

Sex differences in political leadership in an egalitarian society

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ABSTRACT

We test the contribution of sex differences in physical formidability, education, and cooperation to the acquisition of political leadership in a small-scale society. Among forager-farmers from the Bolivian Amazon, we find that men are more likely to exercise different forms of political leadership, including verbal influence during community meetings, coordination of community projects, and dispute resolution. We show that these differences in leadership are not due to gender per se but are associated with men's greater number of cooperation partners, greater access to schooling, and greater body size and physical strength. Men's advantage in cooperation partner number is tied to their participation in larger groups and to the opportunity costs of women's intrahousehold labor. We argue these results highlight the mutual influence of sexual selection and the sexual division of labor in shaping how women and men acquire leadership.

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1. Introduction

As of Jan 1, 2017, only eleven women were elected heads of national governments, and the world average of women in parliament was 23.4% (Inter-Parliamentary Union, 2017). Women hold ~25% of senior level manager or board positions in Fortune 500 companies (Catalyst, 2015). In pre-industrial societies historically and cross-culturally, women are much less likely than men to hold formal positions of political leadership (Low, 1992). Even in some of the most egalitarian societies described by anthropologists, men show a political leadership advantage (Collier & Rosaldo, 1981). Ethnographies of the !Kung San describe women as less frequent contributors than men to mixed-sex group discussions (Lee, 1982; Shostak, 1981). In central African BaYaka pygmies, men more than women organize and conduct meetings to coordinate camp-wide activities (Lewis, 2014). Among the Agta of the Philippines, men are nearly four times more likely than women to be classified as influential during camp-wide discussions, according to nominations by camp residents (Smith et al., 2017; D. Smith, personal communication, January 6, 2018).

Nevertheless, women tend to wield more political leadership in egalitarian societies, relative to women in more economically stratified societies (Dyble et al., 2015; Endicott & Endicott, 2008; Leacock, 1978). Women among the !Kung San and BaYaka initiate public criticism of jealousy, stinginess, and other non-normative behavior more frequently

than men (Lewis, 2014; Wiessner, 2005). In Amazonian horticulturalists from Conambo, Ecuador, women broker factional disputes within the community, and men's status benefit from their wives' roles as mediators (Bowser & Patton, 2010). There are society-wide benefits to women's roles in public criticism and conflict mediation: men who engage in these activities are at greater risk of provoking cycles of violence (Lewis, 2014).

In addition to economic equality and associated egalitarian norms, anthropologists have identified other factors that cross-culturally predict women's political participation: monogamy (Henrich, Boyd, & Richerson, 2012; Tertilt, 2006), matrilineal postmarital residence (Yanca & Low, 2004), a matrilineal descent system (Low, 1992), and low rates of inter-group violence (Hayden, Deal, Cannon, & Casey, 1986; Ross, 1986). Inter-group conflict associates with institutions that foster male coalition-building and segregation of the sexes (Rodseth, 2012), including costly male initiation rites (Sosis, Kress, & Boster, 2007). Furthermore, inter-group conflict can increase preferences for male leaders, particularly more masculine-appearing men (Laustsen & Petersen, 2015; van Vugt & Spisak, 2008), which may reflect an evolved human psychology that privileges dominant leaders when coordination failure and free-riding pose existential threats (von Rueden & van Vugt, 2015).

However, none of these explanations identify why men in all human societies have tended to wield more political leadership than women, particularly overt forms of leadership such as coordination of community decision-making. A more universally applicable explanation is the opportunity costs experienced by women due to the sexual division of

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labor. In all human societies, men tend to engage in more labor outside of the household and women in more intra-household labor, including childcare (Gurven, Winking, Kaplan, von Rueden, & McAllister, 2009; Hewlett & MacFarlan, 2010). In the United States, married women who have full-time careers continue to do more domestic work than their spouses, especially childcare, and women more than men state that parenting negatively impacts career advancement (Pew Research Center, 2015). In traditional societies, it is often only when women near menopause and have fewer direct childcare demands and domestic chores that they socialize more broadly and gain greater influence within their communities (Brown, 1985).

The sexual division of labor also contributes to normative expectations that women assume less agentic roles in groups (Eagly & Karau, 2002; Ridgeway, 2001). This social role perspective is often contrasted with evolutionary (sexual selection) approaches to sex differences (Fine, 2017), whereby women and men evolved different, but overlapping social strategies. These different strategies are reflected in body size and strength dimorphism (Wood & Eagly, 2012) as well as in behavioral differences related to competition and cooperation (Benenson & Markovits, 2014; Campbell, 2013; Geary, 2009; Seabright, 2012). However, social role theory and evolutionary theory are compatible. Evolved sex differences in physical formidability and social behavior help explain (but do not justify) the emergence, persistence, and cross-cultural patterning of the sexual division of labor and gender-related cultural norms. The balance of political leadership between women and men is the interplay of evolved sex differences with local ecology and cultural norms (Low, 2005).

We define leaders as individuals who are accorded differential influence within a group over the establishment of goals, logistics of coordination, monitoring of effort, and reward and punishment (von Rueden, Gurven, Kaplan, & Stieglitz, 2014). In this paper, we present measures of three overt domains of political leadership: verbal influence during community meetings, coordination of community-wide projects, and conflict mediation. We compare women's and men's degree of political leadership in these domains to sex differences in physical formidability and cooperation. We also assess the extent to which sex differences in cooperation and leadership are impacted by the sexual division of labor and access to formal education. Our study population is the Tsimane, a small-scale society of forager-farmers from lowland Bolivia. Estimation of the effects of sex differences in social behavior on the acquisition of leadership is rare outside of experimental settings. The institutions and diffuse, often non-overlapping social networks that structure social life in large-scale societies complicate such an analysis. Furthermore, the face-to-face politics, relative egalitarianism, and natural fertility that characterize the Tsimane more closely approximate the conditions under which much of women's and men's physiology and behavior evolved. By quantifying sex differences in political leadership and their determinants, among the Tsimane and other small-scale societies, we better understand the conditions that foster sex-based inequalities in any society.

In the following section, we develop a sexual selection account of sex differences in physical formidability and cooperation to better motivate our specific predictions. We then describe our predictions, the Tsimane, our methods, and results.

1.1. Sexual selection and sex differences in physical formidability and cooperation

Across animals, greater access to mates tends to have a stronger relationship with male reproduction than female reproduction, due to greater female investment in parenting and greater male potential reproductive rate (Janicke, Häderer, Lajeunesse, & Anthes, 2016; Trivers, 1972). As a result, sexual selection often acts more strongly on males, in terms of competition for access to mates and development of secondary sexual characteristics like larger body mass or weaponry that facilitate that competition (Darwin, 1871). In primate societies, females tend

to engage in dominance contests with greater selectivity (Clutton-Brock & Huchard, 2013; Foerster et al., 2017), and the relationship between dominance and reproduction is typically weaker relative to males (Ellis, 1995; Majolo, Lehmann, de Bortoli Vizioli, & Schino, 2012). However, the common sex difference in competitiveness over mates belies tremendous variation within and across species (Clutton-Brock & Huchard, 2013). Females often benefit from multiple mating partners (Hrdy, 1981; Kvarnemo & Simmons, 2013), and sex differences in competitiveness and dominance will attenuate or reverse in response to factors like sex ratio, variation in mate quality, or male parental investment (Brown, Laland, & Bergerhoff Mulder, 2009; Hemelrijk, Wantia, & Isler, 2008; Kokko & Jennions, 2008; Rosvall, 2011).

Human evolution depended critically on pair-bonding between women and men, biparental care, and extensive cooperation among non-kin (Kaplan, Hill, Lancaster, & Hurtado, 2000; Tomasello, 2009), which resulted in greater reproductive equality relative to other group living primates (von Rueden & Jaeggi, 2016). Nevertheless, physiological and behavioral differences between the sexes suggest greater selection on men to compete for status and mates via direct, physical aggression (Puts, 2010). In terms of upper body strength, the average man is stronger than 99% of women (Lassek & Gaulin, 2009), and men are on average more likely to engage in physical combat (Archer, 2009; Daly & Wilson, 1988). The greater contribution to female reproductive success from parental investment, including gestation and lactation, makes injury-causing activities more risky (Campbell, 2013). However, intra-group violence is infrequent in humans relative to chimpanzees and bonobos (Wrangham, 2017) and is often stigmatized if not punished when it does occur. Physical size and strength remain determinants of status in human societies because of their potential deployment, which can make physically formidable individuals valuable coalition partners (von Rueden, Kaplan, & Gurven, 2008) as well as more confident and persuasive when coordinating group members and representing the community's interests to outsiders (Lukaszewski, Simmons, Anderson, & Roney, 2015; von Rueden et al., 2014).

Men are more likely to cooperate in order to compete for status. Men's contribution to the sexual division of labor often indicates a greater willingness than women to trade-off household well-being for status gains and signaling of mate value (Bliege Bird & Smith, 2005; Hawkes, O'Connell, & Blurton Jones, 2001). For example, men in forager societies specialize in hunting not just to complement women's production, but also to show-off by pursuing riskily acquired food they can share widely beyond the household (Hawkes et al., 2001). Men are also more likely to value, build, and participate in large coalitions, often involving non-kin, in the service of intra-group status competition (Irons, 1983; Low, 1992; Smuts, 1995) and inter-group warfare (McDonald, Navarrete, & van Vugt, 2012). Historically, inter-group warfare was conducted almost entirely by men (Wrangham & Peterson, 1996), and its functions included the capture of women (Keeley, 1996) and enhancement of mate value via acquisition of resources and social status (Chagnon, 1988; Glowacki & Wrangham, 2015). Because women experienced less variance in reproduction and greater obligate parental investment over our evolutionary history (Betzig, 2012), women's reproduction may have benefited more from trading off status-enhancing coalitional activity with greater investment in intimate dyadic relationships that improved childcare (Benenson & Markovits, 2014; Campbell, 2013; Linney, Korologou-Linden, & Campbell, 2017; Low, 1992).

Consistent with greater selection on men to engage in large-scale coalition-building, men tend to be more cooperative than women when interacting with same-sex strangers in social dilemmas (Balliet, Li, Macfarlan, & Van Vugt, 2011), boys and men are more likely (on average) to organize their groups hierarchically and revere each other's competitiveness (Benenson & Markovits, 2014; Rose & Rudolph, 2006), and men can be quicker to resolve differences after a one-on-one conflict with a friend or rival (Benenson & Wrangham, 2016; Vigil, 2007). In building relationships with each other, women and girls are

more likely (on average) to eschew overt hierarchy and enforce egalitarianism, prefer dyadic relationships to group interaction, and trade-off a large social network for greater relationship intimacy and longevity (Campbell, 2013; David-Barrett et al., 2015; Maccoby & Jaklin, 1987; Vigil, 2007).

1.2. Predictions

Among the Tsimane, we first test whether men exhibit more political leadership than women, in terms of verbal influence during community meetings, coordination of community-wide projects, and conflict mediation (**prediction 1**). We then test whether men have more cooperation partners, especially same-sex cooperation partners (**prediction 2**). The latter prediction may result from greater motivation by men, as a result of sexual selection, to share widely beyond the family and to build large social networks with same-sex peers as a means of status competition.

Sex differences in motivation also contribute to the sexual division of labor, which may more directly explain our predicted sex difference in number of cooperation partners. Tsimane women with more dependent offspring may face greater constraints on their opportunity to network broadly beyond the extended household. Or motivations for such broad networking, as a means of acquiring status, may decline with motherhood more than fatherhood. A study of American subjects found that women with children (but less so men with children) reported that they would be most self-actualized via caring for their children, whereas women without children linked their anticipated self-actualization more to status and affiliation (Krems, Kenrick, & Neel, 2017). Past research with the Tsimane found a negative relationship between number of dependents and travel for women, but no relationship for men (Miner, Gurven, Kaplan, & Gaulin, 2014). We predict that women's greater investment in direct childcare partially explains the sex difference in number of cooperation partners (**prediction 3**).

Finally, we test whether sex differences in number of cooperation partners, in body size and strength, and in access to formal education associate with sex differences in political leadership (**prediction 4**). If Tsimane men have more opportunity or more motivation to form a large number of social ties, they are better positioned to emerge and be effective as village-wide leaders. Previous research suggests that social support, from both kin and non-kin, is the strongest predictor of leadership in Tsimane men (Glowacki & von Rueden, 2015; von Rueden et al., 2014). Despite their egalitarianism, the Tsimane show evidence of preferring larger, stronger individuals as leaders (Glowacki & von Rueden, 2015; von Rueden et al., 2008, 2014), which may mean sexual dimorphism in body size disfavors Tsimane women as leaders. Formal education also associates with leadership in Tsimane society, because community debates often concern interaction with Spanish-speaking Bolivians and with the market economy (von Rueden et al., 2008). Where schools are present, Tsimane girls tend to drop out of primary or secondary school at a faster rate than boys, which many Tsimane have explained to us as the result of parents' desire for their daughter's labor at home, parents' worries that their daughters will get pregnant too soon, and limited access to sanitary pads.

2. Tsimane economy and social life

The Tsimane live in small villages in the neotropics of central Bolivia. Their economy is based on swidden horticulture (plantains, manioc, rice, and corn), hunting, fishing, and fruit gathering. Food sharing and collaboration in productive activities are mostly confined to extended families residing in the same or nearby households (Hooper, Gurven, Winking, & Kaplan, 2015). The extended family, not the village, remains the central unit of social organization. On the other hand, unrelated community members will regularly visit each other to socialize and drink *shocdye* (chicha), an alcoholic beverage fermented from manioc and maize (Hooper, DeDeo, Caldwell Hooper, Gurven, & Kaplan,

2013). Women specialize in chicha-making and so play a pivotal role in social integration across families (Melgar, 2009).

The sexual division of labor is pronounced. Women average approximately 9 offspring over their lifetime and do the large majority of direct childcare and food processing (McAllister, Gurven, Kaplan, & Stieglitz, 2012). When parents are in their twenties, direct childcare is at its peak and consumes roughly 25% and 3% of women and men's time, respectively (Gurven et al., 2009). Men do nearly all the hunting, but there is less of a sex difference in terms of horticultural labor and fishing. Women will often coordinate collective fishing involving both sexes (Reviriego, Fernandez-Llamazares, Howard, Molina, & Reyes-Garcia, 2017; von Rueden et al., 2014). <5% of men are polygynously married, almost always to two sisters, and few marriages end in divorce (Gurven et al., 2009). Postmarital residence is often but not always matrilocal, followed by patrilocal or neolocal residence after the birth of one or two children.

Conflicts within Tsimane society tend to concern disputes over arable land, sexual rivalry, accusations of theft or adultery, and stinginess in the context of social exchange. The Tsimane have no documented history of intervillage warfare. Conflicts tend to be resolved by the parties directly involved. For many of the conflicts that remain unresolved, third parties within the extended family or in the community may step in to help mediate. Alternatively, village meetings may be organized by influential individuals to try to generate consensus concerning the relative guilt of the parties in conflict. The community may decide to inflict punishment, usually verbal censure, community service (e.g. clearing village trails), or public whippings on rare occasions.

Villagers also hold meetings to respond to incursion by illegal loggers or other colonists, negotiate with itinerant merchants, or coordinate projects with the Bolivian government or NGOs. The Tsimane remained largely unconnected to Bolivian society until the mid twentieth century with the arrival of Protestant and Catholic missionaries (Chicchón, 1992). In 1989, an evangelical organization, the New Tribes Mission, helped the Tsimane establish primary and secondary schools and more structured political organization, including a system of village corregidores (literally, 'correctors') and a pan-Tsimane council (Gran Consejo). Each village has a corregidor who is elected to facilitate community meetings and represent the community's interests. To date, only men have been elected corregidor. Their tenure can be as short as a couple of months, though most corregidores hold their position for approximately 5 years. Corregidores are normatively constrained to lead via consensus-building rather than by fiat, and their role during village meetings is often no greater than other influential residents. In past generations, shamans were among the more influential village members. Shamans were almost always male, and they would engage in verse to communicate with the guardian spirits of game animals and to cure disease (Ellis, 1997). Shamans have all but disappeared from Tsimane society, largely due to missionary influence.

3. Methods

3.1. Photo-ranking

In June of 2014, all adults from one Tsimane village ($n = 72$ women, 80 men) were rated by peers on two measures of political leadership:

Table 1

Descriptive statistics for adult women ($n = 72$) and men ($n = 80$) in the study community.

	Women avg.	Women range	Men avg.	Men range
Age	36.2	15–92	37.4	18–77
Height (cm)	150.5	142–163	162.6	150–174
Weight (kg)	58.3	38–94	65.6	52–107
Upper body strength (kg)	51.0	27–81	80.2	45–116
Education (years)	3.9	0–12	5.8	0–17

verbal influence during community meetings and coordination of community-wide projects. Mean age for women and men (Table 1) did not differ significantly ($t = 0.530$, $p = 0.597$). Six women and six men were randomly selected as raters; they represented most ages and extended families within the village. First, each rater evaluated two arrays of photographs of members of their community, one array at a time, according to “whose voice carries the most weight during community debates”. Each array contained nineteen photos. Photos were Polaroids™ of the top-half of each person's body, set against as neutral a background as possible. The raters were asked to rank the photos within each array from highest (19) to lowest (1). Second, the raters then repeated this procedure with two additional arrays of photos, which they evaluated according to “who knows how to manage community projects”.

To generate the photo arrays, we used random sampling without replacement. This was done separately for each of the two photo-ranked measures of leadership. We stratified our sampling according to gender, in order to ensure that each array contained photos of 9 women and 10 men. In addition, we ensured that no one rated themselves. For every array, the 19 selected photos were shuffled, and the order of the photos after shuffling determined the order in which they were placed in front of the rater. Raters were then asked to rearrange the photos into a line however they saw fit, with the highest ranked photo on the right and to its left lower ranking photos in succession.

Across our 12 raters, our photo-ranking method resulted in each of the 152 residents receiving three different ratings for each of our two measures. And each time a resident's photo was rated, it was against a different set of their fellow villagers. Ratings of each individual were summed, yielding a range in possible scores from 3 to 57 for each measure. Actual scores ranged from 4 to 57. Each rater evaluated the photos with no one else present but CvR and SA. Verbal instructions were translated into the Tsimane' language from Spanish and then, as a test of the accuracy of translation, back-translated into Spanish by Tsimane' from other villages.

3.2. Socioeconomic interview

The majority of adults ranked on political leadership were interviewed regarding their conflicts and cooperation partners ($n = 56$ women, 73 men). Women and men reported the names of other individuals in the village with whom they have been in conflict during the past 6 months and who mediated each conflict (if anyone). The number of times individuals were nominated as mediators constitutes our third measure of political leadership. Women and men also reported the names of individuals who they consider regular cooperation partners (food exchange, cooperation in food production, assistance with childcare, and aid when sick). Informal conversations with many Tsimane identified social visitation and support from allies as important indices of women's and men's popularity, respectively. So we also asked women to report the names of other women whose household they like to visit, and we asked men to report the names of allies who would assist them in a conflict. The number of times a woman was nominated constitutes her “visited by others” score, and the number of allies a man nominated constitutes his “allies” score. Finally, men and women reported their years of schooling and household income over the past year. Income was determined by asking about all potential sources of income, including wage labor and sales of horticultural goods produced by the household. CvR interviewed all men, while SA and a female Tsimane research assistant from another village interviewed all women. This division of labor was preferred because of the reticence of some Tsimane women when alone with unrelated men.

3.3. Observation

As a validity check on our leadership ratings, CvR attended two community-wide meetings during which attendance and verbal participation by attendees were recorded. All uninterrupted acts of speech

were summed per attendee, which is a conservative estimate of participation since speech acts varied widely in duration. As a validity check on our comparison of men and women's reported cooperation, we also compare men and women's observed cooperation. In 2005, CvR and other members of the Tsimane Health and Life History Project (THLHP: <http://www.unm.edu/~tsimane>) collected time allocation data in the study community. Spot observations were made of household residential clusters during 2-hour observation blocks. During these blocks, all activities of members from the household were recorded every half hour. Over a 9 month observation period, this procedure resulted in 79 ± 14 (1 SD) observations, on average, for each adult (>18yo) community resident ($n = 116$). From the time allocation data, we calculated the average activity group size and total number of different adults with whom adult men and women engaged in any kind of joint activity. We also calculated the fraction of time individuals spent in intra-household labor, including childcare, food processing, tool manufacture, and cleaning.

3.4. Anthropometry and demographics

Between 2013 and 2015, clinicians employed with the THLHP measured participants' height and weight with a portable stadiometer and a digital weigh scale, respectively. Shoulder and chest strength were measured with a Lafayette Manual Muscle Tester and grip strength was measured with a Smedley III dynamometer; we sum these values to create a composite upper body strength measure. All demographic data used to age individuals and determine kinship relations come from reproductive history interviews first collected in 2005 by the THLHP and updated annually thereafter (Gurven, Kaplan, & Zelada Supa, 2007). We designate three categories of kin relations: consanguineal kin (parent, child, or sibling), affinal kin (parent-in-law, child-in-law, or sibling-in-law), and non-kin (all others). These categories reflect the concentration of Tsimane social life within clusters of households consisting of siblings, their spouses, their parents, and their children. We estimate a producer-consumer ratio for each household: the number of individuals over 10 years divided by total number of individuals. We classify individuals under 10 years as “dependents”. While individuals over 10 are not yet self-sufficient producers, they do not receive much direct supervision and participate in much household labor.

Institutional Review Boards at the University of Richmond and the University of California, Santa Barbara gave approval for this research.

4. Results

4.1. Tests of prediction 1: men exhibit more political leadership than women

Comparing men and women's average photo-ranked scores, Tsimane men ($n = 80$) score 67% higher than women ($n = 72$) on verbal influence during village meetings (mean scores = 37.0, 22.2) and 64% higher than women on ability to coordinate community projects (mean scores = 36.8, 22.5). In support of **prediction 1**, these sex differences are significant, for both verbal influence ($t = 7.365$, $p < 0.001$) and coordination of community projects ($t = 7.656$, $p < 0.001$). Stratifying the analysis by sex of the rater does not significantly change these results. Within subjects, ratings of women are more variable than ratings of men: intra-class correlations for women's and men's influence are 0.704 (95% CI: 0.562–0.805) and 0.847 (95% CI: 0.779–0.897), respectively.

Verbal influence and project coordination show high inter-correlation, both for women ($r = 0.678$, $p < 0.001$) and for men ($r = 0.770$, $p < 0.001$). Principal components analysis of these two measures reveals a single factor with an eigenvalue greater than one, and which explains 90% of the variance. Thus, for the rest of our analyses and our discussion of results, we do not describe verbal influence and project coordination separately but as a single construct we call political leadership.

Our confidence in the validity of this latent political leadership factor is strengthened by ethnographic observation of two village meetings attended by CvR in 2014. How individuals score according to the political leadership factor correlates with their attendance at these meetings ($r = 0.370$, $p < 0.001$, $n = 152$) and with their frequency of speaking if they did attend ($r = 0.666$, $p = 0.002$, $n = 49$). At these meetings, women spoke $<10\%$ as many times as men did. We ran a linear regression model of political leadership, with sex, age, and age^2 as covariates (adj. $R^2 = 0.321$, $n = 152$). In the model, men score roughly half a standard deviation higher on political leadership than women (std. beta = 0.520, $p < 0.001$), though sex differences are maximal in mid-life (Fig. 1). For both sexes, political leadership tends to peak in middle age.

We also assess whether there are sex differences in the mediation of conflicts between adults. Village residents reported 124 conflicts over the previous six months. For 70 of the reported conflicts, residents described the involvement of one or more third party mediators. Individuals named as conflict mediators include 6 women (6 total mediations) and 17 men (65 total mediations). The conflicts mediated by women include a sexual affair, accusations of negligence in child and animal care, and perceived lack of support from a friend. The conflicts mediated by men include the above categories in addition to mediation of conflicts over land, theft, debts, gossip, free-riding on community projects, and support of allies. On average, men were reported to mediate more conflicts than women (Fig. 2). One individual (the male corregidor) reportedly participated in 56% of all conflict mediations. After removing the corregidor, a negative binomial regression model controlling for age and age^2 indicates men are almost five times more likely to be named as conflict mediators (Exp(B) = 4.532, 95% CI = 1.756–11.698, $p = 0.002$). We used a negative binomial regression because linear and Poisson distributions were a worse fit to the data based on information criteria, likely due to the large number of individuals who did not mediate any conflicts.

Men were also reported to mediate the majority of conflicts in which the mediator was not closely related to the participants (52 of 54 conflicts). Of the mediated conflicts they reported, women were more likely to identify a man than a woman as the mediator (16 of 21 conflicts). Women named as mediators do not score higher on the political leadership factor relative to other women ($t = 0.153$, $p = 0.884$). Men named as mediators do score higher on the political leadership factor relative to other men, even after removing the corregidor ($t = 6.659$, $p < 0.001$).

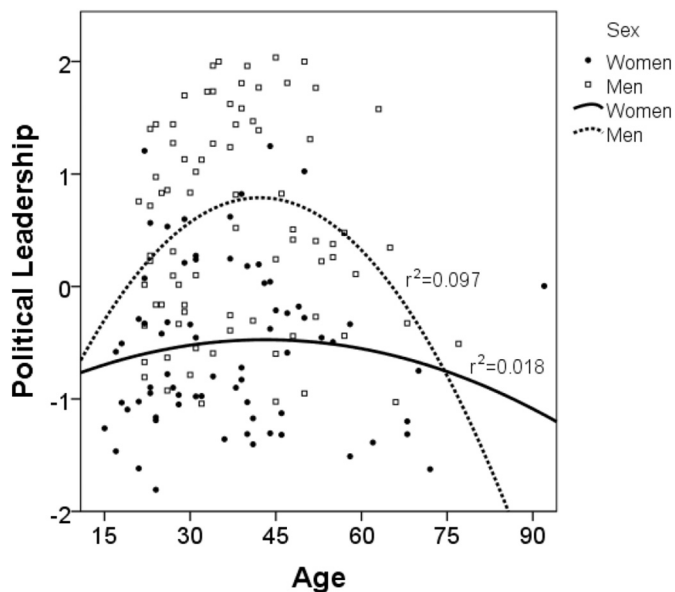


Fig. 1. Tsimane political leadership (factor loadings from PCA of “verbal influence” and “manages projects”) by sex and age ($n = 72$ women, 80 men).

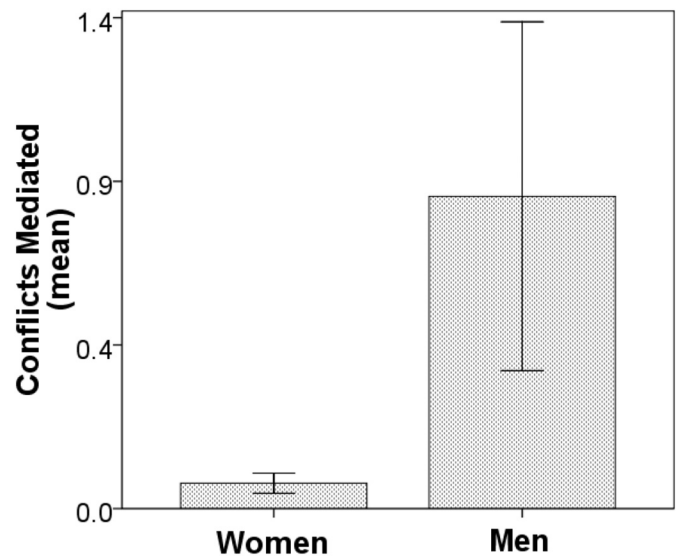


Fig. 2. Number of conflicts mediated on average by Tsimane women ($n = 72$) and men ($n = 80$) over previous 6 months. Error bars are ± 1 standard error.

4.2. Tests of prediction 2: men have more cooperation partners, especially same-sex cooperation partners

Women and men report on average 4.8 and 6.6 cooperation partners, respectively. We test **prediction 2** with Poisson regression models of different categories of cooperation partners, with sex (64 women, 76 men) as a covariate and age and age^2 as controls. Based on information criteria, Poisson models of cooperation partners outperformed those based on linear or negative binomial distributions. Men on average report 34% more cooperation partners, 113% more same-sex cooperation partners, and 305% more non-kin cooperation partners, despite no sex difference in number of intra-village consanguineal kin, affinal kin, or reported cooperation partners who are either type of kin (Table 2). Women report 29% more opposite-sex cooperation partners (Table 2).

As a validity check on the sex difference in reported cooperation partners, we compared men and women's total number of different activity partners based on observational data from our study community in 2005. Over the 9 month sampling period, adult women ($n = 53$) and men ($n = 63$) were on average observed in joint activities with 9.2 (range = 2–20) and 13.7 (range = 4–44) different adults (>18 years), respectively. We tested a Poisson regression model of each adult's total number of different, adult activity partners, with sex

Table 2

Effect of sex (64 women, 76 men) on number of intra-village kin and self-reported cooperation partners. Each estimated effect is from a separate Poisson regression with sex as a covariate and controls for age and age^2 .

Dependent variable	Women avg.	Men avg.	Exp(B) for sex	95% CI	p
Consanguineal kin	4.6	4.5	0.928	0.805–1.069	0.302
Affinal kin	9.4	9.3	0.932	0.844–1.030	0.167
Female kin	6.5	7.6	1.106	0.986–1.240	0.085
Male kin	7.5	6.2	0.779	0.694–0.875	<0.001
Coop. partners	4.8	6.6	1.335	1.155–1.542	<0.001
Coop. partners (same sex)	2.1	4.6	2.128	1.740–2.602	<0.001
Coop. partners (opp. sex)	2.7	2.0	0.713	0.572–0.890	0.003
Coop. partners (non-kin)	0.3	1.4	4.047	2.549–6.424	<0.001
Coop. partners (kin)	4.5	5.2	1.124	0.963–1.313	0.139

Bolded averages indicate significant sex difference.

as a covariate and number of observations, age, and age² as controls. Men were interacting with 44% more adults in the community ($p < 0.001$).

In 2005, adult women and men also differed in the average size of their groups when engaged in joint activities (women = 2.6 individuals; men = 2.9 individuals; $t = 3.149$, $p = 0.002$). We ran an additional Poisson regression model of observed activity partners from 2005, with average group size, sex, and their interaction as covariates, and number of observations, age, and age² as controls. Each standard deviation increase in individuals' average group size associates with 30% more activity partners within the village ($p < 0.001$). The effect of sex is reduced but remains significant ($\text{Exp}(B) = 1.179$, $p = 0.008$), and the interaction between group size and sex is nonsignificant ($p = 0.448$).

4.3. Tests of prediction 3: women's greater investment in direct childcare partially explains the sex difference in number of cooperation partners

Since Tsimane women invest more in direct childcare, number of dependents might place a stronger burden on women's opportunity to build a broad social network. Controlling for age and age², number of dependents does not significantly correlate with reported number of cooperation partners, whether for women (partial $r = -0.119$, $p = 0.358$) or for men (partial $r = -0.093$, $p = 0.435$). Also, number of dependents does not correlate with reported number of cooperation partners who are non-kin, whether for women (partial $r = 0.011$, $p = 0.934$) or for men (partial $r = 0.033$, $p = 0.780$). We ran a Poisson regression model of number of reported cooperation partners, with sex, number of dependents (standardized), and their interaction as covariates and age and age² as controls. As before, we find that being male associates with 33% more reported cooperation partners ($p < 0.001$). We find no effect for number of dependents ($p = 0.308$) or the interaction between sex and number of dependents ($p = 0.927$). An additional control for household producer-consumer ratio does not significantly change these results.

We ran two additional Poisson regression models, but with observed activity partners from 2005 as the dependent variable. These models tested the effects of number of dependents in 2005, time spent in intrahousehold labor in 2005, and their interactions with sex. Number of observations, age, and age² were included as controls. In the first model, each standard deviation increase in dependent offspring associates with 11% fewer activity partners ($p = 0.035$), but the effect of sex remains unchanged ($\text{Exp}(B) = 1.439$, $p < 0.001$). Sex interacts with dependent offspring ($p < 0.001$) such that among women and men, each standard deviation increase in number of dependent offspring is associated with 28% fewer and 38% more observed activity partners, respectively. In the second model, a 1% increase in time spent in intrahousehold labor associates with 1% fewer activity partners ($p = 0.011$), and the effect of sex is reduced and loses significance ($\text{Exp}(B) = 1.296$, $p = 0.096$). Intrahousehold labor interacts with sex ($p = 0.037$) such that among women and men, each 1% increase in time spent in intrahousehold labor associates with 11% more and 10% fewer observed activity partners, respectively. Given the high intercorrelation between sex and % time in interhousehold labor ($r = -0.808$, $p < 0.001$), these results should be interpreted with caution.

4.4. Tests of prediction 4: sex differences in number of cooperation partners, in body size and strength, and in access to formal education explain sex differences in political leadership

We first assess which of several traits most associate with men and women's score on the political leadership factor. We used the Automatic Linear Modeling procedure in SPSS (ver. 23) to add or remove predictors stepwise based on Akaike's Information Criterion Corrected (AICc). The traits we evaluated are: age, age², height, weight, upper body strength, education, household income, consanguineal kin, affinal

kin, spouse's leadership score, number of dependents under age 7, household producer-consumer ratio, reported cooperation partners, reported allies in event of a conflict (men only), and popularity in terms of social visitation (women only). Traits were only included in the modeling procedure if they correlated with leadership score at $p < 0.05$ (Table A.1). For women, the best fit linear model explains 47.8% (adj. R^2) of the variation in political leadership score and retains (in order of importance) visited by others, spouse leadership score, education, and weight as covariates (Table 3). For men, the best fit model explains 55.8% (adj. R^2) of the variation in political leadership score and retains (in order of importance) number of allies, education, weight, and spouse leadership score (Table 3). In bivariate correlation, the leadership scores of spouses are positively associated ($r = 0.523$, $p < 0.001$, $n = 66$).

We next assess which of the traits that show a sex difference best explain the sex difference in political leadership score. In addition to the sex difference in reported cooperation partners, men are taller than women ($t = 16.682$, $p < 0.001$), heavier ($t = 4.557$, $p < 0.001$), have more upper body strength ($t = 13.507$, $p < 0.001$), and spent more years in school ($t = 2.876$, $p = 0.005$). We ran a linear regression of political leadership score, with sex, height, weight, upper body strength, education, reported cooperation partners, and age and age² as covariates (adj. $R^2 = 0.583$, $n = 127$). In support of **prediction 4**, sex is no longer a significant predictor of political leadership score (std. beta = 0.078, $p = 0.517$). With the exception of height, all other covariates have significant effects: weight, upper body strength, education, and reported cooperation partners (Table 4). Only in combination do weight, upper body strength, education, and cooperation partner number fully mediate sex; in separate models they each only partially mediate the effect of sex (Table A.2).

5. Discussion

We studied political leadership in a relatively egalitarian community of Tsimane forager-farmers, where community-level politics tends to be consensus-based and there is a relative absence of formal institutions regulating behavior. We find that gender explains roughly 27% of the variation in a political leadership factor, which reflects who acquires verbal influence during community meetings and who coordinates community projects. Roughly 27% of men score higher on this measure than the highest scoring woman, and the average male leadership score is higher than 89% of all women's scores. These results are reflected in our observation in two community meetings we attended that women spoke <10% as many times as men did. Men are also more likely to mediate conflicts, particularly if the mediator is unrelated to the conflict participants. A previous study of social status in other Tsimane communities suggests a similarly large sex difference: 28% of men were nominated as important people in the community whereas only 2% of women were so nominated (Reyes-Garcia et al., 2008). The sex differences in overt leadership we identify in the Tsimane may be larger than in other relatively egalitarian societies. Several ethnographies of foragers and horticulturalists indicate that women play a large role in conflict resolution or denunciation of norm violators (e.g. Bowser &

Table 3

Estimates from stepwise linear regression models of women's ($n = 58$) and men's political leadership ($n = 69$).

Covariate	Women		Men	
	Std. effect	p	Std. effect	p
Allies	–	–	0.481	<0.001
Visited by others	0.334	0.001	–	–
Spouse leadership score	0.275	0.002	0.124	0.026
Education	0.189	0.008	0.187	0.007
Weight	0.114	0.037	0.138	0.019
Adj. R^2	0.478		0.558	

Table 4
Estimates from multiple regression models of political leadership (n = 127).

Covariate	Model 1		Model 2	
	Std. effect	p	Std. effect	p
Sex	0.481	<0.001	0.078	0.517
Age	0.759	0.031	0.808	0.010
Age ²	−0.789	0.025	−0.569	0.058
Height	–	–	−0.025	0.840
Weight	–	–	0.261	0.001
Upper body strength	–	–	0.246	0.034
Education	–	–	0.347	<0.001
Cooperation partners	–	–	0.267	<0.001
Adj. R ²	0.321		0.583	

Patton, 2010; Lewis, 2014; Wiessner, 2005), even if on average men in these societies are more likely to coordinate decision-making or speak during community meetings (Collier & Rosaldo, 1981; Lee, 1982; Lewis, 2014).

Our models suggest Tsimane men's leadership advantage is the joint effect of their (1) greater weight and physical strength, (2) greater number of cooperation partners (including kin and non-kin), and (3) more years of formal schooling. However, these traits associate with both men's and women's leadership. Also, the political leadership scores of spouses are correlated, which could be due to assortative mating or, subsequent to marriage, spouses converging on similar social strategies or influencing each other's reputations by pooling their production and social connections. In a previous study across several Tsimane villages, we found that spouses also associated on time spent in food production (Gurven et al., 2009). For women relative to men, body weight associated less with leadership and spouse leadership score associated more with leadership.

The association of physical formidability with leadership is not because leaders are more likely to use violence or physical intimidation. Anger and violence are stigmatized in Tsimane society, as in other relatively egalitarian societies. Rather, physical size and strength are valuable in leaders because of their potential deployment, which can make physically formidable individuals valuable coalition partners (von Rueden et al., 2008) as well as more persuasive when coordinating group members and representing the community's interests to outsiders (Lukaszewski et al., 2015; von Rueden et al., 2014). Physical formidability may also affect leadership via effects on personality. Previous research among the Tsimane found an association between physical strength and having an extraverted personality, for both men and women, which is consistent with the theory that personality is in part calibrated by physical condition over development (von Rueden, Lukaszewski, & Gurven, 2015). While Tsimane men score higher on extraversion than Tsimane women (Gurven, von Rueden, Stieglitz, Kaplan, & Rodriguez, 2014), this is not always the case in large cross-cultural studies with more educated, industrialized samples (Schmitt, Realo, Voracek, & Allik, 2008).

Tsimane men reported having more unique cooperation partners than women, particularly non-kin cooperation partners, and our statistical models suggest this sex difference may partly explain why men are more likely to be leaders. Cooperation partners include food- and labor-sharing partners and individuals who provide assistance in childcare and during sickness. We validated this sex difference in cooperation partner number with observations of the same study community 9 years earlier. Tsimane couples often live with the mother's family, especially early in the marriage, which may explain why men are not privileged in terms of number of cooperative ties to kin.

The sex difference in cooperation partner number may in part reflect sexually-selected social strategies, including greater motivation among men to show-off via sharing widely outside the household (Hawkes et

al., 2001) and to build coalitions in the service of status and mate competition (Benenson & Markovits, 2014; David-Barrett et al., 2015; Low, 1992; Smuts, 1995). Another, complementary explanation of the sex difference in cooperation partner number involves men's and women's labor. Sexually-selected social strategies contribute to the cross-cultural sexual division of labor, in which men are more likely to pursue high-risk productive activities and women invest more effort in parenting, intra-household tasks, and less risky productive activities (Hawkes et al., 2001). This division of labor can constrain women's social networking and increase men's reliance on or exposure to multiple cooperation partners. While we found no relationship between number of dependents and number of cooperation partners, our observational data suggests the sex difference in time spent in intra-household labor (including parenting, cleaning, tool manufacture, and food processing) substantially explains the sex difference in cooperation partner number. Tsimane men spend 37% less time than women, on average, in intra-household labor. However, increases in a woman's time in intra-household labor associated with *more* not fewer cooperation partners, while the reverse was true for men. Our observational data also show that men are cooperating in larger groups, which contributes to their greater number of cooperation partners.

Variation across societies in demographics, subsistence, and the sexual division of labor can produce variation in cooperation opportunity or motivation by sex, so we do not expect a male advantage in cooperation partner number to be universal. Throughout highland New Guinea, men reportedly had more exchange partners than women, as in our study of the Tsimane, and this sex difference is attributable to men's public displays of wealth (Lederman, 1990). In a study of Martu foragers in Australia, on the other hand, women were reported to cooperatively hunt more than men and to be more central than men in the village network of food transfers (Bliege Bird & Power, 2015). However, Martu women may not necessarily translate their centrality in food-sharing to positions of overt political leadership, especially since Aborigines in general have steep political and religious hierarchies that privilege men (Hiatt, 1996).

Tsimane women have fewer cooperation partners than Tsimane men, but social support is likely important for acquiring and maintaining overt political leadership in both sexes. Women who are visited more often by other women are more likely to be political leaders, as are men who report more allies in the event of a conflict. These measures showed stronger associations with political leadership in each sex than all other variables we assessed. Access to various forms of social support can associate with greater lifetime reproduction in both Tsimane men (von Rueden, Gurven, & Kaplan, 2011) and women (Rucas, 2015). In other small-scale societies, such as Agta and Bayaka foragers, women who are more central in their social networks have higher lifetime reproduction (Page et al., 2017), and men who are more popular are more likely to be polygynous (Chaudhary et al., 2015). Over the course of human evolution in small-scale societies, both sexes experienced positive selection on motivations to build and maintain social capital.

We find that formal education has a similar relationship with women's and men's political leadership, independent of cooperation partners and other attributes. However, men tend to complete more years of school than women, and this sex difference in education contributes to the sex difference in leadership. Community meetings privilege the educated because meetings often involve negotiation of contracts with non-Tsimane (thus requiring familiarity with the non-Tsimane world), and because bilingual Tsimane will occasionally converse in Spanish when non-Tsimane are in attendance. Our informal conversations with the Tsimane over many years suggest girls may be dropping out of school sooner to assist in domestic tasks, because their parents fear they'll get pregnant too soon, or because of lack of access to sanitary pads once girls reach menarche. The following quotes from Tsimane women illustrates the difficulties many women feel engaging in the discussion during meetings:

“You should speak [at the meeting],’ said my husband. But I said ‘I can’t speak; I don’t know how.’ ‘You should speak as you are now,’ he said. ‘But I am ashamed to,’ I said... [With you] I am able to speak in my own language.”

[Melgar (2009)]

“We come [to the meeting] and don’t say what we said we were going to say...that is how we are as women.”

[Melgar (2009)]

The large variation across men and women in access to formal education means women who do receive more education can gain political power over men. In a more remote Tsimane community, an educated Tsimane woman who had immigrated from the market town scored third in the community in a measure of political leadership (von Rueden, 2011). In our study community, roughly 60% of men and 75% of women have not completed primary school, and 11% of men and 21% of women have zero education. Women who acquire education and political leadership may then encourage more women to pursue education. A randomized natural experiment in India found that village level leadership by women erased the gender gap in educational attainment, arguably due to a role model effect on girls’ aspirations (Beaman, Duflo, Pande, & Topalova, 2012).

Tsimane men are also more likely than women to earn income from wage labor and to travel to the market town to sell horticultural goods produced by their household. A recent study of savings-led microfinance programs in poor rural communities in Ghana, Malawi, and Uganda found that participation in microfinance increased women’s attendance at community meetings (Karlán, Savonitto, Thuysbaert, & Udry, 2017). In our multivariate models, household-level income did not emerge as a significant predictor of men’s or women’s political leadership, likely due to covariation with formal education.

5.1. Study limitations

We do not claim to have evaluated all aspects of political leadership within this community, and our leadership measures do not capture less overt forms of political influence that may advantage women. Theoretical work is needed to develop metrics of status and leadership that do not necessarily emerge from men’s preferred forms of cooperation and competition. Also, public deference can be misleading. For example, women may speak confidently to their husbands in private but not in public, as evident in one of the above quotes from Tsimane women. Decision-making influence at the household level, such as in brokering marriages or residence moves, likely shows less difference between adult women and men (Dyble et al., 2015). And Tsimane women will coordinate small group collective action that involves both sexes, such as collective fishing (Reviriego et al., 2017; von Rueden et al., 2014).

Our linear ranking procedure may be less applicable to women than to men. Status negotiation can be more subtle and complex among women than men (Anderson, John, Keltner, & Kring, 2001), because women are more likely to enforce egalitarianism among same-sex peers (Benenson & Markovits, 2014) and because women tend to use indirect aggression more than men, including gossip (Benenson & Markovits, 2014; Hess & Hagen, 2006; Rucas, 2015). As a result, women’s hierarchies may tend to be less linear (Liesen, 2013). Indeed, we found greater variance in the rankings received by a woman compared to a man.

We did not directly measure women’s or men’s motivation to acquire overt political leadership. Across disparate cultures and samples, men are more likely than women to value power (Davies, Broekema, Nordling, & Furnham, 2017; Schuh et al., 2014; Schwartz & Rubel, 2005). As with sex differences in cooperation, power valuation by sex may result from sexually selected social strategies, the sexual division of labor, and reinforcement of the latter by gender discrimination.

Since our methods are correlational, we can only speculate about causality. For example, change in Tsimane men’s number of allies over a four year period positively associated with change in their influence during community meetings (von Rueden, 2011), but the relationship is likely bidirectional. Individuals with more cooperation partners are more likely to be leaders, and effective leaders are likely to attract more cooperation partners or participate in more events requiring cooperation. The sex differences in Tsimane cooperation and conflict may be a consequence as well as a cause of the sex difference in political leadership. However, it is less likely that leadership increases physical size, strength, or time in school.

5.2. Conclusion

Why women and men have differed in access to overt forms of political leadership across human societies may be due in part to sexual selection, on body size and on behaviors related to parenting, status competition, and coalition-building. The cross-cultural sexual division of labor emerges from (but is not justified by) such sex differences, affording men greater opportunity to compete for political leadership while restricting women’s opportunity. Over human history, men’s political advantages were exacerbated when changes in subsistence, particularly the spread of agriculture, favored greater competition between male coalitions to monopolize territory and surplus wealth. The winning coalitions used their power to increase control over women’s economic and reproductive behavior (Carmichael & Rijpma, 2017; Dong et al., 2017; Ross, 1986; Smuts, 1995), producing extreme variation in male reproduction (Betzig, 2012). Societies with the longest history of intensive agriculture, particularly use of the plough, evince the greatest gender inequality today (Alesina, Giuliano, & Nunn, 2013; Hansen, Jensen, & Skovsgaard, 2015).

Even in the absence of overt gender discrimination, job promotion or political advancement in industrialized societies may unduly depend on the kind of informal social networking which privileges men’s evolved coalitional psychology (Colarelli, Spranger, & Hechanova, 2006; Seabright, 2012). However, a contribution of sexual selection to sex differences in cooperation and acquisition of leadership does not entail genetic determinism, nor discounts the lability of the sexual division of labor as cultural norms change. Evolved sex differences can influence and interact with ecology and cultural norms to produce much variation in women’s political power. For example, the tendency for men to be more competitive in experimental games was eliminated in an experiment where women’s decisions can directly benefit their children (Cassar, Wordofa, & Zhang, 2016) and reversed in a matrilineal society (Gneezy, Leonard, & List, 2009). Matrilineal societies are not matriarchal, but they provide women greater opportunity to materially benefit their offspring and are where women were most likely to have held formal political power in preindustrial societies (Low, 2005). Progressive academics often view evolutionary arguments as antithetical to their aims, but the evolutionary perspective is invaluable in interpreting sex differences in leadership, in understanding how ecology, norms, and policies affect sex differences, and in making the case for more women in power (Konner, 2015).

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.evolhumbehav.2018.03.005>.

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Data availability

The data associated with this research are available at <https://doi.org/10.17632/626kth8pc5.1>.

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