Territoriality and Gender in the Laboratory

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Abstract: We investigate the behavior or males and females in an experimental Prisoner's Dilemma game with a partisan audience. In each session, there are two same-gender groups, either both male, both female, or one group of males and one group of females. Groups are separated into two rooms; each period, the Prisoner's Dilemma is played in each room. One player from the other room is seated across a table from a player from that room, with all other participants from that room seated behind the home player and observing. Each person plays twice, once at home and once on the road; to make group identity more salient, each person receives a 1/3 share of the payoffs from every outcome in which the person did not participate, so that most of one's payoffs are derived from the actions of others.

We find very different patterns of behavior across gender. While there is no significant difference in the overall cooperation rates for males and females, males cooperate substantially and significantly more often when on the road, while females cooperate substantially and significantly more often when at home. Our results constitute a puzzle not only for economic theory, but also for evolutionary psychology. While the latter predicts the home-away difference for males that we observe, it does not explain the pattern for females.

Keywords: Territoriality, group membership, gender differences, cooperation

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Introduction

Males of nearly every species exhibit at least a fair degree of *territoriality*. By this we mean that one acts in an aggressive manner when there are intruders within the bounds of one's own 'territory'.[1] By the same token, women have typically been more nurturing and less involved in the defense of their territory. There is considerable evidence of territoriality in modern affairs, whether on the battlefield or in sports.

One wonders, however, the extent to which the traditional gender roles and patterns of behavior that have been with us for so long may have become blurred in contemporary society, particularly with respect to the most recent generations. While disciplines such as evolutionary psychology might predict territoriality and dominance relations for males, the predictions for women are less obvious. Women are now in roles that are very different than in hunter-gatherer times, being competitive in venues ranging from the business world to politics to water polo. It is therefore not entirely clear whether we should expect the degree (or even the direction) of territoriality and cooperation to differ greatly across gender.

We investigate this issue in the context of an experimental game played by (primarily) undergraduate students at the University of California at Santa Barbara. The game is a classic Prisoner's Dilemma, but with some important differences in implementation: We induce a sense of group membership by randomly allocating participants into two groups (of 6-10 people), who then reside in separate rooms. In each period, two players (one from each room) are seated on opposite sides of a table in each of the two rooms and simultaneously select a choice by sliding a card face down to the experimenter, who then reveals the choices by turning the cards over. Those participants not actively making a choice are seated behind the home player and serve as

[1] Classic references on this topic include Gottmann (1973), Halloway (1974), and Sack (1986).

an audience. Participants receive 1/3 of the payoffs from each outcome in which they did not make a choice, as well as full payoffs from the outcomes resulting from their own choices. Each person plays once in his or her own room and once in the other room. Finally, each group is comprised of people of only one gender; in five sessions both groups are male, in five sessions both groups are female, and in five sessions, one group is male and one group is female.

We observe some striking differences in the behavior of males and females. While there is no significant difference in the overall cooperation rate across gender, there is a remarkable difference in the patterns of play in one's own territory and in the other group's territory. Males are significantly and substantially less cooperative when playing in their own territory, while females are significantly *more* cooperative in the home environment. Thus, we do indeed find evidence of territoriality in the laboratory for males. In addition, despite possible changes in gender roles in contemporary society, females behave quite differently than do males.

Theoretical Background

While game theory is a very effective tool for analyzing behavior in social interaction among individuals with preferences over individual and social outcomes, it is typically silent on the effect of group membership and composition on behavior. Nevertheless, there may very well be effects from group membership and composition by itself on the decisions made by individual members. Nevertheless, we are not aware of any economic theory that addresses differences in behavior in our laboratory environment according to gender.

One discipline that might shed light on this issue is evolutionary psychology. This is an approach to psychology in which knowledge and principles from evolutionary biology are put to use in research on the structure of the human mind. In this view, the mind is a set of

information-processing machines that were designed by natural selection to solve adaptive problems faced by our hunter-gatherer ancestors. Since mankind lived as hunter-gatherers far longer than as anything else, and since natural selection is too slow a process for it to design circuits that are well-adapted to our contemporary environment evolutionary psychology takes the position that "our modern skulls house a stone age mind".[2]

From this perspective, principal male tasks throughout hunter-gatherer times included hunting for food and guarding the group against invaders. Both of these tasks would be expected to foster a high degree of territoriality in males; such territoriality is quite common among the males of many species; Huntingford and Turner (1987) find that males are much more aggressive when defending a home territory. Furthermore, Wingfield and Wada (1989) test male sparrows and find that an invasion induces a higher testosterone level. Regarding human males, there is current biological evidence that the biochemistry of a team of athletes competing against another team is affected by the location of the event. Neave and Wolfson (2003) examine the origin of the phenomenon known as the "home advantage" by testing salivary testosterone levels in soccer players. These levels were found to be about 50% higher before home games than before away games. Further, stronger perceived rivalry triggered substantially higher testosterone levels. Thus, the automatic processes designed for hunter-gatherers seem to be alive and well today.

The female role has been quite different throughout this period. Women have historically been the primary source of nurturing for children, and the prescribed tasks on one's own turf may have more of a community-oriented flavor. However, a woman who happens to find herself in another group's territory may well be more guarded and protective, since there is no network

[2] This quote is taken from *Evolutionary Psychology: A Primer* (http://www.psych.ucsb.edu/research/cep/primer.html), which provides some background on the topic. For a much more complete introduction to evolutionary psychology, see Tooby and Cosmides (1992). Arguments are presented in more depth in Tooby and Cosmides (1990) and Cosmides and Tooby (2000).

of group members to fall back upon. When people are in the territory of another group, they might expect hostility, regardless of their own gender or the gender of the people they are 'visiting'. On the other hand, interactions between males and females of different groups often reflected mating opportunities in hunter-gatherer times, so we might expect more accommodating behavior when there is cross-gender contact.

The question remains whether the relatively calm and unemotional environment of an experiment will be sufficient to trigger differentials in aggression based on a completely artificial (and transparently temporary) division into groups. Nevertheless, to the extent that these patterns can manifest in the laboratory, we should certainly expect males should play more aggressively when challenged on their own territory. We might also expect women to not exhibit this differential, although it is also possible that women have become more like men in contemporary society.

Method

We conducted our experimental sessions at the University of California at Santa Barbara. Participants were recruited by e-mail from a general database of students who had registered as being interested in participating in paid experiments. There were 12-20 people in each session (always an even number), depending on how many people actually showed up for the experiment. The Prisoner's Dilemma game played is shown in Figure 1. Entries denote payoff units; each unit was worth $0.50 in actual money.

Figure 1: Prisoner's Dilemma

	A	B
A	5, 5	1, 7
B	7, 1	2, 2

Actions were labeled, as in Figure 1, A and B: in the analysis we will refer to the choice of A as cooperation and B as defection, as usual in the interpretation of behavior in the game. There were 15 sessions overall; five sessions were all-male, five sessions were all-female, and in the other five sessions one group was all-male and the other group was all-female; no participant was permitted to attend more than one session. Overall, there were 234 participants (120 female and 114 male), who earned an average of about $16 (including a show-up fee) for a bit less than an hour of their time. The instructions can be found in Appendix A.

Participants initially all met in the same room, and they were randomly assigned (participant to gender constraints in the mixed sessions) to either the Row group or the Column group for the duration of the session. Row players went to a room labeled Room R, while Column players went to a different room labeled Room C.[3] In each room, participants received instructions that explained how play would proceed (the complete instructions are presented in Appendix A). Numbered slips of paper were drawn in each room to determine the period in which each person played in Room R and Room C. At the beginning of a period, a Row player sat on one side of a table in Room R while a Column player who arrived from Room C sat across from her or him.[4] In this framework, one can think of the Row player as being 'at home' in Room R and of the Column player as being 'away' in that same room. In each room, group members belonging to that room were seated in a semi-circle behind the active member of their group and observed the players.[5] All participants were required to observe strict silence at all times.

[3] These labels were prominently displayed on the blackboards of the respective rooms.
[4] Similar events, with labels switched, simultaneously occur in the other room.
[5] Therefore, Row players are the audience in Room R and Column players are the audience in Room C.

Two index cards were face down on the table; each player examined these cards and made a choice by passing the card face down to the experimenter. The experimenter then revealed the outcome to everyone in the room by flipping over the two cards immediately after receiving the choices. At the end of the period, the visitor went back to the room from which he or she arrived. The experiment continued for as many periods as needed until each player has made a choice in each room, once at home and once when away.

Payoffs had two components: the outcome of the two games one played and the outcome of all the games played by one's group members. The first component equals the sum of the payoffs in those two games. The second component equals 1/3 of the sum of the payoffs received by the active players in one's group, but only for the periods when one was not an active player. These rules were clearly explained to the participants prior to the commencement of play.

Experimental Results

The independent variable of greatest interest is the cooperation rate. Table 1 summarizes the aggregate cooperation rates for males and females, depending on the type of session and whether they are at home or away. Complete results for each individual session are shown in Appendix B.

Table 1: Aggregate Cooperation Rates.

Number of times the participant chose A and total number of choices.

	Home	Away	Combined
Males in homogenous sessions	21/76 (27.6%)	34/76 (44.7%)	55/152 (36.2%)
Males in mixed sessions	12/38 (31.6%)	14/38 (36.8%)	26/76 (34.2%)
Males, overall	33/114 (28.9%)	48/114 (42.1%)	**81/228 (35.5%)**
Females in homogenous sessions	36/82 (43.9%)	24/82 (29.3%)	60/164 (36.6%)
Females in mixed sessions	19/38 (50.0%)	15/38 (39.5%)	34/76 (44.7%)
Females, overall	55/120 (45.8%)	39/120 (32.5%)	**94/240 (39.2%)**

The overall cooperation rates (in bold) for males and females are quite similar, 35.5% and 39.2% respectively. The test of the difference of proportions (see Glasnapp and Poggio 1986) finds no significant difference in these cooperation rates ($Z = 0.81$, $p = 0.418$, two-tailed test[6]). The difference is even smaller in gender-homogenous sessions, with overall cooperation rates of 36.2% for males and 36.6% for females. Thus, we see no evidence of differences in average cooperation across gender over the different conditions.

However, this is the result of a balancing of significant effects of the interaction of role and gender. Males cooperate significantly less when at home than do females, the test of proportions gives $Z = 2.67$, $p = 0.008$. Males cooperate more when away than do females, but this difference is not statistically significant; the test of proportions gives $Z = 1.52$, $p = 0.129$. Overall the cooperation rate for males is 30 percentage points higher when away than when at home, while the cooperation rate for females is 40 percentage points lower when away than when at home. Both of these differences are significant; the test of proportions gives $Z = 2.08$, $p = 0.038$, and $Z = -2.12$, $p = 0.035$, respectively. The cooperation rate in all-male sessions is 13.2

[6] All statistical tests are two-tailed, unless otherwise indicated. We round off p-values to three decimal places.

percentage points higher when away than at home; this difference is significant by the test of the difference of proportions, which gives $Z = 2.19$, $p = 0.028$. This pattern is reversed in all-female sessions, with a cooperation rate 13.3 percentage points higher when at home than when away; the test of the difference of proportions gives $Z = -1.95$, $p = 0.051$.[7] In the mixed-gender sessions, these results go in the same directions, but are more muted (especially for males) and are not significant; the test of proportions gives $Z = 0.48$, $p = 0.631$ for males in mixed-gender sessions and $Z = -0.92$, $p = 0.358$ for females in mixed-gender sessions

However, these tests do not take into account the potential interaction between gender and role at home and away, as well as differences in treatment, particularly the gender composition of the other group in the session. In Table 2, we present the marginal effects estimated from logit regressions, after clustering on each individual participant.

Table 2: Marginal effects from the Logit Regressions for Cooperation

	Cooperate
Female Away	-0.126*** (0.048)
Male Home	-0.160*** (0.056)
Male Away	-0.035 (0.060)
N	468
Log-pseudolikelihood	-304.61

Standard Errors are in parentheses; *** indicates significance at $p = 0.010$ and ** indicates significance at $p = 0.050$ (two-tailed tests). The omitted category is the female cooperation rate when at home.

[7] An alternative test when an individual makes choices in two environments (e.g., when at home and when away) is the sign test (see Siegel and Castellan 1988). This test gives $Z = 2.57$, $p = 0.010$ for the all-male case and $Z = -2.20$, $p = 0.028$ for the all-female case.

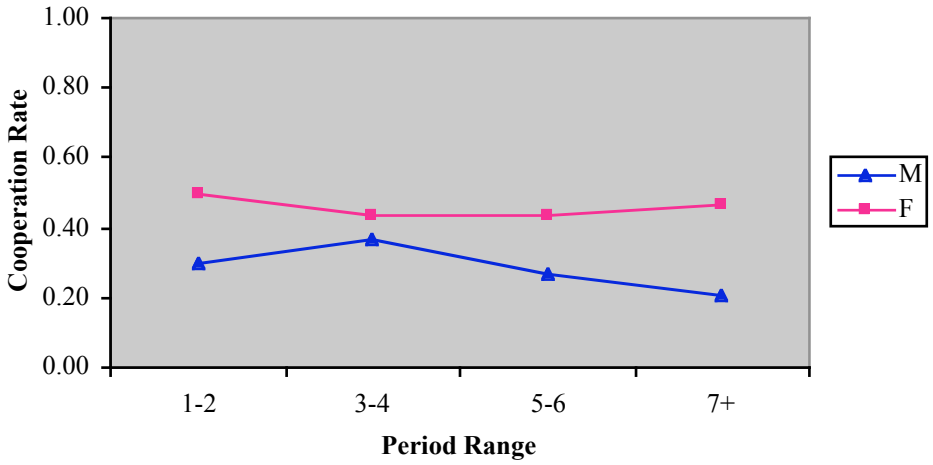
Females cooperate significantly less when away than when at home (a reduction of 13 percentage points), and male cooperate significantly less when at home than do females (a difference of 16 percentage points); both of these differences re significant at $p = 0.010$. There is no significant difference between the cooperation rates for females when at home and males when away.

While each individual makes only one choice in each environment, one might argue that each individual's decision is not independent, since an individual has observed previous outcomes when at home. The most conservative statistical test considers each session as one independent observation for each gender's cooperation rates (for both genders, there are five same-gender and five mixed-gender sessions). As can be seen from Appendix B, cooperation rates for males were higher when they were away in eight of the 10 sessions and lower in one of the 10 sessions (the rates were the same in the other session). A simple sign test indicates statistical significance ($Z = 2.06$, $p = 0.040$).

Similarly, cooperation rates for females were lower when they were away in seven of the 10 sessions and higher in two of the 10 sessions (the rates were the same in the other session); however, here the difference is not statistically significant with session-level data ($Z = -1.34$, $p = 0.180$). Finally, we can calculate the difference in home and away cooperation rates for each session and compare these across gender. A Wilcoxon-Mann-Whitney ranksum test gives $Z = 2.67$, $p = 0.008$, so that even the most conservative test indicates strongly that the male and female patterns across roles are different.

Given the possibility that participants may be influenced by previous choices by group members, we analyze (see Figure 2) the rate of cooperation at home over time for males and females:

Figure 2: Cooperation rate at home over time



There is a somewhat decreasing rate of cooperation for males, and virtually no time trend for female cooperation.[8] Panel data logit analysis of the effect of the past periods on choice confirms that the time trend exists (reducing the cooperation rate by an estimated 3.4 per cent every period) and is significant ($Z = 2.58$, $p = 0.010$) for male participants playing at home, thus strengthening the effect of the male gender on cooperation. The effect is not significant for individuals (male or female) playing when away.

A further check is to look at the correlation between a choice in one period and a choice in the next. Recall that participants only observe the host choices of their own group. The correlation between host cooperation from one period to the next is 0.475, significant at $p = 0.000$. This appears to indicate that one teammate's decision at host influences teammates who follow. However, the correlation between guest cooperation from one period to the next is even slightly higher, at 0.495 (also significant at $p = 0.000$). Since one does not observe one's

[8] The number of observations (standard errors) for male cooperation rates in the respective period ranges is 30 (0.085), 30 (0.089), 30 (0.082), and 24 (0.085); for female cooperation rates in the respective period ranges, we have 30 (0.093), 30 (0.092), 30 (0.092), and 30 (0.093).

teammates' play as guests, there is no mechanism for influence.[9] Thus, we interpret this as evidence that host choices are no less independent than guest choices.

A final issue concerns differences in behavior across mixed-gender and homogenous-gender sessions. The predictions regarding male territoriality provided by an evolutionary psychology approach are somewhat less clear in this case: the difficulty is that females were rarely invaders in hunter-gatherer times. However, it seems reasonable to presume that males are more threatened by other males in their territory, so that we might expect the difference between home and away male cooperation rates to be smaller in the mixed-gender sessions. In fact, there is some suggestive (but not conclusive) evidence for this; in Table 1, we see that males cooperate more when away by an average of 17 percentage points in the all-male sessions, as compared to five percentage points in the mixed-gender sessions. By comparison, there is little corresponding difference (15 percentage points versus 11 percentage points) for females across all-female and mixed-gender sessions.

We also test for differences using the session-level data in Appendix B. The Wilcoxon-Mann-Whitney ranksum test gives $Z = 1.32$, $p = 0.186$ for males across session type, compared to $Z = 0.40$, $p = 0.690$ for females across session type. A logit regression finds a marginal effect on cooperation of 10 percentage points for the interaction between males and same-gender or opposite-gender pairings; however, this effect is not statistically significant ($Z = 0.93$, $p = 0.352$).

[9] Of course, one observes the visitor choices in one's own room, and this could affect their own behavior when away. But it would seem more likely that the channel of influence runs through observing one's group members rather than from observing strangers.

Discussion

Previous research by Charness, Rigotti, and Rustichini (2007) shows that individual behavior in the Prisoner's Dilemma and the Battle of the Sexes is affected by salient group membership, as people are more aggressive at home than when away. However, groups were comprised of a mix of males and females, and we found no significant differences in behavior across gender in this environment. However, the picture changes dramatically when each group is comprised of only males or only females, and we find strong gender effects in the relatively calm and unemotional environment of a laboratory experiment. While there is no difference in overall cooperation rates for males and females, we find that males tend to cooperate less at home and females tend to cooperate more at home. These effects are most pronounced when both groups are the same gender, and diminish (particularly for males) in mixed-gender sessions.

Needless to say, our results are outside the confines of neo-classical economic theory Beyond this, recent experimental research on gender behavior (e.g., Gneezy, Niederle, and Rustichini 2003) suggests that females are less competitive than males, so that we might have expected to see females behave more cooperatively in our game. But we do not observe such a difference, and this previous research says nothing about differences in home and away behavior for males and females. Moreover, while evolutionary psychology offers an explanation for this observed differential when all players are male, it does not provide a clear prediction for mixed-gender or all-female sessions. In this sense, our results do not conform to any theory of which we are aware. Indeed, males exhibit signs of territoriality, but this is reversed for females.

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Appendix A - Instructions

INSTRUCTIONS (room R)

Thank you for participating in this experiment. You will receive $5 for your participation, in addition to other money to be paid as a result of decisions made in the experiment.

There are 20 people participating in this session. They have been randomly divided into two rooms, each with 10 people. You are in room **R**, this means you are a **Row decider**.

There will be ten rounds in this session, and each person will make two decisions, one in each room. You have a card with a green number and a card with a (different) yellow number. These numbers will determine when and where you make decisions.

Your **green number** indicates the round during which it will be your turn to make a decision in the **room where you are now (room R)**.

Your **yellow number** indicates the round during which it will be your turn to **go to the other room (room C)** and make a decision there.

In each round there are two people making a decision. Each person will be making a simultaneous choice between A and B in the following decision matrix:

		Column	
		A	*B*
Row	*A*	5 , 5	1 , 7
	B	7 , 1	2 , 2

In each cell, the first number represents the outcome for the Row decider and the second number represents the outcome for the Column decider.

Thus, if both people choose A, the Row decider receives 5 and the Column decider receives 5. If both people choose B, the Row decider receives 2 and the Column decider receives 2. If the Row decider chooses A and the Column decider chooses B, the Row decider receives 1 and the Column decider receives 7. If the Row decider chooses B and the Column decider chooses A, the Row decider receives 7 and the Column decider receives 1.

The other nine members of each room also have a financial stake in the outcome – each person not making a decision receives 1/3 of the amount shown for the realized outcome.

Thus, if both deciders choose A, every inactive person in room R receives 5/3 and every inactive person from room C receives 5/3. If both deciders choose B, every inactive person from room R receives 2/3 and every inactive person from room C receives 2/3. If the Row decider chooses A and the Column decider chooses B, every inactive person from room R receives 1/3 and every

inactive person from room R receives 7/3. If the Row decider chooses B and the Column decider chooses A, every inactive person from room R receives 7/3 and every inactive person from room R receives 1/3.

Each unit is worth $0.50 in actual money (2 units = $1) that will be paid in cash at the end of the experiment.

All people in the room (except for the person from the other room) will be able to watch the decider who belongs to their room make his or her choice (however, no verbal comments are permitted).

The decision of the person who walks into the room, on the other hand, is made privately.

The outcome of the joint decision is immediately revealed to all people in the room.

After the 10 rounds are completed, we will total each person's earnings (from the outcomes of the two self-made decisions, as well as the other 18 outcomes), add the $5 show-up fee, and pay each person individually and privately, using the numbers on your two cards to identify your decisions.

Please feel free to ask questions.

Appendix B – Session-level data

Cooperation Rates for Males

	Home	Away	Combined
All-male sessions			
Session 1	2/16 (12%)	7/16 (44%)	9/32 (28%)
Session 2	5/16 (31%)	7/16 (44%)	12/32 (38%)
Session 3	4/16 (25%)	5/16 (31%)	9/32 (28%)
Session 4	5/14 (36%)	8/14 (57%)	13/28 (46%)
Session 5	5/14 (36%)	7/14 (50%)	12/28 (43%)
MF sessions			
Session 1	1/10 (10%)	2/10 (20%)	3/20 (15%)
Session 2	3/8 (38%)	4/8 (50%)	7/16 (44%)
Session 3	2/6 (33%)	2/6 (33%)	4/12 (33%)
Session 4	2/6 (33%)	3/6 (50%)	5/12 (41%)
Session 5	4/8 (50%)	3/8 (38%)	7/16 (44%)

Cooperation Rates for Females

	Home	Away	Combined
All-female sessions			
Session 1	11/20 (55%)	6/20 (30%)	17/40 (42%)
Session 2	6/14 (43%)	3/14 (21%)	9/28 (32%)
Session 3	4/12 (33%)	5/12 (42%)	9/24 (38%)
Session 4	10/16 (62%)	4/16 (25%)	14/32 (44%)
Session 5	5/20 (25%)	6/20 (30%)	11/40 (28%)
MF sessions			
Session 1	5/10 (50%)	4/10 (40%)	9/20 (45%)
Session 2	3/8 (38%)	2/8 (25%)	5/16 (31%)
Session 3	3/6 (50%)	3/6 (50%)	6/12 (50%)
Session 4	4/6 (67%)	3/6 (50%)	7/12 (58%)
Session 5	4/8 (50%)	3/8(38%)	7/16 (44%)