

Gender reversals in social networks based on prevailing kinship norms in the Mosuo of China

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Abstract: Although cooperative social networks are considered key to human evolution, emphasis has most often been placed on the functions of male cooperative networks. As a result, gender differences in social networks are under-studied and remain incompletely theorized. Variation in kinship systems may be leveraged to test and generate hypotheses that explain the causes and effects of variation in gendered social networks. Specifically, by linking socio-ecological drivers to variation in kinship systems, human behavioral ecology provides a framework to anticipate and explain divergent patterns in gendered social networks within different kinship ecologies. In this paper, we test the ‘universal gender differences’ hypothesis positing gender-specific network structures against the ‘gender reversal’ hypothesis that women’s social networks in matriliney will more closely resemble those of men’s in patriliney. We compare these hypotheses using tools from social network analyses and data on men’s and women’s social networks in matrilineal and patrilineal Mosuo communities. In support of the gender reversal hypothesis, we find that women’s networks in matriliney are more similar to men’s in patriliney. Specifically, women in matriliney have higher edge density than do men, and women have higher measures of degree centralization than do men in matriliney whereas patrilineal men have higher measures of centrality than do women. Additionally, we find that geographic proximity and relatedness together predict women’s friendships in patriliney whereas relatedness predominates in matriliney. Finally, we find that friendship predicts ties in other domains of cooperation and social support. These results support the idea that the socio-ecological factors that result in different kinship systems also impact the ways that men and women operate within these systems, underscoring the importance of human flexibility in family making, and challenging the predominant narrative of universal gender differences.

Keywords: social relationships; matriliney; patriliney; cooperation; evolution; behavioral ecology

Introduction:

In summary, we propose that men and women are equally social, but their sociality is directed differently. To caricature, female sociality is dyadic, whereas male sociality is tribal. In other words, men seek social connection in a broad group with multiple people, particularly by competing for a good position in a status hierarchy; women, in contrast, seek social connection in close personal relationships based on mutual, dyadic intimacy.
- (Baumeister & Sommer, 1997, p. 39)

Humans are a deeply cooperative species. Indeed, many have gone so far as to argue that humans cannot reproduce without the assistance of others (Kramer, 2010). Social relationships are sources of information, resources, and other support that promote reproductive success (Apicella et al., 2012). Accordingly, evolutionary theory suggests that individuals should cultivate different social relationships and capitalize on them in different ways, depending on their circumstances and cultural contexts (Palchykov et al., 2012). Research suggests that males and females leverage networks differently in ways that correspond with gender-specific reproductive and cooperative strategies (David-Barrett et al., 2015). However, this research rarely takes an explicitly evolutionary perspective; furthermore, it has left low- and middle-income nations and non-Western participants under-represented (David-Barrett et al., 2015), and has predominantly relied on young children and adolescents, rather than adult participants (Vigil, 2007). Thus, the generalizability of observed gender differences in the properties of social networks is potentially limited as little attention has been given to how gender differences in social relationships may vary across social contexts. This is despite well-characterized variation in population structure and household demography, which shape individuals' interactions and formation of social ties (Power & Ready, 2019). In this paper, we compare gendered social networks in two villages - one matrilineal and one patrilineal - among Mosuo agriculturalists of Southwest China to test two hypotheses: that gender differences in social network structure are universal and reflect gender-specific reproductive strategies or that gender differences in social structure are shaped by the social environment, including kinship.

Evolutionary hypotheses positing universal gender differences are based on the premise that male and female reproductive and cooperative strategies diverge (Geary, 2006; Trivers, 1972) and that social relationships therefore serve different purposes for men and women (e.g., Baumeister & Sommer, 1997; Geary, 2006). Men are hypothesized to use social networks to achieve status-oriented objectives, whereas women's networks are hypothesized to be geared toward affiliative activities, such as childcare and other domestic activities (e.g., Benenson, 1990; David-Barrett et al., 2015; Rose & Rudolph, 2006). Predictions stemming from these hypotheses include: i) a stronger emphasis on protection and "in-group" concerns in men (and boys) (Benenson, 1990); ii) larger, more diffuse groups among men and more intimate, often dyadic relationships among women (e.g., Baumeister & Sommer, 1997; David-Barrett et al., 2015; Vigil, 2007); iii) deeper reliance on kin for men, because they have access to male relatives due to male philopatry; and iv) fewer heterosexual friendships in male networks, because these threaten male solidarity (Benenson, 1990).

The "universal gender differences" (UGD) hypothesis has garnered a fair amount of support across a range of studies. Women have been reported to treat friends more like kin, with men

treating friends more like strangers and pursuing status-oriented relationship goals (Ackerman et al., 2007), for example. In a large study of Facebook friendships surmised from profile photographs, David-Barrett et al. (2015) found evidence consistent with women favoring dyadic relationships and men favoring larger, all-male cliques. University men reported more friendships than women, and were reportedly more willing to sacrifice intimacy to secure more friends (Vigil (2007). In a review of available evidence, Rose and Rudolph (2006) concluded that girls were more likely than boys to engage in prosocial relationships and were motivated by 'connection-oriented' goals, whereas boys had larger, more hierarchical networks, with 'dominance' and 'self-interest' goals at the fore. These differences are generally thought to solidify into adolescence (Benenson, 1990). Similarly, in humans' closest living relatives, the chimpanzees, male social networks are differentiated based on dominance rank and based strongly on maternal kinship relationships (Mitani, 2009) and, in gorillas, male philopatry results in more dispersed networks for males (Bradley et al., 2004). While these results are not compared to female networks, they are often used as evidence of the primacy of hierarchical and relatively large male networks in primate and human evolutionary history.

Many evolutionary arguments appeal to male philopatry as a primary reason for gender differences in social networks, on the premise that philopatry was common or universal during much of human (or primate) evolutionary history (e.g., David-Barrett et al., 2015; Vigil, 2007). However, philopatry is variable among non-human primates, where the benefits of social bonds to females have been argued to be a causal driver of female philopatry in a majority of non-human primate species (e.g., Wrangham, 1980). Even in non-human primates most closely related to humans, where male philopatry prevails, it appears that the importance of female social bonds has been under-emphasized (Emery Thompson, 2019) and that males and females show less divergent use of social bonds than sometimes reported (Langergraber et al., 2009; Psylla et al., 2017). Among humans, contemporary hunter-gatherers are highly flexible in residence (Kramer & Greaves, 2011; Wood & Marlowe, 2011). More generally, although male philopatry and female exogamy are modal among human societies (Murdock & White, 1969), humans are remarkably flexible in post-marital residence across cultures (Surowiec et al., 2019), creating varying constraints on the social relationships available to men and women (Power & Ready, 2019). In sum, flexibility in human social bonds may be more extensive than in non-human primates, but several lines of evidence in humans and non-humans suggests that we should expect flexibility rather than universals in gendered relationships (Langergraber et al., 2009; Power & Ready, 2019; Rodseth & Novak, 2006).

In this paper, we leverage variation in kinship norms and institutions among the Mosuo of Southwest China to investigate differences and similarities in gendered social networks. Evolutionary anthropologists have hypothesized that kinship systems are shaped by social and environmental circumstances (Alvard, 2011; Shenk & Mattison, 2011) in ways that alter the costs and benefits associated with gender-specific reproductive strategies (Holden et al., 2003; Mattison, 2011; Mattison et al., 2016). We have argued previously that Mosuo matriliney is driven by limited reproductive differentiation between the genders due to a resource base (agriculture) that is expansive and not particularly productive and that does not therefore support a strongly divergent male reproductive agenda (see also Alesina et al., 2013; Brown et al., 2009), as well as norms and institutions that allow some men to limit investment in reproductive partners and parenting activities (Mattison, 2011; Mattison et al., 2019; see also Fortunato,

2012). By contrast, patriliney, which predominates in the Mosuo villages located in more rugged, mountainous terrain, appears to be reinforced by monogamous unions and the need for stable male support of spouses and children (Mattison et al., 2021). In this context, we anticipate that many of the reported gender differences in social networks will be apparent among patrilineal, but not matrilineal, Mosuo. Furthermore, we test the hypothesis that matrilineal women – who are arguably more central and autonomous than previously thought (Mattison et al., 2019; Reynolds et al., 2020) – may display similar use of networks as men in patriliney (the “gender reversal hypothesis”; GRH).

Specifically, we compare the universal gender differences hypothesis (UGD) and gender reversal hypothesis (GRH) with the following predictions:

- 1) UGD: Men have larger networks across matriliney and patriliney; women will show greater evidence of dyadic relationships. GRH: Women will have larger networks in matriliney and men will have larger networks in patriliney.
- 2) UGD: Men’s networks will show greater evidence of the influence of relatedness on structure than women’s across contexts. GRH: Women will be more reliant on kin in matriliney than men and men will be more reliant on kin in patriliney than women.

Methods and Study Site:

Population: The Mosuo are a population of roughly 40,000 agriculturalists residing in the Hengduan Mountains on the border of Sichuan and Yunnan Provinces in Southwest China. They are famous among anthropologists for their matrilineal traditions, involving inheritance that effectively moves through lineally related household women (Mattison, 2011), prominent roles for grandmothers and maternal uncles (Shih, 2010), and lack of consistent involvement in parenting by some, but not all, fathers (Mattison et al., 2014, 2019). Less well known are geographically distinct populations of Mosuo, who are patrilineal and whose norms involve transmission of wealth and status from parents to their sons, monogamous marriage, and more limited, if still relatively strong, female autonomy (Mattison et al., 2021). Evidence suggests that the patrilineal Mosuo separated from the matrilineal region 500 years ago or earlier, establishing separate norms and institutions while continuing to identify as Mosuo and maintaining a variety of shared customs, language, religion, and attire (Mathieu, 2003; Mattison et al., 2021). We have shown previously that these differences in kinship norms and institutions are associated with reversals in child gender preference (Mattison et al., 2016) and gendered differences in health (Reynolds et al., 2020). We speculated that some of this arises via more limited social support for women in patriliney (Reynolds et al., 2020), a hypothesis which we test directly here.

While little is known about cooperation among the patrilineal Mosuo, ethnographic and quantitative evidence suggests that it is extensive among the matrilineal Mosuo. Mosuo people routinely come together to help during planting and harvesting seasons, for example, and cooperate in the construction of homes or in home repairs, help with ceremonial preparation and costs, and jointly invest in economic ventures (C.-K. Shih, 2010; Thomas et al., 2018). Large households help with domestic activities such as childcare, and household sisters are said to reproduce as a communal effort toward ensuring lineage and household longevity (Ji et al., 2013; Shih & Jenike, 2002). At the same time, tourism and acculturation have led to an increasing

fraction of households adopting non-normative institutions and plausibly acting more autonomously than might otherwise be expected (Mattison, 2010; Walsh, 2001; see also Wu et al., 2015). The villages sampled in this study were both relatively far removed from sites of tourism and are considered relatively ‘traditional’ by locals.

Data collection: We carried out social network interviews as part of the [ENDOW project](#) in an attempt to do full networks of households in one matrilineal (N=40 households) and one patrilineal (N=35 households) community of Mosuo in the summers of 2017 and 2018. Accompanied by local guides, we walked from house to house and asked any available adult member of the household, male or female, who could also comment on the networks and kin relatedness of other adult members of the household, to participate. After the study was explained and their questions were answered, participants provided informed consent (UNM IRB 06915). We used a name generator approach in which respondents were asked to free list individuals with whom they have various kinds of social ties (Marsden, 2005). Two network layers were double sampled and inquired about sharing of money and capital: respondents were asked to/from whom they would lend/borrow a week’s wages if needed, and to/from whom they would lend/borrow farm equipment. Four layers were focused on household productive activities, including providers/recipients of help to carry out home repairs, work in the fields during harvest, and (for women) help with childcare or preparing for a family/community event, such as a wedding or funeral. Two additional network layers asked respondents to identify individuals that the men and women of the household considered close friends (“*pengyou*”) with whom one would ‘hang out’ (*wan*) or ‘chat’ (*liaotian*) after dinner, a common activity among friends.

Data Analysis: We used social network analysis to describe differences in gendered networks. Social network analysis is a useful tool for understanding qualitative dynamics of network structure when the full network is known. Here, we used social network density, centrality, and degree distributions to assess whether there are qualitative differences in men’s and women’s social networks between the matrilineal and patrilineal communities of Mosuo.

We used exponential random graph models (ERGMs) to test investigate whether male and female friendship networks in the two contexts were structured by relatedness and household distance. We also used ERGMs to test whether a household’s instrumental network layers were predicted more by men’s or women’s social ties. We estimated all ERGMs with a parameter for kinship, distance, and reciprocity (when appropriate and estimable). To assess the importance of men’s and women’s social ties for instrumental networks, the men’s and women’s social networks were also included as predictors. ERGMs use a maximum likelihood method to assess whether the presence of particular structural features increase or decrease the likelihood of producing a network of the observed structure.

Results:

Prediction 1 (network size and dyadic relationships): In matrilineal friendship networks (responses to the two “friendship” name generator questions), the degree distribution (k) – the number of alters (social ties) nominated by each ego (participant) – revealed a fatter distribution and a higher average number of alters for women than men (Figure 1). Edge density – the

number of nominated friendships over all possible friendships – was correspondingly higher for women (0.045) than men (0.027) in matriliney (Table 1), and the modal number of friends was 2 for both men and women.

Figure 1. Degree (k) distributions in matriliney and patriliney, by gender. The distributions reference the number of alters nominated in friendship ('hangout') networks.

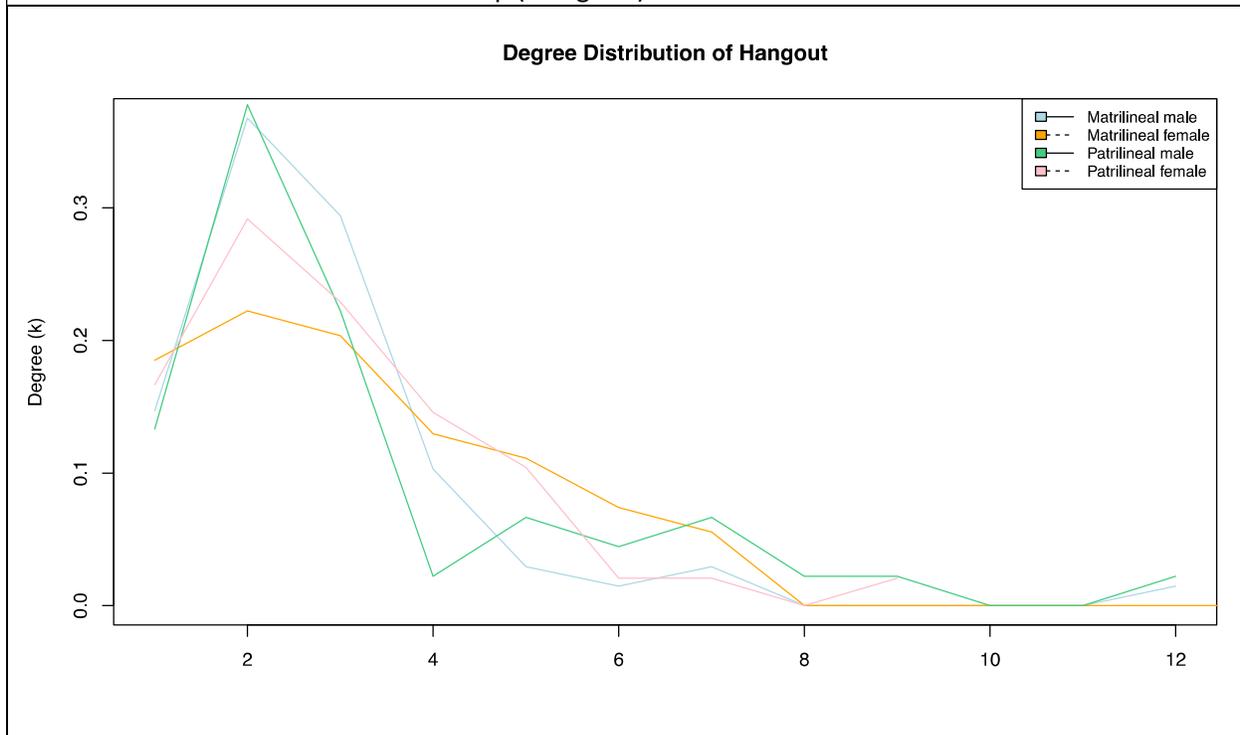


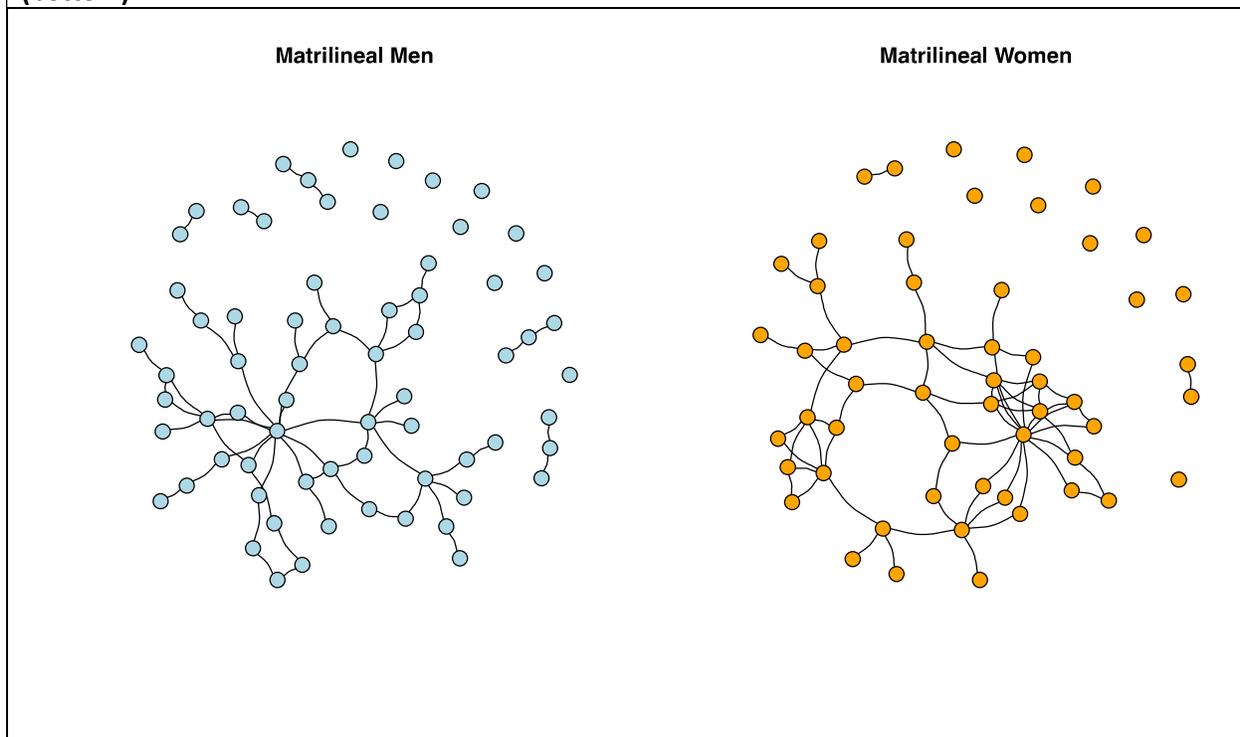
Table 1. Matrilineal and patrilineal network descriptive statistics for a range of social networks.

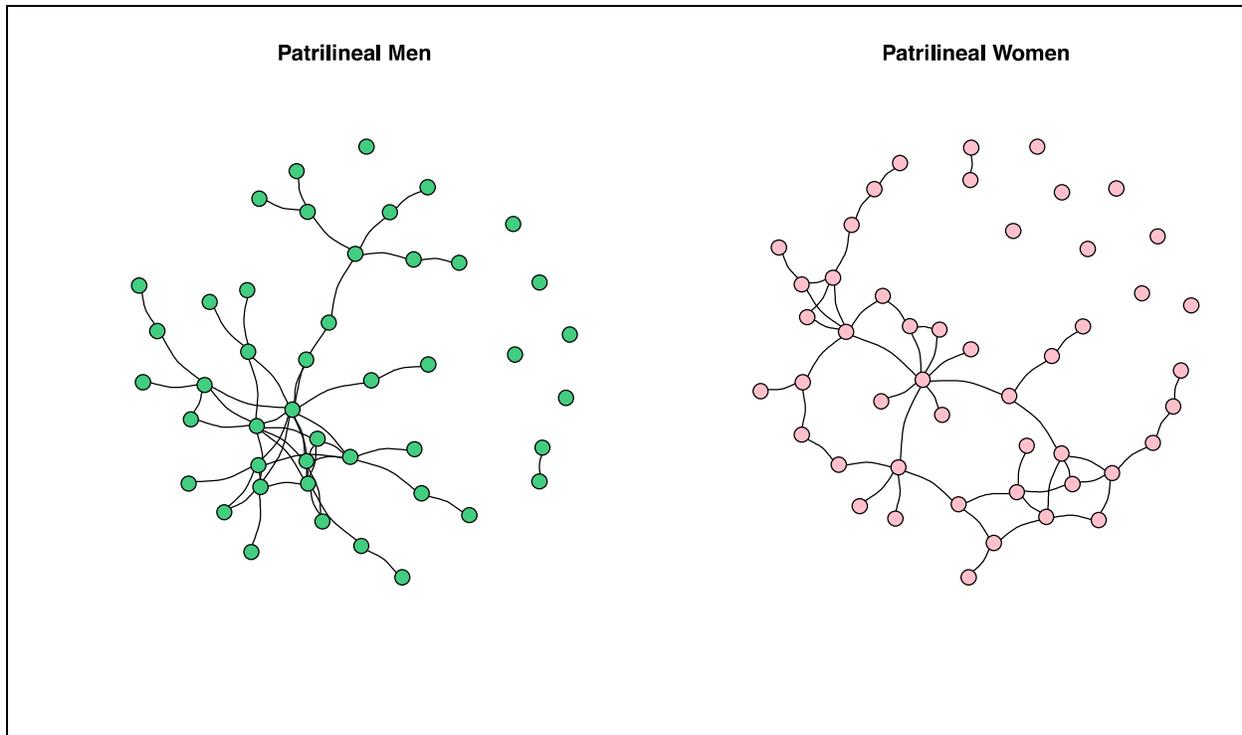
	Degree centrality		Edge density	
	Matriliney	Patriliney	Matriliney	Patriliney
Hangout (women)	0.1999	0.128	0.045	0.043
Hangout (men)	0.137	0.196	0.027	0.054
Childcare	0.016	0.028	0.006	0.01
Community meals	0.1224	0.056	0.02	0.022
Harvest	0.026	0.056	0.007	0.021
Farm equipment	0.0676	0.148	0.014	0.329
Money	0.059	0.052	0.009	0.026

In patriliney, the degree distribution was also a bit fatter for women, but men had a longer right tail, indicating greater heterogeneity among patrilineal men (Figure 1). Edge density was slightly higher for men (0.054) than women (0.043) in patriliney (Table 1).

Overall, women in matriliney stand out as having relatively more friends, but both genders in both contexts most commonly reported 2-3 friends, rather than larger numbers of friendships. Dyadic friendships that were fully isolated from broader networks were not more apparent among women in either matriliney or patriliney, although we caution that these are one-way indicators of potential relationships over an incompletely measured network, so must be interpreted with caution. The number of isolates is the same (10) among matrilineal men and women, but is slightly higher for women in patriliney (8) compared to men (5) (Figure 2).

Figure 2. Men's and women's friendship ('hangout') networks in matriliney (top) and patriliney (bottom).





The network characteristics summarized in Table 1 reveals an interesting reversal in centralization between men and women in matriliney versus patriliney. Specifically, men have higher degree centralization (0.196) than women (0.128) in patriliney and women have higher degree centralization (0.1999) than men (0.137) in matriliney. This may provide a sense of status pursual within networks; the highest heterogeneity seems to be in men's networks in patriliney, where a few men seem to be in relatively strong positions relative to others.

Prediction 2 (relatedness and reliance on kin): In matriliney, relatedness predicted a friendship tie for both men and women (Table 2). In patriliney, relatedness, but not geographic distance, predicted a friendship tie in men, whereas both relatedness and geographic distance predicted a tie in women (Table 2). Thus, women in patriliney stand out as using both geographic proximity and relatedness to structure friendships.

Table 2. ERGM: Predictors of a tie in the hangout network

		Matriliny		Patriliny	
		Women	Men	Women	Men
Edges	Estimate	-3.03	-3.74	-2.74	-3.175
	Std. Error	0.211	0.224	0.245	0.256
	MCMC%	0	0	0	0
	P value	<0.0001	<0.0001	<0.0001	<0.0001
Kinship	Estimate	5.86	9.53	6.131	7.815
	Std. Error	1.46	1.365	1.573	1.515
	MCMC%	0	0	0	0
	P value	<0.0001	<0.0001	<0.0001	<0.0001
Physical distance	Estimate	-0.0003	-0.0004	-0.0011	-0.00003
	Std. Error	0.0001	0.0002	0.0003	0.0003
	MCMC%	0	0	0	0
	P value	0.075	0.0584	0.00174	0.926

In matrilinearity, friendships seem to be meaningful predictors of support (i.e., the presence of a tie in networks of support of a particular type, e.g., childcare): Women's friendships and relatedness predicted assistance in childcare and help preparing community meals (Table 3). The latter was also predicted by geographic proximity. Assistance with harvesting was predicted by relatedness and both men's and women's friendships (Table 3). Matrilineal men's friendship networks predicted lending of farm equipment, as did relatedness and reciprocity (Table 3). Money lending was not predicted by friendship networks, but by relatedness and reciprocity (Table 3). Overall, the results suggest that relatedness is important across networks and that gendered friendships predict support in other gendered activities in matrilinearity.

Table 3. ERGM prediction for different activity in Matrilinearity

		Childcare	Harvest	Community meals	Money	Farm equipment
Edges	Estimate	-6.32	-5.77	-4.145	-5.327	-5.173
	Std. Error	0.694	0.529	0.225	0.443	0.344
	MCMC%	0	0	0	0	0
	P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Kinship	Estimate	11.77	6.98	3.687	4.282	4.077
	Std. Error	3.242	2.73	0.069	1.971	1.543
	MCMC%	0	0	10	0	0
	P value	0.0003	0.011	<0.0001	0.0299	0.008
Physical distance	Estimate	-0.0004	-0.0002	-0.0004	-0.001	-0.0003
	Std. Error	0.001	0.0004	0.0002	0.0007	0.0003
	MCMC%	0	0	0	0	0
	P value	0.574	0.697	0.044	0.1332	0.247

Reciprocity	Estimate			0.526	4.988	4.66
	Std. Error			0.731	0.911	0.661
	MCMC%			0	0	0
	P value			0.472	<0.0001	<0.0001
Female network	Estimate	1.384	1.237	2.069	0.031	0.227
	Std. Error	0.648	0.599	0.352	0.552	0.394
	MCMC%	0	0	0	0	0
	P value	0.03	0.039	<0.0001	0.9546	0.564
Male network	Estimate	0.58	1.729	0.302	0.687	1.223
	Std. Error	0.702	0.612	0.428	0.488	0.333
	MCMC%	0	0	0	0	0
	P value	0.41	0.00475	0.4812	0.1597	0.0002

P value: <0.001***; <0.01**;<0.05*

Reciprocity is used for prediction when it is not zero in metrics calculation (see Supplementary Table.1)

Contrasting this with patriliney reveals striking differences: childcare network ties were not predicted by kinship, but by friendship and geographic proximity (Table 4). Preparation of community meals - activities dominated by women – were predicted by *men's* friendship networks, as well as relatedness and geographic proximity (Table 4). The same pattern holds for harvest networks, activities to which both men and women contribute (Table 4). However, both men's and women's friendships predicted a tie in the money lending network, as did relatedness and reciprocity (Table 4).

Table 4. ERGM prediction for different activity in Patriliney

		Childcare	Harvest	Community meals	Money	Farm equipment
Edges	Estimate	-4.668	-3.54	-3.358	-4.597	-3.93
	Std. Error	0.439	0.235	0.22	0.28	0.238
	MCMC%	0	0	0	0	0
	P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Kinship	Estimate	3.59	5.89	4.387	4.146	1.179
	Std. Error	2.516	1.38	1.49	1.375	1.233
	MCMC%	0	0	0	0	0
	P value	0.1536	<0.0001	0.003	0.003	0.338
Physical distance	Estimate	-0.002	-0.001	-0.001	0.00003	-0.0007
	Std. Error	0.0008	0.0004	0.0003	0.0002	0.0002
	MCMC%	0	0	0	0	0
	P value	0.0474	<0.0001	0.0002	0.9	0.004
Reciprocity	Estimate		-0.013	-0.309	3.677	4.391
	Std. Error		0.835	1.08	0.58	0.46
	MCMC%		0	0	0	0
	P value		0.988	0.775	<0.0001	<0.0001
Female network	Estimate	1.789	-0.0013	-0.002	0.98	0.676
	Std. Error	0.582	0.03	0.011	0.34	0.285
	MCMC%	0	0	0	0	0

	P value	0.0021	0.967	0.882	0.004	0.017
Male network	Estimate	0.998	1.37	0.903	0.72	0.141
	Std. Error	0.623	0.37	0.399	0.33	0.346
	MCMC%	0	85	0	0	0
	P value	0.1093	0.0002	0.024	0.03	0.684

Reciprocity is used for prediction when it is not zero in metrics calculation (see Supplementary Table.1)

Discussion:

Despite the repeatedly demonstrated importance of social relationships to human and non-human primate reproductive success and well-being, there has been remarkably little work in evolutionary anthropology investigating how social relationships may be structured and used differently by men and women in varying contexts. The bulk of existing work posits and finds universal differences in the structure and use of networks between men and women, based largely on young, wealthy, industrialized participants. Our study is the first of which we are aware to compare male and female social networks in two very different kinship contexts: matriliney and patriliney. Because these contexts differ in the extent to which they support divergent male and female reproductive strategies, they are ideal for understanding how fixed (or flexible) gendered social relationships are. Here, gender *reversals* are apparent across a range of network structures: under patriliney, we see men displaying the pattern anticipated for men according to the universal gender differences hypothesis, whereas under matriliney, we see *women* displaying similar patterns. Specifically, we see higher edge densities among men compared to women in patriliney versus higher among women than men in matriliney; degree centralization metrics are similarly reversed; we also see male relationships structuring activities that are commonly led by women (e.g., childcare) in patriliney, where there is also apparently a lesser reliance on relatedness; women's friendships predict activities known to be led by women in matriliney.

These findings reinforce the need to critically evaluate the assumptions that underlie hypotheses of universal differences in male and female social and reproductive strategies. There are at least two, neither of which characterizes both subpopulations of the Mosuo. First, the Universal Gender Differences (UGD) hypothesis assumes that reproductive variance is higher in men than in women – due to women being constrained by childcare – and that this motivates men to cultivate larger (“diffuse”) networks as a means to gain status (and, as a result, more mating opportunities). Among the Mosuo, patriliney is more likely to produce the condition of larger variance in reproductive success for men (Holden et al., 2003; Mattison, 2011), and indeed we found differences between male and female social networks that are consistent with the UGD hypothesis under patriliney. More generally, although male variance in reproductive success is higher, on average, than female variance among humans, there is substantial population-level variation (Brown et al., 2009), with variation in female reproductive success occasionally outstripping male. Furthermore, monogamy results in substantial decreases in male and female divergence in RS, given relatively high investments into childcare by both men and women and otherwise overlapping reproductive interests (Fortunato & Archetti, 2009; Kokko & Jennions, 2008). Monogamy characterizes the bulk of relationships among patrilineal and matrilineal Mosuo (Mattison et al., 2021), but exists within the context of relatively small, mostly nuclear domestic units in patriliney, suggesting that status-oriented pursuits may have more limited

impact on male reproductive success among the Mosuo – even in patriliney – than it might in contexts where polygyny prevails.

Second, the UGD hypothesis often references male philopatry and female emigration as an ancestral pattern of community organization to which men and women adapted differently. Specifically, scholars have argued that general tendencies toward male-biased philopatry in humans should lead to stronger, kin-based coalitionary networks in men versus a focus on fewer, more intimate relationships in women (Vigil, 2007; Wrangham, 1980). Although patrilocality is the modal form of human social organization in contemporary societies (Murdock & White, 1969), it is far from universal (Surowiec et al., 2019) and is very unlikely to have been the single emigration pattern of Pleistocene foragers, who were much more likely to have displayed flexibility in residence (Kramer & Greaves, 2011; Wood & Marlowe, 2011). Our results reinforce the importance of differences in the social and demographic constraints imposed by kinship systems in structuring access to kin and the costs and benefits to men and women of sex-specific strategies (Koster et al., 2019; Power & Ready, 2019; Starkweather et al., 2020). For example, whereas men and women's friendships in were predicted by relatedness, women's friendships in patriliney were also predicted by geographic proximity. This suggests that women in patriliney may rely on non-kin to a greater extent than women in matriliney, where kin are more readily available. The number of isolates for women in patriliney is also relatively high, which is to be expected if the proportion of new immigrants is also higher (Koster et al., 2019).

Gender reversals in social network characteristics may also call into question existing dogma surrounding the absence of matriarchy and the possibility of matriliney as a mirror image of patriliney (Parkin, 2021; Schneider, 1961). Women in matriliney are often implicitly or explicitly assumed to never fully take on the roles of men in patriliney, particularly as societal leaders. However, a variety of evidence points to the importance of female leadership and status in securing evolutionarily relevant benefits, such as their own and their children's health and welfare (Alami et al., 2020; Reynolds et al., 2020). While they may not fully mirror the extent to and means by which men wield authority in domestic and political spheres, *reversals* in network structure suggest that women's activities look more similar to men's when women are more central and have more authority and social support (Hrdy, 2000; Mattison et al., 2019; Smuts, 1994). This underscores the importance of general, rather than gender-specific, models of reproductive and cooperative strategies that consider social, demographic, and ecological constraints affecting the potential for complementarity and divergence between men and women (Bliege Bird & Bird, 2008; Mattison, 2016; Starkweather et al., 2020). The large households characteristic of the matrilineal Mosuo are likely to free many women from the demands of childcare by providing ample and capable allocarers, whereas the nuclear households characteristic of patrilineal Mosuo are more likely to be conducive to more domestic-oriented activities among women envisioned by many evolutionary models. Certainly, gender reversals in social network patterns - edge density and degree centralization, among others - provide further evidence of variation, rather than universals, as the rule in human social and reproductive strategies (Sear, 2016).

Our study is subject to a number of important limitations. First, this is a static, largely descriptive portrait of relationships, which are known to change across the life course, perhaps more for women than for men (Palchykov et al., 2012). Stability of relationships may have important

implications for health, well-being, and reproductive success (Cheney et al., 2016) that we cannot capture here, perhaps particularly for women in patriliney where many relationships are established subsequent to marriage. Our ability to capture spatially and temporally diverse friendships that characterize humans and distinguish us from non-humans (Rodseth et al., 1991) is incomplete. Nor do we have information on the intimacy or specific exchanges implied by observed relationships that might help to test differences in the quality and intensity of relationships anticipated by hypotheses as reviewed in the introduction (e.g., Rose & Rudolph, 2006; Vigil, 2007). This, too, would provide important insights on how the strength of relationships relates to fitness and well-being (Scelza, 2011; Silk et al., 2010), and whether this varies by gender across different social systems. Our networks are based on self-reported, often one-way ties. Although we have no reason to suspect biases in any particular direction, observations of specific types of cooperation (e.g., working on someone's farm (Thomas et al., 2018)) would help to verify the patterns we describe here. Because we did not sample every adult in the villages, certain metrics are not fully comparable across networks. Still, relatively sparse networks have previously been reported for the Mosuo (Thomas et al., 2018; Wu et al., 2015) compared to what is seen in foraging and pastoralist communities and this is consistent with our ethnographic observations of significant within-household cooperation with more limited between-household cooperation except under specific circumstances such as organizing community events. Finally, comparing our results to prior network studies based on more complete networks drawn from other settings, e.g., classrooms, is difficult (Benenson, 1990; Vigil, 2007). Considering the limitations of network methods and metrics in field settings will be important in future studies of gender differences in social relationships.

Conclusion: Social relationships are critical to health, well-being, and reproductive success in both human and non-human animals. Females provide important forms of support (Silk, 2007) that often go unrecognized in evolutionary studies of cooperative networks, which have often been focused on men or Western, non-adult population. We have shown here that, across a number of important metrics, gender differences in social and cooperative networks reverse in matriliney compared to patriliney. This calls into question common assumptions undergirding universal models of gender differences in social and reproductive strategies, which are likely to be met sometimes, but not always, and which were unlikely to have fully characterized ancestral human environments. Our point is not to say that men and women never diverge or that they do not pursue complementary strategies, but to suggest that more general models of human evolutionary strategies that incorporate non-gender-specific constraints, will offer a broader understanding of human flexibility. Given the links between social support, health, and well-being across species (Cheney et al., 2016; Power & Ready, 2019; Silk et al., 2003), this is not merely a theoretical exercise.

Supplementary Table 1. Other metrics for a range of social network in Matriliney and Patriliney.

	Eigenvector centrality		Betweenness centralization		Transitivity		Reciprocity		Assortativity	
	Matriliney	Patriliney	Matriliney	Patriliney	Matriliney	Patriliney	Matriliney	Patriliney	Matriliney	Patriliney
Hangout Female	4.97	3.53	0.18	0.34	0.21	0.104	1	1	-0.15	-0.121
Hangout male	4.02	5.41	0.298	0.41	0.08	0.285	1	1	0.014	0.145
Childcare	1.62	1.90	0	0	0	0	0	0	-0.083	0.092
Meals	5.86	3.83	0.025	0.005	0.164	0.077	0.12	0.033	-0.21	-0.198
Harvest	1.902	4.095	0	0.004	0	0.125	0	0.068	-0.1	-0.196
Farm equipment	4.11	6.19	0.009	0.08	0	0.054	0.57	0.588	-0.11	-0.34
Money	3.70	3.55	0.005	0.04	0	0.136	0.56	0.488	-0.25	-0.086

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