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40	Abstract	This paper examines social determinants of resource competition among Tsimane Amerindian women of Bolivia. We introduce a semi-anonymous experiment (the Social Strategy Game) designed to simulate resource competition among women. Information concerning dyadic social relationships and demographic data were collected to identify variables influencing resource competition intensity, as measured by the number of beads one woman took from another. Relationship variables are used to test how the affiliative or competitive aspects of dyads affect the extent of prosociality in the game. Using a mixed-modeling procedure, we find that women compete with those with whom they are quarreling over accusations of meat theft, mate competition, and rumor spreading. They also compete with members of their social network and with those who were designated as cooperative helpers or as close kin. Women take fewer beads from desired friends, neighbors, and from those viewed as enemies. We interpret favoritism toward enemies as resulting from fear of retribution. Our results suggest that social relations among women are multifaceted and often cannot be simplified by exclusive focus on genetic relatedness, physical proximity, or reciprocity. We argue that a complex understanding of cooperation and competition among women may require important contextual information concerning relationship history in addition to typical features of resource ecology.
41	Keywords separated by ' - '	Experimental economics - Social networks - Resource competition - Altruism - Tsimane
42	Foot note information	

**The Social Strategy Game: Resource Competition  
Within Female Social Networks  
Among Small-scale Forager-horticulturalists**

**Stacey L. Rucas · Michael Gurven ·  
Hillard Kaplan · Jeffrey Winking**

**Q1/Q2**  
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**Abstract** This paper examines social determinants of resource competition among Tsimane Amerindian women of Bolivia. We introduce a semi-anonymous experiment (the Social Strategy Game) designed to simulate resource competition among women. Information concerning dyadic social relationships and demographic data were collected to identify variables influencing resource competition intensity, as measured by the number of beads one woman took from another. Relationship variables are used to test how the affiliative or competitive aspects of dyads affect the extent of prosociality in the game. Using a mixed-modeling procedure, we find that women compete with those with whom they are quarreling over accusations of meat theft, mate competition, and rumor spreading. They also compete with members of their social network and with those who were designated as cooperative helpers or as close kin. Women take fewer beads from desired friends, neighbors, and from those viewed as enemies. We interpret favoritism toward enemies as resulting from fear of retribution. Our results suggest that social relations among women are multifaceted and often cannot be simplified by exclusive focus on genetic relatedness, physical proximity, or reciprocity. We argue that a complex

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**Keywords** Experimental economics · Social networks · Resource competition · Altruism · Tsimane 31  
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Material resources and continual access to these resources are key factors limiting the reproductive success of women, whereas men’s reproductive success has generally been described as being limited primarily by direct access to mates (Bateman 1948; Borgerhoff Mulder 1987; Cronk 1994; Darwin 1871). This discrepancy, based on the differential costs of reproductive effort and differential benefits of increased mating investments for males versus females, has been the theoretical underpinning that has helped explain sex differences in mating psychology and behavior in humans (Buss 1995; McGraw 2002; Waynforth 1999), variation in mating and parental investment patterns (Anderson 2000; Anderson et al. 1999), and spatial grouping patterns among primates (Janson 2000). 34  
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Access to material resources depends on the sex- and skills-specific requirements of economic production and the relationship between production and distribution. Resources are not usually monopolizable in small-scale, non-market communities, and their distribution is less formally regulated than in larger, market-oriented societies with storeable wealth. However, resources and property are nonetheless governed by rules of ownership and of obligations (e.g., kinship). Women in subsistence societies can acquire resources directly by producing food on their own or by receiving from others via provisioning, altruism, reciprocity, or trade. Among hunter-gatherers, women on average directly acquire less than half of the daily diet (Kelly 1995), and among tropical forest foragers men tend to acquire the majority of the calories, especially protein and lipids (Cordain et al. 2000). In these societies, the majority of a woman’s (and her children’s) diet is subsidized by other individuals, including spouses, parents, siblings, other relatives, friends, allies, neighbors, suitors, and other benefactors. Unlike nonhuman primates, who must increase foraging effort when pregnant or lactating, hunter-gatherer women reduce their foraging efforts yet do not suffer from reduced consumption (Hurtado et al. 1985; Marlowe 2001). Human infants are weaned early compared with other primates (Hawkes et al. 1998), and women have high compound fertility (Gurven and Walker 2006) such that during much of a woman’s reproductive years she will depend on the foraging labor of other group members. The quantity and quality of social relationships that constitute one’s social network are therefore critical requirements for mediating access to material resources of food, wealth, services, and mates, and non-material resources such as comfort, emotional support, and security. 44  
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Since the components of reproductive success—survivorship and fertility—are each limited by access to resources, we should expect that women will compete over material and social resources. Women should and do cultivate friendships, cooperative alliances, and coalitions, usually in the context of competition with other coalitions or rivals, that function to gain and maintain better access to critical resources. Work with baboons indicates that the complexity of female primate social 67  
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networks may also aid in gaining and maintaining access to resources and friends 73  
and that this may positively impact fitness (Silk 1983; Silk et al. 2003, 2004). 74

Despite some attention given to intrasexual competition among women in the context 75  
of gossip and mating in modern societies (Campbell 2002), relatively little recent 76  
attention has been paid to the social dynamics among women in non-market, 77  
subsistence societies (for notable exceptions see Lamphere 1977; Lamphere and 78  
Rosaldo 1974). However, social coalitions, networks, dominance interactions, and 79  
physically aggressive behaviors of men have been studied extensively (Chagnon 1990; 80  
Flinn et al. 2005; Parker et al. 1972; Pelegrini and Bartini 2001; Wagner et al. 2002; 81  
Wilson and Daly 1985; Yamaguchi 1992). Competitive interactions among men 82  
usually occur in the form of overt, physical displays of aggression. Competition among 83  
men has been viewed as occurring largely between, rather than within, groups in the 84  
context of raids or warfare, while between-group competition is bolstered by within- 85  
group male coalitions (Wrangham and Peterson 1996). Although physical aggression is 86  
not totally uncommon among women (Campbell 2002), most competition among 87  
women occurs in a more subtle manner, dubbed “indirect aggression” (Archer and 88  
Coyne 2005) or “relational aggression” (Underwood 2003) or, more recently, 89  
“informational warfare” (Hess 2006; Hess and Hagen 2006b). Owing to the potentially 90  
high costs of escalating physical aggression, competition among women is believed to 91  
have been relegated to largely non-physical forms (Campbell 1995, 2002). And in the 92  
absence of intense between-group competition, maintaining large cooperative female 93  
coalitions may be more costly than they are worth for women, resulting in a higher 94  
frequency of dyadic groups (pairs), where competition occurs mostly within the 95  
framework of a social network rather than between groups (Hess 2006; Hess and Hagen 96  
2006b). The lack of overt physical competition among women on a large scale (such as 97  
their lack of involvement in warfare) has sometimes been interpreted naively as an 98  
absence of competition altogether; hence the relative scarcity of systematic studies on 99  
resource competition among women, especially in traditional societies. However, 100  
studies of modern societies show strong evidence that women form social networks and 101  
coalitions, and that they engage in significant amounts of socially aggressive behaviors 102  
over a broad range of resources (Bjorkqvist et al. 1992; Campbell 2002; Campbell et al. 103  
1996; Cashdan 1998, 2003; Crick 1995; Hess 2006; Hess and Hagen 2006a, b). 104

We propose, as have others (Hess 2006; Hess and Hagen 2006a, b; Lancaster 105  
1991), that social networks are the vehicle for processing exchanges of resources 106  
among women and that women therefore pay strong attention to the affiliative and 107  
competitive aspects of their relationships with other group members. In this paper we 108  
explore how the character of dyadic social relationships predicts the direction and 109  
intensity of resource transfer among Tsimane women. We expect that the context of 110  
the relationship between two women should predict the level and direction of 111  
resource competition between those women. Given the theory that prosociality is 112  
influenced by kinship and friendship status, we predict that women should be more 113  
competitive with social antagonists, such as non-friends, distant kin, enemies, those 114  
who have damaged ego’s reputation in the past, and age-mates who are likely to be 115  
competitors for similar resources (i.e., mates or food) across the lifecourse. Likewise, 116  
we predict that women will act more prosocially with friends, helpers, close kin, and 117  
neighbors, who often choose residence based on their positive affiliation with other 118  
women. However, we also acknowledge that even within their own group, women 119

may still compete at times with friends and kin. This prediction is based on the within-group competition hypothesis, which predicts that women encounter more aggression from within their groups rather than between their groups, relative to men. And according to Hamilton's rule, women are not always expected to engage in altruism because the cost to themselves may not be outweighed by the benefit to the recipients, even for very close kin.

The above predictions are consistent with work in the evolutionary social sciences which shows that more prosocial (exchange) sentiment and behavior is directed toward ingroup than outgroup members, where the ingroup is defined according to genetic kinship, friendship, or other positive affiliation, and with the idea that women use their networks as the means of transferring and competing over resources. We acknowledge that women may actively compete with women in their social networks in a variety of domains. For example, one may cooperate with one's sister in chopping down a tree and collecting its fruit while competing with this same sister over the attentions of an eligible bachelor. In this example, food transfer is likely, but information transfer pertaining to a marriage opportunity is not. In addition, the increased amount of time that ingroup members spend together may carry an increased likelihood of conflict owing to increased frequency of mutual resource encounters. Asking whether women are more likely to be pro- or antisocial toward other known individuals may be likely to produce ambiguous results for kin and neighbors with whom frequent interaction is most common because the question may illicit strong feelings regarding the current circumstances and the status of the pair's relationship. However, little ambiguity in prosocial behavior is expected toward women categorized at the extremes as intimate friends or bitter enemies.

While we test the specific predictions made above, we acknowledge that the complexity and context-specificity of social interactions may produce ambiguous results. Nonetheless, our study makes several important contributions. First, this study, conducted among a subsistence-based population in the Bolivian Amazon, is aimed at improving our understanding of the dynamics of female social relationships by focusing on the character and extent of both cooperation with friends, kin, and allies and competition with rivals and enemies. Second, it employs an experimental approach in a community-based population in order to explore the effects of social context on cooperation among women systematically. Field observation may be a problematic approach to studying resource competition because of problems of self-selection and because obtaining a large sample of relationship information on many women could require long-term observations. Experiments as employed in this paper are relatively rare in anthropological studies and to date have been limited largely to ultimatum games, dictator games, and public goods games (e.g., Henrich et al. 2001, 2004). Third, a semi-anonymous research design (as described further below) allows us to explain variation in resource transfer based on the status of the social relationship of givers and receivers. This semi-anonymous structure takes advantage of the known social relationships in a field-based population, rather than assuming all individuals are strangers who interact anonymously. We add external validity to experimental economics approaches (Gurven and Winking 2008; Levitt and List 2009) by linking game behavior with information about known relationships, and we test the use of an experimental approach for gaining understanding of difficult-to-observe informal networks and domains of conflict among women.

**Simulating Resource Transfer and Competition: The Social Strategy Game**167 **Q4**

An examination of women's social lives in the context of resource competition and cooperation requires an assessment of the frequency and intensity of affiliative and competitive interactions and an understanding of the ecology of women's subsistence behaviors and the division of labor within families. However, observing and recording instances of resource exchange and competition among women in a small-scale community is methodologically challenging. First, one must be present at the time of overt conflicts and recognize that they are occurring, a feat not easily accomplished in the subtle, covert world of women's aggression. Second, one must be able to identify contested resources and quantify the outcomes of competitive episodes by measuring the quantities of resource held by interested parties both pre- and post-conflict. Another challenge with relying on behavioral observation of resource competition and social aggression is that one is limited by instances that occur naturally over time; in other words, one might only observe competition over one kind of resource and only among one set of players during a typical field season.

As a complementary methodological approach, we designed an experimental game (hereafter referred to as the social strategy game, or SSG) that was intended to simulate opportunities for resource competition among pairs of women living in each of three study communities. The game establishes a common resource and measures the potential conflict from all pairs of women within each of the study communities. A woman must choose how many beads (out of 10) she wishes to take from each other woman living in the community. She immediately receives all of the beads that she takes, and later she receives those left to her by all other women after they have played. Thus if woman  $i$  takes quantity  $x_{ij}$  beads away from woman  $j$ , for this particular transaction woman  $i$  receives  $x_{ij}$  beads and woman  $j$  will receive  $10 - x_{ij}$ . Since she must make a similar decision concerning each other woman in the village, she will earn  $\sum_j x_{ij}$  {formula}. After all women in a village have played, woman  $i$  will receive an additional  $\sum_{i \neq j} (10 - x_{ij})$  {formula} beads. All adult women over the age of fourteen in a community were invited to play the game. The quantity of resources (beads),  $x_{ij}$ , that each woman  $i$  took from each woman  $j$  was used as our dependent variable and is intended to be a proxy for the *intensity of resource competition* expressed by  $i$  against  $j$ . With  $n_k$  women playing the game in community  $k$ , any particular woman could earn anywhere from 0 beads (if she did not take any and if none were left her by other women) to a maximum of  $2 \times 10(n_k - 1)$  beads (if she takes all of the beads from the other women and none of the other women take any beads from her).

**Methods**203 **Q4****Study Population: Tsimane and the Tsimane Project**204 **Q4**

The work described in this paper is one piece of a much larger project combining the talents of anthropologists, doctors, and Tsimane health promoters and translators. The major focus of the collaborative venture is to understand the implications and

relationships of human health and behavior. Various life-history, evolutionary, and economic theories are utilized to examine a wide variety of topics, including male-male aggression, altruism, food sharing, age-specific production curves, disease ecology, and economic decision making. The data for this paper were collected during the first year of field research (2002–2003). The larger longitudinal project is still ongoing, and work is currently being conducted on human life history, biodemography, and aging.

The Tsimane are South American Indians, numbering more than 8,000, who live in the tropical rainforest and moist savannas of the Beni region of Bolivia. They live in semi-autonomous extended family groups in small villages ranging from 60 to 400 individuals. The communities are relatively stable, and although movement between villages is not infrequent, owing to postmarital residence rules and migration, most women have extensive knowledge of the reproductive, residential, and personal histories of other women in their community because of years of social interaction and via informal gossip networks.

Tsimane subsistence is based on small-scale horticulture, fishing along a network of rivers and streams, hunting wild game, and gathering fruits and other resources. Wild game, such as paca, collared peccary, deer, and numerous monkey species, are hunted with the use of shotguns and bow and arrow (Gurven et al. 2006). The diet staples come from small family fields, including plantains, corn, rice, and sweet manioc, the latter being commonly used in the fermentation of calorically dense types of traditional beer. Women's economic production is focused on the harvesting of crops such as manioc roots and rice. They also contribute labor to planting, weeding, and burning tasks. Women also gather seasonal fruits and occasionally engage in hook-and-line fishing. Much of their daily time is spent preparing and cooking food, engaging in domestic work, and in childcare.

Women marry on average by age sixteen, have their first child by age nineteen, and have an average of nine births over their lifetime (Gurven unpublished data). Marriages are fairly stable, monogamous unions, although polygyny is not uncommon in many villages. Divorce is most common in first marriages before the birth of the first child. Postmarital residence is usually matrilineal until at least the first child is born, and then the new family may move or stay. Women often prefer to stay when they have large, influential families, and so decisions about residence can be a source of conflict when husbands prefer to live closer to their own families.

The typical domains of conflict and competition among women include food distribution and accusations of theft, perception of social contract defections (e.g., regarding food sharing, visitation, and reciprocal helping activities), sexual jealousies over current or desired mates, and concerns over social capital in the form of trust and loyalty to kin and friends. Aspects of social life such as shifting loyalties and perceived defections are the most frequently voiced categories of conflict among women, supporting the notion that the desire and need for women in small-scale societies is to recruit allies and supporters and to foster the formation and maintenance of social networks of helpers, food providers, and caregivers (Rucas 2004). These networks are especially important to rely on during stressful periods of resource depletion, bouts of illness, or periods of extensive child dependency.

Study participants were 94 women and teenage girls ages 14–70 living in three separate communities situated along the Maniqui River during January–May 2003.

The three communities chosen for the study varied in the extent of market integration, formal education, contact with non-Tsimane, and proximity to nearby towns. Fifty-six women and 14 girls were from two slightly acculturated villages and 24 women were from a village of very low acculturation (village acculturation estimates based on relative market access and level of cultural diffusion). Biological kinship ( $r$ ) among women was ascertained separately based on demographic interviews conducted by one of the authors (MG) (Gurven et al. 2007). Proximity was categorically defined as 1 = same household, 2 = same household cluster, 3 = nearest proximate cluster of houses, 4 = farthest household cluster.

All participants in the game and the subsequent survey were given a show-up fee consisting of several bars of soap for their time.

#### Designing the Social Strategy Game (SSG) Q4

Colored plastic beads were used as the currency of competition because they are highly valued, readily portable, easily quantifiable, and women do not seem to show diminishing utility for amassing large quantities. Tsimane women use beads for making jewelry, necklaces, bracelets, and anklets. Plastic beads are highly regarded for their strength, quality, color, and novelty among Tsimane women, who delight in adorning themselves and their children with colorful ornamentations. We did not find that beads were so valuable as to incite conflict outside the confines of the game. Our informants also confirmed that there was no danger in using beads. The game was also approved by all village members in group meetings a day or two prior to play in each of the three villages. For these reasons, beads appeared to be a better resource option for the game than other currencies typically used in games, such as money. From our experience, women of all communities desire them, whereas the value of money may be highly variable depending on access to markets and existing cash obtained from sporadic wage labor opportunities and trade.

After each woman was interviewed regarding her social relationships with all other women in the community (see below), she was then invited to play the SSG. For this game, Polaroid photographs of each other woman in the community were lined up in a standard randomized order with ten beads placed on each picture. Each photo was of a woman's face and was taken in a standardized position with similar lighting, but women were not forced to smile. A statement was read to each woman, in both Tsimane and Spanish, by Juana Bani, a bilingual Mosekene-Tsimane assistant who is not a member of any of the study communities. It was explained to each player that each person in the photographs (woman  $j$ ) owned the ten beads, and that she (woman  $i$ ) is being given the opportunity to take from 0 to 10 beads from the women whose photos were displayed. Each woman was assured that the number of beads they opted to take would not be reported to any of the other women and that their game behavior was strictly confidential. It was also explained that all other women in the community would also have a chance to play the SSG and would be making the same decisions that she is making. Although the player could walk home with all of the beads that she took from the other women, all beads left on her photograph by all other players would not be received until after all other women had played the game. At that stage, the beads left to each particular woman would be counted up and subsequently given to her in one payment. Each woman played the

game in private, and only after she finished and left the game room were the results recorded. The number of beads that were taken by every woman from each of the other women in the community was eventually compiled and used as our proxy measure of resource competition (dependent variable).

This game has some similarities with the popular dictator game (Forsythe et al. 1994), but there are significant cognitive and perceptual differences between *giving away* something that you own and *taking* something that belongs to someone else. This “endowment effect” refers to the fact that someone who owns something values it more than someone who does not (Thaler 1980). In the SSG, women are invited to *take beads away* from others as opposed to giving away their own beads. All women took at least some beads during the game, and no one left all beads with their original owners. If a woman did not take any beads from another woman, she would walk home empty-handed (apart from the show-up fee). Players examined each photo carefully before deciding whether and how many beads to take. As mentioned above, photos were randomly displayed in several rows on the floor beneath a closed canopy to provide privacy. The order in which beads were taken was not recorded because we did not wish to record any data during the time the beads were taken, nor did we wish to watch game play directly in case it would make the participant feel uncomfortable. However, it was mentioned that the order did not matter in terms of payment.

Questionnaire on Social Relationships Q4

The character and content of dyadic social relationships form the basis for examining the extent of competition among women. We developed a questionnaire for assessing personal impressions of the reputations of other women, prior relationship history with other women, and pro- or antisocial sentiment toward those women in the community. Different possible relationships were used as independent variables regarding the nature of their social partnerships. Each player was asked to name three women, in no particular order or ranking system, that come to mind in response to each question concerning a relationship category. Categories were chosen to cover a broad range of typical positive and negative social relationships among Tsimane women, who routinely recognize other women by these emblematic social relationships. Investigations and conversations were conducted with women to inquire about the terminologies that are often used to identify and refer to other women. These categories consist of those referring to positive relations: women identified as best friends, women with whom they gossip, those who help them in domestic chores or in any other productive capacity, those who have been personal advisors during difficult periods, and those who were desired as friends but currently were not friends. The categories describing negative relations included current enemies, past friends who were no longer friends, and social rivals. For the category of social rivals, women identified those with whom they were actively quarreling over mates, women who were considered defectors on social contracts or were accused of stealing food from them, those who were accused of gossiping about them to others, and finally those with whom they refuse to visit socially.

As mentioned previously, age and biological kinship data were gathered as part of the larger demographic data project (Gurven et al. 2007). Kinship refers to the

coefficient of relatedness ( $r$ ) between pairs of women, the only kinship variable used for this analysis. Affines were not differentiated in this study. The  $r$  was calculated to as many degrees as possible between each pair of women, even to the extent of distant cousins.

## Data Analysis

A linear mixed-effects model (MIXED procedure in SPSS) was used to examine the effect of particular social relationships or demographic characteristics of women on the number of beads woman  $i$  took from woman  $j$ . A mixed-effects model has the ability to handle between-subjects effects with repeated observations, correlated data, and unequal variances. The repeated measures stem from the fact that each woman took a quantity of beads (0–10) from each other woman and each woman also identified their social relationship with these other women in the community. Thus, observations are not independent. Because each observation corresponds to a pair of women, our complete dataset contains 3,454 observations. In the model, we assign the ID number of each woman as a random effect, and age of the bead collector, woman  $i$ , was used as a control variable. Age was chosen as a control variable because it is often documented among hunters and gatherers that older individuals supplement the resource consumption of the young by overproducing. We therefore expected that younger women would take more beads from older women, even if only out of habit. We present two models: a full model including all predictors and a final, reduced model that includes only the predictors that were statistically significant at the 0.05 level.

## Results

Table 1 presents parameter estimates from the full and reduced regression models that examine the effect of each dyadic social relationship on the number of beads that woman  $i$  took from woman  $j$ , our experimental measure of the intensity of resource competition (all variables are shown). Results for two meaningful interaction effects are also displayed, but interaction effects for *all* variables were not run owing to their ability to overcomplicate the findings as a consequence of the large number of total social variables. Positive parameter estimates mean that more beads were taken from a woman owing to the presence of that particular social factor, whereas negative estimates mean that fewer were taken than the average after controlling for the other variables in the model. On average, a woman took 7.47 (SD=1.67) beads from every other woman. Thus, on average, just under four (25%) of the 10 beads were left in front of each woman's photograph. The fact that such a large percentage of beads was taken is notable, but it is not inconsistent with other economic games, such as the dictator game, where individuals frequently offer up to 30% of the resources to partners. What is likely captured here, as has been found in other similar work, is that individuals consistently choose to distribute resource quantities in their favor and at the expense of others whenever possible. There was a large range in the number of beads taken, with a per-woman average ranging between a minimum of 1.82 and a maximum of 10. Woman  $i$ 's age was negatively

t1.1 **Table 1** Effects of social relationship variables on intensity of resource competition (number of beads taken)

Relationship variable	Full model				Final model			
	Est.	SE	<i>t</i>	<i>p</i>	Est.	SE	<i>t</i>	<i>p</i>
Positive social relationships								
Coefficient of relatedness ***	1.64	0.34	4.89	0.00	1.57	0.33	4.71	<0.00
Cooperative helper ***	0.40	0.06	6.61	0.00	0.39	0.06	6.54	<0.00
Distance between houses ***	0.19	0.04	5.46	0.00	0.19	0.03	5.56	<0.00
Desired as a friend ***	-0.20	0.07	-2.90	0.00	-0.20	0.07	-2.90	<0.00
Helper × kinship ***	-1.60	0.39	-4.05	0.00	-1.53	0.38	-4.04	<0.00
Best friends	-0.20	0.12	-1.61	0.11	-	-	-	-
Gossiping partners	0.09	0.18	0.49	0.63	-	-	-	-
Offers good advice	-0.11	0.09	-1.30	0.20	-	-	-	-
Negative social relationships								
An enemy ***	-0.61	0.16	-3.87	0.00	-0.26	0.15	-4.08	<0.00
Used to be a friend **	0.36	0.16	2.19	0.03	0.68	0.16	2.39	0.02
Refuse to visit *	0.18	0.09	2.06	0.04	0.16	0.09	1.89	0.06
Gossips about you **	0.15	0.08	1.94	0.05	0.15	0.08	2.01	0.05
Social antagonists quarreling over:								
Theft of meat *	0.58	0.33	1.79	0.08	0.59	0.33	1.82	0.07
Social contract defection ***	-0.77	0.24	-3.18	0.00	-0.76	0.24	-3.15	<0.00
Helpers × contract defection ***	1.14	0.40	2.86	0.00	1.09	0.40	2.74	0.01
Enemies × mate competition ***	1.22	0.50	2.45	0.02	2.17	0.50	2.57	0.01
Closeness in age	0.00	0.00	-1.32	0.19	-	-	-	-
Control								
Age of woman <i>i</i> ***	-0.02	0.00	-9.29	0.00	-0.02	0.00	-11.3	<0.00

\*\*\* *p*<0.01

\*\* *p*<0.05

\* *p*<0.1 (predicted direction)

associated with bead collection from individuals, and distance between pairs of houses (see below) was positively associated with bead collection such that younger women took more beads from others, and women took more beads from those who live in a more distant location from their house, but still within their community. Note that all social relationships were added to the statistical model and are only separated below for ease of reading and comparison.

Positive Social Relationships

Inconsistent with our predictions, Table 1 indicates that women took significantly more beads from their affiliative friends and close kin—relationships that were expected to elicit prosocial, as opposed to competitive, sentiments. However, when kinship is restricted to only those dyads where the coefficient of genetic relatedness

is greater than 0 (that is, any dyad where the pair has any genetic relatedness, whether as close as sisters or as distant as third cousins), we find that women acted more prosocially and generally took fewer beads from closer kin (Fig. 1). An interaction effect was found between *affiliative helpers* and *kinship* whereby women took significantly fewer beads from closer kin who were also designated as helpers, as opposed to kin who were not helpers, or non-kin who were helpers. As predicted, fewer beads were taken from those women who live closer to each other (Fig. 2) or whose friendship, while not certain now, was desired for the future. The latter implies an inclination for women to engage in altruism as a means to encourage friendship.

Women who were named as gossip partners, best friends, or advisors were not treated any differently in the game from other women who were not named in these categories. This is likely because a significant portion of the variation in these social categories is taken up by the more powerful constraints of kinship and reciprocal helpers, which significantly correlate with these predictors (for example, best friends and advisors were typically also named as helpers).

Negative Social Relationships Q4

As predicted for negative social relationships, women behaved more competitively by taking more beads from others who were gossiping about them behind their back, those they refused to visit socially, and past (but not current) friends. However, women took fewer beads from enemies, which is again contrary to what we initially expected. Two interaction effects produce results that are more consistent with the notion that direct competitors and defectors should be treated more harshly in the game. Players were more likely to take more beads from (1) affiliative helpers who defected on social contracts and (2) enemies with whom they were engaged in mate competition. This latter category is the strongest effect we find, with two additional beads (20% of stakes) being taken from mate competitors who are viewed as enemies. Women also took more beads from women with whom they had conflicts

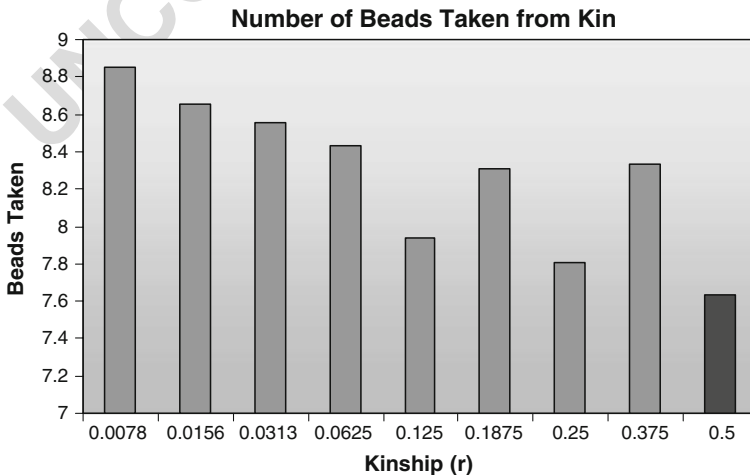
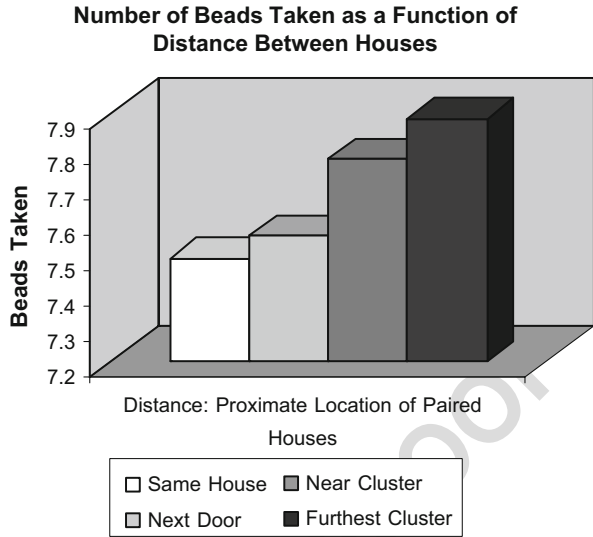


Fig. 1 The effects of kinship on the intensity of resource competition

**Fig. 2** The effects of residence on the intensity of resource competition



over accusations concerning stolen food, such that if a woman reported that another had stolen meat from her, during the game she also took more beads from her. 425 426

It is noteworthy that biological kinship had a more significant impact on the number of beads taken from other women than the majority of the negative social relationship indicators. The kinship effect, however, is partly counteracted when considering the interaction of kinship with affiliative helpers. Women took fewer beads from kin who were perceived to be active helpers in their daily lives. Also, as noted above, when non-kin were eliminated from the dataset, coefficient of genetic relatedness negatively correlated with the number of beads taken (Fig. 1). Thus, while kinship generally appears to facilitate competition, under certain circumstances it increases prosociality. 427 428 429 430 431 432 433 434 435

Relationships with individuals identified as best friends, advisors, and gossip partners failed to predict the number of beads collected. General age effects indicate that younger women take more beads from other women overall. But it is also the case that women appear to compete more strongly with age-mates. When the age of the bead collector is not used as a control, the absolute age difference between the pairs of women strongly affects the number of beads collected, such that women take more beads from others who are of similar ages ( $p < 0.01$ ). The implication of this finding is that women of similar ages are probably competing for the same resources at the same times across the lifecourse. This result is supported by comparable findings among the Tsimane which indicate that the number of quarrels that women are having with each other at a given time is positively influenced by closeness in age. 436 437 438 439 440 441 442 443 444 445 446

**Discussion**

447 **Q4**

We found supporting evidence that women acted more favorably toward (took fewer beads from) women in their intimate social networks (such as desired friends and 448 449

neighbors) and behaved less favorably toward women with whom they had disputes or conflicts. Despite this general trend, we also found similar evidence to the contrary, in that women took more beads from affiliative helpers and kin, and fewer beads from enemies. The simple prediction that ingroup or coalition members should always be favored with prosocial behaviors in a domain-general way is not strongly supported; in fact, our results seem to support the hypothesis that women may encounter *greater* competition from within their social networks. Indeed, there appears to be strong evidence for the within-group aggression hypothesis supporting the idea that women frequently compete with positive network affiliates within their coalitions.

Most importantly, our results indicate that the context of these variables must be taken into account to better understand the intricate interactions between these relationship conditions. For example, the finding that women take fewer beads from kin who are also affiliative helpers suggests that defections or contributions made by ingroup versus outgroup members may be perceived differently. Kin who are perceived as not helping or as not meeting other obligations or expectations may therefore be viewed less favorably than non-kin by having more beads taken from them. For example, using the parameter estimates from the final model in Table 1, a woman is likely to take 0.4 more beads away from a “non-cooperative” sister than from a cooperative one, and she is indifferent between cooperative sisters and cooperative non-kin.

In a high-fertility population such as the Tsimane, biological kinship by itself may be insufficient to reliably predict resource exchange behavior. In addition to the interaction effect with helping described above, we also found that prosociality had nonlinear effects with kinship. Women took fewer beads from non-kin ( $r=0$ ), but they showed opposite effects with women in dyads defined by greater genetic relatedness (Fig. 1). Among non-kin, other factors seem to be important, as revealed by the significant effects in Table 1 that describe positive and negative qualities of social relationships independent of kinship.

Physical proximity was predictably associated with less competition. The result that women took fewer beads from those women who lived in the same house or a nearby cluster of houses is confounded by the fact that women are more likely to reside with or very close to ingroup members, many of whom will be close kin, and treat these residents more favorably than those living outside their common social network. This result runs counter to the notion that more competition occurs among women with whom they are likely to interact on a daily basis. While ingroup members may not always be treated favorably, owing to the reasons described earlier, women may sometimes be less inclined to be stingy toward those with whom they are likely to interact on a daily basis. Even if competition among these women may be likely, a fear of stirring trouble among those who live nearby (even if the game was semi-anonymous) by taking more beads from them may act as a precaution. Certainly when the beads are made into necklaces and worn by players and their children, co-resident women and those who live in nearby households are more likely to take notice of the overall quantities of beads that were earned.

Exceptions aside, women generally appear to compete more readily with those identified in one way or another as social antagonists. They take more beads from those with whom they are in conflict. In particular, women more readily take beads

from women who are accused of taking valuable food items from them, those 497  
gossiping about them behind their backs, helpers who are currently defecting on 498  
some social contract, enemies who are competing for similar mates, and past friends 499  
with whom they no longer maintain positive social relations. Women also take more 500  
beads from kin who are currently not viewed as affiliative helpers. Our interpretation 501  
is that women actively target social rivals by attempting to secure more resources 502  
from them when possible and when retributive costs are low. 503

Our unexpected results, however, merit further attention. One of the particularly 504  
surprising results was that fewer beads were taken from women named as “enemies,” 505  
except for those with whom women were directly engaged in mate competition. The 506  
explanation for this result is unclear, but one possibility is that women are less 507  
willing to antagonize women with whom they are involved in a particularly socially 508  
aggressive conflict. Disgruntled enemies are often feared and viewed as *tsäqui*, or 509  
dangerous, because of the potential for enemies to use sorcery to inflict harm on 510  
family members, especially young children. Other individuals who may have 511  
gossiped or defected on social contracts, but who are not viewed as enemies, 512  
presumably do not fall into this category. Direct confrontation with or punishment of 513  
non-family members is not very common. Prior economics games have shown that 514  
the Tsimane rarely punish second- or third-party stinginess, at least in experimental 515  
contexts (Gurven 2004). That women take significantly more beads from enemies 516  
with whom they are also competing over mates suggests that women may be willing 517  
to risk further antagonizing an enemy only when the value of the contested resource 518  
(in this case, a potential marital partner) is high. Indeed, because mates potentially 519  
provide resources across the entire lifetime, it is not surprising that we found this to 520  
be the most significant effect overall, in that on average an extra 2.17 beads was 521  
taken from enemies who were competing over mates. And although this work looks 522  
at many relationship categories and dynamic states of dyadic identity, the robusticity 523  
of this result indicates that the overall area of mate competition may warrant further 524  
attention and should not be underestimated as a significant source of conflict among 525  
women in small-scale, natural fertility populations. 526

Another surprising result was that women took fewer beads from those who were 527  
named as defectors on a variety of social contracts. An important exception was that 528  
when the defectors were also affiliative helpers, more beads were taken away. One 529  
possibility is that stronger ingroup affiliative defections evoke greater punitive 530  
sentiment than outgroup defections. Greater punishment may be directed at ingroup 531  
members if such punishment is designed to increase labor or prevent future 532  
defections by active members of one’s social network. Conversely, punishing 533  
outsiders may be less effective at changing future behavior and therefore not worth 534  
the cost (retribution risk) of the punitive act. 535

Overall we find less support for favoritism toward ingroup members. Women 536  
strategically favor other women whom they desire as friends and act more favorably 537  
toward neighbors than toward those living in more distant areas of the village. Other 538  
studies have shown some indication that women may choose to cooperate rather than 539  
compete on first game encounters (Eckel and Grossman 1998) This result is 540  
consistent with a social preference to initiate cooperative relationships by parceling 541  
benefits in an escalating manner (Roberts and Sheratt 1998). We were surprised to 542  
find that they took more beads from helpers and that favoritism toward advice givers 543

or toward best friends, although in the predicted direction, was not statistically significant in our regression models. 544  
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Lastly, despite the different design, currency, and framing of the SSG when compared with the dictator game (DG), we find similar overall patterns here as we did with the DG played in 2002 (Gurven and Winking 2008). Mean and modal DG offers were 26% and 30%, respectively, while mean and mode amounts given to another woman in the SSG were 28% and 20%, respectively. Of the four villages where the SSG was played, the mean amount given (16%) was lowest in the village (Cosincho) where the DG was also played earlier in the same year. It is unclear whether this village effect was a result of prior familiarity and potential contamination from other economics games or if it represents a different pattern of behavior. Social norms concerning proper levels of resource division and appropriate recipients are minimal, and individual discretion probably plays a large role (Gurven et al. 2008). 546  
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**Conclusion** 557

Women’s social dynamics are complex, and women’s decisions governing competitive and cooperative behavior are influenced not only by biological kinship but also by the friendship and relationship status of their peers, within a dynamic and ecological framework. Previous research in the area of female competition and cooperation led to the prediction that women engage in more “within-group” competition than do males, who experience a greater intensity of competition with men from other residential groups. The present work, which only focused on women’s social networks, lends some support to that hypothesis; however, when given the opportunity, women will take more resources from those outside their social network. We argue that a complex understanding of cooperation and competition among women may require important contextual information concerning relationship history in addition to typical features of resource ecology. 558  
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The semi-anonymous design of the SSG enabled us to gain unexpected insights into social relationships and behavior. Future experimental approaches should employ a similar design to explore the dynamics of sociality in ethnographic context. The game design could be modified, for example, to allow women to redistribute beads or other resources to other women as desired, or in another scenario, women could be given the option to throw away beads that are subsequently given to no one. 570  
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