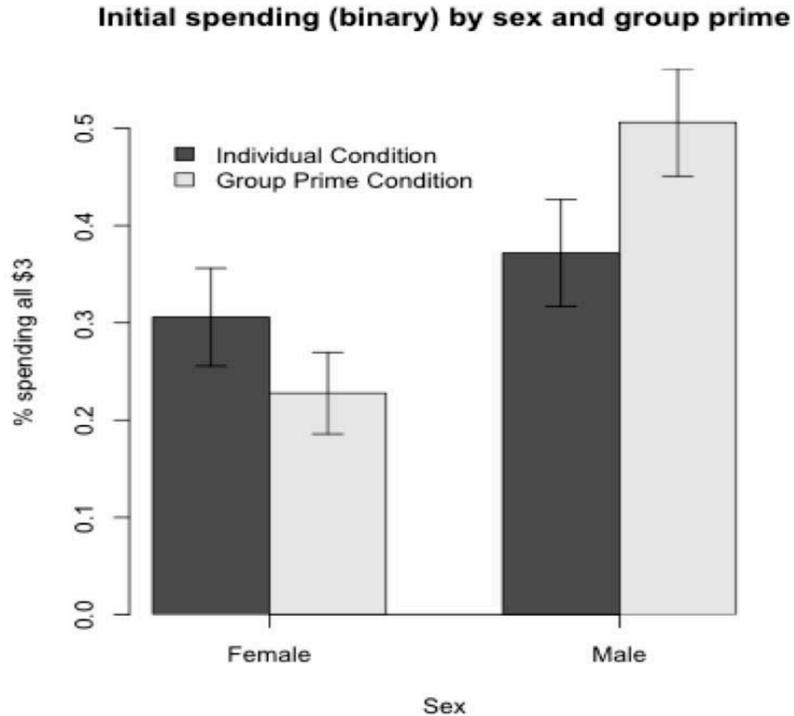
*Moral foundations questionnaire.* The 30 item scale assesses valuation of five moral dimensions: whether an act causes harm or provides care (harm/care), whether an act is unjust or fair (fairness/reciprocity), whether an act shows disobedience or respect of authority (authority/respect), whether an act is carnal or pure (purity/sanctity), and whether an act shows betrayal or loyalty (in-group/loyalty). The first 15 items ask how relevant certain statements (e.g. "Whether or not someone acted unfairly") are in deciding whether or not something is right or wrong. These are answered using a 0 (not at all relevant) to 5 (extremely relevant) scale. The second set of 15 items asks the participant to rate their agreement with a series of statements. Each question is also answered using 0 (strongly disagree) to 5 (strongly agree) scale. Items in this section of the questionnaire include, "I am proud of my country's history" and "Justice is the most important requirement for a society." (Graham, Haidt, and Nosek, 2009).

## **Results**

### *Spending by Group and Sex*

The first spending trial yielded findings similar to Van Vugt et al.'s (2007) one-shot experiment. Analyzing spending on this trial as an all or nothing decision (coded as 1 if the participant invested all \$3 in the group and coded as 0 otherwise), yielded a significant sex by group-prime interaction using logistic regression ( $z = 2.05, p = 0.04$ ).

**Figure 2.** First-trial sex differences in the percent of individuals who invested all of their money in the group



The interaction was not significant, however, when spending was analyzed as a continuous variable ( $t[343] < 1$ ).

### *Spending Across Trials*

A multilevel model with sex, group prime, and two outcome variables were used as predictors of investment in the public good (measured continuously). The first outcome variable was whether the participant had won (i.e., received a payout of \$5 because the groups' combined contribution was  $> \$12$ ) in the immediately preceding trial and the second was whether the participant had lost in the immediately preceding trial (coded as 1 if the participant had lost in the immediately preceding trial and coded as 0 otherwise). The parameter estimates for these effects are displayed in Table 2. These indicate a main effect for previous loss (individuals contributed more after a loss). A nonsignificant trend toward a sex by previous win interaction indicated that, in the individual condition, men gave more after a win relative to women.

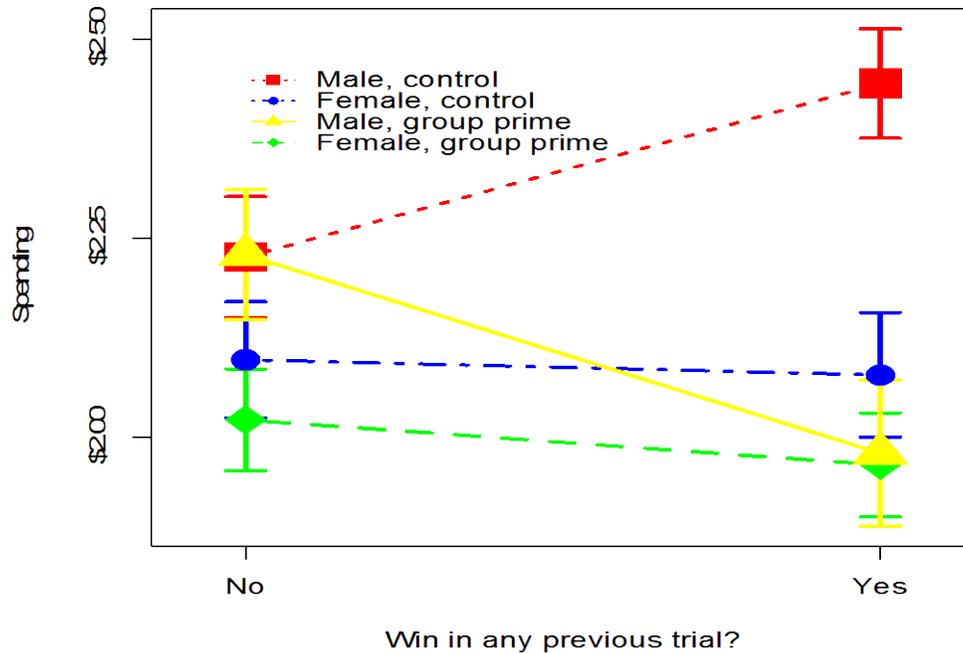
**Table 2.** Maximum likelihood estimates from the multilevel model assessing investment as a function of previous win or loss

<b>Effect</b>	<b>Estimate</b>	<b>se</b>	<b>df</b>	<b>t value</b>	<b>Pr &gt;  t </b>
Intercept	5.04	0.46	341	10.94	<0.0001
Sex	0.81	0.64	686	-0.48	0.63
Group Prime	-0.12	0.26	686	-0.48	0.63
Previous Win	0.09	0.19	686	0.50	0.62
Sex* Group Prime	0.37	0.37	686	0.99	0.32
Sex* Previous Win	0.51	0.27	686	1.87	0.06
Group Prime* Previous Win	0.01	0.26	686	0.06	0.95
Sex* Group Prime* Previous Win	-1.23	0.37	686	-3.29	0.001
Previous Loss	0.54	0.19	686	2.88	0.004
Sex* Previous Loss	-0.13	0.27	686	-0.48	0.63
Group Prime* Previous Loss	-0.17	0.26	686	-0.69	0.49
Sex* Group Prime* Previous Loss	-0.60	0.37	686	-1.60	0.11
Group size	-0.02	0.10	686	-0.18	0.86
Group size*Sex	-0.11	0.14	686	-0.79	0.43

However, these effects were qualified by a 3-way interaction among sex, group prime, and previous win. This interaction is shown in Figure 3 (this same interaction remains significant when individuals' first and second trials only are considered in the model or when only their second and third trials are considered in the model, and can be seen when data are plotted across trials given participants' previous win/loss feedback, condition, and sex; Appendix: Figures 4 and 5). The 'No' trials on the x-axis indicate contributions on the first trial of the experiment or on the second trial, if their group did not contribute enough to win the bonus on the first trial. The 'Yes' trials are contributions immediately after their group won the bonus. On trials following a win, women invested similarly whether or not

they were exposed to the group prime. Men, however, invested less after a previous win after exposure to the group prime and more after a previous win without the group prime. Results were not influenced by group size or its interaction with sex<sup>1</sup>.

**Figure 3.** Three way sex by group prime by previous win interaction for continuous spending



*Potential Mediators*

To search for potential mediators of the sex by group prime by previous win interaction, each sociocognitive variable was entered into a separate model identical to the model in Table 2, except with the sociocognitive variable, group prime, previous win, and previous loss and interactions between them as additional predictors. The three way interaction between the sociocognitive variable, group prime, and previous win was evaluated. In none of these 12 models did this interaction reach statistical significance ( $p > 0.10$ ). Therefore, further analyses for mediation were not performed, as the first condition for such analyses was not met.

Notably, the model that came closest to yielding a significant result was a main effect for the fairness dimension of Graham et al.’s (2009) moral foundations measure. Individuals who endorsed this item, that resources should be equally distributed among group members, contributed *less* to their group ( $t[337] = -1.93, p = 0.054$ ).

<sup>1</sup> To test whether group size influenced variables of interest, we ran 15 regression models with sex, group condition, and group size predicting each of the 12 sociocognitive variables and spending at each of the 3 timepoints. None of these models yielded a significant effect of group size. Therefore, we found no evidence that group size affected participants’ behavior or social cognition in this study.

## **Discussion**

Our research investigated sex differences in cooperation under group or individually competitive conditions using a multi-trial public goods game. Results from the first trial were consistent with Van Vugt et al.'s (2007) finding that men's public investment was higher when competing against an out-group than when there was no such competition, whereas women's investment was not influenced by the presence or absence of an out-group. Our findings also revealed that both men and women adjusted their public investment in response to outcomes from previous trials, indicating that the level of cooperation for both sexes changed dynamically. Generally, there was an increase in public spending after a previous loss—when the total contributions of the group were not sufficient to earn the bonus—and a decrease in such spending after a previous win—after a bonus was earned. However, the pattern was more nuanced for men. This is because men made a smaller public contribution in the group condition following a win, and made a larger contribution in the individual condition following a win. In short, men were more sensitive to perceived between group competition than were women, and to the perceived level of cooperation among other group members. These results are consistent with the hypothesis that men have an evolved sensitivity to competitive situations and outcomes, especially when these involve between-group competition (Bugental and Beaulieu, 2009; Yuki and Yokota, 2009).

The finding that men contributed more to the group than women for the initial investment, when competing against out-groups, but then decreased public spending after their group had received the bonus suggests they may more finely calibrate their investment in the group than women. This investment is contingent on the investments of others and in theory according to the perceived strength of the out-group. When a male coalition faces a relatively strong out-group, in-group cohesion becomes particularly important, that is, men must contribute more to the group for the group to stay competitive (Benenson, Markovits, Thompson, and Wrangham, 2009). However, when men perceive a rival group as relatively weak, or that their marginal contributions (contributions above and beyond those of other in-group men) will not affect the outcome, they may act in a more individualistic and selfish manner. Studies of suicide terrorism, perhaps the ultimate form of group sacrifice, consistently demonstrate that they are perpetrated by relatively weak groups (Atran, 2003, 2006; Pape, 2003). In a similar vein, historians and moralists have long lamented that opulence increases hedonism and unwillingness to make extreme sacrifices for the larger group (Gibbon, 2001; Plutarch, 2001). When professional basketball teams play back-to-back games at the same site, after controlling for relative team strength and home court advantage, it is the team that lost the first game that is more likely to win the second, that is, it appears that individuals of the losing team may increase their efforts following a loss (Mirzuchi, 1991).

In light of this, it is somewhat counterintuitive that men in the individual condition invested more publicly following a previous win. It appears to be the case that different psychological mechanisms are activated in men depending on whether they are in the group or individual condition. We speculate that men in the individual condition engage in a form of competitive altruism to facilitate the likelihood that they will be considered desirable coalitional partners and/or mates (Barclay, 2004; Hardy and Van Vugt, 2006), but this remains to be tested. Given the importance to men of being part of a successful group, such

a strategy may be rational. It must be noted, however, that none of the group members were aware of each other's previous investments, making this explanation open to doubt.

We were surprised that not one of the sociocognitive variables we measured mediated or moderated the spending differences between the sexes, given Van Vugt and colleagues' (2007) finding that heightened identification with the in-group mediated men's increased investment in the public group during a between-group competition. Further, none of the variables we measured accounted for individual differences in investment, with the possible exception of the fairness dimension, Graham et al.'s (2009) moral foundations, which was, somewhat paradoxically, negatively related to public investment. One potential explanation is that participants represent themselves on the moral foundations items as they hope to be perceived and not as they are. Alternatively, participants may hold themselves to a different moral standard than they hold others, with the most moralistic individuals being the most hypocritical. However, the gist is that the mechanisms that mediate men's dynamic investment in their group during intergroup competition were not captured by the social dominance, religiosity, or morality measures used in this study.

Men's in-group psychology likely affects real world behavior. Our results could manifest in conditions that involved some type of investment by men during any between-group competition, but the specifics of the investment will depend on the context of the competition. In the current study, it involved money but in contexts involving physical, coalitional competition, for example, it could manifest as higher or lower levels of behavioral risk taking, that is, risking actual injury to facilitate their group's competitiveness.

Limitations of our study should be noted. First, the amount of money offered to winners was not large, making it difficult to extend these results to conditions where the costs and benefits of cooperation could be substantial. Second, the group condition featured a relatively male-biased prime (rival athletic Universities) which leaves open the possibility that women may be more responsive to intergroup competition when presented with an out-group prime that might be similarly salient to men and women (e.g., nationality, religion). However, a basic corollary of men being more sensitive to group competition is that most primes should be male biased (Geary, 2010). Also, we did not assess every construct that could possibly affect investment in the in-group. Future studies of mediators of sex differences in cooperation might include constructs such as empathy.

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## **Appendix**

Full instructions given to participants:

### Group Condition

Welcome to the Oxford Experiment. You are going to play a public goods game and fill out some questionnaires.

The Oxford Experiment is part of a larger experiment that is taking place at all of the Universities in the Big 12 conference. We are interested in investigating how well you perform **AS A GROUP compared to OPPOSING BIG 12 UNIVERSITIES**. Before we begin the experiment, I will walk you through the instructions of the public goods game and make sure that you understand how the game works. If you have any questions please ask.

In this game each of you will receive three dollars which you may choose to keep or invest in the group. To do this, simply look at your computer screen and press the number key corresponding to the amount you wish **TO INVEST IN THE GROUP**.

(If there are not six people read this: Since there are not six people, the empty computer(s) will invest an amount in the group which is equal to the average investment of (males or females) who have participated)

If the group invests a total of 12 or more dollars each individual will receive a five dollar bonus on top of the money that you chose to keep for yourself.

So, for example, if you chose to invest two dollars into the group and the group as a whole hit the target of 12 or more dollars, you would receive the five dollar bonus plus the dollar you decided to keep. However, if you invested the two dollars and the group did not make the target, you would only keep your dollar and would not receive a bonus.

Any questions?

(Answer any questions at this time and give participants a short verbal quiz to make sure they understand the rules fully).

You will play a total of three rounds. You will actually get paid based on your responses from the last round of play. Remember, we are comparing your performance **AS A GROUP** to other Big 12 Universities.

After you are done with the public goods game you will be asked to fill out a few questionnaires. When you have completed the questionnaires, please see me. I will debrief you at that time and you will be free to go. Are there any questions?

### Individual Condition

Welcome to the Oxford Experiment. You are going to play a public goods game and fill out some questionnaires.

The Oxford Experiment is part of a larger experiment that is taking place at all of the Universities in the Big 12 conference. We are interested in investigating how well you perform **AS INDIVIDUALS compared to other individuals at Missouri and other Big 12 Universities**. Before we begin the experiment, I will walk you through the instructions

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of the public goods game and make sure that you understand how the game works. If you have any questions please ask.

In this game each of you will receive three dollars which you may choose to keep or invest in the group. To do this, simply look at your computer screen and press the number key corresponding to the amount you wish **TO INVEST IN THE GROUP**.

(If there are not six people read this: Since there are not six people, the empty computer(s) will invest an amount in the group which is equal to the average investment of (males or females) who have participated)

If the group invests a total of 12 or more dollars each individual will receive a five dollar bonus on top of the money that you chose to keep for yourself.

So, for example, if you chose to invest two dollars into the group and the group as a whole hit the target of 12 or more dollars, you would receive the five dollar bonus plus the dollar you decided to keep. However, if you invested the two dollars and the group did not make the target, you would only keep your dollar and would not receive a bonus.

Any questions?

(Answer any questions at this time and give participants a short verbal quiz to make sure they understand the rules fully).

You will play a total of three rounds. You will actually get paid based on your responses from the last round of play. Remember, we are comparing your performance **AS INDIVIDUALS** to other students at Universities in the Big 12.

After you are done with the public goods game you will be asked to fill out a few questionnaires. When you have completed the questionnaires, please see me. I will debrief you at that time and you will be free to go. Are there any questions?

The Figure 3 results broken down across trials

Figure 4 shows the separate contributions on the first and second trials for men (upper left panel) and women (upper right panel) who won on the first trial (time 0) and those who lost on the first trial (lower panels). A mixed model confirmed that the sex\*previous win\*group prime interaction remained significant for participants in these trials alone ( $F[1,339] = 7.40, p = 0.007$ ) even without controlling simultaneously for previous loss effects ( $F[1,343] = 6.15, p = 0.01$ ).

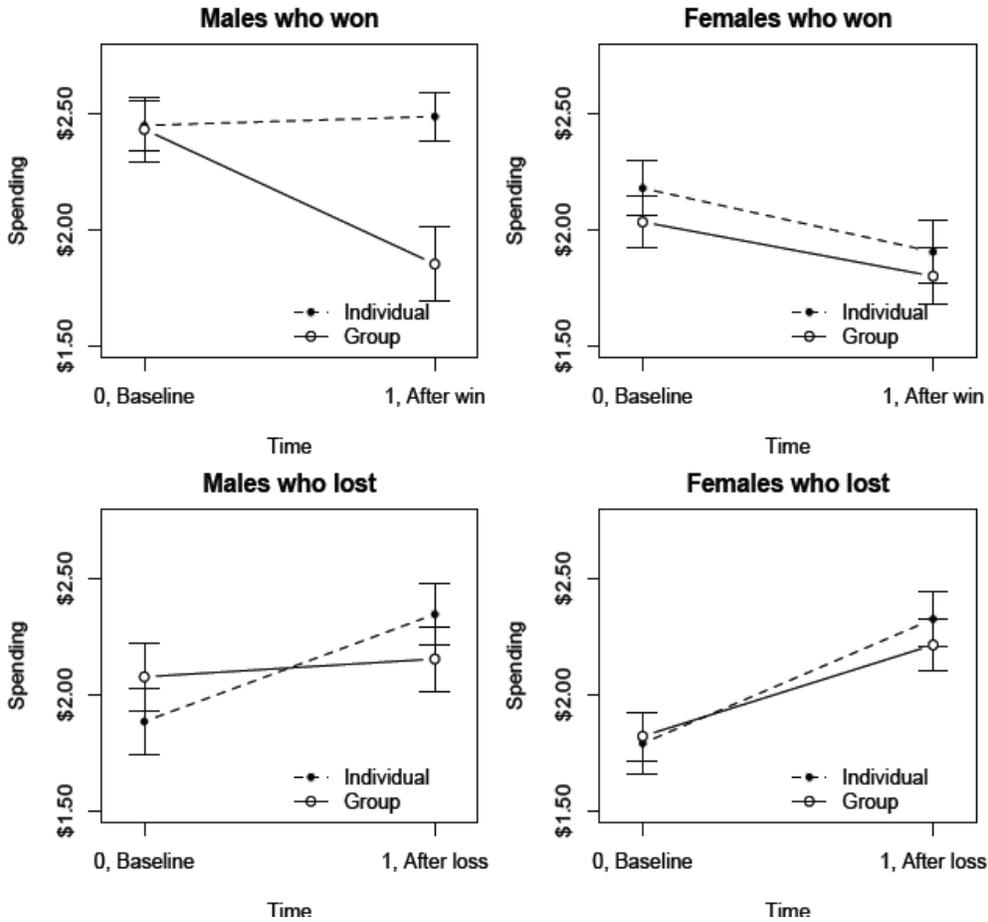


Figure 5 shows the separate contributions on the second and third trails for men (upper left panel) and women (upper right panel) who won on the second trial and those who lost on the second trial (lower panels). The mixed model for only these conditions did not include previous loss, as in the second and third trials previous loss is perfectly negatively correlated with previous win. In this model, sex\*previous win\*group prime is marginally significant ( $F[1,343] = 3.24, p = 0.07$ ).

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