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Kin and Kinship Psychology both influence cooperative coordination in Yasawa, Fiji

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Abstract

Genes shared through common ancestry are among the oldest social bonds. Despite these ancient roots, humans often co-opt the psychology of genetic relatedness and extend it to genetically unrelated others through culturally-acquired kinship systems. We investigate how genealogical relatedness and kinship norms might mutually support or oppose each other within a known kin network in Yasawa, Fiji. Yasawans' reliance on intensive, kin-based cooperation for daily life makes Yasawan kinship an interesting test case to compare the effects of genealogy and kinship norms. Confirming qualitative ethnographic claims, we find that Yasawan kin terms can be described in two dimensions of respect/ closeness and joking/ authority. Individual players use different strategies for genealogical relatives and non-relatives by making economic game choices that are increasingly beneficial to partners who share a higher percentage of genes through common ancestry. However, pairs of players are most successful in coordinating their game choices despite conflicting self-interests based upon kinship norms relevant to hierarchy. Thus, while genealogical relatedness may boost generosity, the extra behavioral structuring from kinship norms facilitates more productive but difficult coordinated action even when communication is not possible.

Keywords

Cooperation, kinship, norm psychology, coordination, economic games, field experiments, Fiji

1. Introduction

They say that blood is thicker than water. Though this phrase is often used to emphasize the importance of family, its original meaning was the opposite: that the blood of the covenant (with God – connections made by choice) is thicker than the water of the womb (connections made through birth; Jack, 2005). The paradoxical history of even this simple idiom encapsulates the paradoxical nature of kin psychology. Though social ties through common ancestry are among the oldest forms of sociality, the psychology of kinship across human societies regularly co-opts sentiments geared toward genetic relatives and extends them to unrelated strangers.

Kin selection (Eberhard, 1975; Hamilton, 1964; Nowak, 2006; Read & Grushka-Cockayne, 2011; Smith, 1964) explains how some traits can evolve in a population through an organism's own reproductive success and their genetic relatives' success. This inclusive fitness should favor traits that boost altruism toward genetic relatives. Kin-selected traits may include cognitive and psychological mechanisms that direct our interactions with genetic relatives (Fessler & Navarrete, 2004; Lieberman, Tooby, & Cosmides, 2007; Schaich Borg, Lieberman, & Kiehl, 2008; but see also Glassman, Packel, & Brown, 1986; Kurzban, Descioli, & Fein, 2012); a suite of psychological traits that forms kin psychology.

Along with psychological mechanisms for managing interactions with genetic relatives, human kinship also involves extensive cooperation with genetic non-relatives. Humans in every society have culturally evolved kinship systems - complex arrays of norms that harness kin psychology and apply it to govern behavior towards others of all degrees of genetic similarity. These kinship norms can make kin-focused psychological mechanisms more potent, extend activation to include genetic non-relatives, and suppress activation toward actual genetic relatives (J. Henrich, 2015: Chapter 9). Importantly, this array of norms can expand cooperation beyond genes. Kinship systems also include terminological systems – sets of labels that we use to identify various others to whom we should behave in a certain way – that constantly re-enforce the kinship norms through daily use. The ways that kin psychology extend feelings of familial interconnectedness may itself be a building block to other norm systems like economic markets and resource trade (J. Henrich et al., 2010; Malinowski, 1932; Seabright, 2010); religious systems (Graham & Haidt, 2010; Johnson, 2009; Johnson & Bering, 2006; Norenzayan, 2013; Sosis & Ruffle, 2004; D. S. Wilson, 2003); and secular governments (Kay, Shepherd, Blatz, Chua, & Galinsky, 2010; Norris & Inglehart, 2004; Shariff & Norenzayan, 2007) that support ever expanding, increasingly complex societies. Kinship norms provide just one of the many norm systems we use to facilitate cooperation (Kimbrough & Vostroknutov, 2013; Sripada & Stich, 2006).

Despite evolutionarily ancient roots, evidence for the specific effects of kin selection on human psychology is mixed. Some observational studies suggest kin selection can boost cooperation, especially in small-scale societies (Apicella, Marlowe, Fowler, & Christakis, 2012; Lieberman et al., 2007; C. J. Morgan, 1979). Other studies suggest kin selection may only explain a limited amount of human cooperation (Laland, Odling-Smee, & Myles, 2010; Richerson & Boyd, 2006; Richerson, Boyd, & Henrich, 2010) with reciprocity acting as a stronger motivation – especially in small-scale societies (Kaplan & Hill, 1985; Winterhalder, 1996; Gurven, 2004a; Patton, 2005; Allen-Arave et al., 2008; Jaeggi & Gurven, 2013). Still others claim that adaptations ascribed to kin selection may be described by more general processes of group selection (Nowak, Tarnita, & Wilson, 2010; Lehmann, Keller, West, & Roze, 2007), though non-human mammals show favoritism toward genetic relatives (Silk, 2006; Smith, 2014). Many critics of kin selection's impact on human evolution suggest that culture is the more prominent force. Indeed, one of the most potent aspects of normative kinship is in its ability to structure routes of reciprocity and resource allocation in human societies by blurring lines of blood and marriage to unite and divide particular classes of relatives independently from genetics. In that case, cultural phenomena like kinship norms and kinship terminology may be the more important factor in shaping human behavior.

It is tempting to see kinship norms act as a bridge genetic relatedness and cultural convention, but it remains unclear whether any kinship norm or terminological system correctly and consistently identifies kin by degree of genetic relatedness (H. L. Morgan, 1870; Stone, 2014). Further, fictive kinship – the use of kin terms to designate others who are genetically unrelated, such as brothers in Christ or brothers in arms – can co-opt the psychology of cooperating with relatives and apply it to unrelated others (Carsten, 1995; 2000; Clarke, 2008; Schneider, 1984). Kinship systems, especially in smaller-scale societies throughout the Pacific, often encompass relationships beyond genetic similarities (Sahlins, 2013; 1976). Though these Pacific societies' kinship systems often include terminology that does not directly convey genetic relatedness, favoritism toward more closely genetically related children over adopted children shows that these kinship systems do not totally override genetic favoritism (Silk, 1980). Therefore, the interplay between kin psychology directed toward genetic relatives and normative kinship is an interesting topic for investigation.

1.1. Overview of Studies

We recruited villagers in Yasawa, Fiji, to investigate how members of a small-scale society balance genealogical kin relations against kinship norms. We predict that, if Yasawans preferentially cooperate with genetic relatives, then they will make more generous choices for more closely genetically related others in an economic game. However, there is more to social life than generosity. We also predict that the extra norm structure of kinship facilitates coordination on either symmetric or asymmetric payouts that present a conflict of interest between players.

We first briefly describe how Yasawan kinship blurs consanguine and afinal lines that allow us to examine how genealogy and kinship interrelate to influence social decisions. In study 1, we quantitatively map out the insider, emic norms around Yasawan kinship terms through a card sort task. In study 2, we describe an economic game Yasawans played with kin. We analyze game results for both individual players and pairs of players. We investigate what factors promote more generous choices toward partners; kin altruism should promote more generous choices for closer genealogical relatives. We also examine what factors facilitate coordination on symmetric or asymmetric payouts when players' self-interests conflict.

1.2. Kinship in Yasawa

Yasawa Island is the northern most in the Yasawa Island Chain, a cluster of volcanic islands in northwestern Fiji. Most Yasawans subsist as fisher-horticulturalists, relying on traditional food production techniques, local ecological conditions, and cooperative sharing. Yasawans organize their cooperative activities around traditional kin-based social hierarchy, which confers certain obligations, responsibilities, and privileges based upon relative rank.

Traditional Fijian village life centers around a highly-structured, clan-based kinship system, culminating in a hereditary chief. Maintaining one's place within this hierarchy through proper observance of kin obligations is central to the definition of being a good Fijian (Brison, 2001). Properly observing traditional norms is also often believed to provide supernatural protection from local spirits and sorcery (Brison, 2001; Katz, 1999; McNamara, Norenzayan, & Henrich, 2014; Tomlinson, 2004). Even the hereditary chiefs can be ousted from power if they are seen to fail in their duties to the community (Gervais, 2013).

1.2.1. Kinship, Hierarchy, Communal Ownership, and Kerekere

Traditional Indigenous Fijian resource exchange is marked by three principles: communal ownership among members of a given kin group, top-down decision-making, and the *kerekere* system for soliciting aid from kin. Within a village or kin group, the highest-ranking individuals are responsible for instigating and directing group action. Namely, the chiefs decide how resources and labor will be arranged within the village, elders have the next say, then the eldest male of each household, etc. Those who are lower in status must not exhibit too much ambition so as to supersede their place, while those who are higher in authority are obliged to look out for the wellbeing of those who are below (Sahlins, 1962; Schlossberg, 1998; Torren, 1990).

The *kerekere* ("please") system can be seen as a mechanism for resource redistribution within this hierarchical-decision making and communal ownership setting. *Kerekere* can be used to make requests for food, service, use of property, money, etc. Importantly, a *kerekere* request should ideally only be directed toward kin. *Kerekere* fits hand-in-glove with the ideal of community ownership, as it is a great shame to have to make a *kerekere* request outside of the family and to reject a *kerekere* request from a person who is genuinely in need. *Kerekere* may act as an informal insurance system that helps distribute resources from those with many resources to those with few. When one chooses to fulfill a *kerekere* request, this fulfillment comes with the expectation that it can be reciprocally called upon for aid in the future (though the scale need not be exactly equivalent; the relationship is often more important than items exchanged; Farrelly & Vudiniabola, 2013; Sahlins, 1962; Schlossberg, 1998; Thomas, 1992).

This traditional exchange system embedded within hierarchical decision-making and communal ownership adds an illuminating dimension to the present study. *Kerekere* in particular is controversial in modern Fiji because it is quite antithetical to individual accumulation of capital necessary for Western-style economic development. *Kerekere* is often cited as a major hurdle to small business growth, deemed detrimental to entrepreneurial spirit in Indigenous Fijian villages, and blamed for a dependency orientation in Indigenous Fijian culture (Farrelly & Vudiniabola, 2013). Further, traditional deference to authority may reduce the effectiveness of initiatives that require egalitarian community engagement (Schlossberg, 1998). As such, individuals' self-maximizing motivations may be mitigated by both the inclusive-fitness tracking motivations to distribute resources to genetic relatives and – particularly in the presence of this kin-mediated hierarchical exchange system – may be re-directed against individual self-interest to benefit the communal interests of the family based upon norms of how to interact with particular kin. Importantly, evidence that Yasawans might be using these relationship cues to act differently toward particular relatives may further highlight how cooperation systems may operate outside of the context of individualist orientation and third-party monitoring systems inherent to modern Western economic and governmental systems.

1.2.2. Indigenous Fijian Kinship Structure

The Yasawan kinship system,[1] broadly similar to kinship throughout Fiji, is patrilocal and bifurcate merging patrilineal (Capell & Lester, 1945a; 1945b; 1946a; 1946b; H. L. Morgan, 1870; Nayacakalou, 1955; 1957). Hierarchy within the traditional political system is organized along the distinction between male and female (with men out-ranking women) and age (with older out-ranking younger). The Yasawan kinship system, like kinship elsewhere in Fiji, comprises several primary units that track increasing distance beyond the immediate family: *itokatoka* (extended family or sub-clan), *mataqoli* (clan, several *itokatoka* linked by a common male ancestor, act as land-owning units), and *yavusa* (phratry, a cluster of *mataqoli* linked by a common male ancestor). The archetypal *yavusa* is sub-divided into five *mataqoli* clans, each descending from one of five founding brothers who were the sons of the local ancestor spirit *Kalou-vu*; the chiefly clan comes from the eldest brother's line. Traditional village affairs like gardening, fishing, building houses, etc. are often organized around *yavusa* and *mataqoli* bonds. Though the clans forming each *yavusa* are intimately tied to the land where their founders established their lineages, *mataqoli* and *yavusa* can span multiple villages, and some villages include multiple *yavusa* (France, 1969; Nayacakalou, 1955; 1957).

This intimate connection between place and people makes one's place/ family background an important part Fijian identity (Brison, 2001). The Fijian kinship system includes terms that track individuals' origins according to both their father's and mother's lineages (Felgentreff, 1999). *Taukei* (native, technically "owner") refers to a person who belongs in and to a particular place. *Koi* tracks father's village (*koi* is followed by a place name – a person whose father is from a particular village), and *vasu* tracks mother's village (*vasu* also connotes privileges to take freely from one's mother's relatives). Origin is so fundamental to identity that Yasawans who are born in the city and who have never even been to the village will still call themselves e.g. *koi Teci* (if their father was from Teci village).

Yasawan kin terms within the immediate family (Figure 1) assign various kin labels based upon sex and seniority. Following the bifurcate merging logic, some terms combine consanguine and affinal relations together in parallel/ classificatory vs. cross designations. The parallel vs. cross designations are determined by relationship to one's parents. Kin terms for mother (*nau*) and father (*tata*) are applied to parents, parents' same-sex siblings, and parent's same sex siblings' spouses (e.g., mother's sister's husband is *tata*). Conversely, parents' opposite-sex siblings are cross, thus avuncular (*gwadi* is both "mother's brother/ uncle," and "father's sister/ aunt"). Similarly, the same *tamaya* "brother" and *tinaya* "sister" sibling terms are used for full siblings and for children of a parents' same sex siblings, while children of parents' opposite sex siblings are cross-cousins (*tavale*). Importantly, classificatory sibling cousins and cross-cousins are equally genealogically related to the ego, but the norms for how to interact with them differ drastically. For example, cross-cousins are often ideal marriage partners, are friends who are

[1] The kinship terms used here are in the Yasawan (Teci) dialect. Different influences of Polynesian settlement in the East vs. Melanesian settlement in the West led to cultural and linguistic differences across Fiji; for example, unlike some Fijians, Yasawans generally avoid marrying first cousins. We therefore focus on Yasawa-specific kinship terms and norms. Terms used in other works based on villages elsewhere in Fiji often use the Standard Fijian/ Bauan dialect, which is Fiji's *lingua franca*. Some terms are slightly different in Yasawan vs. Bauan; for example, the Yasawan *koi* is *kai* in Standard Fijian, and *mataqoli* is *mataqali.*

easy to joke with, and are generally treated more informally. However, classificatory siblings are treated with the utmost respect and avoided for marriage even more strictly than full siblings. For example, conversation between a woman and her classificatory brother is strictly prohibited, and the two must always be chaperoned. Classificatory siblingship can extend to even distant cousins who are practically genetically unrelated.

[Figure 1 here]

Figure 1 Yasawan kinship terms from the perspective of a child (ego). Yasawan kinship tracks male lineage, ranks based on sex and seniority, and follows a bifurcate merging system.

2. Study 1: Yasawan Kinship Norms

In study 1, we examine Yasawan kinship norms to investigate how kin terms compare to each other within the Yasawan kinship system. We later use these kinship norms to compare the effects of culturally defined, linguistic terms against genealogical relatedness in study 2.

2.1. Method: Kin Term Card Sort

We assess Yasawan kin term norms in a series of interviews conducted in July 2011 (interview 1, n = 61) and July 2013 (interview 2, n = 60). To get at the normative core of Yasawan kin terms, we asked participants to imagine how a hypothetical man (interview 1) or woman (interview 2) would behave toward various kin across five behavioral dimensions: interpersonal closeness, asking for help, giving help, respect, joking, and giving commands. We focus on these dimensions due to their theoretical relevance, prior ethnographic work suggesting these dimensions are especially relevant to Yasawan kinship, and ease of participant comprehension. We presented participants with 26 kin terms (see Table 1) written on 3x5 in. index cards. Participant sorted these kin terms in order of least to most relevant to that dimension (e.g. most emotionally close to most emotionally distant; most respected to least respected, etc.). We asked participants to rank all 26 terms simultaneously to ensure they were thinking about terms' comparative importance.

Yasawan Kin Term	English Translation
Nau	Mother & Mother's sisters
Tata	Father & Father's brothers
Tinaya	Sister; Full & Classificatory – Parents' same-sex siblings' daughters
Tamaya	Brother; Full & Classificatory – Parents' same-sex siblings' sons
Tutua	Older sibling (same for male & female, full & classificatory)
Nau Levu	Mother's older sister ("Big Mother")
Nau Sewa	Mother's younger sister ("Little Mother")
Tata Levu	Father's older brother ("Big Father")
Tata Sewa	Father's younger brother ("Little Father")
Tai	Grandparent (same for grandmother & grandfather)
Gwadi	Parents' or Grandparents' opposite-sex siblings (both aunts & uncles)
Tavale	Cross-cousin; Parents' opposite-sex siblings' children (males & females)
Batuvu	Opposite-sex siblings' children

Vugaya	Same-sex siblings' children (classificatory children)
Viagoya	Grandchildren (full & classificatory)
Weleya	Spouse (same for husband & wife)
Tabu	Wife's sister/ Husband's brother ("taboo")
Karua	Same-sex siblings-in-law; spouse of *tabu* ("second spouse")
Navi	Man's brother-in-law
Vasu	A man's sisters' children, esp. sons/ denotes maternal ties to a village
Itokani	Friend
Vulagi	Foreigner

Table 1 Yasawan kin terms used for kinship norms card sort. Kin terms range from nuclear family to in-laws to genetically unrelated friends and foreigners.

2.2. Results: Kin Term Principle Components Analysis

We ran a principle components analysis on kin term rankings to reduce their dimensionality and get an average score for each kin term using the psych (Revelle, 2011) and FactoMineR (Le, Josse, & Husson, 2008) packages in R (R Development Core Team, 2008). We used varimax rotation to capture the maximum amount of variance. Our analysis supported a two-component solution with a component for closeness, respect, and giving/ receiving help (accounting for 48% of the variance) and a second component for joking and giving commands (accounting for 26% of the variance; see Table 2).

Kin Term Dimension	Component 1: Respect/ Closeness	Component 2: Joking/ Authority
Closeness	0.77	0.34
Ask for help	0.84	0.25
Give help	0.85	0.08
Respect	0.80	-0.25
Joking	0.15	0.84
Give commands	0.02	0.88

Table 2 Principle Component loadings for kin terms with varimax rotation (n=121).

Figure 2 shows how each kin term scores on a 2-demensional space of both components. Of note, grandparents (*tai*) and aunts/ uncles (*gwadi*) are high on respect/ closeness and lowest on joking/ authority, while cross-cousins (*tavale*) are highest on joking/ authority. We use component scores extracted from these kin term dimensions to examine how kinship norms compare to genealogical relatedness in the social decisions.

[Figure 2 here]

Figure 2 Kinship terms mapped on our norm ranking components. More respected and emotionally close terms are high on component 1. Kin with less authority/ lower rank and more likely to be joked with are high on component 2.

2.3. Discussion

Our cluster analysis of Yasawan kin term norms reveals two main dimensions that describe how kinship directs interpersonal relations. In the first dimension, kin terms may promote more emotional closeness and respect. Relationships high on this respect/ closeness dimension are one's immediate family, people that Yasawans rely on most for help and support. On the other hand, the second dimension of joking/ authority tracks relationships that are less respected. Respect in Yasawa generally centers on obedience, quietness, and humility. Within the Yasawan kinship hierarchy, higher rank garners more respect. A high-ranking, highly respected relative is free to joke around with lower ranking relatives, but a lower ranking relative should not be so frivolous and nonchalant with the respected relative – they should remain humble, obedient, and quiet. Similarly, higher-ranking relatives have the authority to command lower ranking relatives to do various things, whereas lower-ranking relatives would never make such demands. We also see that aunts and uncles are treated more like grandparents than parents and are the most respected and the least likely to be joked with. Kin terms that combine high closeness/ warmth (high on dimension 1) and high likelihood of joking around are the most nonchalant and the most equal relationships. Cross-cousins and spouses dominate this high closeness/ high joking quadrant of our two-component kinship norm space. Cross-cousins can be treated with less formality and relative disrespect – one can be loud, boisterous, demanding, and flirtatious with cross-cousins in a way that is not condoned in most other relationships. Often, the closest emotional relationships are with cross-cousins (spouses are here too, mirroring the cross-cousin marriage ideal; see Radcliffe-Brown (1940) for more detail on joking and non-authority in cross-cousin relationships).

We include foreigner and friend, two common non-genetic social relationships, to orient terms that may have genetic similarity against clear genetic non-relatives. Spouse's same-sex siblings (*tabu*) garner as much distance as foreigners. *Tabu*, in this normative framework, are practically outsiders. On the other hand, friends are clustered with in-laws; friends are treated with more nonchalance than foreigners and *tabu*, but not as much warmth as spouses or cross-cousins. Yasawans appear far more likely to rely on the immediate family for warmth and closeness than friends.

3. Study 2: Kin Coordination Game

In study 2, we investigate how genealogical relatedness and kinship norms influence Yasawans' social decisions. Participants played an economic game with a series of known others in the village, identified solely through photographs (without name or kinship label). Economic games have been used to measure prosocial norms and preferences in cultures around the world and within this population (Engel, 2011; Gervais, 2013; Gurven, 2004b; J. Henrich, 2006; 2012; J. Henrich & Henrich, 2014; Marlowe, 2003). Other studies have shown local norms of resource allocation within families can differentially influence how genealogical relatedness modifies economic game behavior an anonymous game (Macfarlan & Quinlan, 2008). For our study, we ask players to make choices toward known others, which can further target how players might balance genealogical relatedness vs. normative kinship (for other non-anonymous games in Yasawa, see Gervais, 2016).

3.1. Method: The Kin Game

We use a modified, three-choice, asymmetric pay-off coordination game similar to a three choice battle of the sexes game (Luce, 1957; see online supplement for detail). We modified the game by making it impossible for players to get a self-maximized outcome unless their partner also chose the option that was most against their own self-interest. By building this conflict of interest into the game, we can pit preference for egalitarianism against preference for maximum self-benefit and against a preference for generosity. This mixed strategy game can highlight whether certain dimensions of Yasawan kinship might be described by equity or by mutual recognition of differing hierarchical rank and acceptance of payout asymmetries. Examining how normative and/ or genealogical relatedness might be referenced to resolve these conflicts of interest may further highlight how kin-directed sentiments can be called upon to direct social action, even in the absence of explicit communication.

3.1.1. Participants = Players

We recruited 60 participants (ages 20-80, *M*= 43.7; formal education 3-13 years, *M*=9; 33 women) from two adjacent villages that encompass a single *yavusa* (phratry). Participants received a $1 FJD show-up fee in addition to any game earnings.

3.1.2. Partners

Partners (N=107; ages 19-89, *M*= 46.04; 55 women; 2 were dropped due to unknown genealogical relatedness) were randomly selected from existing databases of known kin relationships. Players made choices about each partner as they were presented from a randomized stack of photographs.

3.1.3. Kin Terms

We determined kin terms players use to identify partners using data from an interview conducted in 2010. Villagers identified as many other villagers as possible using 19 of the 26 kin terms described in study 1. *Tavale* (370) "cross-cousin" (child of parent's opposite-sex siblings) was the most common, followed by *gwadi* (326) "uncle/ aunt" (opposite-sex sibling of parent and that person's spouse), *luvenqu* (189) "son/ daughter," *tamaya* (172) "brother," and *tinaya* (138) "sister." The high frequency of cross-cousins (*tavale*) and parent's opposite-sex siblings (*gwadi*) are due to these terms having a particularly prominent classificatory function. For example, if one's grandfather's sister had a child, both that grandfather's sister *and* her child would be called *gwadi*. Full details of the 18 kin terms, frequencies of their observation, and average genealogical relatedness for each term are in the online supplement.

3.1.4. Genealogical relatedness

We calculate degree of genealogical relatedness using genealogies that go back five generations, collected through previous demographic interviews that were cross-checked for accuracy.[2] We calculate Wright's r (Wright, 1922) values using the kinship2 package (Therneau, Atkinson, Sinnwell, Schaid, & McDonnell, 2014) in R (R Development Core Team, 2008). Wright's r indicates the probability that any two genes sampled from two individuals will be the

[2] However, as we do not have samples of participants' DNA, we cannot account for potential paternal uncertainty.

same due to common ancestry. Wright's r for this sample ranges from 0.0-0.51 with a mean of 0.02 (a bit less than second cousins) and a standard deviation of 0.078. Of 1800 choices (30 for each of 60 participants), approximately 81% were toward genealogically unrelated others (Wright's r = 0). Though this may seem low, even small, highly-cooperative, traditional hunter-gatherer societies often have at most around 25% of the population with a detectable genetic relatedness (Henrich, 2015; Hill et al., 2011). Across our sample, the smallest detectable relatedness r value we calculate is 0.0039. If we look just at the subset of 320 choices from players who were genealogically related to their partners (Wright's r > 0.0039), the average relatedness jumps to 0.11 (a bit less than first cousins), with standard deviation of 0.15.[3]

We multiply Wright's r values by 100 to convert them from a proportion to a percentage.[4] Kin altruism should be greatest between pairs with the highest percentage of probable shared genes through common descent.[5] We therefore expect that players who are more closely genealogically related to their partners should be less likely to make self-maximizing choices (i.e., more likely to choose neutral or generous options) against those genealogically close relatives. On average, this should be especially evident in how players who have the closest genealogical ties to the rest of the community play the game, because more of their partners will be genealogical relatives. To determine whether players are changing their game strategies based upon their genealogical ties with the community, we use each player's average genealogical relatedness to their 30 partners (within-participant or within-cluster mean) compared to the average relatedness for all 1800 player/ partner pairings (the grand mean for the sample, giving us the between-participants or between-clusters effects). We further compare each individual pair's relatedness to the player's average relatedness (within-cluster centering). By using this cross-level interaction approach (see: Enders & Tofighi, 2007; Kreft, de Leeuw, & Aiken, 1995), we can test whether players adopt different strategies for genealogical relatives vs. non-relatives, and whether their strategy for relatives produces more generous offers for closer relations.

3.1.5. Game Procedure

The payout matrix for our kin game is shown in Figure 3. Individually, if a player wanted to maximize their own returns, they would choose A (2 of 3 outcomes produce money for the self;

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[3] The apparently small Wright's r values may also relate to an assumption within the calculation that supposes the founders of each clan are unrelated. Because the deeper ancestry of these clans is likely based on a common founder (this is at least the case in the oral tradition), then this assumption of relatedness in the calculation may artificially deflate our estimates of relatedness a bit.

[4] Converting genes in common from a proportion to a percentage allows for our later regression models to run more smoothly by placing them on a more similar scale to the other predictors in our models. Models run with Wright's r as proportion produce equivalent effect sizes, with scaling differences that reflect the change in scale.

[5] Human altruistic behavior toward kin may be driven by a discrete gene or set of genes that specifically promote altruism. Wight's r would then approximate the probability that the actor and target of an altruistic act share that altruistic gene or set of genes through common descent. Alternatively, humans may use a general rule or strategy to be more altruistic toward others who are more similar. Humans do use similarity as a heuristic for decision-making (Read & Grushka-Cockayne, 2011), in making judgments about possible kinship (Park, Schaller, & Van Vugt, 2008), and in choosing more altruistic vs. selfish behaviors (Jaho, Karaliopoulos, & Stavrakakis, 2010). Humans might use this similarity bias via increased number of shared genes to approximate the likelihood of sharing a specific altruism gene or set of genes, such that these mechanisms might not be mutually exclusive.

the only option worth up to $4). If a player instead preferred equal payouts for self and partner, they would choose B – our neutral/ egalitarian option. Finally, if players want to maximize their partner's gains, then they would choose C (2 of 3 outcomes produce $0 the self; the only option that produces more money for the partner than the self; requires player to consent to their partner getting more money).[6] If we instead focus on the game play between pairs of players, we can investigate factors that affect successful coordination. The game can result in two kinds of successful coordination: egalitarian coordination where both players choose B and get $2 ($4 for the pair total), or an asymmetric distribution in which the pair gets more money overall ($6), but this money is unequally distributed (one gets $4 while the other gets $2). Players must independently agree who should get the higher payoffs to achieve the biggest net gain as a pair.

[Figure 3 here]

Figure 3 Kinship Coordination Game pay-off matrix. Choice A has the highest expected payout, making it the self-maximizing choice. B has a lower but equal expected payout, thus is more neutral. C has the lowest expected payout, but A is only maximally productive if the other player chooses C. Thus, C is the generous choice.

Players participated in the kin game in the village hall of village A and in the house of the *turaga ni koro* (village headman) of village B in May 2013. Participants all spoke and understood Standard Fijian. Study materials were translated into Standard Fijian and back-translated into English by research assistants fluent in both languages and checked for quality. Due to variable literacy, the game administrator read all materials to players. We recruited participants through door-to-door invitations; participants played in the order they showed up. Participants received a $1 FJD show-up fee and could earn up to $4 FJD, or about a quarter of a day's wage. Everyone played the game using a paper payout matrix game board with real money displayed for each choice option (Figure 4). We asked participants a series of pre-test questions about what payments would result from each pair of choices they and their partners might make; payers had to pass this pre-test to demonstrate comprehension before they played.

[Figure 4 here]

Figure 4 Example of kin game set up. Participants played with known others depicted in photographs. The pay-out matrix was illustrated with real money to facilitate comprehension. Photo credit: XXX

Though game decisions are based on player/ partner pairings, each participant played individually. Participants were randomly assigned 30 partners. Partners included both sexes and spanned the entire adult age range (from 18-80). Partners were shown in photographs, selected at random from a stack of photos. These photographs were taken for previous interviews assessing which kin term each villager used for every other villager. This allows comparison between pairings of both known genealogical relatedness and known kinship without directly asking about these relationships during play. Players made one choice for each of their 30 partners and reported these choices to the game administrator. Game choices were therefore not anonymous, but we did not identify partners to each other outside of the game. Players and partners had no chance to communicate their choices to each other and we did not identify partners to each other when giving out payments. Players understood their decisions would not be known by anyone

[6] Players may also choose to maximize their partner's gains if they 1) think the partner should get a higher payout or 2) think that, perhaps as part of a family unit, they might get some of that money outside of the game.

except the researchers. Game choices should therefore be the result of existing knowledge of the partner. Participants were not given any explicit instruction on what strategy to use (e.g., no language highlighting kinship except that fellow players were in their *yavusa*, no mention of friends, men vs. women, etc.). We also emphasized that payouts depended their and their partners' combined choices.

Because we randomly assigned partners to players, not all partners actually played the game. As a result, only a subset of each player's game choices matched up with other players. Of the subset of choices where players and partners did choose for each other, we selected one pairing at random and distributed the payments to each player. We specified that payouts would be based on just one of these partners that would be selected at random[7] after everyone finished playing.

3.2. Results: Individuals and Pairs

We analyze game choices for both individuals and as pairs; we look for predictors of individual strategies and pairs' success at coordination.

3.2.1. Individual Player Choices

For individual players' choices, we assume the baseline strategy is to maximize payoffs to the self. If kin altruism is driving game behavior and players are tracking genealogical relatedness, then players should be more likely to choose more generous options for partners who have a higher genealogical relatedness. If kinship norms are influencing game behavior, then kinship relationships that are characterized by more respect, helping, and emotional closeness should increase the likelihood of more generous choices, while relationships characterized by more joking and giving commands should reduce the likelihood of generous choices.

We first focus on individual player strategies. We examine how genealogical vs. normative kinship affects probabilities of choosing self-maximizing, neutral/ egalitarian, or generous/ other-maximizing choices using ordered logistic regression fit with the ordinal (Christensen, 2013) and lme4 packages (Bates et al., 2014) in R (R Development Core Team, 2008). We use clustered robust standard error adjustments to account for repeated measures.[8] We model the baseline probabilities for each choice (self-maximizing, neutral, generous) by including players' percentage of probable shared genes with each partner (within-player genealogical relatedness) and how closely genealogically related each player is to all 30 partners compared to other players (between-player genealogical relatedness). We test for effects of normative kinship using the component scores from our two kin term components from study 1, centered such that kin terms that score higher-than-average on that component have a higher value. We also include demographic variables for player's and partner's sex, player's years of formal education, player/

[7] We explained the concept of "at random" during the verbal consent process by demonstrating how cards with numbers written on them could be drawn from a hat at random.

[8] Regressions with standard error corrections make fewer assumptions about the data and are more robust to potential model misspecification than multilevel models. Multilevel ordered probit models with random effects on player, partner, and kin term produce similar results (see online supplement) to the simpler models presented here, and suggest our player-level robust error corrections are sufficient.

partner age difference, number of years players lived in the village, and partner presentation order.[9]

As shown in Table 3, we find players who are most closely related to all 30 partners appear to be using a relatedness-dependent strategy. Players who are highly genealogically related to all their partners are less likely to choose the self-maximizing option when playing with more closely genealogically related partners. Participants are also marginally significantly more likely to choose more generous offers for partners who are younger; each additional year of age difference makes players 2% more likely to choose a more generous offer for a younger partner ($p = 0.08$). Generous choices toward younger partners may reflect favoritism toward more reproductively viable relatives, thus boosting probable benefit from one's altruism by spreading shared genes. However, we find no significant effects for either kinship norms component variable (respect/ closeness $p = 0.57$; joking/ authority $p = 0.34$).

All Player 1 choices observed n=1493	Odds Ratio
% Probable shared genes between Player & Partner @ <u>1 SD Lower-than-Average</u> Across-Player relatedness	0.97 [0.94, 1.01]
% Probable shared genes between Player & Partner @ <u>Average</u> Across-Player relatedness	0.99 [0.97, 1.01]
% Probable shared genes between Player & Partner @ <u>1 SD Higher-than-Average</u> Across-Player relatedness	1.01 [1.00, 1.02]*
Across-Players Grand Mean % probable shared genes	1.06 [0.81, 1.39]
Partner's kin term Respect/ Closeness Component Score	0.95 [0.65, 1.41]
Partner's kin term Joking/ Authority Component Score	0.91 [0.71, 1.16]
Cross-level interaction % Probable shared genes between Player & Partner x Across-Player Grand Mean relatedness	1.02 [1.00, 1.03]*
Significance codes: '***' 0.001 ,'**' 0.01, '*' 0.05, '†' 0.1	

Table 3 Individual players' game choices ordinal regressions, controlling for years in village, player/ partner age difference, players' formal education, player sex, partner sex, and partner order (full model in online supplement). Odds ratios with 95% confidence intervals in brackets, calculated with standard errors corrected for clustering on player.

We look at the genealogical relatedness simple slopes using the Aiken and West (1991) simple slopes method, illustrated in Figure 5. Each additional percentage point of probable shared genes increases the odds of choosing generous options by up to 2%. Put in more concrete terms, players are 62% more likely to choose a more generous option for a full sibling (with 50% shared genes) than a first cousin (with only 12.5% shared genes). Specifically, players are 8% more likely to choose the self-maximizing option against a cousin and an 11% more likely to choose the generous option for a full sibling. This effect is only significant for those most closely genealogically related to their partners (+1 SD across players average, $p = 0.01$). When we look only at the choices made between pairs with detectable genealogical relatedness (see online

[9] Dropping demographic controls from the model does not substantially change our estimates; see the online supplement for models with and without these controls, plus VIF estimates showing the chance of collinearity in this model is small.

supplement), we find that this interaction disappears. Odds of generous choices increase with closer genealogical ties, and players appear to use different strategies for genealogical relatives vs. non-relatives.

[Figure 5 here]

Figure 5 Cross-level interaction for all individual player 1 game choices, showing genealogical relatedness moderated by players' relatedness to all 30 partners. Players who are more closely related to their partners than average are more likely to choose more generous options for partners who are more closely related.

3.2.2. Pairs of Players: Coordination

We next examine the subset of game choices that players made about each other. Because we assigned partners to players at random, we have fewer paired observations than individual player game choices. Table 4 shows choice combination counts. We have 155 pairs, with each member acting as player 1 for a total of 310 observations. We find 35% of all combinations result in successful coordination on either egalitarian (B/B; both get $2, or $4 for the pair) or on asymmetric but overall larger payouts (A/C or C/A, with the A player getting $4 and the C player getting $2 for $6 total). Half of all choice combinations result in failed coordination on selfish/ neutral (A/B & B/A) or neutral/ generous (B/C & C/B). Another 15% mis-coordinate on unproductive combinations of A/A or C/C. Of the 108 successful coordinations, 66% are on the egalitarian/ neutral choice B.

		Player 2			
	Choice	**A**	**B**	**C**	Total
Player 1	**A**	24	39	18	81
	B	39	72	39	150
	C	18	39	22	79
	Total	81	150	79	310

Table 4 Observed choice combinations between players who made decisions with each other.

Player pairs appear to be better overall at coordinating on egalitarian rather than unequal payoffs; of the 150 times a player chose B, the neutral option, their partner also chose B 48% of the time. On the other hand, of the 81 times a player chose the self-maximizing option A, they got a C from their partner only 22% of the time. Similarly, when a player chose the generous C option, they got A 23% of the time. Though more productive for players as a pair, A/C or C/A combinations are hard to coordinate on.

These results are surprising given the game-theoretic prediction that, because A has the highest expected payout regardless of what the other person chooses, it should be dominant. Though rare at only 8% of all choice combinations, both players choosing A is slightly more common than coordinating on A/C or C/A (each comprising 6% of all combinations). However, game theory has little to say about why the generous/ low expected payoff option C is so common. A and C were chosen with similar frequency, perhaps indicating that players were attempting asymmetric coordination. Players may have chosen C expecting the other to choose A; C then is only option that will give them any payout. On the other hand, players may anticipate their partner would choose A and decided to choose A against them out of spite or as a joke. There is some anecdotal evidence that especially male cross-cousins show this sort of non-cooperative allocation strategy in other known-recipient economic games; these choices are not necessarily malicious but more of a teasing/ humorous non-cooperation.[10] We do find that male cross-cousins have among the highest proportions of choosing A against each other (see online supplement). Finally, the tendency for pairs to choose C might reflect a more giving and cooperative, rather than an egalitarian or non-cooperative, relationship.

We use multinomial logistic regression, fit using the mlogit R package (Croissant, 2012) to determine what predicts coordination between pairs of players. We analyze four observed combinations of choices: A/A, A/C, B/B, C/A, and C/C (see Table 5).[11] If players are acting in game-theoretic rational self-interest, then self-maximizing A should be the dominant choice. We are therefore particularly interested in determining which factors predict choices other than the self-maximizing, self-interested option. We again use cluster robust standard errors, this time clustering on pair. We include pairs' percentage of probable shared genes and kinship component scores from study 1. We also examine the combined effects of both kinship components by coding kin terms with their quadrants in Figure 2 (for example: cross-cousins are coded as high closeness/ high joking).

Compared to high closeness/ high joking relationships (like cross-cousins), low closeness / high joking relationships (e.g. in-laws) are around 13-14 times more likely to both choose the neutral B option and achieve egalitarian coordination ($p = 0.03$). This may reflect relatively equal social rank with more socially distant relationship between relatives identified with these kin terms. We also find that players who identify their partner with a high closeness / low joking kin term (e.g. parents, grandparents, parents' opposite-sex siblings) are 10.67 times more likely to choose C for this partner, and have this partner choose A toward them, than for both to choose A ($p = 0.05$). This points to high respect/ closeness and low joking as stronger facilitator behind asymmetric coordination, with the higher-ranking relative receiving the higher payout. Playing with kin that have more authority (higher on the joking / authority dimension) independently predicts higher odds of egalitarian, other-beneficial, or both choosing generous options. Genealogical relatedness, however, does not predict coordination success.

[10] Source: M. M. Gervais, personal communication May 2015. Also see Gervais (2013).

[11] See online supplement for full model and for coordination analysis on all failed vs. successful coordination.

Compared to both choose self-maximizing A / A, High Closeness/ High Joking, Same-sex pairs n=154	Kin Norm Quadrants OR [95% CI]	Kin Term Components OR [95% CI]
AC: High Closeness / Low Joking (e.g. Grandparents)	5.03 [0.45, 55.8]	---
BB: High Closeness / Low Joking (e.g. Grandparents)	6.37 [0.94, 43.31]†	---
CA: High Closeness / Low Joking (e.g. Grandparents)	10.67 [0.98, 116.32]*	---
CC: High Closeness / Low Joking (e.g. Grandparents)	15.57 [0.56, 433.8]†	---
AC: Low Closeness / High Joking (e.g. In-laws)	3 [0.08, 112.64]	---
BB: Low Closeness / High Joking (e.g. In-laws)	14.35 [1.4, 146.98]*	---
CA: Low Closeness / High Joking (e.g. In-laws)	10.21 [0.66, 157.71]†	---
CC: Low Closeness / High Joking (e.g. In-laws)	25.94 [0.77, 875.78]†	---
AC: Respect/ Closeness (Higher = less close, less respect)	---	1.64 [0.05, 58.65]
BB: Respect/ Closeness (Higher = less close, less respect)	---	4.1 [0.2, 83.61]
CA: Respect/ Closeness (Higher = less close, less respect)	---	3.98 [0.16, 100.97]
CC: Respect/ Closeness (Higher = less close, less respect)	---	3.34 [0.18, 61.38]
AC: Joking/ Authority (Higher = less joking, more authority)	---	2.82 [0.34, 23.37]
BB: Joking/ Authority (Higher = less joking, more authority)	---	5.09 [1.07, 24.34]*
CA: Joking/ Authority (Higher = less joking, more authority)	---	5.94 [1, 35.17]*
CC: Joking/ Authority (Higher = less joking, more authority)	---	6.56 [1.09, 39.44]*
AC: Pair's % probable shared genes	0.94 [0.03, 30.05]	1.04 [0.03, 36.19]
BB: Pair's % probable shared genes	0.3 [0.03, 2.76]	0.34 [0.03, 3.44]
CA: Pair's % probable shared genes	0.05 [0, 2.34]	0.05 [0, 2.6]
CC: Pair's % probable shared genes	0.06 [0, 2.79]	0.07 [0, 2.82]

Significance codes: '***' 0.001 ,'**' 0.01, '*' 0.05, '†' 0.1

Table 5 Selected combinations of game choices compared to both choosing the self-maximizing option A, controlling for years in village, age difference, education, sex difference, and game order. Cluster robust standard errors are clustered on pair. Kinship terms in the low closeness/ low joking quadrant were included but are not presented here due to small sample size (n=2; see online supplement).

3.3. Discussion

We find that economic game choices made within a known kin network can be described by both individual and pair-level strategies. Individual players tend to select more generous options for more closely related partners, and may be playing differently for genealogical relatives vs. non-relatives. However, coordination between pairs is better predicted by kinship norms than genealogical relatedness. Players of roughly equivalent rank but greater social distance are more likely to coordinate on neutral/ egalitarian choices. Asymmetric coordination is more likely between kin terms marked by hierarchical respect and authority, with the higher-ranking relative being more likely to get the higher payout.

4. General Discussion

We use a card sort task and principle component analysis to extract two dimensions – respect/closeness and joking/ authority – that describe Yasawan kinship norms. We use a three-choice, battle of the sexes-style economic game to investigate how Yasawans balance genealogical relatedness against kinship norms when forced to choose between self-interested, egalitarian, or generous options. This conflict between self and other-interest recapitulates the balance of obedience and interdependence within Yasawan kinship. Game choices were better predicted by genealogical relatedness at the individual level, and by kinship norms at the level of pairs of players coordinating choices with each other.

If we relate our Yasawan kinship dimensions to Fiske's four elementary social forms (Fiske, 1992), the majority might be best described as communal sharing. Kin relations in Yasawa (and Fiji in general) overlap with the ego substantially, especially for kin terms high on the closeness/ respect dimension. This overlapping self across family ties is both a fundamental part of being Fijian and a fundamental barrier to success in Western, economic market driven interactions (Hulkenberg, 2015) – therefore, poorly described by market pricing. Conversely, the kin terms high on the authority/ joking dimension and hierarchically most distant from than the ego are most marked by authority ranking. This appears to be borne out by the higher probability of asymmetric coordination between more hierarchically distant pairs, with the higher-ranking relative getting the higher payout. However, equality matching may apply more to relationships that are closer in rank and more socially distant (high joking/ authority, low closeness/ respect). Interestingly, most of these kin terms are in-laws; because they more similar in rank but have less self-other overlap with the ego, they may direct action toward maintaining relatively equal gains rather than commanding benefits or requiring sacrifices from each other. Our finding that kin in this low closeness/ high joking quadrant are more likely to achieve neutral/ egalitarian coordination supports this conclusion.

Despite these patterns, coordination was relatively rare. This game presents a greater level of ambiguity than other coordination games like the stag hunt, because players' individual interests cannot fully align (Alvard & Nolin, 2002; Luce, 1957; Skyrms, 2004). We find that successful coordination was most frequent on egalitarian neutral choices. Other battle of the sexes games that offer at least one player a neutral option find that, when the probability of success is ambiguous, players will often prefer the neutral option (Kelsey & Le Roux, 2015). Because successful coordination requires anticipating the other player's thoughts, this low success rate may be due in part to Yasawans' normative tendency to think less about others' internal mental states than other populations (part of a wider phenomenon known as Opacity of mind, see: Keane, 2008; Robbins & Rumsey, 2008; Rumsey & Robbins, 2008; for Yasawa-specific evidence, see [identifying information removed]). If Yasawans are not referring to their expectations about what the other player will think, then any successful coordination likely results from players' relationships. Further, our data offers a glimpse into how these normative aspects of relationships might tacitly shift decisions, providing a more externally valid model of behavior than if kinship was explicitly evoked. Because both kinship and genealogic relatedness are constantly present but may not be explicitly referenced, most mundane cooperative tasks will require this kind of tacit kinship awareness.

Though Yasawans appear to be tracking genealogy and kinship norms for different strategic ends, additional factors that might also influence game decisions. For example, another major strategy for resource distribution in small-scale societies (including other villages in Yasawa, see: Gervais, 2013) is through known need. We do not include these known economic needs in this game because we are more interested in the kinship norms and genealogical relationships than specific details about individuals. However, future studies may benefit from adding this economic variable. Given the normative value on deference to authority and hierarchical decision-making outlined in the introduction, it also remains unlikely that perceptions of greater need would totally eclipse the effects of norms on kinship in this community. If rank signals unspoken agreement that higher ranking individuals should get more resources, this then would speak against these higher ranking individuals needing more support in the first place. Future investigations that may explicitly investigate known need and kinship norms may likely find that known need and norms of kinship interact in a fashion similar to the interplay between genealogical kinship and reciprocity found in other studies (Allen-Arave et al., 2008).

These results may also speak to the wider evolution of kinship systems. In these highly cooperative kin networks, conflicts of interest will inevitably arise. Having a norm system in place provides a cognitive shortcut to facilitate communication and resolve conflicts. If everyone knows their role within a social system, then actors can spend less time talking and more time doing. Importantly, as shown in our results, these norms may facilitate coordination even when communication is not possible. In Yasawa, the expectations based on kin hierarchy provide just such a social structure. Men out-ranking women may support the patrilocal inheritance pattern that may have also supported Pasifika expansion (Hage, 1999). In day-to-day affairs, resources held within the family are communally owned; lower-ranking members must give resources to the higher-ranking members, but the higher-ranking members are responsible for assuring the wellbeing of those below.[12] This commonly known but tacit system of power and obligation may facilitate more complicated collective works with less deliberation. More broadly, the bifurcate merging unilineal descent system within Yasawan kinship can rally cooperation especially well in contexts of intensive inter-group competition and in the absence of centralized political authority (Hage, 2001; Ember, Ember, & Pasternak, 1974). That the norms embedded within these kinship systems might be called upon to rally sacrifice at another’s behest may speak to how these kinds of kinship systems could succinctly rally group support. These findings may shed light on how cultural layers of normative kinship build up on the pre-existing genetic relationships to facilitate further, more extensive cooperation in the early evolution of increasingly complex social groups.

[12] As touched upon in the introduction, this normative deference to hierarchical decision-making presents challenges to Fiji’s national push for Western-style economic development. When the kinship cooperation networks are operating as they are normatively idealized to work, they do generally meet the needs of everyone in the community. However, when cooperation begins to break down, there is the possibility for higher-ranking community members to intervene (e.g. elders can tell a head of household to take better care of his family) or for lower ranking members to oust a leader seen as ineffectual (i.e. a chief who is not taking care of his village can be seen as lacking in traditional values and, in some cases, replaced).

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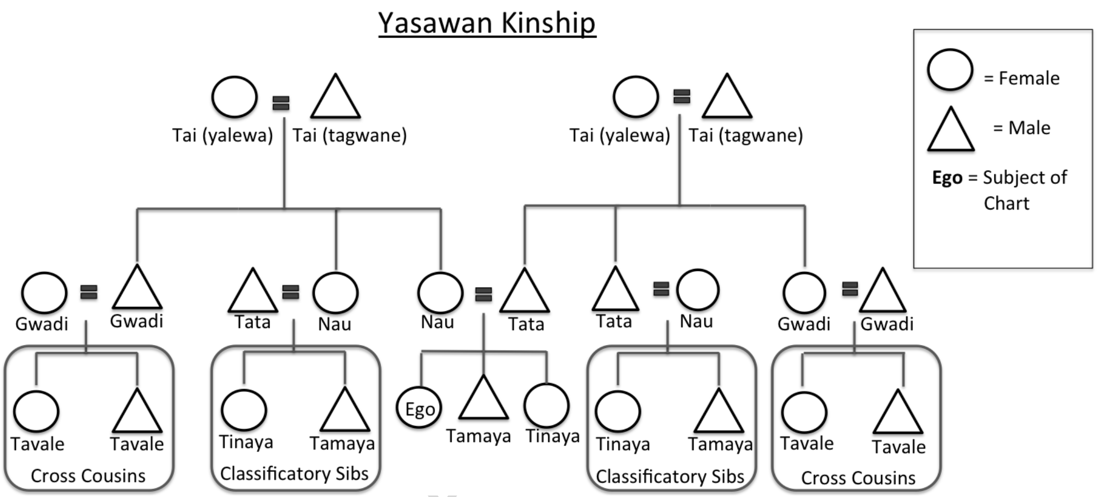
Yasawan Kinship
= Female
= Male
Ego = Subject of Chart
Tai (yalewa)
Tai (tagwane)
Tai (yalewa)
Tai (tagwane)
Gwadi
Gwadi
Tata
Nau
Nau
Tata
Tata
Nau
Gwadi
Gwadi
Tavale
Tavale
Cross Cousins
Tinaya
Tamaya
Classificatory Sibs
Ego
Tamaya
Tinaya
Tinaya
Tamaya
Classificatory Sibs
Tavale
Tavale
Cross Cousins

Fig. 1

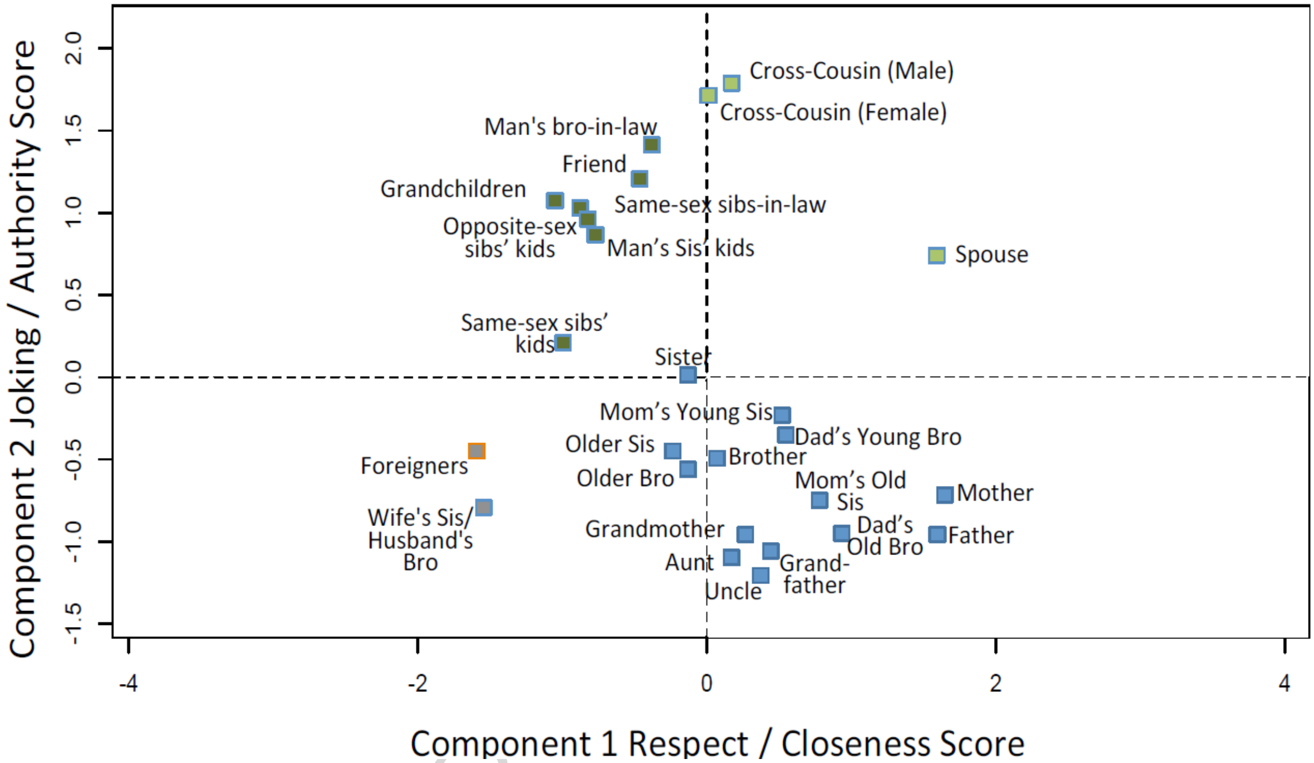
Component 2 Joking / Authority Score
Component 1 Respect / Closeness Score
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-4
-2
0
2
4
Cross-Cousin (Male)
Cross-Cousin (Female)
Man's bro-in-law
Friend
Grandchildren
Same-sex sibs-in-law
Opposite-sex sibs' kids
Man's Sis' kids
Spouse
Same-sex sibs' kids
Sister
Mom's Young Sis
Dad's Young Bro
Older Sis
Brother
Foreigners
Older Bro
Mom's Old Sis
Mother
Wife's Sis/ Husband's Bro
Grandmother
Dad's Old Bro
Father
Aunt
Grand- father
Uncle

Fig. 2

Fig. 3

		Other Villager			
	Choice	C	B	A	
You	A	4,2	2,0	0,0	Self-Maximizing
	B	2,0	2,2	0,2	Neutral
	C	0,0	0,2	2,4	Generous

Fig. 4

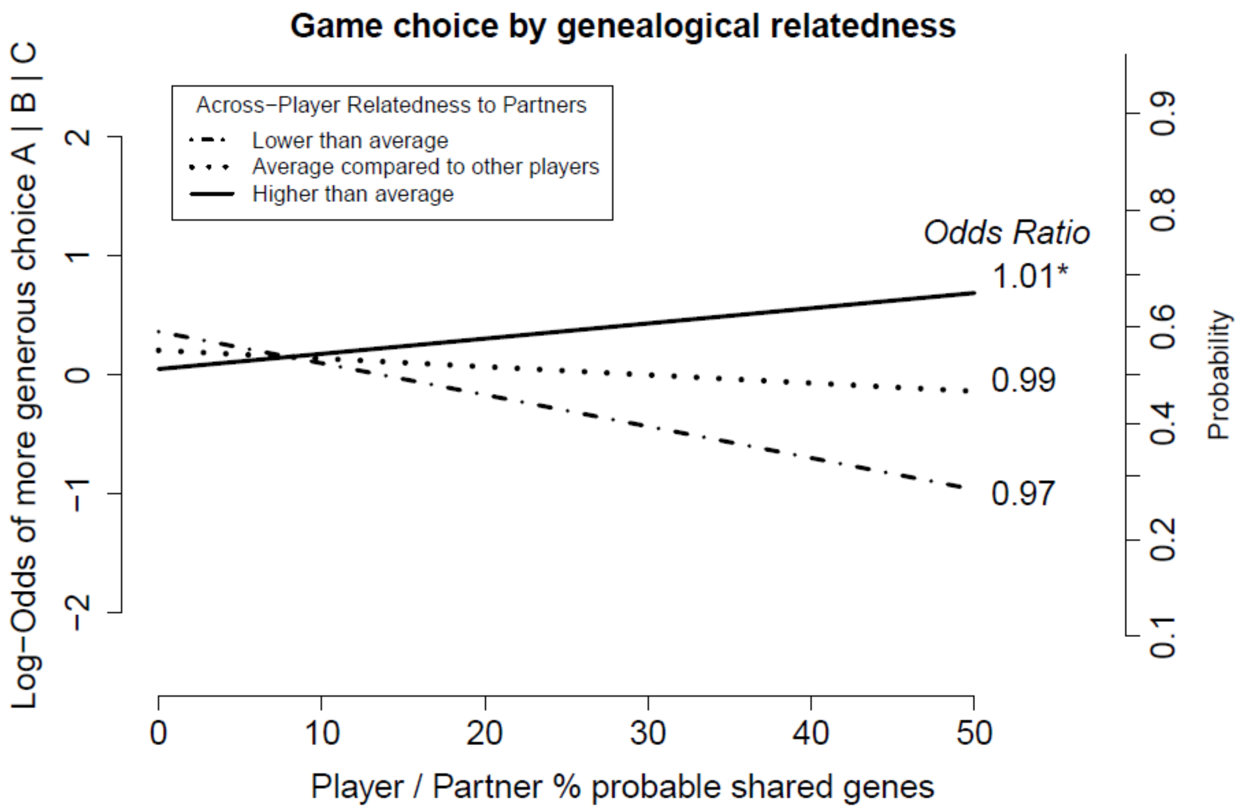
Game choice by genealogical relatedness
Across−Player Relatedness to Partners
Lower than average
Average compared to other players
Higher than average
Odds Ratio
1.01*
0.99
0.97
Log−Odds of more generous choice A | B | C
−2
−1
0
1
2
Probability
0.1
0.2
0.4
0.6
0.8
0.9
0
10
20
30
40
50
Player / Partner % probable shared genes

Fig. 5

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