

Title: The Social Strategy Game: Resource competition within female social networks among small-scale forager-horticulturalists

October 29, 2008

Stacey L. Rucas

Department of Social Sciences

California Polytechnic State University (Cal Poly)

San Luis Obispo, CA 93401

(805) 756-1374

[srucas@calpoly.edu](mailto:srucas@calpoly.edu)

Michael Gurven

Department of Anthropology

University of California Santa Barbara

Santa Barbara, CA 93106

(805) 893-2202

[gurven@anth.ucsb.edu](mailto:gurven@anth.ucsb.edu)

Hillard Kaplan

Department of Anthropology

Human Evolutionary and Behavior Science

University of New Mexico

Albuquerque, NM 87131

(505) 277-1541

[hkaplan@unm.edu](mailto:hkaplan@unm.edu)

Jeff Winking

Department of Anthropology

Texas A&M University

College Station, Texas 77843

(979) 845-5242

[jwinking@tamu.edu](mailto:jwinking@tamu.edu)

@DO NOT CITE WITHOUT PERMISSION OF THE AUTHORS. Direct correspondence to

[srucas@unm.edu](mailto:srucas@unm.edu)

Keywords: experimental economics, social networks, resource competition, altruism, Tsimane

**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 a woman took from another.

Relationship variables are used to test how the affiliative or competitive aspects of dyads affect the extent of pro-sociality in the game. Using a mixed-modeling procedure, we find that women compete with those they are quarreling with due to 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 due to fearfulness 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.

## List of Tables

Table 1: Effects of social relationship variables on intensity of resource competition (# beads taken)

## List of Figures

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

Figure 2. The effects of residence on the intensity of resource competition

## INTRODUCTION

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).

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 due to provisioning, altruism, reciprocity or trade. Amongst 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 of protein and lipid (Cordain, et al. 2000). In these societies, the majority of a woman's (and her children's) diet is subsidized from other individuals including spouses, parents, siblings, other relatives, friends, allies, neighbors, suitors and other benefactors. Unlike

non-human 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 to other non-human 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 upon the foraging labor of other group members. The quantity and quality of social relationships that comprise 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.

As 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 networks may also aid in gaining and maintaining access to resources and friends and that this may positively impact fitness (Silk, et al. 2004; Silk 1983; Silk, et al. 2003).

Despite some attention given to intrasexual competition among women in the context of gossip and mating in modern societies (Campbell 2002), relatively little recent attention has been paid to the social dynamics among women in non-market, subsistence societies (for notable older exceptions, please see (Lamphere 1977; Lamphere and Rosaldo 1974). However, social coalitions, networks, dominance interactions and physically aggressive behaviors of men have been studied extensively (Chagnon 1990; Flinn, et al. 2005; Parker, et al. 1972; Pelegriani and Bartini 2001; Wagner, et al. 2002; Wilson and Daly 1985; Yamaguchi 1992). Competitive

interactions among men usually occur in the form of overt, physical displays of aggression. Competition among men has been viewed as occurring largely between, rather than within, groups in the context of raids or warfare, while between-group competition is bolstered by within-group male coalitions (Wrangham and Peterson 1996). While physical aggression is not totally uncommon among women (Campbell 2002), most competition among women occurs in a more subtle manner, dubbed ‘indirect aggression’ (Archer and Coyne 2005), or ‘relational aggression’ (Underwood 2003), or more recently, ‘informational warfare’ (Hess 2006; Hess and Hagen 2006). Due to the potentially high costs of escalating physical aggression, it is believed that competition among women has been relegated to largely non-physical forms (Campbell 1995; Campbell 2002). And in the absence of intense between group competition, maintaining large cooperative female coalitions may be more costly than they are worth for women, resulting a higher frequency of dyadic groups (pairs), where competition occurs mostly within the framework of a social network, rather than between groups (Hess 2006; Hess and Hagen 2006). The lack of overt physical competition among women on a large scale (such as their lack of involvement in warfare, for example) has sometimes been interpreted naively as an absence of competition altogether, and hence the relative scarcity of systematic studies on resource competition among women, especially in traditional societies. However, existing studies in modern societies show strong evidence that women form social networks and coalitions, and that they engage in significant amounts of socially aggressive behaviors over a broad range of resources (Bjorkqvist, et al. 1992; Campbell, et al. 1996; Campbell 2002; Cashdan 1998; Cashdan 2003; Crick 1995; Hess 2006; Hess and Hagen 2002; Hess and Hagen 2006).

We propose, as have others (Hess 2006; Hess and Hagen 2002; Hess and Hagen 2006; Lancaster 1991) that social networks are the vehicle for processing exchanges of resources

among women and that women therefore pay strong attention to the affiliative and competitive aspects of their relationships with other group members. In this paper we explore how the character of dyadic social relationships predict the direction and intensity of resource transfer among Tsimane women. We expect that the context of the relationship between two women should predict the level and direction of resource competition between those women. Given the theory that pro-sociality is influenced by kinship and friendship status, we predicted that women should be more competitive with social antagonists, such as non-friends, distant kin, enemies, those who have damaged ego's reputation in the past, and age-mates who are likely to be competitors for similar resources (i.e. mates or food) across the lifecourse. Likewise, we predict that women will act more pro-social with friends, helpers, close kin, and neighbors, who often choose residence based on their positive affiliation with other women. However, we also acknowledge that it may be true that even within one's group, women may still compete at times with friends and kin due to the within-group competition hypothesis which predicts that women encounter more aggression from within their groups, rather than between their groups, compared to men. And due to Hamilton's rule, women are not always expected to engage in altruism, because sometimes the cost to themselves is not outweighed by the benefit to the recipient, even if they happen to be very close kin.

The above predictions are consistent with much of the work in the evolutionary social sciences that show more pro-social (exchange) sentiment and behavior towards ingroup members than towards 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 compete 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. Additionally the increased amount of time that ingroup members spend together may carry an increased likelihood of conflict due to increased frequency of mutual resource encounters. Asking whether women are more likely to be pro-social or anti-social towards 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 current circumstances and status of the pair's relationship. However, little ambiguity in pro-social behavior is expected towards 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. Despite these, our study makes several important contributions. First, this study, conducted in a subsistence-based population in the Bolivian Amazon, hopes to improve 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 systematically the effects of social context on cooperation among women. Field observation may be a problematic approach to study 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 largely limited to Ultimatum Games, Dictator Games and Public Goods Games (e.g. (Henrich, et al. 2004; Henrich, et al. 2001). 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 in press; Levitt and List in press) by linking game behavior with information about known relationships, and 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***

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 it is 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 upon 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 thus 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 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  $\sum_j x_{ij}$ . After all women in a village have played, woman  $i$  will receive an additional  $\sum_{j \neq i} (10 - x_{ji})$  number of beads. All adult women over the age of fourteen in a community were invited to play the game. The quantity of resources (beads in this study),  $x_{ij}$ , 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) up to a maximum of  $2 \cdot 10(n_k - 1)$  beads (if she takes all of the beads from the other women and if none of the other women take any beads from her).

## **METHODS**

### ***Study Population: Tsimane and the Tsimane Project***

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, but not limited to, male-male aggression, altruism, food sharing, age-specific production curves, disease ecology, and economic decision making. The present data for the current paper was 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 over 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 within small villages, ranging in size from 60-400 individuals. The communities are relatively stable, and while movement between villages is not infrequent, due to post-marital residence rules and migration, most women have extensive knowledge of the reproductive, residential and personal histories of other women in their community due to years of social interaction and through 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. Post-marital residence is usually matrilocal 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 (regarding things such as 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 upon 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)***

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), they were 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 them, 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 photograph (woman  $j$ ) owned the ten beads, and that she (woman  $i$ ) is being given the opportunity to take as many beads from any of 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. While 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 have played the game. At that stage, the beads left to each particular woman  $i$  would be counted up and subsequently given to woman  $i$  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* away 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 give away their own beads. It was found that all women took at least some beads during the game,

and that no one left all beads to all owners. If a woman did not take any beads from other woman then 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 directly watch game play so as not to make the participant feel uncomfortable. However it was mentioned that the order did not matter in terms of payment.

### ***Questionnaire on Social Relationships***

The character and content of dyadic social relationships forms 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-social or anti-social sentiment towards those women in the community. Different possible relationships that woman  $i$  maintained with woman  $j$  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 that were considered as defectors on social contracts or who were accused of stealing food from them, those other women 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 was gathered as part of the larger demographic data project (conducted by Gurven et al.). Kinship, with respect to the analyses within, only refers to the coefficient of relatedness ( $r$ ) between pairs of women and was the only kinship variable used for 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 stems from the fact that each woman took a quantity of beads away from each other woman and also identified the social relationship of these other women in their 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 what they need. Because of this fact, it was expected that younger women would take more beads from older women, even if only out of habituation. 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 due 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 away from a woman due to the presence of that particular social factor, while negative estimates mean that fewer were taken away than the average after controlling for the other variables in the model. On average, a woman took 7.47 (s.d. = 1.67) beads from each other woman. Thus, on average, 25% of the 10 beads was left in front of each woman's photograph. It is notable that such a large percentage of beads were taken, but this is not inconsistent with other economic games, such as the dictator game, where individuals frequently offer up 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 minimum of 1.82 and maximum of 10. Woman *i*'s age was negatively associated with bead collection from individuals, and distance

between pairs of houses (Figure 2) was positively associated with bead collection such that younger women took more beads from others and women took more beads away from those who live in a more distant location from their house, but still within their community. Note, all social relationships were added to the statistical model and are only separated below for organization and ease of read and comparison.

### ***Positive social relationships***

Inconsistent with our predictions, results in Table 1 indicate that women took significantly *more* beads from their affiliative friends and close kin; relationships that were expected to elicit pro-social, as opposed to competitive, sentiments. However when kinship is restricted to only those dyads where the coefficient of genetic relatedness,  $r$ , 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 pro-socially and generally took fewer beads from closer kin (Figure 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 in proximity to each other (Figure 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*

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 competitively take more beads away from; 1.) Affiliative helpers who defected on social contracts and 2.) From enemies with whom one was engaged in mate competition. This latter category is the strongest effect we find with 2 additional beads (20% of stakes) taken from mate competitors who are viewed as enemies. Women also took more beads from women with whom they had conflicts 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.

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 away 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 away (Figure 1). Thus, while kinship generally appears to persuade competition, under certain circumstances it increases pro-sociality.

Those individuals that women 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 effects the number of beads collected, such that women take more beads from others who are of similar ages (p-value <.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 with the Tsimane that indicate that the number of quarrels that women are having at a given time is positively influenced by closeness in age.

## **DISCUSSION**

We found supporting evidence that women acted more favorably (took fewer beads) from women in their intimate social networks (such as desired friends and 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 pro-social behaviors in a domain-general way is not strongly supported; our results do 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 members 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 away 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 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 pro-sociality had non-linear 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 (Figure 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 that 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 of their common social network. This result runs counter to the notion that more competition occurs among women with whom they are likely to interact with on a daily basis. While ingroup members may not always be treated favorably, due to the reasons described earlier, women may sometimes be less inclined to be stingy towards 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 away from those with whom they are in conflict. In particular, women more readily take beads away from women who are accused of taking valuable food items from them, those gossiping about them behind their backs, helpers who are currently defecting on some social contract, enemies who are competing for similar mates, and past friends with which they no longer maintain positive social relations. Women also take more beads from kin who are currently not viewed as affiliative helpers. Our interpretation is that women actively target social rivals by attempting to secure more resources from them when possible and when retributive costs are low.

Our unexpected results merit further attention though. One of the particularly surprising results was that fewer beads were taken from women named as “enemies”, except for those with whom women were directly engaged in mate competition. The explanation for this result is unclear, but one possibility is that women are less willing to antagonize women with whom they are involved in a particularly socially aggressive conflict. Disgruntled enemies are often feared and viewed as *tsäqui*, or dangerous, because of the potential for enemies to use sorcery to inflict harm on family members, especially young children. Other individuals who may have gossiped or defected on social contracts, but who are not viewed as enemies, presumably do not fall into this category. Direct confrontation with or punishment of non-family members is not very common. Prior economics games have shown that the Tsimane rarely ever punish second-party or third-party stinginess at least in experimental contexts (Gurven 2004). That women take

significantly more beads from enemies than they are also competing with over mates suggests that women may be willing to risk further antagonizing an enemy only when the value of the contested resource (in this case, a potential marital partner) is high. Indeed, because mates potentially provide resources across the entire lifetime, it is not surprising that we found this to be the most significant effect overall, in that enemies women were fighting with over mates resulted in an average of 2.17 extra beads being taken. And while this work looks at many relationship categories and dynamic states of dyadic identity, it can be observed from the robusticity of this result that the overall area of mate competition may warrant further attention, and should not be underestimated as a significant source of conflict among women in small-scale, natural fertility populations.

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

Overall we find less support for favoritism toward ingroup members. Women strategically favor other women who they desire as friends, and act more favorably towards neighbors than towards those living in more distant areas of the village. Other studies have shown some indication that women may choose to cooperate rather than compete on first game encounters (Eckel and Grossman 1998) This result is consistent with a social preference to

initiate cooperative relationships by parceling benefits in an escalating manner (Roberts and Sheratt 1998). We were surprised to find that they took more beads from helpers and that although in the predicted direction, favoritism toward advice givers or toward best friends was not statistically significant in our regression models.

Lastly, despite the different design, currency and framing of the SSG when compared with the popular 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 offer was 26% and 30%, respectively, while mean and mode amount given to another woman in the SSG was 28% and 20% respectively. Of the four villages where the SSG was played, 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 due to 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. in press).

## **CONCLUSION**

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 predicted 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

The semi-anonymous design of the SSG allowed 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 any 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.

#### **ACKNOWLEDGEMENTS**

We would like to thank the Tsimane women of our host communities for their gracious participation and wonderful camaraderie. This research was funded by LAII Field Research Grants, provided by the Tinker Foundation, and by NSF grant BCS-013274. We would also like to thank Dan Fessler, Steve Gangestad, and our anonymous reviewers for their helpful criticisms.

## BIOGRAPHICAL INFORMATION

Stacey Rucas is Assistant Professor of Anthropology at Cal Poly. She received her PhD in Anthropology at the University of New Mexico in 2004 and trained in the interdisciplinary Human Evolutionary and Behavior Science program. Her research interests include competition and cooperation among women, evolutionary theory, hormones and health, and sleep ecology. She actively publishes in the area of women's social dynamics and is currently working on a new behavioral endocrinology research project entitled "*Sleep, health, risk and stress among SLO County Firefighters.*"

Michael Gurven is Associate Professor of Anthropology at University of California-Santa Barbara. He received his Ph.D. from the University of New Mexico in 2000. He has conducted fieldwork in Paraguay and Bolivia with Ache and Tsimane forager-horticulturalists. His research interests include intra-group cooperation and problems of collective action, and the application of life history theory to explain human longevity, development and sociality. Since 2002, Gurven and Kaplan have co-directed the Tsimane Health and Life History Initiative to further develop theory and test implications of different models of human life history evolution.

Jeffrey Winking is Assistant Professor of Anthropology at Texas A&M University. He received his Ph.D. from the University of New Mexico in 2005. His research has focused on men's reproductive and parenting decisions, based on fieldwork among Tsimane forager-horticulturalists in Bolivia.

Hillard Kaplan is Professor of Anthropology at University of New Mexico. He received his Ph.D. from the University of Utah in 1983. He has conducted fieldwork in Paraguay, Brazil, Botswana, and Bolivia. His research interests include evolutionary perspectives on life course development and senescence, and brain evolution. He has applied human capital theory towards explaining human life history evolution, and the proximate physiological and psychological mechanisms governing fertility and parental investment in both traditional, high-fertility, subsistence economies and modern, low-fertility industrial societies.

## REFERENCES

- Anderson, Connie M.  
2000 The persistence of polygyny as an adaptive response to poverty and oppression in apartheid South Africa. *Cross-Cultural Research* 34(2):99-113.
- Anderson, K.G., Hillard Kaplan, and Jane Lancaster  
1999 Parental care by genetic and step fathers I: Reports by men in Albuquerque, New Mexico. *Evolution and Human Behavior* 20:433-451.
- Archer, John, and Sarah M. Coyne  
2005 An Integrated Review of Indirect, Relational, and Social Aggression. *Personality and Social Psychology Review* 9(3):212-230.
- Bateman, A.J.  
1948 Intra-sexual selection in *Drosophila*. *Heredity* 2:349-368.
- Bjorkqvist, K., K.M.J. Lagerspetz, and A. Kaukiainen  
1992 Do girls manipulate and boys fight- developmental-trends in regard to direct and indirect aggression. *Aggressive Behavior* 1992(18):2.
- Borgerhoff Mulder, Monique  
1987 Resources and reproductive success in women, with an example from the Kipsigis. *Journal of Zoology* 213(489-505).
- Buss, David M.  
1995 Psychological sex differences: origins through sexual selection. *American Psychologist* 50(3):164-168.
- Campbell, A., et al.  
1996 Social representation of aggression: crossing the sex barrier. *European Journal of Social Psychology* 26:135-147.
- Campbell, Anne

- 1995 A few good men - evolutionary psychology and female adolescent aggression. *Ethology and Sociobiology* 16(2):99-123.
- 
- 2002 A mind of her own: the evolutionary psychology of women. New York: Oxford Press.
- Cashdan, E.  
1998 Are men more competitive than women? *British Journal of Social Psychology* 37:213-229.
- 
- 2003 Hormones and competitive aggression in women. *Aggressive Behavior* 29(2):107-115.
- Chagnon, Napoleon A.  
1990 Reproductive and somatic conflicts of interest in the genesis of violence and warfare among tribesmen. *In Anthropology of war*. J. Haas, ed. Pp. 242. New York, NY: Cambridge University Press.
- Cordain, Loren, et al.  
2000 Plant-animal subsistence ratios and macronutrient energy estimations in worldwide hunter-gatherer diets. *American Journal of Clinical Nutrition* 71:682-92.
- Crick, N.R.  
1995 Relational aggression- the role of intent attributions, feelings of distress, and provocation type. *Development and Psychopathology* 7(2):313-322.
- Cronk, Lee  
1994 Wealth, status and reproductive success among the Mukogodo of Kenya. *American Anthropologist* 93(2):345-360.
- Darwin, Charles  
1871 The descent of man, and selection in relation to sex. London: J. Murray.
- Eckel, Catherine, and Philip Grossman  
1998 Are women less selfish than men? Evidence from dictator experiments. *The Economic Journal* 108(448):726-735.
- Flinn, Mark, D. Geary, and C. Ward  
2005 Ecological dominance, social competition and coalitionary arms races: Why humans evolved extraordinary intelligence. *Evolution and Human Behavior* 26:10-46.
- Forsythe, Robert, et al.  
1994 Fairness in simple bargaining experiments. *Games and Economic Behavior* 6(3):347-369.
- Gurven, Michael  
2004 Economic games among the Amazonian Tsimane: exploring the roles of market access, costs of giving, and cooperation on pro-social game behavior. *Experimental Economics* 7(1):5-24.
- Gurven, Michael, Hillard Kaplan, and Maguin Gutierrez  
2006 How long does it take to become a proficient hunter? Implications for the evolution of extended development and long lifespan. *Journal of Human Evolution* 51:454-470.
- Gurven, Michael, Hillard Kaplan, and Alfredo Zelada Supa  
2007 Mortality experience of Tsimane Amerindians of Bolivia: Regional variation and temporal trends. *American Journal of Human Biology* 19:376-398.

- Gurven, Michael, and Robert Walker  
2006 Energetic demand of multiple dependents and the evolution of slow human growth. *Proceedings of the Royal Society of London Series B-Biological Sciences* 273:835-841.
- Gurven, Michael, and Jeffrey Winking  
in press Collective action in action: prosocial behavior in and out of the laboratory. *American Anthropologist*.
- Hawkes, Kristen, et al.  
1998 Grandmothering, menopause, and the evolution of human life histories. *Proceedings of the National Academy of Sciences* 95:1336-1339.
- Henrich, Joseph, et al., eds.  
2004 *Foundations of human sociality: economic experiments and ethnographic evidence from fifteen small-scale societies*: Oxford University Press.
- 2001 In search of *Homo economicus*: Experiments in 15 Small-Scale Societies. *American Economic Review* 91(2):73-79.
- Hess, Nicole C.  
2006 *Informational warfare: The evolution of female coalitions and gossip*, University of California, Santa Barbara.
- Hess, Nicole C., and Edward H. Hagen  
2002 *Informational warfare*. *Cogprints*.
- Hess, Nicole, and Edward Hagen  
2006 Sex differences in indirect aggression: Psychological evidence from young adults. *Evolution and Human Behavior* 27(3):231-245.
- Hurtado, A. Magdalena, et al.  
1985 Female subsistence strategies among Ache hunter-gatherers of eastern Paraguay. *Human Ecology* 13:1-28.
- Janson, C.H.  
2000 Primate socio-ecology: The end of a golden age. *Evolutionary Anthropology* 9(2):73-86.
- Kelly, Robert L.  
1995 *The foraging spectrum: Diversity in hunter-gatherer lifeways*. New York: Smithsonian.
- Lamphere, Louise  
1977 The Navajo cultural system: an analysis of concepts of cooperation and autonomy and their relation to gossip and witchcraft. *In Apachean Culture History and Ethnology*. M. Opler, ed. Pp. 91-114. Tucson: University of Arizona Press.
- Lamphere, Louise, and Michelle Zimbalist Rosaldo  
1974 *Woman, culture and society*. Stanford: Stanford University Press.
- Lancaster, Jane B.  
1991 A Feminist and Evolutionary Biologist Looks at Women. *Yearbook of Physical Anthropology* 34:1-11.
- Levitt, Steven, and John List  
in press What do laboratory experiments tell us about the real world. *Journal of Economic Perspectives*.
- Marlowe, Frank

- 2001 Male contribution to diet and female reproductive success among foragers. *Current Anthropology* 42:755-760.
- McGraw, K.J.  
2002 Environmental predictors of geographic variation in human mating preferences. *Ethology* 108(4):303-317.
- Parker, G.A., R.R. Baker, and F.C.F. Smith  
1972 The origin and evolution of gamete dimorphism and the male-female phenomenon. *Journal of Theoretical Biology* 36:529-553.
- Pelegriani, Anthony D., and Maria Bartini  
2001 Dominance in early adolescent Boys: Affiliative and aggressive deminisions and possible functions. *Merrill-Palmer Quarterly* 47(1):142-163.
- Roberts, G, and TN Sheratt  
1998 Development of cooperative relationships through increasing investment. *Nature* 394:175-179.
- Rucas, Stacey L.  
2004 Female intrasexual social behaviors among the Tsimane of Bolivia, University of New Mexico.
- Silk, J.B., Susan C. Alberts, and Jeanne Altmann  
2004 Patterns of coalition formation by adult female baboons in Amboseli, Kenya. *Animal Behaviour* 67(3):573-582.
- Silk, Joan  
1983 Local resource competition and facultative adjustment of sex ratios in relation to competitive abilities. *The American Naturalist* 121(1):56-66.
- Silk, Joan B., S.C. Alberts, and J. Altmann  
2003 Social bonds of female baboons enhance infant survival. *Science* 302(5648):1231-1234.
- Thaler, Richard  
1980 Toward a positive theory of consumer choice. *Journal of Economic Behavior and Organization* 1:39-60.
- Underwood, Marion K.  
2003 *Social aggression among girls*. New York, NY: Guilford Press.
- Wagner, J.D., M.V. Flinn, and B.G. England  
2002 Hormonal response to competition among male coalitions. *Evolution and Human Behavior* 23(6):437-442.
- Waynforth, David  
1999 Differences in time use for mating and nepotistic effort as a function of male attractiveness in rural Belize. *Evolution and Human Behavior* 20(1):19-28.
- Wilson, M., and M. Daly  
1985 Competitiveness, risk-taking, and violence- The young male syndrome. *Ethology and Sociobiology* 6(1):59-73.
- Wrangham, R.W., and Dale Peterson  
1996 *Deomonic Males: Apes and the origins of human violence*. New York: Houghton Mifflin.
- Yamaguchi, H.  
1992 Formations of Grand Coalition When Consciousness of Intragroup Competition is Activated. *Japanese Journal of Psychology* 62(6):357-363.



Table 1: Effects of social relationship variables on intensity of resource competition (# beads taken)

Relationship Variable	Full Model				Final Model			
	Est.	Err.	t	Sig.	Est.	Err.	t	Sig.
<b>Positive Social Relationships</b>								
Coefficient of relatedness ***	1.64	0.34	4.89	0.00	<b>1.57</b>	<b>0.33</b>	<b>4.71</b>	<b>&lt;0.00</b>
Cooperative helper ***	0.40	0.06	6.61	0.00	<b>0.39</b>	<b>0.06</b>	<b>6.54</b>	<b>&lt;0.00</b>
Distance between houses ***	0.19	0.04	5.46	0.00	<b>0.19</b>	<b>0.03</b>	<b>5.56</b>	<b>&lt;0.00</b>
Desired as a friend ***	-0.20	0.07	-2.90	0.00	<b>-0.20</b>	<b>0.07</b>	<b>-2.90</b>	<b>&lt;0.00</b>
Helper x kinship ***	-1.60	0.39	-4.05	0.00	<b>-1.53</b>	<b>0.38</b>	<b>-4.04</b>	<b>&lt;0.00</b>
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	-	-	-	-
<b>Negative Social Relationships</b>								
An enemy ***	-0.61	0.16	-3.87	0.00	<b>-0.26</b>	<b>0.15</b>	<b>-4.08</b>	<b>&lt;0.00</b>
Used to be a friend **	0.36	0.16	2.19	0.03	<b>0.68</b>	<b>0.16</b>	<b>2.39</b>	<b>0.02</b>
Refuse to visit *	0.18	0.09	2.06	0.04	<b>0.16</b>	<b>0.09</b>	<b>1.89</b>	<b>0.06</b>
Gossips about you **	0.15	0.08	1.94	0.05	<b>0.15</b>	<b>0.08</b>	<b>2.01</b>	<b>0.05</b>

## Social Antagonists Quarreling Over:

Theft of meat *	0.58	0.33	1.79	0.08	<b>0.59</b>	<b>0.33</b>	<b>1.82</b>	<b>0.07</b>
Social contract defection ***	-0.77	0.24	-3.18	0.00	<b>-0.76</b>	<b>0.24</b>	<b>-3.15</b>	<b>&lt;0.00</b>
Helpers X contract defection ***	1.14	0.40	2.86	0.00	<b>1.09</b>	<b>0.40</b>	<b>2.74</b>	<b>0.01</b>
Enemies x mate competition ***	1.22	0.50	2.45	0.02	<b>2.17</b>	<b>0.50</b>	<b>2.57</b>	<b>0.01</b>
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	<b>-0.02</b>	<b>0.00</b>	<b>-11.3</b>	<b>&lt;0.00</b>
---------------------------	-------	------	-------	------	--------------	-------------	--------------	-----------------

---

\*\*\* sig. &lt; .01

\*\* sig. &lt; .05

\* sig. &lt; .1 (predicted direction)

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

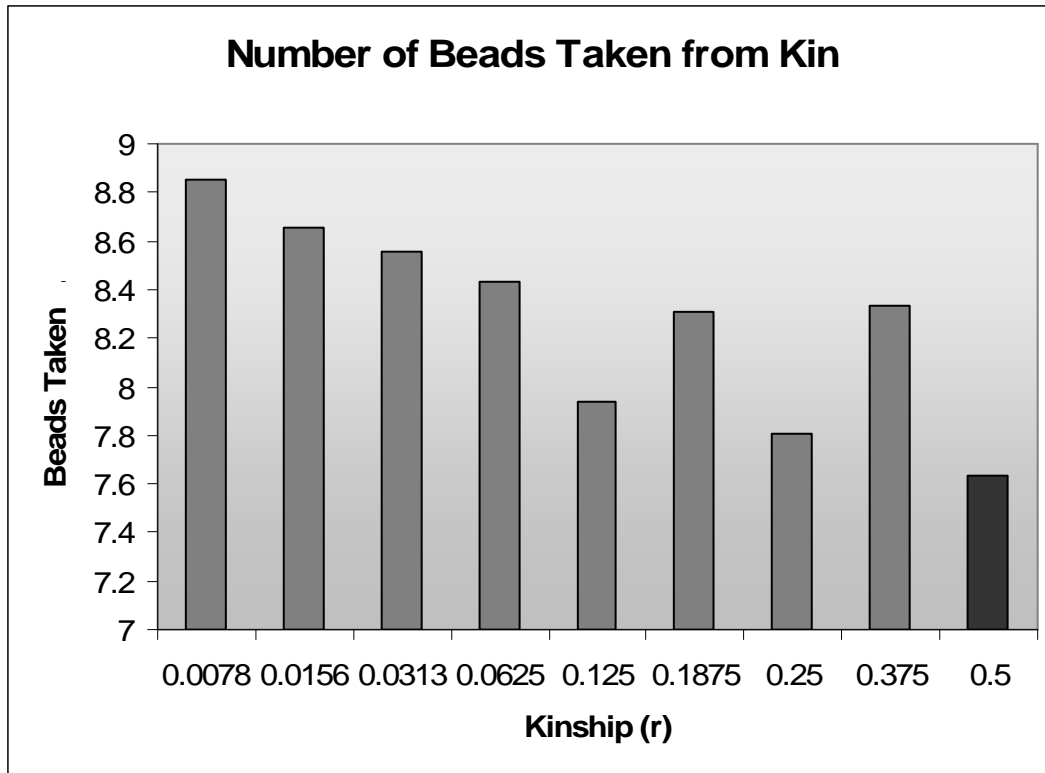


Figure 2. The effects of residence on the intensity of resource competition

