UNIVERSITY OF CALIFORNIA

Santa Barbara

Evidence of Human Adaptations for Cooperative Partner Choice in a Biological Market

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Psychological & Brain Sciences

by

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June 2017

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ACKNOWLEDGEMENTS

I am grateful to the many friends and mentors who supported, helped and taught me during my time at UCSB, but there are a few to whom I owe an especially large debt. Jim Roney provided a perfect model of scientific thought and rigor, and was patient and supportive even when my interests meandered. I'm fortunate to have learned from him how to be a scientist. Leda Cosmides and John Tooby did the intellectual trailblazing and community-building that made my work possible. We all stand on the shoulders of giants, but I was lucky to find in John and Leda two exceptionally warm and welcoming giants. I am grateful to Michael Barlev and Rachel Grillot for their friendship and companionship; toiling in the mines isn't so bad if you can do it with people like them.

My parents, Laurel and Ran Eisenbruch, have given me all the opportunities, love and support that anyone could ever hope for. I can never thank them enough.

Finally, I would like to dedicate my dissertation to Eliza Schafler, who brings me joy, comfort, and inspiration every day – an adaptive partner choice if ever there was one.

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Eisenbruch, A. B., Grillot, R. L., Maestripieri, D. & Roney, J. R. (2016). Evidence of partner choice heuristics in a one-shot bargaining game. Evolution and Human Behavior 37(6), 429-439.

Eisenbruch, A. B. & Roney, J. R. (2016). Conception risk and the ultimatum game: When fertility is high, women demand more. Personality and Individual Differences 98, 272-274.

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ABSTRACT

Evidence of Human Adaptations for Cooperative Partner Choice in a Biological Market

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Despite the importance of human cooperation, how humans choose their cooperative partners and how they divide the spoils of cooperation are not yet fully understood. Mutual partner choice creates competitive conditions for cooperative relationship formation, in which individuals compete to form cooperative relationships with the most valuable available partners. Biological market theory therefore predicts that the spoils of cooperation will be divided as a function of each party's cooperative partner value. This dissertation reports research designed to test two interrelated hypotheses: (1) humans will possess psychological mechanisms designed by natural selection to assess the value of an individual as a long-term cooperative partner, and (2) human intuitions about how the spoils of cooperation should be divided will track cues of cooperative partner value.

Six studies were conducted to test these hypotheses. Two commonly-used economic games (the ultimatum game and the trust game) were used to test cooperative partner preferences and resource division intuitions (studies 1-5), and a friend choice task was used to test cooperative partner preferences (study 6). Cooperative partner traits were represented by facial photographs (studies 1, 2 and 6), or were experimentally manipulated with verbal information and in-game monetary consequences (studies 3-5).

Results supported the hypotheses. Participants exhibited preferences for partners who appeared more valuable as long-term cooperative partners, and these preferences appeared to be specialized for ancestral forms of cooperation: participants were more

sensitive to cues of ancestral productivity than contemporary productivity, participants were more sensitive to cues of productivity when they revealed stable skills rather than luck, and men relied relatively more on a partner's productivity (versus their generosity) than did women. In addition, intuitions about resource divisions were sensitive to cues of partner value: partners who appeared more valuable received more favorable divisions in the ultimatum game, and more productive partners were judged as more fair in the trust game, regardless of their actual generosity. The discussion of results focuses on future directions for the application of biological market theory and the logic of cooperative partner choice to problems in social psychology.

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I. Introduction – Cooperation in a Biological Market

Widespread and flexible cooperation is one of the hallmarks of the human species. For example, cooperation is crucial for survival in a harsh environment (Sugiyama, 2004), rearing of highly altricial offspring (Hrdy, 2006), and the evolution of the distinctively slow human life history strategy (Gurven, Stieglitz, Hooper, Gomes & Kaplan, 2012). Human cooperation is complex in many ways: humans engage in long-term cooperative relationships with known individuals (Delton, Krasnow, Cosmides & Tooby, 2011; Krasnow, Delton, Tooby & Cosmides, 2013), exhibit reciprocity as well as exchange across commodities (e.g. providing meat in exchange for produce; Jaeggi, Hooper, Beheim, Kaplan & Gurven, 2016), and choose their cooperative partners (e.g. Barclay, 2013). This last feature – the ability to choose cooperative partners – creates what is known as a biological market (Hammerstein & Noë, 2016; Noë & Hammerstein, 1994, 1995).

This cooperative ecology likely created numerous selection pressures that have shaped the human mind. For example, humans have sophisticated adaptations for identifying cheaters in social exchange (e.g. Cosmides, 1989; Cosmides & Tooby, 2005). While much is known about cognitive adaptations for cooperation (for review, see Cosmides & Tooby, 2005), several fundamental questions about the psychology of cooperation remain unanswered. Specifically, the heuristics used to choose cooperative partners and divide cooperatively-produced resources are unclear. The goal of this dissertation is to argue that humans have specialized, evolved mechanisms for estimating people's value as long-term cooperative partners, and that these estimates of partner value regulate each party's entitlement to cooperatively-generated resources. To make this argument, first I will contextualize the psychology of cooperation within a biological market framework, and then

I will present results from several economic games and social partner selection tasks that suggest people's choices of cooperative partners and intuitions about fair divisions of cooperatively-gained resources are consistent with evolved design for a biological marketplace of cooperators.

1.1. Functioning of a biological market

The key feature of biological markets is that individuals possess choice over cooperative partners, creating competition for access to partners and causing the exchange rate between commodities to fluctuate with supply and demand (Noë & Hammerstein, 1994, 1995). Biological markets have frequently been observed in non-human species (covering both intra-specific cooperation and inter-specific mutualisms; e.g. Noë & Hammerstein, 1994, 1995; Barrett & Henzi, 2006). For example, cross-species mutualisms exist in which cleaner fish eat ectoparasites and dead tissue off of client fish (see Bshary & Noë, 2003 for review). There are at least three potential points of conflict between cleaners and clients: how long the client will have to wait before being serviced (perhaps while the cleaner is servicing another client); the degree to which the cleaner will cheat by eating mucus or living tissue (preferred food sources) instead of dead tissue or parasites; and for how long the cleaner will clean the client. Some clients live in ranges with only one available cleaner, while other clients have access to multiple cleaners, thereby introducing partner choice and competition between cleaners. Clients with partner choice will change cleaners if they have recently been cheated or made to wait, but return to cleaners who have recently provided good service (Bshary & Schaffer, 2002). As a result, clients who have access to multiple cleaners receive more prompt (Bshary, 2001; Bshary & Grutter, 2002) and longer (Soares,

Bshary & Côté, 2008) cleaning than clients without partner choice. On reefs where the supply of client fish is relatively low, cleaner fish are forced to compete with each other for the available clients, resulting in less cheating (Soares, Bshary, Cardoso & Côté, 2008).

There is also evidence of supply-and-demand effects in primate biological markets. For example, wild vervet monkeys direct more grooming towards a low-ranking female who has suddenly gained the ability to access a new food source, but reduce their level of grooming towards her when a second female gains the same ability (Fruteau et al, 2009). In macaques (Gumert 2007a), baboons (Henzi & Barrett, 2002) and golden snub-nosed monkeys (Wei et al, 2012) females groom mothers in exchange for permission to handle their infants; mothers receive more grooming per exchange when infants are scarce than when they are relatively abundant (but see Tiddi, Aureli & Schino, 2010 for null results in capuchins). In both chimpanzees and macaques, males groom females in exchange for sex, but the amount of grooming that each female receives (i.e. the price of sex) is inversely related to the number of available females in the group (Gumert, 2007b; Koyama, Caws & Aureli, 2012). In redfronted lemurs, central males receive more grooming from subordinate males when there are more subordinate males present in the group, suggesting that subordinate males use grooming as competing bids for the central males' favor (Port, Clough & Kappeler, 2009). The importance of biological market theory for understanding human behavior as well is becoming increasingly recognized (e.g. Barclay, 2013; Baumard, André, & Sperber, 2013; Griskevicius et al, 2012; Stone, Shackelford & Buss, 2007), for example in human mating markets (e.g. Kandrik, Jones & DeBruine, 2014).

Widespread cooperation would have created selection pressures on humans to maximize the benefits gained via cooperation (Trivers, 1971). However, since human

cooperation occurs within a biological marketplace of long-term relationships, the selection pressure facing humans would have been to maximize the cumulative gains of those relationships, rather than the profit of individual cooperative exchanges. In addition, the set of close cooperative relationships that an individual can have is finite (e.g. DiScioli & Kurzban, 2009; Tooby & Cosmides, 1996). Under these circumstances, a likely strategy to maximize the gains of long-term cooperative relationships would be to form relationships with the best available cooperative partners. This suggests two adaptive problems facing ancestral humans: how to identify the best available cooperative partners, and how to attract those partners for a relationship.

1.2. Identifying the best partners

How would ancestral humans have known which of the available cooperative partners would probabilistically provide the greatest stream of benefits over the course of a relationship? We propose several criteria of partner choice that could have addressed this problem (see also Barclay 2013, 2016). First, any cues of a relationship's likely duration would predict the total benefits that could accrue over its course, so people will likely prefer individuals who are healthy and in-group members as cooperative partners. In fact, evidence suggests that apparently-healthy individuals and majority-group members receive preferential treatment in a variety of cooperative settings (e.g. Bertrand & Mullainathan, 2004; Krupp, DeBruine & Jones, 2011). A second criterion of partner choice is likely an individual's dispositional cooperativeness, that is, their desire to cooperate and their inclination to generously share the spoils of cooperation. Dispositional cooperativeness has been the focus of most partner choice research to date. A wide body of theoretical and

empirical research has shown that humans have cognitive adaptations for identifying cheaters (i.e. individuals who take undeserved benefits from social exchange; Cosmides, 1989; Cosmides, Barrett & Tooby, 2010; Cosmides & Tooby, 1989, 1992); individuals identify and preferentially cooperate with others who also want to cooperate (e.g. Aktipis, 2004; Delton & Robertson, 2012; Fu, Hauert, Nowak & Wang, 2008); partner choice causes individuals to compete to appear generous (e.g. Barclay & Willer, 2007; Macfarlan, Remiker & Quinlan, 2012; Roberts, 1998); and warmth- or morality-related traits predominate perceptions of others (reviewed by Fiske, Cuddy & Glick, 2007; Wojciske, 2005).

A third criterion of partner choice is an individual's ability to produce material benefits, which I will term "productivity." Any cues of variance in the ability to produce material benefits (e.g. physical strength, hunting skill, other specialized skills) would have given ancestral humans the opportunity to choose cooperative partners who would have produced the largest possible stream of benefits, regardless of the division of those benefits. Though most research on partner choice has focused on dispositional cooperativeness, there is evidence that some non-human species choose cooperative partners based on competence. For example, chimpanzees choose collaborators who have previously proven more competent in a joint food retrieval task (Melis, Hare & Tomasello, 2006). Coral trout selectively solicit cooperation from model moray eels who have previously displayed behavior that is useful in capturing prey (Vail, Manica & Bshary, 2014). Jackdaws select a partner in a blocked-exit task who has previously successfully freed them from the enclosure (von Bayern, Clayton & Emery, 2011). Humans should also select cooperative partners on the basis of the resources they are capable of producing; consistent with this,

anthropological work has found that individuals or households with productive reputations receive more help from others (Gurven, Allen-Arave, Hill & Hurtado, 2000; Macfarlan & Lyle, 2015).

Due to a sexual division of labor over human evolution, men and women likely evolved different heuristics for evaluating the benefits offered by potential partners. In small-scale societies, large-game hunting and coalitional violence are nearly-exclusively male pursuits, while gathering plant foods and providing direct childcare are predominantly female pursuits (e.g. Hrdy, 2000; Marlowe, 2007, 2010; Wrangham, 1999). These different domains of cooperation likely selected for different psychologies of partner choice in men and women. Since large-game hunting and coalitional violence are high-variance pursuits (e.g. Kaplan et al, 1985) with publicly-known skill rankings (Apicella, 2014; von Rueden, Gurven & Kaplan, 2008), men's partner choice heuristics may prioritize productivity more than do women's. In contrast, women's partner choice psychology may have been shaped by the challenges of finding reliable alloparents and reciprocal food sharers, often outside of their natal group (Vigil, 2007). A wide body of evidence suggests that men and women have psychological differences corresponding to the challenges posed by these different cooperative domains: men prefer larger, more flexible friend groups, while women prefer fewer, more intimate friendships (e.g. Aukett, Ritchie & Mill, 1988; David-Barrett et al, 2015; Vigil, 2007); male social relationships are more oriented around activities, especially athletic activities, while female friendships place a greater emphasis on emotional intimacy (e.g. Aukett, Ritchie & Mill, 1988; Caldwell & Peplau, 1982; Hall, 2011; Lewis et al, 2011; Vigil, 2007); men are more willing to tolerate costs and conflict in a relationship in order to maintain access to potentially-valuable cooperative partners, while women have a greater

insistence on strict reciprocity (e.g. Benenson et al, 2009; Benenson et al, 2014; Benenson & Christakos, 2003; Benenson & Wrangham, 2016); and women prioritize warmth (over competence) in person-perception to a greater degree than men do (reviewed by Fiske et al 2007). (For additional theory and evidence on evolved sex differences in cooperative preferences, see Balliet, Li, Macfarlan & van Vugt, 2011; van Vugt, de Cremer & Janssen, 2007). In sum, if men evolved to pursue cooperative relationships in the domains of large-game hunting and coalitional violence, then we may expect men to prioritize cues of a partner's productivity more than do women. On the other hand, if women evolved to pursue more intimate and reliable cooperative relationships, then women may prioritize cues of dispositional cooperativeness more than do men.

1.3. Attracting the best partners

Once valuable partners have been identified, they must then be convinced to form a relationship. Since other individuals will also want to form relationships with the best partners, the resulting competition should lead to "bidding" for cooperative partners, in which more valuable cooperators will receive more generous treatment (Noë & Hammerstein, 1994, 1995). The result of this process is that resources created via cooperation should be shared proportionally to each partner's outside options for production (Baumard, André, & Sperber, 2013; Debove. André & Baumard, 2015; Zaatari & Trivers, 2007 make a similar argument). Baumard, André and Sperber (2013) argue that human fairness intuitions likely evolved for cooperation in a biological market, and should therefore reflect this market dynamic. In effect, if fairness intuitions evolved to regulate resource distributions in a biological marketplace, and generous resource distributions are a means of

establishing cooperative relationships with valuable partners (as they appear to be in other species – see above), then it should seem fairer for more valuable partners to receive more advantageous resource distributions.

1.4. Predictions

If the human psychology of cooperation evolved in a biological marketplace, then humans should have specialized heuristics for securing relationships with partners who would have probabilistically generated greater-than-average benefits in the environment of our ancestors. This leads to the two basic predictions that will be tested in this dissertation:

(1) Preferences for social and cooperative partners will be based on ancestrally-valid cues of long-term cooperative partner value.

(2) Fairness intuitions will track partner value estimates, such that partners with greater cues of partner value will be seen as more entitled to advantageous treatment.

II. Evolved Partner Preferences in the Ultimatum Game[1]

I will first test these predictions in the Ultimatum Game (UG), which has often been used to study human cooperation and bargaining (for reviews, see Camerer, 2003; Guth & Kocher, 2014). In the UG, a proposer offers a specific split of a fixed sum of money, and the responder either accepts the offer – in which case the proposed split is enacted – or rejects it, in which case both players receive nothing. Behavior in the UG is typically regarded as economically "anomalous" (Thaler, 1988), because people fail to pursue the income-maximizing strategies whereby responders accept any positive offer and prescient proposers therefore make the lowest possible offer. Instead, proposers in industrial societies typically offer 40-50% of the endowment and responders frequently reject low offers (but see Henrich et al, 2005 regarding cultural differences). To explain these results, economists have developed a variety of models suggesting that people are averse to unequal distributions between the two players (reviewed by Camerer, 2003).

Exogenous to these models, however, is a body of research showing that people are sensitive to the traits of their UG partner, not merely to the structure of the game. For example, offers are more likely to be accepted if they are from a smiling proposer (Mussel et al, 2013) or one described as generous (Marchetti et al., 2011); more symmetrical responders receive higher offers (Zaatari, Palestis & Trivers, 2009); and more attractive individuals receive higher offers from proposers but responders also demand more from them in order to accept an offer (Solnick & Schweitzer, 1999). There is complementary evidence from other economic games as well, for example showing that attractive

[1] These results have previously been published as Eisenbruch, A. B., Grillot, R. L., Maestripieri, D., & Roney, J. R. (2016). Evidence of partner choice heuristics in a one-shot bargaining game. *Evolution and Human Behavior*, *37*(6), 429-439.

[2] These results have been published as Eisenbruch, A.B. & Roney, J. R. (2017). The skillful

individuals are more likely to be trusted (Wilson & Eckel, 2006) and to have their trust reciprocated (Krupp, DeBruine & Jones, 2011) in a trust game. These results suggest that people process economic games, including the UG, as though they are real-world social interactions, in which the biological and behavioral traits of their partners matter.

There are (at least) two competing adaptationist theories of how resources might be divided in the UG. First, there is evidence suggesting that people divide resources according to the logic of the asymmetric war of attrition (AWA; Hammerstein & Parker, 1982; Maynard Smith, 1979), in which resources are allocated based on the relative ability and willingness of each individual to inflict damage on the other. Physically stronger men feel more entitled to advantageous outcomes and are more willing to use force to resolve conflicts in their favor (Sell et al., 2009; see also Petersen et al., 2013). If resources are divided in the UG according to the logic of the AWA, then any cues of the likelihood of winning a violent conflict over resources (e.g., strength, aggressiveness) should lead to more advantageous treatment in the game.

The second theory is that people will treat the UG not as a conflict over an existing resource (in which the AWA would apply), but as an opportunity to initiate a long-term cooperative relationship. Humans evolved in a biological marketplace of long-term cooperative relationships, and therefore faced selection pressures to choose (and be chosen by) the most valuable available cooperators (Barclay, 2013; Baumard, André & Sperber, 2013; Noë & Hammerstein, 1994, 1995; see chapter I). If mechanisms that evolved for partner choice (PC) govern behavior in the UG, then participants should offer advantageous treatment to partners who appear high in partner value, as a type of opening bid for the establishment of a cooperative relationship. On this account, any cues that a potential partner

is more valuable than alternative possible partners should cause that potential partner to be treated better in the UG. As discussed further below, cues of health, strength, and prosociality, among other traits, likely predicted relative partner value in the ancestral environments in which PC mechanisms evolved. As such, on the PC model, players perceived to possess these traits should receive more generous treatment in the UG.

In the present research, I used face photographs that had been measured and rated for various traits as partners in the UG in order to test how perceived traits affect treatment in the game. I initially hypothesized effects consistent with the AWA – in which more threatening and formidable individuals would receive better treatment – but initial results suggested that cues of high partner value might be the stronger predictor of treatment in the game. Subsequent data collections were therefore designed to test between the AWA and PC models.

2.1. Study 1a

2.1.1. Study 1a Introduction

Since humans form rich impressions of others based on limited exposure to faces (e.g. Willis & Todorov, 2006), I used a face-perception paradigm to test the effects of various cues on treatment in the UG. In an initial study using male participants, I predicted on the basis of the AWA that cues of the likelihood of escalating and winning a violent conflict over resources would lead to more generous treatment in the UG. Recent research suggests that men's facial-width-to-height ratio (fWHR) may be a cue of formidability. Men with greater fWHRs are judged as more aggressive (Carré et al., 2009), dominant (Alrajih & Ward, 2014) and intimidating (Hehman et al., 2013), and are in fact more aggressive both in

the laboratory and in real-world settings (Carré & McCormick, 2008). Similarly, men with wider faces are trusted less and are less trustworthy in an economic task (Stirrat & Perrett, 2010). Men with wider faces are more likely to be violent (Christiansen & Winkler, 1992), but less likely to die in fights (Stirrat, Stulp & Pollet, 2012). In sum, there is evidence to suggest that men with wider faces may be calibrated to a more aggressive, exploitative interpersonal strategy, and are perceived as such. Therefore, the logic of the AWA predicts that men with a higher fWHR will receive more generous treatment in the UG.

2.1.2. Study 1a Materials and Methods

2.1.2.1. Study 1a Design

I tested this prediction using stimulus faces drawn from a sample of men who participated in a study on mating psychology and behavior. These men had been measured for physical strength, and photos of their faces were measured for fWHR and rated for health, attractiveness, dominance, and prosociality. I then used these pictures to represent UG partners (hereafter "targets") for a new set of male participants. The above measurements and ratings were initially made because of their relevance to the larger project on mating psychology, but they also allowed for tests of predictors of treatment in the UG. On the basis of the AWA, I predicted that fWHR would positively predict generosity received in the UG; the other traits were also examined because prior findings suggest that facial traits may be influential in the UG (see Introduction).

The strategy method of the UG was employed (see Guth & Kocher, 2014). In the strategy method, the responder states the minimum offer they would accept from the proposer (their "demand), rather than accepting or rejecting a specific offer. This method

allows all subjects to play as both proposer and responder with all possible partners, and elicits continuous measures of UG behavior. During session 1, participants played a series of one-shot ultimatum games (with a $10 endowment) with multiple same-sex partners ("targets") who were represented by a facial photograph. Participants saw a picture of a target's face and were asked to state either an offer or a demand for that target, and this was repeated for all targets (participants were instructed to skip any targets they recognized). Participants were randomly assigned to play first as the proposer towards all targets and then as the responder towards all targets, or vice versa. Targets were presented in a random order. These targets had previously played a single, one-shot UG for real money using the strategy method with an anonymous partner (i.e. their partners were not identified to them, nor they to their partners, in any way beyond knowing that they were all participants in the same study). These recorded UG decisions allowed us to pay our study 1a participants based on the actual outcomes of their games.

Session 2 occurred a few weeks after session 1. During session 2, subjects rolled a die. If the die came up 6, one of their UG decisions from session 1 was chosen at random, and compared to the corresponding decision of their target from that round. Participants were then paid their earnings for that round in cash. As such, all participant decisions were incentive-compatible, and there was no deception. All targets, photograph raters, and participants were students at UCSB, who gave informed consent to participate or have their picture used for research.

2.1.2.2. Male target stimuli

Facial photographs of 83 male students were used as stimuli ("targets") in study 1a. They were 18 – 26 years old (mean = 20.0, s.d. = 1.85). Thirty-five self-identified as Caucasian, 20 as Asian, 16 as Hispanic, and the rest self-identified as multiracial or "Other." All gave permission for their photographs to be used for research purposes.

Photographs were taken directly facing the camera under standardized lighting conditions, and were digitally rotated so that the pupils were aligned on a horizontal axis. fWHR was measured as the distance between the left and right zygion (the outermost edge of the face, before the ear) divided by the distance from the top of the upper lip to the upper edge of the eyelids. Measurements were made independently by two research assistants; there was high agreement between the two sets of measurements (r = .95), and their mean was used in analysis. Photographs were then cropped with an oval around the face. Strength was measured as the composite of grip and chest strength (measured with a dynamometer) and flexed bicep circumference (see Sell et al, 2009).

2.1.2.3. Raters

Due to the design of the study from which these target stimuli were drawn, the target face photographs were rated in two batches. Sixty-nine students (42 female) rated 39 of the male targets; these raters were 17 – 22 years old (mean = 18.6 years, s.d. = 0.99). Forty-eight students (19 female) rated the other 44 male targets; these raters' ages ranged from 18 – 22 years (mean = 18.6 years, s.d. = 0.99). Target photos were rated for attractiveness (3 items; alpha = .980), health, dominance (3 items; alpha = .946), and prosociality (3 items; alpha = .974). Items were presented in a random order, and target faces were randomized

within items. Full wording of all items and their intra-class correlations are presented in Appendix A.

2.1.2.4. Male ultimatum game participants

Ninety-nine men played the UG with the target face photographs as partners. None of these men were among the participants who had rated the faces. Eleven men showed no variance in their generosity index (see below), likely indicating disengagement from the task, so analysis was restricted to the other 88 participants. (Given the potential uncertainty regarding whether invariance in generosity reflects disengagement or a consistent strategy, analyses were also run including all participants, and statistical results were very similar. Generally speaking, including all participants changed zero-order correlations only in the third decimal place.) Due to experimenter error, we did not record the ages of these participants. However, they were drawn from the same subject pool as the raters used in study 1a, so their age distribution is likely similar.

2.1.2.5. Data analysis

Mean values for each rating dimension for each target face were computed and used in subsequent analyses. Bivariate correlations were used to evaluate the zero-order effect of each of the target traits (measured fWHR, measured strength, and ratings of attractiveness, health, dominance and prosociality) on how the target faces were treated in the ultimatum game.

2.1.3. Study 1a Results

Table 1 presents the correlations between fWHR, strength, attractiveness, health, dominance and prosociality for the male targets. (Note that the traits rated in study 1b are included in the same table, for efficiency of presentation.) Surprisingly, fWHR was not significantly correlated with strength or dominance, suggesting that it may not in fact be a reliable cue of formidability, at least in this sample. It was, however, negatively correlated with ratings of attractiveness, prosociality, and health, suggesting that raters had negative impressions of men with wider faces.

Table 1
Intercorrelations among fWHR, strength, and the rated traits in Studies 1a and 1b.

Trait	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. fWHR									
2. Strength	0.12								
3. Health	-0.55**	0.13							
4. Attractiveness	-0.44**	0.18	0.88**						
5. Prosociality	-0.31**	0.18	0.68**	0.63**					
6. Dominance	-0.08	0.19	0.46**	0.59**	-0.01				
7. Friend Desirability	-0.29**	0.20	0.75**	0.79**	0.70**	0.45**			
8. Productivity	-0.21	0.27*	0.59**	0.68**	0.34**	0.79**	0.70**		
9. Dangerousness	0.14	0.18	0.03	0.25*	-0.29**	0.82**	0.17	0.61**	
10. Social Status	-0.45**	0.21	0.90**	0.95**	0.66**	0.56**	0.81**	0.68**	0.18

Note. Variables 1-6 were collected in study 1a, and variables 7-10 were collected in study 1b.
*$p < 0.05$, two-tailed
**$p < 0.01$, two-tailed

There was a significant negative correlation between the mean offers and mean demands received by targets (i.e. the UG partner in the photograph), $r(83) = -.45$, $p < .001$,

such that targets who received higher offers also received lower demands. This indicates that participants used offers and demands in concert when responding to UG partners; therefore we used mean generosity received by a target (generosity = offer – demand) as the primary measure of treatment in the UG.

Table 2 presents the zero-order correlations of mean generosity received by targets with their fWHR, strength, and ratings of attractiveness, health, dominance and prosociality (for efficiency of presentation, the traits rated in study 1b are also included in this table). fWHR was significantly negatively correlated with generosity received, but all of the other traits positively predicted mean generosity received. Effect sizes were especially large for health and attractiveness ratings (which were highly correlated with each other; see Table 1), with these traits accounting for nearly two-thirds of the variance in how well specific targets were treated (rs > 0.75).

Table 2
Zero-order correlations between mean generosity received and target traits in men (Study 1).

Study 1a			Study 1b		
Trait	*r*	*p*	Trait	*r*	*p*
fWHR	-0.33	0.002	Friend Desirability	0.75	<.001
Strength	0.25	0.022	Productivity	0.70	<.001
Health	0.79	<.001	Dangerousness	0.24	0.03
Attractiveness	0.80	<.001	Social Status	0.86	<.001
Prosociality	0.56	<.001			
Dominance	0.53	<.001			

Note: p values are two-tailed.

2.1.4. Study 1a Discussion

The results of study 1a were contrary to the AWA-based hypothesis: fWHR negatively predicted generosity received in the UG. This may be because fWHR in this sample did not reliably cue the likelihood of winning a violent conflict over resources, as suggested by the lack of significant correlations between fWHR and strength and dominance. The negative correlation between fWHR and prosociality suggests that fWHR was instead used as a cue that an individual was exploitative or uncooperative.

More importantly, these results suggest that participants may have treated the UG as an opportunity for partner choice. The large positive effects of health, attractiveness, and prosociality suggest that participants gave preferential treatment to the types of people who are generally in high demand as social partners. As such, these results were consistent with a PC model for explaining UG behavior. On the other hand, the positive effect of dominance is still potentially consistent with the AWA model, given that individuals are generally prone to cede resources to dominant individuals. The effect of strength is consistent with both the AWA and PC models, since male strength may have been a reliable cue of either dangerousness or productivity in ancestral environments (Apicella 2014; von Rueden et al., 2008). Because of these ambiguities, the target faces were rated for additional traits in order to test between the PC and AWA models (Study 1b).

2.2. Study 1b

2.2.1. Study 1b Introduction

Study 1b used the same UG decisions as in 1a, but the target faces were rated for additional traits in order to better test the AWA and PC theories against each other. In

particular, I obtained ratings of productivity in an ancestral-like environment (e.g., how good the target would be at finding food on a desert island), dangerousness in response to a low offer (e.g., the target's likelihood of starting a fight in response to an insulting offer), and desirability as a friend. On the PC model, partners who appear more productive should receive greater generosity, while those who appear dangerous should receive less generosity. This is because the mind will implement algorithms designed to secure cooperative relationships with productive, non-exploitative partners in a competitive marketplace of cooperators (Barclay, 2013; Baumard et al., 2013). Desirability as a friend may then serve as a summary judgment of cooperative partner value (Tooby & Cosmides, 1996; Vigil, 2007). Cues of ancestral, rather than modern, productivity were measured because their effects more clearly indicate the operation of evolved heuristics. In other words, if traits that are irrelevant to productivity in modern environments nonetheless have an effect on contemporary economic decisions, this is evidence that those decisions are implemented by mechanisms that have been tailored by natural selection to the environment in which our species evolved.

On the other hand, the AWA model predicts that partners who appear more dangerous will receive more generous treatment, because men will defer to individuals who are likely to win a violent conflict over resources. In addition, the PC model predicts that the positive effect of strength on generosity observed in study 1a will be mediated by productivity, while the AWA model predicts that the effect of strength will be mediated by dangerousness.

Since perceived productivity is a relatively new addition to the partner choice literature (Macfarlan & Lyle, 2015; see Barclay & Reeve, 2012; Debove, Baumard & André,

2017 for theoretical work on the importance of individual quality and productivity, respectively; see Krupp, DeBruine & Jones, 2011; Zaatari & Trivers, 2007; Zaatari, Palestis & Trivers, 2009 for effects of cues of condition), I wanted to test it against other theoretically-relevant partner choice criteria. Most existing research on partner choice focuses on dispositional cooperativeness as the criterion by which partners are chosen (e.g. Aktipis, 2004; Delton & Robertson, 2012; Fu et al., 2008), and health is also a theoretically-important component of partner value (e.g. Barclay, 2013; Krupp, DeBruine & Jones, 2011; Zaatari & Trivers, 2007). Therefore, multiple regression analyses were used to test the independent effect of productivity, controlling for these other traits.

In addition, I tested the PC model against other possible models of UG behavior. First, a "beauty premium" has been previously observed in the UG and other economic settings (see Maestripieri, Henry & Nickels, 2017 for review), which predicts more generous treatment towards more attractive partners. Second, proposers in study 1a could have attempted to maximize their earnings in the game by matching their offer to the demand expected from the responder. Third, participants may have simply reciprocated the treatment they anticipated receiving from their partner. We statistically controlled for each of these possibilities in order to confirm that the effects of PC heuristics obtained above and beyond these other potential influences. Note that these are particularly stringent tests of the PC model, since attractiveness may contain cues of partner value (discussed further below), and the PC model actually predicts that participants will prefer partners whom they expect to be generous; the PC model, however, uniquely predicts that other cues of partner value will matter even controlling for attractiveness halo effects and desires to reciprocate expected treatment.

2.2.2. Study 1b Materials and Methods

2.2.2.1. Male target stimuli

The target stimuli were exactly the same as those used in study 1a.

2.2.2.2. Raters

Eight research assistants (3 female) completed the ratings of dangerousness (3 items, e.g., likelihood of starting a fight in response to a low offer; alpha = .851), productivity (2 items, e.g., skill at acquiring food while stranded on a desert island; alpha = .871), and desirability as a friend. These research assistants also estimated how the targets would behave in an ultimatum game, i.e. the offers and demands that each target would make. Raters were blind to hypotheses, the targets' actual UG behavior, and the treatment the targets received in the UG. They ranged from 19-23 years old (mean = 21.3 years, s.d. = 2.06). Eighteen students (13 female) rated the male target faces for their apparent social status (7 items; alpha = .988). These raters were 18-21 years old (mean = 18.8 years, s.d. = 0.86). (Ratings of male social status were performed after study 2, given the strong effect of social status in women.) Items were presented in a random order, and target faces were randomized within items. Full wording of all items and their intra-class correlations are presented in Appendix A.

2.2.2.3. Data analysis

Bivariate correlations were employed in order to evaluate the zero-order effects of perceived productivity, dangerousness, desirability as a friend, and social status on generosity received in the UG. The positive effect of target strength observed in study 1a is

consistent with both the AWA and PC models. In order to test these two hypotheses against each other, a model was constructed in which ratings of dangerousness and productivity were entered as mediators of the effect of strength on generosity received, using Preacher and Hayes' (2008) INDIRECT macro for SPSS with 2000 random samplings. Multiple regression analyses tested the independent effects of perceived productivity on generosity received, controlling first for prosociality ratings, and then for prosociality and health ratings.

In order to test the effects of target traits beyond attractiveness halo effects, partial correlations, controlling for attractiveness, were calculated between the remaining target traits (from studies 1a and 1b) and generosity received in the UG. In order to control for the possibility that proposers might try to maximize their income by matching their offer to the target's expected demand, I calculated partial correlations between all of the target traits and offers received, controlling for the demands expected from the targets. In order to control for the participants' motivation to reciprocate the treatment they expected from the targets, partial correlations between all of the target traits and generosity received, controlling for estimates of the targets' generosity, were calculated.

Finally, the effect of participants' use of partner choice heuristics on their earnings in the UG was tested. To do this, I calculated, for each participant, the correlations between UG decisions and target traits. The absolute value of these correlations indexes each participant's sensitivity to the various target traits. These sensitivity indexes were then correlated with the participants' mean earnings across all rounds (if they were to be paid out). The correlation between sensitivity to target traits and mean earnings reveals how sensitivity to various target traits affected earnings in the UG.

2.2.3. Study 1b Results

Table 1 presents the correlations between the ratings of productivity, dangerousness, desirability as a friend, and social status, as well as all of the traits rated or measured in study 1a. Of note, the productivity composite generally correlated highly and positively with other positive traits (like friend desirability) but also with dangerousness, although dangerousness did not exhibit strong correlations with the positive traits. This suggests that some cues signal both productivity and dangerousness, but that other cues differentiate between productive individuals who are desirable as opposed to undesirable social partners.

2.2.3.1. Zero-order correlations between perceived traits and generosity received

Table 2 presents the zero-order correlations of mean generosity received by targets with their ratings of productivity, dangerousness, desirability as a friend and social status (for convenience, the variables from study 1a are also shown in this table). Dangerousness was significantly, *positively* correlated with mean generosity received, albeit with a modest effect size; although on its face this supports the AWA model, this could be a byproduct of the positive correlation between dangerousness and productivity (addressed further below). Productivity, desirability as a friend, and social status were all very highly and positively correlated with generosity received (rs ≥ 0.7), which is consistent with the PC model.

2.2.3.2. Mediating the effect of strength

Figure 1 presents the results of the model in which productivity and dangerousness were entered as mediators of the effect of strength on generosity received, and shows that apparent productivity, but not dangerousness, significantly and completely mediated the

effect of strength. Importantly, when productivity was controlled for, the effect of dangerousness reversed in sign and this variable became a significant *negative* predictor of generosity received. (This same reversal also occurred when productivity (β = .89, $t(80)$ = 9.27, $p < .001$) and dangerousness (β = -.31, $t(80)$ = -3.23, p = .002) were entered as the only predictors of generosity received.) These results support the PC model over the AWA model.

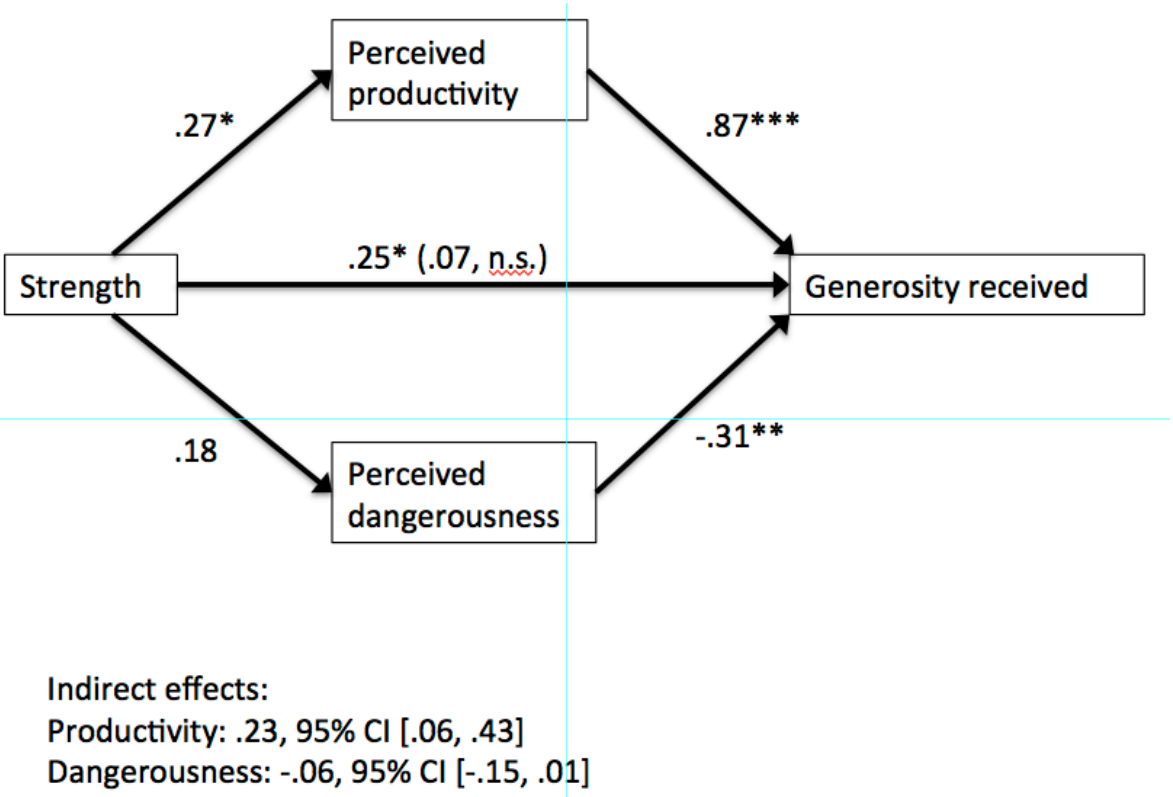

Figure 1. The effect of strength on generosity received, with perceived dangerousness and productivity as mediators (Study 1). Coefficients are standardized; model constructed with 2000 bootstrap samples using Preacher and Hayes' (2008) INDIRECT macro in SPSS.
* p < .05
** p < .01
*** p < .001

2.2.3.3. Independent effects of productivity

In the regression model with productivity and prosociality ratings as simultaneous predictors of generosity received, productivity had a significant positive effect, $\beta = .57$, $t(80) = 7.64$, $p < .001$, as did prosociality, $\beta = .37$, $t(80) = 4.94$, $p < .001$. Adding health as a predictor improved the accuracy of the model, R^2 change = .101, $F(1,79) = 27.18$, $p < .001$. Productivity remained a significant predictor, $\beta = .37$, $t(79) = 4.90$, $p < .001$, and health had a significant positive effect, $\beta = .51$, $t(79) = 5.21$, $p < .001$, but prosociality was no longer a significant predictor of generosity received, $\beta = .09$, $t(79) = 1.10$, $p = .28$. In both models, collinearity diagnostics revealed sufficient independence of predictors (all VIFs < 2.6). These models suggest that productivity is an important independent predictor of generosity received, supporting the PC hypothesis, while prosociality has a less robust effect.

2.2.3.4. Effects on earnings and controlling for alternative explanations

Table 3 presents the results of partial correlations between mean generosity received and the other target traits from studies 1a and 1b, controlling for attractiveness. Desirability as a friend, productivity, health, and social status had significant positive effects above and beyond the effect of attractiveness, while strength and dominance retained marginally-significant effects controlling for attractiveness. This suggests that the zero-order effects observed in studies 1a and 1b cannot be sufficiently explained as an artifact of favoritism towards attractive partners.

Table 3
Partial correlations between target traits and generosity received, controlling for attractiveness, in men (Study 1).

Study 1a			Study 1b		
Trait	partial *r*	*p*	Trait	partial *r*	*p*
fWHR	0.05	0.69	Friend Desirability	0.33	0.002
Strength	0.19	0.092	Productivity	0.35	0.001
Health	0.28	0.012	Dangerousness	0.07	0.537
Prosociality	0.12	0.269	Social Status	0.50	<.001
Dominance	0.20	0.066			

Note: p values are two-tailed.

Participants were more generous toward targets who were expected to be more generous, $r(83) = .43$, $p < .001$, suggesting a desire to reciprocate the expected treatment. However, the effects of target traits on generosity received were largely unchanged after controlling for expected generosity (Table 4), showing that partner choice heuristics have important effects above and beyond the desire to reciprocate generosity.

Table 4

Partial correlations between target traits and mean generosity received, controlling for expected generosity, in men (Study 1).

Study 1a			Study 1b		
Trait	partial *r*	*p*	Trait	partial *r*	*p*
fWHR	-0.19	0.087	Friend Desirability	0.69	<.001
Strength	0.26	0.019	Productivity	0.72	<.001
Health	0.73	<.001	Dangerousness	0.58	<.001
Attractiveness	0.76	<.001	Social Status	0.82	<.001
Prosociality	0.41	<.001			
Dominance	0.69	<.001			

Note: p values are two-tailed.

Participants offered *less* to targets who looked like they would demand more to accept an offer, $r(83) = -.39$, $p < .001$, which is the opposite of the income-maximizing strategy, and sensitivity to all target traits (except productivity) had a negative effect on UG earnings (Table 5). This shows that participants' behavior was not income-maximizing, and in fact men were willing to *reduce* their earnings in order to cooperate selectively on the basis of cues of partner value.

Table 5
Correlations between participant sensitivity to target traits and mean participant earnings across all rounds, in men (Study 1).

Study 1a			Study 1b		
Trait	*r*	*p*	Trait	*r*	*p*
fWHR	-0.40	<.001	Friend Desirability	-0.44	<.001
Strength	-0.20	0.092	Productivity	-0.09	0.405
Health	-0.43	<.001	Dangerousness	-0.38	<.001
Attractiveness	-0.44	<.001	Social Status	-0.22	0.041
Prosociality	-0.39	<.001			
Dominance	-0.36	0.001			

Note: p values are two-tailed.

Together, these analyses show that the present results cannot be accounted for by attractiveness halo effects, reciprocity motivations, or income-maximizing behavior. However, the PC model – the hypothesis that participants calibrated their generosity to targets' cues of partner value as a means of bidding for a cooperative relationship – can account for all of these effects.

2.2.4. Study 1b Discussion

The results of study 1b robustly supported the PC hypothesis over the AWA hypothesis. A target's apparent productivity, social status and desirability as a friend all had large positive effects on the generosity that target received in the UG. While apparent dangerousness had a positive zero-order effect on generosity received, dangerousness had a significant negative effect on generosity once productivity was controlled for, suggesting that formidability above and beyond implied productivity is actually penalized in the UG.

Moreover, the positive effect of strength on generosity observed in study 1a was mediated by ratings of productivity, further supporting the partner choice model.

The existence of a market of potential cooperators likely limits the ability of even formidable individuals to coerce others into cooperative relationships over the long run, given the effectiveness of alliances (e.g. Wrangham, 1999) and social exclusion (e.g. Aktipis, 2004; Debove, Baumard & André, 2015) in mitigating risks from exploitative individuals. This may explain why men appear to respond to apparently dangerous potential partners with aversion, rather than appeasement. However, future research should examine how individual differences (e.g. the perceiver's own formidability) and contextual variables (e.g. the cost of partner switching) moderate the effect of dangerousness on cooperative surplus divisions. In addition, it is possible that the use of target photographs in the controlled setting of the lab muted the effect of target dangerousness (and potentially other target traits), compared to what their effect would be in a spontaneous, face-to-face interaction. Testing the PC and AWA models against each other in more naturalistic settings may be a valuable avenue for future research.

Importantly, we observed effects of partner choice heuristics above and beyond attractiveness halo effects, strategies to maximize earnings, and motivations to reciprocate the target's quality of treatment. In fact, participants appeared to implement *costly* partner choice heuristics: men offered less to targets who looked like they would demand more, thereby reducing the odds of their offer being accepted, and sensitivity to target traits was negatively correlated with participant earnings. While this behavior is "anomalous" with respect to maximizing earnings in the UG, it is sensible as an output of a mechanism designed by natural selection for an ecology in which the benefits of long-term cooperative

relationships may justify the costs incurred in establishing those relationships (see Delton et al., 2011).

Controlling for the target's expected generosity (i.e. controlling for reciprocity motivations) is a particularly strong test of the PC model, since the PC model actually predicts that individuals should be more generous towards partners whom they expect to be generous in turn (e.g. Barclay, 2013; Baumard et al, 2013). Our results show that, on top of being generous towards apparently generous partners, people have additional strong preferences for partners who appear to have other components of long-term cooperative value (e.g. those who appear healthy, productive and high in social status; see Table 4).

The strong effect of ratings of ancestral productivity is an important addition to the partner choice literature. Previous modeling (e.g. Aktipis, 2004; Fu et al., 2008) and empirical (e.g. Delton & Robertson, 2012) research has focused on dispositional cooperativeness as the criterion by which partners are chosen or rejected. While individuals should certainly prefer partners who are cooperative, generous and value them highly, our results show that men also prefer partners who have above-average resource production capabilities. This is consistent with partner choice theory (Barclay, 2013; Debove, Baumard & André, 2017) and research in other species on partner choice for competence (von Bayern et al., 2011; Melis et al., 2006; Vail et al., 2014). Moreover, the fact that contemporary economic decisions were strongly predicted by ratings of productivity in a hunter-gatherer-like environment (which appear irrelevant or even bizarre in a modern context) suggests that humans implement a psychology of partner choice that was designed by natural selection for an ancestral environment. The positive effect of target productivity on generosity above and beyond the effect of expected target generosity (Table 4), and the robustness of the effect of

productivity in comparison to prosociality (see section 2.2.3.3), raises the possibility that men might be willing to trade off generosity in a partner in favor of productivity; future research will be necessary to identify the precise parameters of that trade off (see Debove, Baumard & André, 2017 for modeling results to a similar effect).

2.3. Study 2

2.3.1. Study 2 Introduction

Study 2 was designed to test whether women would also offer better treatment to same-sex UG partners who possessed indicators of high partner value. I expected replication of the study 1 findings of better treatment of partners who appeared healthier and more prosocial, since these traits should have predicted larger streams of benefits for women's cooperative partners in ancestral environments. Strength was measured in women but was not expected to replicate its positive effect on UG treatment in men; since women have historically been less involved in large game hunting and coalitional violence (e.g. Marlowe, 2007; Wrangham, 1999), for which strength is beneficial (Apicella, 2014; von Rueden et al., 2008), women's perceived partner value may be less related to this variable. Relatedly, I expected that the effect of productivity might be reduced in women compared to men, since gathering has lower variance of outcomes than hunting does (Kaplan et al, 1985), female foraging parties tend to be larger than optimal with respect to food production (Marlowe, 2010), and female same-sex relationships tend to be less task-oriented than male same-sex relationships (e.g. Aukett, Ritchie & Mill, 1988), all of which suggest that women may have faced weaker selection pressures than men for choosing partners on the basis of their ability to collaboratively create food resources (see also chapter I). Perceived dangerousness was

tested in order to evaluate whether the AWA model might account for women's behavior with same-sex partners, though it was not expected to. Ratings of target face attractiveness were collected, allowing tests of partial effects of other variables when controlling for attractiveness, as well as allowing us to test whether more attractive individuals are treated better in the UG.

To further extend the PC model, social status was identified as another potential component of partner value, since individuals who are high in social status may be able to provide greater benefits to their partners by virtue of their social influence, and high social status may indicate high quality and quantity of outside options for cooperation. Therefore the female target faces used in study 2 were rated for social status as well, and it was predicted that social status would positively predict the quality of treatment received in the UG.

2.3.2. Study 2 Materials and Methods

2.3.2.1. Study 2 Design

The design of study 2 was largely the same as the design of study 1a; female participants played one-shot UGs with a series of target partners represented by face photographs that had been measured and rated on various dimensions. The only difference from study 1a is that not all of the targets used as UG partners in study 2 had previously played the UG. Some of the targets had previously played a hypothetical, one-shot UG with a partner with whom they had recently had a conversation; other targets had never played the UG. Participants in study 2 were told truthfully that some of the targets they would play with had previously played the UG, but that they would be unable to tell which targets had

or had not played the UG. When participants returned for session 2, they rolled a die. If they rolled a 6, one of their decisions was matched with the corresponding decision from a target who had previously played the UG, and they were paid their game earnings in cash. Therefore all participant decisions were incentive-compatible, and no deception was used.

2.3.2.2. Female target stimuli

Facial photographs of 100 female students that were collected in two unrelated studies were used as targets, i.e. to represent UG partners to the participants in study 2. They ranged in age from 18-23 years (mean = 18.6, s.d. = 0.96). Forty-two self-identified as Caucasian, 2 as African-American, 22 as Asian, 24 as Hispanic, and the rest as multiracial or "Other." All gave permission for their photographs to be used for research purposes.

Photographs were taken and processed in the same way as in study 1a. Strength was computed as the composite of hand grip and chest strength as measured by a dynamometer (bicep circumference was not available for all targets).

2.3.2.3. Raters

A pool of 105 students (66 female) rated the female targets on attractiveness (3 items; alpha = .979), health, prosociality (3 items; alpha = .893), dangerousness (3 items; alpha = .920), productivity (3 items; alpha = .868), and social status (7 items; alpha = .937). These same students also estimated the offer and demand that each target would make if the target were playing the UG. Each rater was randomly assigned to rate or estimate 5-6 items, and ratings on specific items continued until intra-class correlations for all rated items were at least .7. Due to experimenter error, the ages of these raters were not recorded, but they

were drawn from the same subject pool as the raters used for studies 1a and 1b. Ratings of attractiveness were made only by male raters, but other items were rated by both men and women. Items were presented in a random order, and target faces were randomized within items. Full wording of all items and their intra-class correlations are presented in Appendix A.

2.3.2.4. Ultimatum game participants

Seventy-four women played the UG with the female targets as partners. Seven women showed no variance in their generosity index (generosity = offer – demand), likely indicating disengagement from the task, so analysis was restricted to the other 67 participants (but results were very similar when all participants were included). Due to experimenter error, we did not record the ages of these participants, but they were drawn from the same subject pool as the raters used for studies 1a and 1b.

2.3.2.5. Data analysis

A data analysis strategy similar to that of study 1b was used to evaluate the PC hypothesis, control for alternative explanations, and evaluate the effect of partner choice heuristics on UG earnings. First, I tested the zero-order effects of ratings of strength, attractiveness, health, prosociality, productivity, dangerousness and social status on treatment received in the UG.

Second, a series of partial correlations were computed in order to control for various alternative explanations. In order to control for the effect of attractiveness, partial correlations, controlling for attractiveness, between UG decisions and the remaining target

traits were calculated. Next, in order to control for the effect of participants' income-maximization strategies, I computed the effects of target traits on mean offers received, controlling for the targets' mean expected demands. Third, in order to control for participants' motivation to reciprocate the quality of treatment the target is expected to provide, partial correlations between UG treatment received and target traits, controlling for the targets' expected decisions, were computed.

Finally, in order to measure the effect of partner choice heuristics on earnings in the UG, I calculated the correlations between participant earnings and sensitivity to each of the target traits tested in study 2.

2.3.3. Study 2 Results

Table 6 presents the correlations between all of the measured and rated traits in study 2. Of note, dangerousness and strength were uncorrelated with productivity in the female targets, in contrast to the male targets for which productivity was predicted by these variables (see Table 1).

Table 6
Intercorrelations among strength and the rated traits in Study 2.

Trait	1.	2.	3.	4.	5.	6.
1. Strength						
2. Health	-0.23*					
3. Attractiveness	-0.17^	0.84**				
4. Prosociality	-0.14	0.41**	0.32**			
5. Productivity	-0.05	0.50**	0.37**	0.24*		
6. Dangerousness	0.29**	-0.12	-0.03	-0.67**	0.13	
7. Social Status	-0.13	0.84**	0.88**	0.52**	0.49**	-0.05

^$p < 0.10$, two-tailed
*$p < 0.05$, two-tailed
**$p < 0.01$, two-tailed

There was a significant positive correlation between the mean offers and demands received by targets, $r(100) = .20$, $p = .05$. This indicates that women deployed their offers and demands in conflict with each other, such that targets who received higher offers also received higher demands. The generosity index used in study 1 would therefore obscure effects on both offers and demands, so offers and demands were analyzed separately.

2.3.3.1. Zero-order correlations between target traits and UG treatment

Table 7 presents the zero-order correlations between target traits and mean offers and demands received. Targets who appeared healthier, more attractive, more prosocial, more productive and higher in social status all received significantly higher offers, although effect sizes were generally smaller than for men. As expected, strength was uncorrelated with offers received, and dangerousness was marginally, negatively correlated with the size of offers. These patterns appear to support the PC model over the AWA model. When

productivity and prosociality were entered into the same regression model predicting mean offers received, prosociality had a significant positive effect, β = .26, $t(96) = 2.61$, $p = .010$, while productivity did not, β = .15, $t(96) = 1.47$, $p = .15$. This suggests that women prioritize prosociality over productivity in a partner, which stands in contrast to the results in men (see section 2.2.3.3).

Table 7
Zero-order correlations between female target traits and mean offers and demands received (Study 2).

	Offers		Demands	
Trait	*r*	*p*	*r*	*p*
Strength	-0.12	0.237	-0.09	0.380
Health	0.44	<.001	0.39	<.001
Attractiveness	0.43	<.001	0.50	<.001
Prosociality	0.29	0.003	0.15	0.131
Productivity	0.21	0.038	0.16	0.107
Dangerousness	-0.17	0.084	0.07	0.522
Social Status	0.48	<.001	0.48	<.001

Note: p values are two-tailed.

For mean demands received (right side of Table 7), however, traits indicative of high partner value actually predicted worse treatment in the game. Targets who appeared healthier, more attractive, and higher in social status received higher demands for their offers to be accepted. Unlike offers made, prosociality and productivity did not predict demands.

2.3.3.2. Effects on earnings and controlling for alternative explanations

Table 8 presents the partial correlations between target traits and UG treatment received, controlling for attractiveness. The partial correlations were much smaller than the zero-order relationships depicted in Table 7. For offers received, social status was the only variable to retain a significant (positive) relationship, though there were marginal effects for prosociality and dangerousness. There were no significant partial correlations between target traits and demands received. These patterns suggest that many of the effects of target traits on decisions were driven by higher offers and demands directed towards more attractive partners.

Table 8
Partial correlations between target traits and mean offers and demands received, controlling for attractiveness, in women (Study 2).

	Offers		Demands	
Trait	partial *r*	*p*	partial *r*	*p*
Strength	-0.05	0.607	-0.01	0.957
Health	0.17	0.100	-0.06	0.566
Prosociality	0.18	0.068	-0.01	0.952
Productivity	0.06	0.567	-0.03	0.792
Dangerousness	-0.18	0.075	0.09	0.376
Social Status	0.24	0.015	0.09	0.364

Note: p values are two-tailed.

Female participants appeared to engage in reciprocity based on the targets' expected behavior. There were significant positive correlations between mean offers received by targets and the mean offers they were expected to make, $r(100) = .37$, $p < .001$, and between mean demands received by targets and the mean demands they were expected to make,

$r(100) = .37$, $p < .001$. Table 9 presents the partial correlations between target traits and mean offers and demands received, controlling for expected offers and demands, respectively. Ratings of target health, social status and attractiveness had significant positive partial correlations with offers received, controlling for expected offers. Ratings of target health, prosociality, social status and attractiveness had significant positive partial correlations with demands received, controlling for expected demands, and dangerousness has a marginally significant negative partial correlation with demands received. This indicates that participants responded to cues of partner value, above and beyond their desire to reciprocate the treatment they expected to receive from their partners.

Table 9
Partial correlations between target traits and offers, controlling for expected offers, and between target traits and demands, controlling for expected demands, in women (Study 2).

	Offers		Demands	
Trait	partial *r*	*p*	partial *r*	*p*
Strength	-0.09	0.412	-0.11	0.282
Health	0.30	0.003	0.28	0.006
Attractiveness	0.28	0.006	0.38	<.001
Prosociality	0.05	0.601	0.26	0.008
Productivity	0.07	0.523	0.10	0.328
Dangerousness	-0.06	0.547	-0.19	0.055
Social Status	0.34	0.001	0.36	<.001

Note: p values are two-tailed.

There was a significant positive correlation between the mean demands expected from targets and the mean proposals they received, $r(100) = .22$, $p = .028$, suggesting that

women weakly follow the income-maximizing strategy in the UG of matching their offers to the demands expected from their partners. Table 10 presents the partial correlations between target traits and offers received, controlling for expected demands. There were significant positive effects of health, prosociality, productivity (marginally significant), social status and attractiveness, and a significant negative effect of dangerousness, on offers, controlling for expected demands. This indicates that there were effects of target traits beyond those that can be accounted for by the participants' attempts to maximize their earnings.

Table 10
Partial correlations between target traits and mean offers received, controlling for estimated demands, in women (Study 2).

Trait	partial *r*	*p*
Strength	-0.13	0.199
Health	0.40	<.001
Attractiveness	0.38	<.001
Prosociality	0.36	<.001
Productivity	0.17	0.086
Dangerousness	-0.37	<.001
Social Status	0.44	<.001

Note: p values are two-tailed.

There were no effects of sensitivity to target traits on participant UG earnings (Table 11). This suggests that female participants did not engage in costly partner choice, in contrast to the male participants.

Table 11
Correlations between subject sensitivity to target traits and mean subject earnings in women (Study2).

	Earnings as Proposer		Earnings as Responder	
Trait	*r*	*p*	*r*	*p*
Strength	0.05	0.722	-0.03	0.847
Health	-0.01	0.966	-0.03	0.820
Attractiveness	0.10	0.452	-0.08	0.559
Prosociality	-0.00	0.991	0.13	0.311
Productivity	0.10	0.422	0.05	0.697
Dangerousness	0.13	0.311	-0.12	0.347
Social Status	-0.08	0.533	0.03	0.822

Note: p values are two-tailed. N=62 for correlations with earnings as Proposer; N=61 for correlations with earnings as Responder.

Together, these results indicate that the observed relationships between target traits and behavior in the UG cannot be fully accounted for by attractiveness halo effects, reciprocity motivations, or income maximizing strategies. This suggests that cognitive mechanisms designed for long-term cooperative partner choice may offer the best explanation for the observed results.

2.3.4. Study 2 Discussion

As expected, female participants made higher offers in the UG to targets who appeared healthier, more attractive, more productive, more prosocial and higher in social status. This suggests that women also interpreted the UG as an opportunity to establish a long-term cooperative relationship, and therefore offered to divide the surplus based on partner value. However, participants also made higher demands to targets who appeared healthier, more attractive and higher in social status. There are several possible explanations

for this deviation from treating demands as bids for a relationship. Women may implement partner choice heuristics, but may also be more demanding of attractive mating rivals (contrast table 7 with table 8). Women face a tradeoff between forming cooperative same-sex relationships and competing with same-sex rivals (see Benenson et al., 2009), and intrasexual competition may be manifested in the UG (Eisenbruch & Roney, 2016; Lucas, Koff & Skeath, 2007; Lucas & Koff, 2013). Alternatively, women may make high offers to apparently-valuable partners to attract them for a cooperative relationship, but then make high demands to those same partners to ensure that they will reciprocate that generosity. This view may be supported by our finding that women prioritize prosociality over productivity in a partner (section 2.3.3.1.), and research suggesting that equality is emphasized more in female relationships, relative to male relationships (see Benenson, 2013). Future research should disentangle these issues.

Importantly, the effects of partner choice criteria are robust to controlling for income-maximization strategies and reciprocity motivations. While social status, prosociality and dangerousness retained effects on offers after controlling for target attractiveness, controlling for attractiveness substantially reduced the effects of these and all of the other traits. This may represent more than just an attractiveness halo effect; women in ancestral environments likely derived substantial social influence from their attractiveness (Sell et al., 2009), so attractiveness may have been an important cue of women's abilities to generate benefits for social partners.

As expected, there was no effect of targets' strength on offers or demands received, and the effect of perceived productivity on UG treatment was weaker than among men.

2.4. Sex Differences

Figure 2 compares the zero-order effects of strength, health, attractiveness, prosociality, productivity, dangerousness, social status and estimated UG behavior on offers received in men and women. There are statistically significant sex differences in the effects of target strength, attractiveness, dangerousness and expected demands (calculated using Fisher's r-to-Z transformation). Descriptively, in all cases the effect size is larger among men than among women. All of the variables in Figure 2 were entered into multiple regressions predicting mean offers separately for men and women. The overall R^2 for men was .69 and the overall R^2 for women was .30; using Fisher's r-to-Z transformation, this is a significant difference in total variance predicted, $z = 3.84$, $p < .001$, suggesting that women were significantly less influenced overall by cues of partner value than men were.

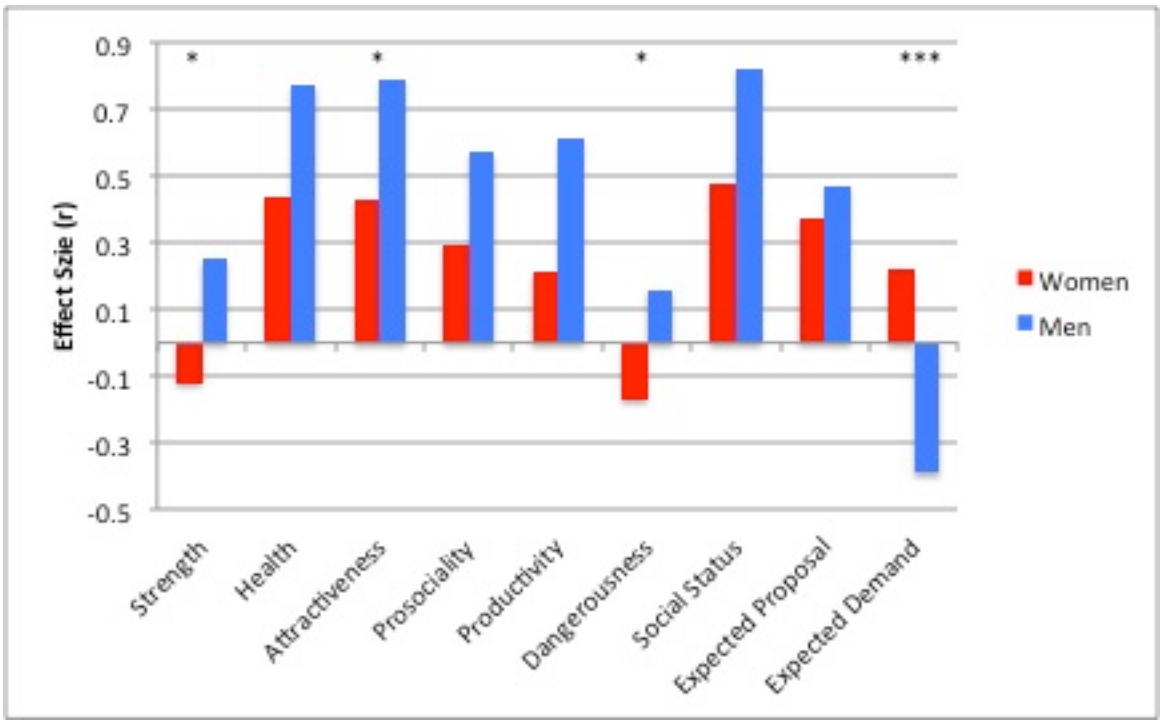

Figure 2. Zero-order effects of target traits and estimated UG behavior on offers received in men and women (Studies 1 & 2). Significant sex differences are indicated, * $p < .05$, *** $p < .001$.

2.5. General Discussion of Ultimatum Game Results

Studies 1 & 2 found that participants' offers and demands in the ultimatum game were related to facial cues of their partner's value as a long-term cooperative partner. Men were more generous to targets who appeared more attractive, prosocial, productive, dominant, healthier, stronger, higher in social status and more desirable as a friend. Women made higher offers and higher demands to targets who appeared healthier, more attractive, and higher in social status; higher offers to targets who appeared more prosocial and productive; and lower offers to targets who appeared more dangerous. Most of the effects of perceived partner traits cannot be explained by attractiveness halo effects, income maximizing strategies, or reciprocity motivations. These findings represent the most direct empirical evidence to date of a human psychology of cooperative surplus division based on partner choice criteria, and they suggest a new interpretation of the UG as an opportunity for overtures to potential cooperative partners.

These results suggest that behavior in the ultimatum game is generated by psychological mechanisms specialized for long-term social exchange relationships (see Cosmides & Tooby, 2005), and therefore that effects of partner traits that are outside of the structure of the game may be central to understanding the UG. Since humans likely evolved in social environments characterized by highly-valuable long-term cooperative relationships (see Delton et al., 2011), a one-shot UG may be interpreted as though it were an opening bid for an ongoing cooperative relationship within a biological market of cooperators (Barclay, 2013; Noë & Hammerstein, 1994, 1995). Therefore, offers and demands in the UG are generated by an evolved heuristic for partner choice that implements a rule like "be more generous to more valuable long-term cooperative partners." Partner choice theory suggests

that a potential partner's "market value" as a long-term cooperator is a function of their ability to create future benefits, their expected generosity in sharing those benefits, and their outside options for production (Barclay, 2013; Baumard, André & Sperber, 2013; Zaatari & Trivers, 2007); consistent with this, we observed that traits such as apparent health, productivity, prosociality, and social status had important effects on offers and demands in the UG.

These data illustrate the close link between cooperation and selectivity regarding cooperative partners (e.g. McNamara, Barta, Fromhage & Houston, 2008). The human psychology of partner choice appears designed to target valuable partners for relationship initiation and establish acceptable "terms of trade" with new partners, rather than establish the greatest possible number of new cooperative relationships (which would manifest as indiscriminate hypergenerosity in the UG). In addition, the system is not designed to establish a relationship at any cost, even with apparently valuable partners, because individuals who accepted worse terms of trade than they could receive from either the same or other partners would likely have faced adverse selection pressures (Trivers, 1971). While this may not maximize the number of accepted offers in the UG, a heuristic that prioritizes the quality rather than the quantity of cooperative relationships appears well-adapted to an ecology in which potential partners vary in value (e.g. Apicella, 2014; Debove, Baumard & André, 2017), and an individual can only have a limited number of social exchange relationships due to time constraints and the finite nature of social closeness and caring (e.g. DeScioli & Kurzban, 2009; Tooby & Cosmides, 1996).

These results suggest that the human psychology of partner choice is specialized to an ancestral ecology. Men, but not women, were more generous toward physically stronger

partners. This effect was driven by perceptions that stronger men would be more productive in an environment similar to that in which our species evolved, but not by perceptions of dangerousness, suggesting that the psychological mechanisms involved are designed to establish cooperative relationships with stronger men rather than merely to avoid violent retribution. In a modern context, this sex difference is senseless: for the types of cooperation that our participants typically engage in (e.g. group assignments for a class), physical strength is equally useless for men and women. However, men likely faced much stronger selection pressures from coalitional violence and large-game hunting (e.g. Marlowe, 2007; Wrangham, 1999), domains in which physical strength does predict productivity (Apicella, 2014; von Rueden et al , 2008). The effect of strength on men's bargaining psychology is typically framed in terms of the AWA (e.g. Petersen et al., 2013; Sell et al., 2009); however, a widespread preference for physically strong men as productive partners provides an alternative account for why strong men may receive more generous divisions of cooperative surpluses (cf. Debove, Baumard & André, 2015; see also Lukaszewski et al, 2016).

Additional sex differences suggest that the partner choice interpretation of UG behavior was more strongly supported for men than for women. Men were more sensitive to target traits overall, and only men reduced their earnings by calibrating their decisions to target traits. Women appeared to follow the income-maximizing strategy by matching their offers to the targets' expected demands, while men made lower offers to targets with higher expected demands. These results suggest that men, but not women, are willing to incur immediate costs in order to cooperate selectively with partners who display cues of long-term partner value. Women, unlike men, both offered more to and demanded more from seemingly high value partners, suggesting that women's UG behavior may have involved an

element of competition with same-sex rivals or a greater insistence on reciprocity from cooperative partners. Overall, these sex differences are consistent with evidence suggesting that men are more willing than women to tolerate costs in a relationship in order to maintain access to cooperative partners who can generate future benefits, likely due to selection pressures from coalitional violence and large game hunting (Balliet et al., 2011; Benenson et al., 2009; Vigil, 2007).

Alternative explanations for the observed sex differences include the possibility that we did not measure the target traits that are most important in female partner choice, or that male faces trigger more powerful behavioral inferences than do female faces. An additional limitation of the present research is that trait inferences from faces are confounded with each other. Alternative methods of representing targets will be important for testing the individual effects of traits and their prioritization in computations of partner value. For instance, the reported effect of social status is ambiguous. It is possible that apparently high status targets receive more generous treatment because they are capable of providing additional benefits to partners via social influence, or because they are assumed to have greater outside options.

The human psychology of partner choice is likely to be an exciting area of research in the near future. The heuristic suggested above ("be more generous to more valuable long-term cooperative partners") is flexible enough to be implemented in a variety of social and economic contexts. For example, the behaviors that are considered generous, and the cues that contribute to the estimation of partner value, may be different for different ecologies and types of cooperation. In addition, parameters such as the costs of searching for new partners should calibrate the prioritization of partner choice strategies relative to other behavioral strategies, such as partner control (Barclay & Raihani, 2015; Schino & Aureli,

2016). It will be important for researchers to systematically map the partner choice psychologies of men and women, including individual and contextual variation in partner choice criteria, effects of different information modalities (e.g. visual information vs. direct experience with a partner vs. communicated information on a partner), and behaviors and judgments in a variety of tasks (e.g. see McCabe, Smith & LePore, 2000 for possible limitations of the strategy method in economic games).

Finally, these data suggest a novel explanation for the advantageous treatment that attractive individuals typically receive in economic settings. A proposed explanation for the "beauty premium" is that it is primarily the result of men attempting to court or maintain access to attractive women (Maestripieri, Henry & Nickels, 2017). This cannot account for the strong effects of attractiveness that we observed, however, given that we conducted the UG exclusively with same-sex partners. We suggest that attractive individuals may be preferred as cooperative partners because many of the traits that made individuals desirable as mates also made them desirable as cooperators within ancestral environments (for example, apparent health, prosociality and competence), and so attractiveness may serve as a summary judgment of partner value. While this explanation is not mutually exclusive with the courtship-based explanation, it may spur new thinking and research on the topic.

The present findings provide direct empirical evidence that people divide the surpluses of cooperation based on estimates of long-term partner value, and that judgments of partner value incorporate the ability to create benefits, not merely dispositional cooperativeness or generosity. This psychology of surplus division based on partner choice criteria appears to be specialized for ancestral ecologies, and is likely to be distinct from heuristics that have evolved for dividing fixed resources (Petersen et al., 2013) or for

choosing partners for risk-pooling relationships (Delton & Robertson, 2012). Finally, these results suggest that non-income-maximizing behavior in the UG may not be "anomalous" at all (Thaler, 1988), but may instead be an output of adaptations for long-term cooperative relationships (see Barclay, 2013; Cosmides & Tooby, 2005; Kenrick et al., 2009).

III. Weighing Productivity and Generosity in the Trust Game[2]

The results from studies 1 and 2 suggest that people divide cooperatively-created resources in accordance with perceptions of long-term cooperative partner value, and that productivity is a criterion of partner value. Men in particular appear to prefer cooperative partners who seem capable of creating resources in an ancestral-like environment, and may even care more about productivity than prosociality (see section 2.2.3.3.). These results suggest that the psychology of partner choice is specialized for the environment of our ancestors, and that it includes some means of implementing a trade-off between desiderata in a cooperative partner.

In order to test how partner traits may combine or be traded off against one another in cooperative partner evaluations, I used a trust game to examine how subjects respond to varying cues of partner productivity and generosity. Raihani & Barclay (2016) asked participants in an economic game to choose between partners who varied in both wealth and generosity. They found that a plurality of participants chose a poor-fair partner over a rich-stingy partner (49.5% and 37.3% respectively, with 13.1% reporting no preference), even though there was a monetary incentive to choose the rich-stingy partner. Though the preference for the fair partner was not statistically significant, this provides evidence that people may weigh a partner's generosity more heavily than their wealth. Here, I used a trust game to further examine how subjects integrate varying cues of partner productivity and generosity, how sex and context cues affect their relative importance, and how cues of

[2] These results have been published as Eisenbruch, A.B. & Roney, J. R. (2017). The skillful and the stingy: Partner choice decisions and fairness intuitions suggest human adaptation for a biological market of cooperators. *Evolutionary Psychological Science*. DOI: 10.1007/s40806-017-0107-7.

productivity and generosity affect perceptions of fairness in addition to partner choice decisions.

In the present game, subjects chose how much money to send to a partner; that money was then multiplied by a factor determined by the partner's ostensible performance on a task; the partner then elected to return a fraction of the multiplied amount to the subject. The multiplier was thus a manipulation of partner productivity – i.e. the resources generated via their performance – and the percent returned a manipulation of their generosity. Since productivity and generosity made identical contributions to game earnings, any differences in these variables' effects on subjects' reactions to their partners cannot be explained by monetary incentives and would instead provide clues about how partner choice mechanisms weigh these two components of partner value.

Two dependent variables were used to test how partner productivity and generosity are weighed. First, there was a direct measure of partner choice: participants either chose or rejected a partner for future rounds of the game after learning their levels of productivity and generosity. Second, we tested the effects of productivity and generosity on perceptions of fairness. Biological market theory suggests that more valuable partners are entitled to more advantageous resource distributions, so intuitions about "fair" distributions should track cues of partner value (e.g. Baumard, André, & Sperber, 2013; see chapter I). Consistent with this, studies 1 and 2 found that apparently-valuable partners received higher offers and lower demands in a bargaining game, suggesting that resource divisions function as bids for cooperative relationships. Therefore, in the present studies I tested the effects of partners' productivity and generosity on perceptions of how fair their distributions of the cooperatively-created resource were.

Since productivity is a relatively new topic in the partner choice literature (Studies 1 & 2; Macfarlan & Lyle, 2015), I was also interested in the design of the preference for productivity. Is the preference for productive partners based on a calculation of the payoffs they can offer in a specific encounter, or does it reflect specialization for ancestral long-term cooperative relationships? To answer this question, the effects of sex and two framing manipulations on the importance of partner productivity were tested. Because ancestral men (more so than women) cooperated in the domains of large-game hunting and coalitional warfare (e.g. Marlowe, 2007, 2010; Wrangham, 1999) – domains in which returns have high variance and skill rankings are publicly known (Apicella, 2014; Kaplan et al, 1985; von Rueden et al, 2008) – men may place greater weight on a partner's productivity than do women. Consistent with this, research suggests that men's social relationships and preferences are oriented towards maintaining access to productive cooperative partners, while women place more weight on emotional intimacy and warmth (e.g. Benenson et al, 2014; Fiske et al, 2007; Hall, 2011; Lewis et al, 2011; Vigil, 2007; see Introduction). I therefore predict that partner productivity will have a greater effect on men's partner choice decisions and fairness judgments, compared to women's (Hypothesis 1).

Two framing manipulations also tested the specialization of the productivity preference. First, if the productivity preference evolved in the context of long-term cooperative relationships, then it should be sensitive to cues of a partner's ability to generate benefits over the course of repeated future interactions, rather than the benefits offered in the present interaction (see Delton, Krasnow, Cosmides & Tooby, 2011). Therefore, whether a partner's performance was indicative of their stable skills (and therefore their ability to generate future benefits), versus being based on luck, was manipulated. I predict that skill-

based productivity will have a greater effect on partner choices and fairness judgments than will luck-based productivity (Hypothesis 2). Second, if ancestral humans engaged in multiple types of cooperation, then evaluations of partner value may be specialized for those different types of cooperation. In risk pooling, partners reciprocally provision each other when one is needy and the other has a surplus (Trivers, 1971). Since risk pooling partners effectively serve as insurance policies, any cues of how much a risk pooling partner cares about you or intends to cooperate may be paramount (e.g. Delton & Robertson, 2012; Tooby & Cosmides, 1996). However, in collaboration (e.g. coalitional violence and large-game hunting), partners coordinate their actions in order to produce greater resources than either would be able to produce alone (e.g. Marlowe, 2010; Wrangham, 1999). Therefore, since collaborative relationships effectively serve to increase individual productivity, I predict that productivity will have a greater effect on partner choices and fairness judgments for collaboration partners than risk-pooling partners (Hypothesis 3).

3.2. Study 3

3.2.1. Study 3 Methods

3.2.1.1. Study 3 Participants

Amazon Mechanical Turk workers in the United States were recruited for this study. 126 participants began the study, and 109 completed it and reported their sex. There were 28 women in the risk pooling condition, 24 women in the collaboration condition, 24 men in the risk pooling condition, and 33 men in the collaboration condition. The mean age of these participants was 34.09 years (s.d. = 12.16). 4.6% of participants reported having a high

school diploma or GED, 36.7% had some college education, 47.7% had completed college, and 11% had a graduate or professional degree.

3.2.1.2. Study 3 Design

Subjects were given a $10 budget, and could choose to send any amount to their partner. The money they sent to their partner was multiplied by either 3, 4 or 5 (the partner's "productivity"), and the partner then returned either 30, 40 or 50% of the new total to the subject (the partner's "generosity"). After learning the partner's productivity, generosity, and how much money they received back, subjects indicated how fair the partner's behavior was, and whether they would like to play another round with the same partner (for up to 3 consecutive rounds with each partner). Note that productivity and generosity make symmetrical contributions to the subjects' earnings (see Table 12), so an income-maximizer would have equal preferences for the two traits. Sham partners were used in order to perfectly manipulate productivity and generosity; subjects were told that they were playing with past participants whose decisions for every contingency had been previously recorded. Subjects were actually paid for the outcome of one round. A framing manipulation was employed in order to vary the cues relevant to H2 and H3 (see below). Thus, the design included one between-subjects factor (framing manipulation) and two within-subjects factors (partner productivity and generosity), in addition to subject sex as a between-subjects participant variable.

Table 12
Returns (in dollars) per dollar sent to the partner, across all levels of partner productivity and generosity

Generosity (%)	Productivity		
	3	4	5
30	0.90	1.20	1.50
40	1.20	1.60	2.00
50	1.50	2.00	2.50

3.2.1.3. Study 3 Procedure and Materials

Subjects agreed to participate and then read an introduction to the game, which varied based on random assignment. In the risk pooling condition, they were told that they would play the "Osotua game," modeled after risk pooling relationships among the Hadza. These relationships were described as social insurance against hard times, whereby partners give each other resources whenever one needs help. In this condition, participants were told that the partners' productivity was based on "how 'lucky' the partners were randomly assigned to be." In the collaboration condition, subjects were told they would play the "Asatua game," modeled after collaborative relationships among the Hadza. These relationships were described as opportunities to work together to create resources that neither partner would be able to create alone. In this condition, participants were told that the partner's productivity was based on "how well your partner performed on a difficult general knowledge and problem-solving test." See Appendix B for full text of these framings. Next, participants were instructed in the structure of the game (see Design).

At the start of the first round with each partner, participants were told that they were beginning play with a new partner. Under a header saying "Round 1," participants chose how much of their $10 budget to send to their partner (in $1 increments). On the next screen, participants were told how much the partner's money had been multiplied by, what

percentage of the money the partner had returned to them, and how much money they had received back from the partner. In order to measure perceptions of the partner's fairness, we capitalized on the function of anger and gratitude as recalibrational emotions (Tooby & Cosmides, 2008). According to this account, anger is elicited when an individual treats you less well than you think they should, while gratitude is elicited when an individual treats you better than you expected them to. Thus, anger indicates that a behavior was perceived as unfair (i.e. below the treatment that an individual can expect in the marketplace of cooperators; Baumard, André, & Sperber, 2013), while gratitude indicates that a behavior was perceived as fair or favorable. Therefore, on the same screen as the results of each round, participants were asked to indicate on 7-point Likert-type scales how angry and how grateful they felt towards their partner, and chose to either play another round with the same partner or switch to a new partner for the next round. If the participant chose to play again with the same partner, this procedure was repeated for up to 3 rounds, with the header changing to reflect the round number (after the third round the participant was told they would have to switch to a new partner for the next round, but were asked to indicate if they would hypothetically like to play with the present partner again). In cases where the participant chose to keep playing with the same partner, the partner's behavior was consistent across all three rounds. If the partner chose to switch to a new partner, they re-started this sequence with a new partner.

This procedure was repeated for all 9 possible partners (3 productivity levels x 3 generosity levels) in a random order. Following game play, participants completed two brief questionnaires that are not relevant to the present results, answered demographic questions, were debriefed about the true nature of the study (including that "osotua" is a form of

helping relationship that exists among the Maasai, while "asatua" was invented for this experiment), and consented to the use of their data. The debriefing included an open-ended solicitation of comments about the study; none of the participants expressed suspicion regarding the manipulation or the use of sham partners.

3.2.1.4. Study 3 Analysis

The effects of partner generosity and productivity were analyzed as within-subject factors, and sex and condition as between-subject factors, using multi-level regression in SPSS with a random intercept at the subject level. (When analyzing partner choice decisions, a binary logistic link was used.) Productivity and generosity levels were coded as -1, 0 and 1, representing low, medium and high, respectively. Females were coded as -.5 and males as .5, and condition was coded as -.5 for risk pooling and .5 for collaboration. A positive sex by productivity interaction predicting partner choice and fairness judgments would support H1 (the hypothesized sex difference in preference for productivity), while a positive condition by productivity interaction would support H2 (the hypothesized luck vs. skill effect) and H3 (the hypothesized risk pooling vs. collaboration effect).

3.2.2. Study 3 Results

Anger and gratitude responses were negatively correlated ($r = -.60$, $p < .001$), so their mean (with anger reverse-coded) was used as a composite fairness measure. Table 13 contains full regression results, but for clarity I will highlight in the text only those results that directly bear on the research questions. First I will present the results for fairness judgments, and then for partner choice decisions. For each dependent variable, I will

examine the main effects of productivity and generosity, test their interaction, and then test H1-H3.

Table 13.
Regression results for study 3.

Model	DV	IV	Coefficient or Odds Ratio	p	95% CI
1	Fairness	Productivity	0.17	.000	0.12 – 0.22
		Generosity	1.02	.000	0.97 – 1.07
2	Fairness	Productivity	0.19	.000	0.14 – 0.24
		Generosity	1.03	.000	0.98 – 1.08
		Productivity x Generosity	-0.12	.000	-0.18 – -0.06
3	Fairness	Productivity	0.17	.000	0.10 – 0.24
		Generosity	1.00	.000	0.92 – 1.07
		Female	0.13	.431	-0.19 – 0.45
		Productivity x Female	-0.02	.742	-0.12 – 0.08
		Generosity x Female	0.05	.326	-0.05 – 0.16
4	Fairness	Productivity	0.23	.000	0.16 – 0.30
		Generosity	1.02	.000	0.95 – 1.10
		Risk pooling condition	0.26	.106	-0.06 – 0.58
		Risk pooling condition x productivity	-0.14	.009	-0.24 – -0.03
		Risk pooling condition x generosity	-0.01	.923	-0.11 – 0.10
5	Stay with partner?	Productivity	1.75	.000	1.50 – 2.05
		Generosity	7.46	.000	6.17 – 9.01
6	Stay with partner?	Productivity	1.76	.000	1.50 – 2.07
		Generosity	7.47	.000	6.18 – 9.03
		Productivity x Generosity	1.04	.733	0.84 – 1.29
7	Stay with partner	Productivity	1.72	.000	1.38 – 2.15
		Generosity	7.42	.000	5.70 – 9.67
		Female	0.89	.666	0.53 – 1.50
		Productivity x Female	1.04	.825	0.75 – 1.42
		Generosity x Female	1.02	.933	0.70 – 1.48
8	Stay with partner?	Productivity	1.73	.000	1.39 – 2.14
		Generosity	6.46	.000	5.06 – 8.26
		Risk pooling condition	1.62	.063	0.98 – 2.70
		Risk pooling condition x productivity	1.04	.819	0.75 – 1.43
		Risk pooling condition x generosity	1.19	.096	0.94 – 2.04

Note. When the DV is fairness, a coefficient is used. When the DV is the choice to stay with the partner, an odds ratio (reflecting the change in the odds of choosing to stay with the partner) is used.

3.2.2.1. Fairness judgments: How are the preferences for productivity and generosity integrated?

In a model with generosity and productivity predicting fairness judgments (table 13, model 1), both generosity and productivity have significant positive effects. Mean fairness judgments increased by 1.02 points (out of 7) for each additional increment of generosity (coefficient = 1.02, $p < .001$ 95% CI = 0.97 – 1.07), and by 0.17 points for each additional increment of productivity (coeff = 0.17, $p < .001$, 95% CI = 0.12 – 0.22). Thus, even though productivity and generosity made equal contributions to game earnings, generosity had a much stronger effect on fairness judgments than productivity did (figure 3). Though it may be unsurprising that generosity had a strong positive effect on fairness judgments, the positive effect of productivity on fairness judgments shows that participants viewed more productive partners as more entitled to selfish behavior, consistent with biological market theory.

Adding an interaction term to this model (table 13, model 2) reveals a significant interaction (coef = -0.12, $p < .001$, 95% CI = -0.18 – -0.06). Figure 3 shows that a partner's productivity had a stronger effect on fairness judgments when they are stingy than when they are highly or moderately generous. This interaction is not responsive to the incentive structure of the game (see Table 11).

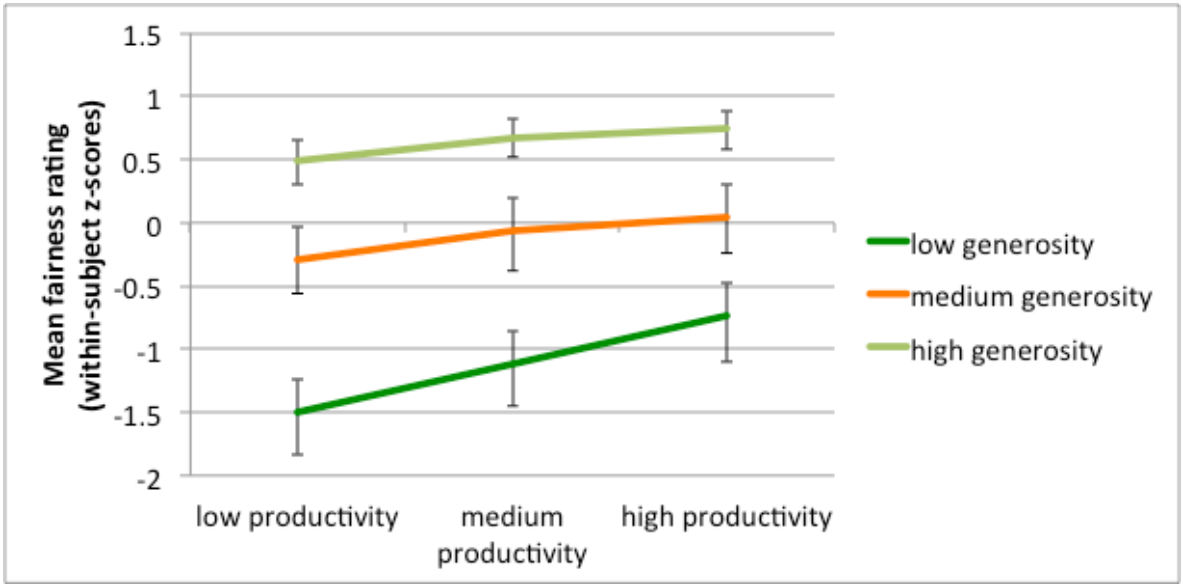

Figure 3. Effects of productivity and generosity on fairness judgments (study 3). Y-axis represents means of within-subject standardized fairness ratings. Error bars are 95% CI.

3.2.2.2. Fairness judgments: H1 – Do men care more about productivity than women do?

Sex did not moderate the effect of productivity or generosity on fairness judgments (Table 13, model 3), failing to support H1. However, additional analyses show that sex moderated the productivity by generosity interaction on fairness judgments, such that the interaction was found only among men (table 14). This suggests that for men's fairness decisions, but not for women's, a partner's productivity becomes more important when that partner is low in generosity. This is congruent with, but more nuanced than, the prediction that men would care more about productivity than women do: Men may not care more about productivity in general, but men increase the importance of productivity among stingy partners.

Table 14.

Productivity by generosity interaction on fairness judgments, moderated by sex (study 3).

Model	DV	IV	Coefficient	p	95% CI
1	Fairness	Productivity	0.22	.000	0.14 – 0.29
		Generosity	1.01	.000	0.94 – 1.08
		Female	0.13	.411	-0.19 – 0.45
		Productivity x Generosity	-0.20	.000	-0.29 – -0.11
		Productivity x Female	-0.05	.324	-0.16 – 0.05
		Generosity x Female	0.04	.420	-0.06 – 0.15
		Productivity x Generosity x Female	0.17	.009	0.04 – 0.30
2	Fairness (women only)	Productivity	0.16	.000	0.09 – 0.24
		Generosity	1.05	.000	0.98 – 1.12
		Productivity x Generosity	-0.03	.529	-0.12 – 0.06
3	Fairness (men only)	Productivity	0.22	.000	0.14 – 0.29
		Generosity	1.01	.000	0.93 – 1.08
		Productivity x Generosity	-0.20	.000	-0.29 – -0.11

3.2.2.3. Fairness judgments: H2 & H3 – Does productivity matter more in the collaboration condition?

Condition moderated the effect of productivity on fairness judgments, such that productivity mattered more in the collaboration condition (coeff = 0.14. p = .009, 95% CI = 0.03 – 0.24; Table 13, model 4 and figure 4), supporting H2 and H3. This shows that productivity had a greater effect on fairness judgments when productivity reflects skill than when productivity is based on luck, even though productivity contributed to payoffs equally in both conditions. Condition did not moderate the effect of generosity on fairness judgments.

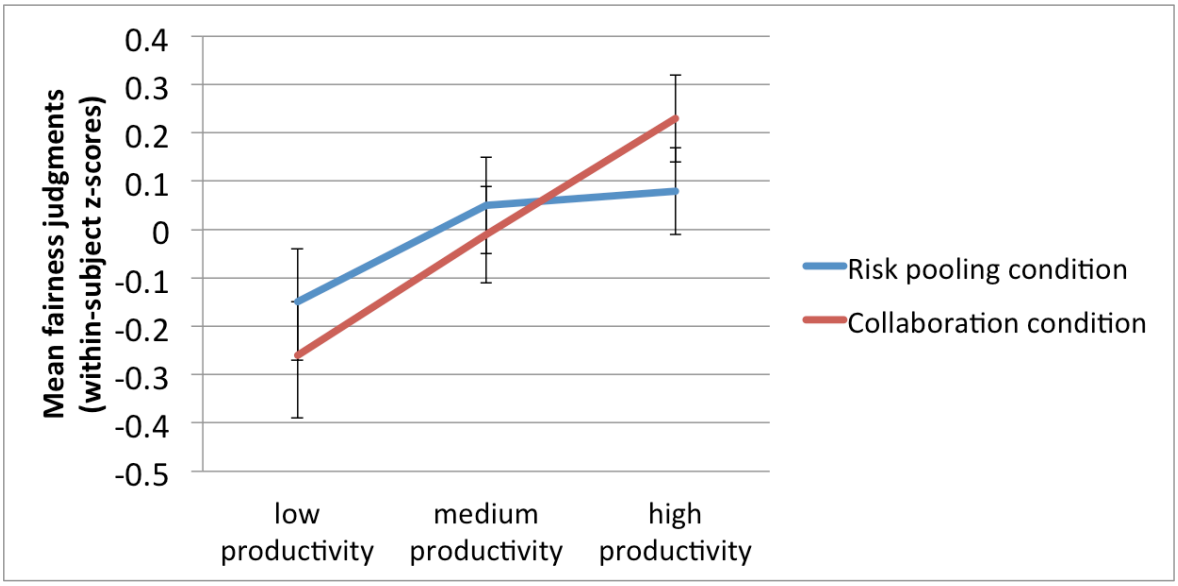

Figure 4. Condition by productivity interaction on fairness judgments (study 3). Y-axis represents means of within-subject standardized fairness ratings. Error bars are 95% CI.

3.2.2.4. Partner choice decisions: How are the preferences for productivity and generosity integrated?

In a model with generosity and productivity predicting decisions to stay with a partner (Table 13, model 5), productivity had a significant positive effect and generosity had a much larger positive effect (Figure 5). The odds of staying with a partner increased by 75% for each additional increment of productivity (Odds Ratio = 1.75, $p < .001$, 95% CI = 1.50 – 2.05), while the odds of staying with a partner increased by 646% for each increment of generosity (OR = 7.46, $p < .001$, 95% CI = 6.17 – 9.01). Thus, even though productivity and generosity made equal contributions to game earnings, the preference for generous partners appears to be much stronger than the preference for productive partners. Adding the interaction term to this model shows that the interaction term is not significant (Table 13, model 6).

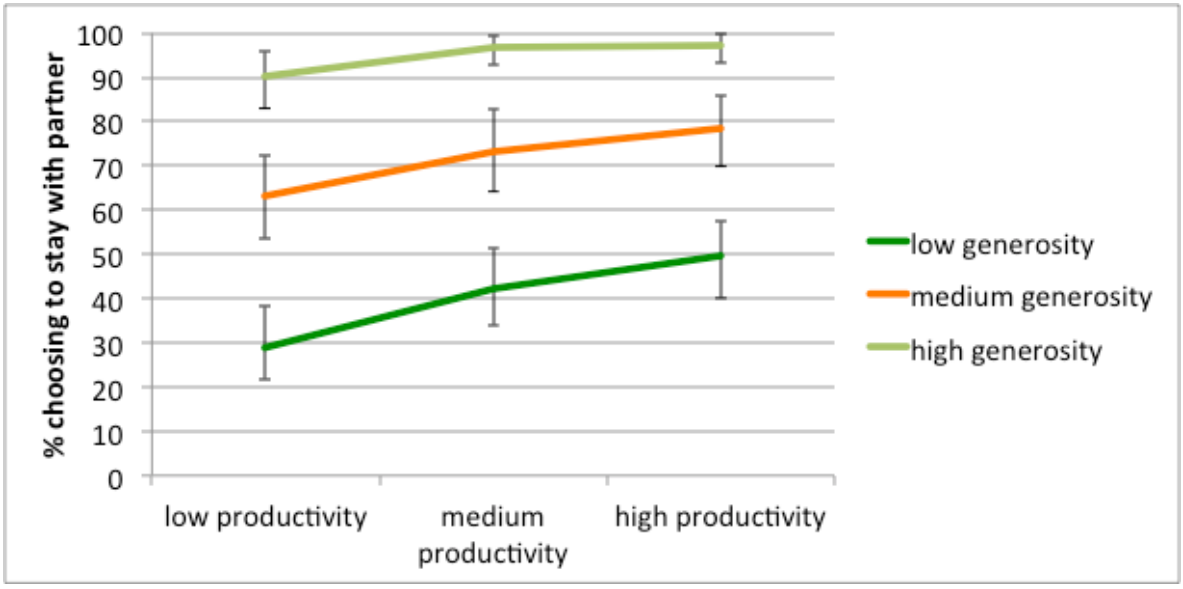

Figure 5. Effects of productivity and generosity on decisions to play another round with a partner (study 3). Error bars are binomial 95% CI based on 1000 bootstrap samples.

3.2.2.5. Partner choice decisions: H1 – Do men care more about productivity than women do?

Sex did not moderate the effect of productivity or generosity on partner choice decisions (Table 12, model 7), thus failing to support H1.

3.2.2.6. Partner choice decisions: H2 & H3 – Does productivity matter more in the collaboration condition?

Condition marginally moderated the effect of generosity on partner choice decisions, such that the effect of generosity was greater in the risk pooling condition, but condition did not moderate the effect of productivity (Table 12, model 8; Figure 6). Though H3 was framed in terms of productivity, this is consistent with the hypothesis that partner choice criteria will differ for different types of ancestrally-recurrent cooperation, with a partner's generosity being more important in a risk pooling partner than in a collaboration partner, even when the payoff structures are the same.

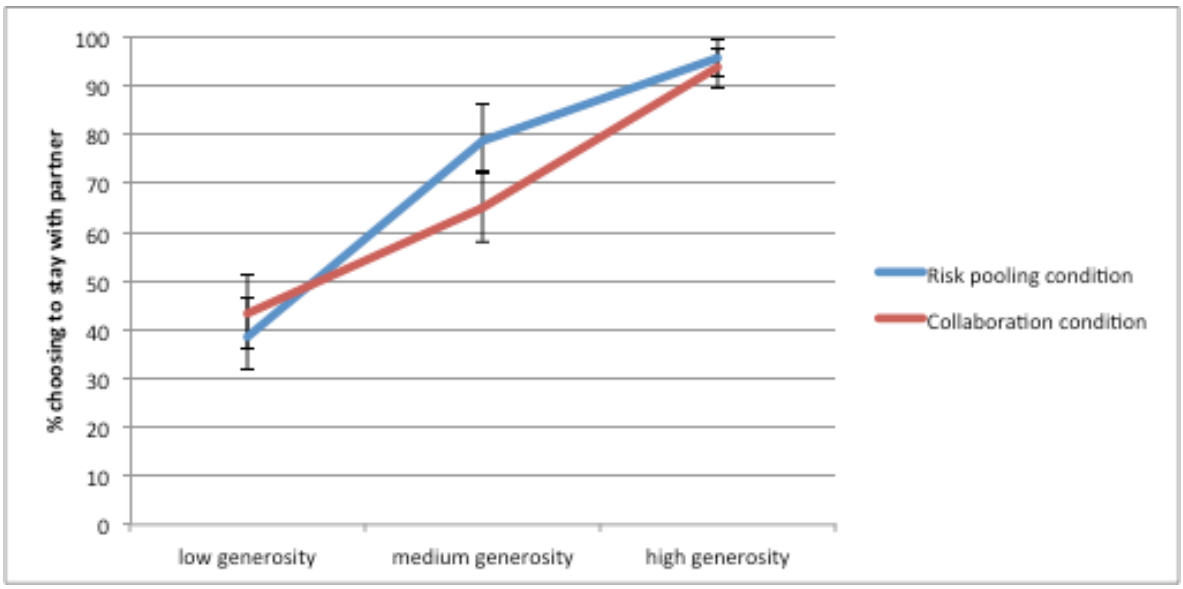

Figure 6. Interaction between condition and generosity predicting decisions to stay with the partner (study 3). Error bars are binomial 95% CI based on 1000 bootstrap samples.

3.2.3. Study 3 Discussion

Though results were mixed, the findings of study 3 suggest that people's partner choice decisions and fairness judgments may be calibrated for a biological market of long-term cooperators, rather than being solely responsive to the incentive structure of the game. Turning first to partner choice decisions, a partner's productivity and generosity each predicted how frequently a partner was chosen for the next round of the game, with generosity having a much stronger effect, even though productivity and generosity contributed equally to payoffs. The effect of generosity on partner choice decisions was even stronger when the game was framed as an opportunity for risk pooling rather than collaboration, even though the framing did not change the payoff structure of the game, suggesting that humans may recalibrate their partner choice heuristics based on cues of different ancestrally-recurrent types of cooperation. This may be due to an evolutionary history of risk pooling relationships serving as social insurance against hard times (e.g. Sugiyama, 2004; Trivers, 1971), such that any cues of how much a partner cares about you

(in this case, their generosity) take on increased importance relative to other relationship types.

Turning next to fairness judgments, it is perhaps unsurprising that partner generosity strongly predicted fairness judgments, but there was also a significant main effect of productivity such that any given percentage returned by the partner was considered fairer the more productive that partner was. This suggests that being productive effectively entitles a partner to greater selfishness, consistent with biological market theory. The effect of productivity on fairness judgments was qualified by an interaction between productivity and generosity, such that generosity had a greater effect on fairness judgments among low-productivity than high-productivity partners (and vice-versa). This suggests a conditional weighting of partner traits in fairness judgments: generosity is always important, but individuals who are selfish *and* unproductive are viewed as especially unfair. A three-way interaction showed that this conditional calculation of fairness existed among men, but not women. In addition, productivity had a stronger effect on fairness judgments in the collaboration condition (when it was based on stable skills, and therefore contained predictive information about future productivity), than in the risk pooling condition (when it was based on luck). This shows that judgments of a partner's entitlement to a resource are sensitive to their long-term partner value, not merely their immediate contribution to the resource. Note that these patterns are not consistent with the payoff structure of the game, but may conform to the demands of an ancestral biological market.

This study has several limitations, however. The first is that the sample size (approximately 25 people per cell) may have been insufficient. A second is that it is unclear how salient the cue of the partners' productivity was. Having performed well on a general

knowledge and problem solving test may not strongly trigger intuitions about the types of productivity that would have mattered to our ancestors. Perhaps most seriously, the framing manipulation confounded the relationship type and the source of the partners' productivity. In the risk pooling condition, the partners' productivity levels were a function of luck, while in the collaboration condition they were based on test results. This design decision was made because risk pooling relationships function to regulate variance in luck while collaboration functions to enhance productivity, but nonetheless this creates a problem of interpretation. For example, we cannot tell whether the interaction between condition and productivity in predicting fairness judgments is due to different heuristics for risk-pooling vs. collaborative relationships, or whether the importance of productivity changes based on whether it is attributable to skill vs. luck. Studies 4 and 5 were conducted in order to address these limitations.

3.3. Study 4

3.3.1. Study 4 Methods

3.3.1.1. Study 4 Participants

Amazon Mechanical Turk workers in the United States were recruited for this study, with the goal of 50 men and 50 women in each condition. 399 people began the study; 235 of them successfully completed the comprehension check, and 208 of those people successfully passed the attention check. 207 of those people agreed to the use of their data, comprising the final sample. There were 48 women in the luck condition, 52 women in the skill condition, 53 men in the luck condition, and 54 men in the skill condition. Mean age of the sample was 33.44 years (s.d. = 10.15). 11.1% of participants reported that they had a

high school diploma or GED, 33.3% had some college education, 43% had completed college, and 12.1% had a graduate or professional degree.

3.3.1.2. Study 4 Design

Study 4 was designed to more clearly test whether the nature of a partner's productivity (revealing of the stable ability to create benefits vs. not) moderates the effect of productivity on partner choice and fairness judgments. If subjects' preference for productive partners is calibrated for long-term partner choice, then subjects should be especially sensitive to cues of productivity that are revealing of the partner's intrinsic ability to create benefits (i.e. based on skill, physical fitness, etc.), because that ability would predict benefits generated over the long run. Productivity based on luck, however, does not predict the ability to generate benefits in the future, so it should have less of an effect on long-term partner choice mechanisms. On the other hand, if subjects choose and respond to their partners based on monetary payoffs, they should be indifferent to the source of the partner's productivity, since this does not change the payoff structure of the game.

Study 4 used the same game structure as study 3 with two modifications: In order to conserve funds, subjects were paid half of their stated earnings from one round; and instead of playing multiple rounds with the same partner consecutively, subjects played one turn with each partner, and after learning the outcome of each turn had the choice to either play another turn with that partner later, or exclude that partner from later rounds of the game (though in fact the game had only one round).

3.3.1.3. Study 4 Procedure and Materials

As in study 3, participants agreed to participate and were instructed in the structure of the game. All participants were told that the partners' productivity levels were based on how well those partners had performed in a virtual reality foraging task; subjects randomly assigned to the "skill" condition were told that "success in the foraging game is mostly a function of skill, since it depends on the person's spatial intelligence, memory, hand-eye coordination and effort." Subjects randomly assigned to the "luck" condition were told that "success in the foraging game is mostly a function of luck, since it depends on whether the person happened to encounter patches with lots of available food."

Following the introduction, participants answered three multiple-choice questions designed to check their comprehension of the study. Only participants who answered all three questions correctly could proceed with the study.

At the start of each turn, subjects saw a screen that said "You will now start playing with a new partner," and were asked how much of their budget they wanted to send to their partner. The next screen reported how much the money sent to the partner had been multiplied by, what percentage the partner had returned, and how much the participant had consequently received from them. On the same screen, the participant was asked "How fair is the amount that your partner sent back to you?," and answered five questions pertaining to the partner's association value (how much they wanted to be friends with that partner in real life, how likely they would be to choose them as a business partner, how likely they would be to choose them as a spouse for their sister or brother, how likely they would be to choose them as a neighbor, and how much they would like to have a social relationship in real life; all questions were framed as being relative to the other partners in the game) on seven point

Likert-type scales, and indicated whether they wanted to keep or exclude the partner from the next round of the game.

This sequence was repeated for all 9 partners in a random order. Randomly interspersed with the 9 partners was one item designed to check that participants were paying attention; only participants who answered this item correctly were allowed to continue with the study. After playing once with all 9 partners, participants answered demographic questions, were debriefed about the true nature of the study, and consented to the use of their data. Before being told the true nature of the study, participants were asked what they thought the study was about and to leave any other comments they had about the study; none of the participants expressed suspicion regarding the manipulation or the use of sham partners.

3.3.1.4. Study 4 Analyses

The same analysis strategy was used as in study 3. A sex by productivity interaction would support H1, and a condition by productivity interaction would support H2. The same multi-level modeling approach was also used to test the relationship of association value perceptions to fairness judgments. I predicted that judgments of fairness would be positively related to perceptions of association value, suggesting that the degree to which a person is entitled to keep a resource (i.e. the fairness of a distribution) is related to their perceived value as a long-term cooperator.

3.3.2. Study 4 Results

The five association value items were strongly intercorrelated (Cronbach's alpha = .975), so their mean was used as a composite association value measure. There was a strong relationship between association value perceptions and fairness judgments, such that for every 1-point increase in association value, fairness ratings increased by 1.00 points ($p <$ .001, 95% CI = 0.98 – 1.03). This supports the prediction that people who are perceived as more valuable social partners and cooperators are also perceived as more entitled to keep cooperatively-gained resources, but due to its correlational nature we should not over-interpret this result: Perceptions of association value may drive perceptions of fairness, or perceptions of fairness may drive perceptions of association value, and both are necessarily based on cues of productivity and generosity.

As for study 3, I will highlight only the most theoretically-relevant results in the text, while full regression results are presented in table 15.

3.3.2.1. Fairness judgments: How are the preferences for productivity and generosity integrated?

In a model with productivity and generosity predicting fairness judgments (Table 15, model 1), each additional increment of productivity increased fairness judgments by .26 points (coeff = 0.26, $p <$ .001, 95% CI = 0.20 – 0.31), while each additional increment of generosity increased fairness judgments by 1.69 points (coeff = 1.69, $p <$ .001, 95% CI = 1.63 – 1.75). This suggests that fairness intuitions are primarily based on generosity, but increasing productivity makes any given level of selfishness seem fairer (Figure 7). Recall that productivity and generosity contributed equally to game payoffs, so the stronger effect

of partner generosity is not responsive to earnings. Adding the interaction term to this model reveals no interaction between productivity and generosity on fairness judgments (Table 15, model 2).

Table 15
Regression results for study 4

Model	DV	IV	Coefficient or Odds Ratio	p	95% CI
1	Fairness	Productivity	0.26	.000	0.20 – 0.31
		Generosity	1.69	.000	1.63 – 1.75
2	Fairness	Productivity	0.26	.00	0.20 – 0.31
		Generosity	1.69	.00	1.63 – 1.75
		Productivity x Generosity	-0.03	.362	-0.10 – 0.04
3	Fairness	Productivity	0.31	.000	0.23 – 0.39
		Generosity	1.67	.000	1.59 – 1.75
		Female	0.15	.188	-0.07 – 0.37
		Female x Productivity	-0.12	.052	-0.23 – 0.00
		Female x Generosity	0.03	.557	-0.08 – 0.15
4	Fairness	Productivity	0.33	.000	0.25 – 0.41
		Generosity	1.75	.000	1.67 – 1.83
		Luck Condition	0.05	.635	-0.17 – 0.27
		Luck Condition x Productivity	-0.15	.013	-0.26 – -0.03
		Luck Condition x Generosity	-0.12	.038	-0.24 – -0.01
5	Keep partner	Productivity	2.24	.000	1.89 – 2.67
		Generosity	15.38	.000	12.27 – 19.28
6	Keep partner	Productivity	2.33	.000	1.95 – 2.78
		Generosity	15.87	.000	12.61 – 19.99
		Productivity x Generosity	1.34	.024	1.04 – 1.72
7	Keep partner	Productivity	2.35	.000	1.85 – 2.97
		Generosity	12.69	.000	9.44 – 17.06
		Female	1.30	.270	0.82 – 2.08
		Female x Productivity	0.92	.620	0.65 – 1.30
		Female x Generosity	1.59	.050	1.00 – 2.52
8	Keep partner	Productivity	2.67	.000	2.08 – 3.42
		Generosity	15.72	.000	11.42 – 21.65
		Luck Condition	0.92	.726	0.58 – 1.47
		Luck Condition x Productivity	0.71	.053	0.50 – 1.01
		Luck Condition x Generosity	0.99	.953	0.63 – 1.56

Note. When the DV is fairness, a coefficient is used. When the DV is the choice to keep the partner for the next round of the game, an odds ratio (reflecting the change in the odds of choosing to keep the partner) is used.

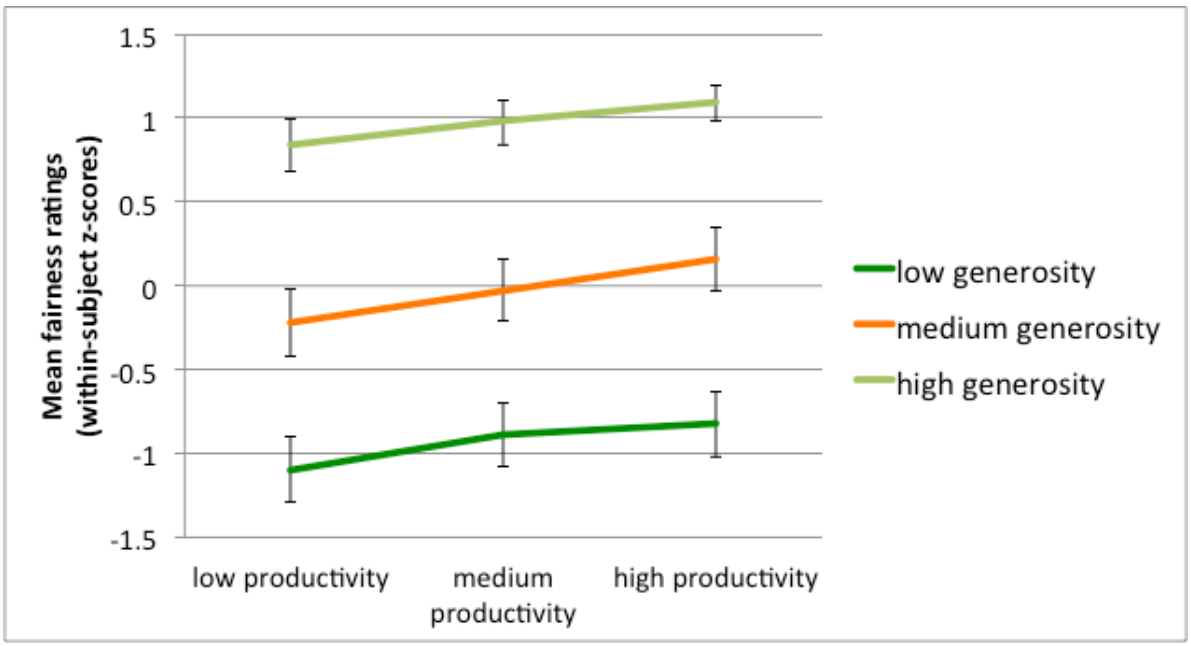

Figure 7. Effects of productivity and generosity on fairness judgments (study 4). Y axis represents means of within-subject z-scores. Error bars are 95% CI.

3.3.2.2. Fairness judgments: H1 – Do men care more about productivity than women do?

Sex marginally moderated the effect of productivity on fairness judgments, such that men's fairness judgments were more affected by partner productivity than women's were, supporting H1 (coeff = 0.12, p = .052, 95% CI = 0.00 – 0.23; Table 14, model 3; Figure 8). Sex did not moderate the effect of generosity on fairness judgments.

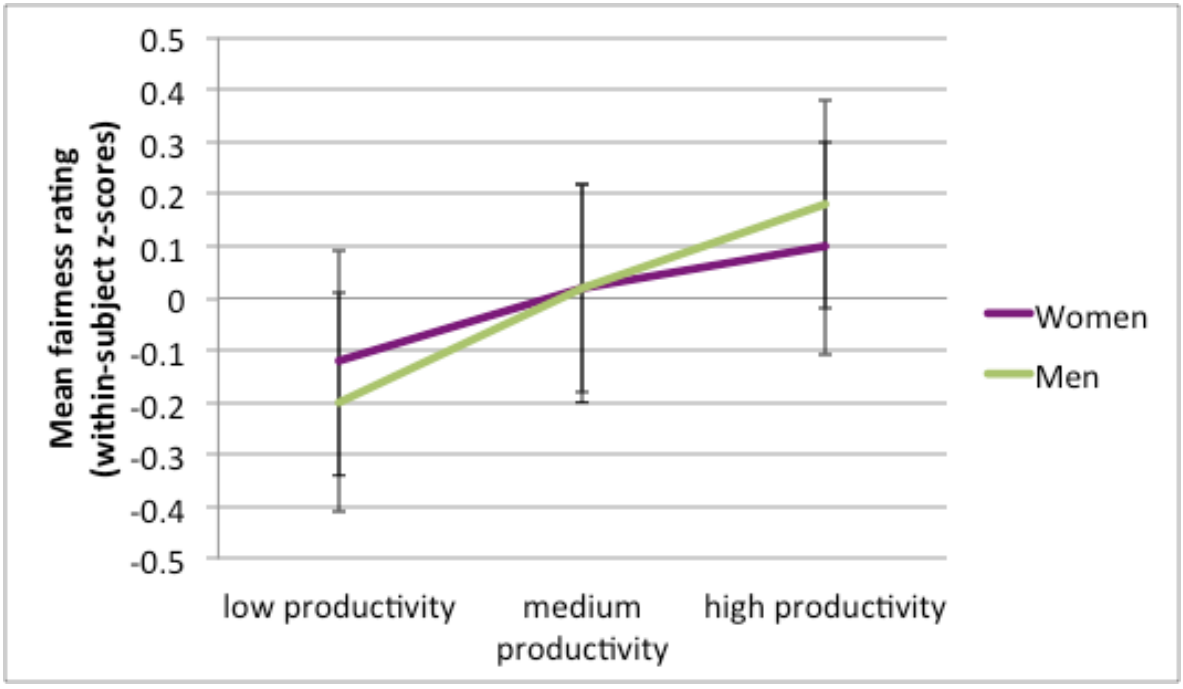

Figure 8. Sex by productivity interaction predicting fairness ratings (study 4). Y axis represents means of within-subject z-scores. Error bars are 95% CI.

3.3.2.3. Fairness judgments: H2 – Does productivity matter more in the skill condition?

Both productivity and generosity had stronger effects on fairness judgments in the skill condition (productivity: coeff = 0.15, p = .013, 95% CI = 0.03 – 0.26; generosity: coeff = 0.12, p = .038, 95% CI = 0.01 – 0.24; Table 14, model 4; Figures 9 & 10). The interaction between condition and productivity supports H2, while the interaction between condition and generosity was not predicted.

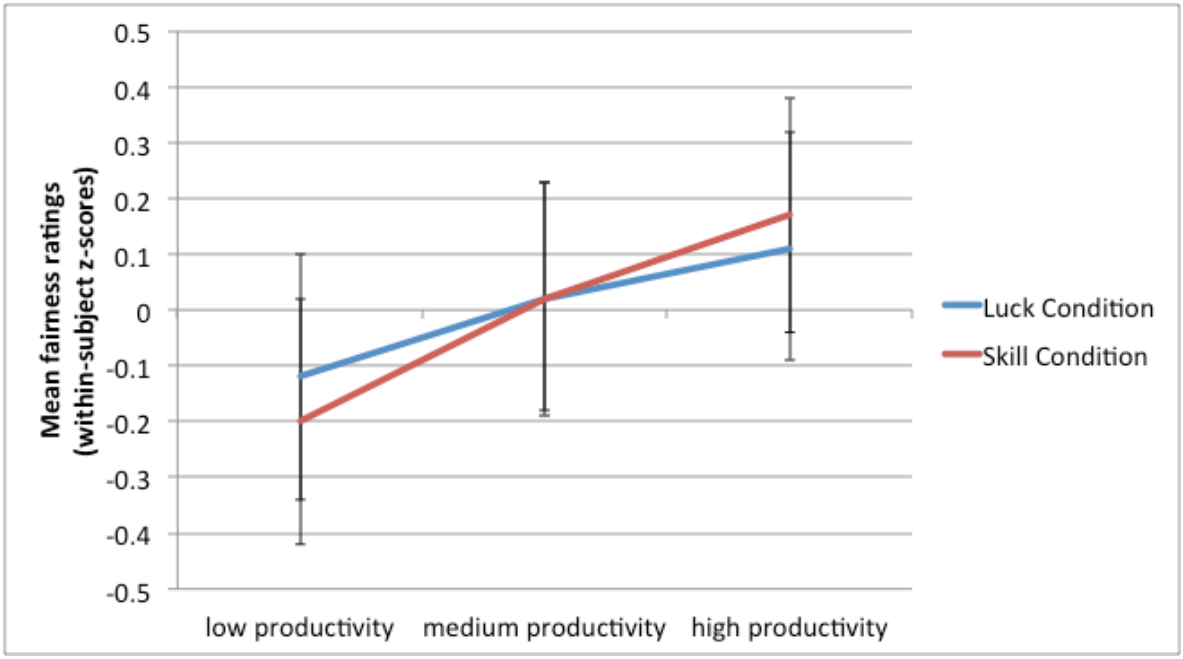

Figure 9. Condition by productivity interaction predicting fairness judgments (study 4). Y axis represents means of within-subject z-scores. Error bars are 95% CI.

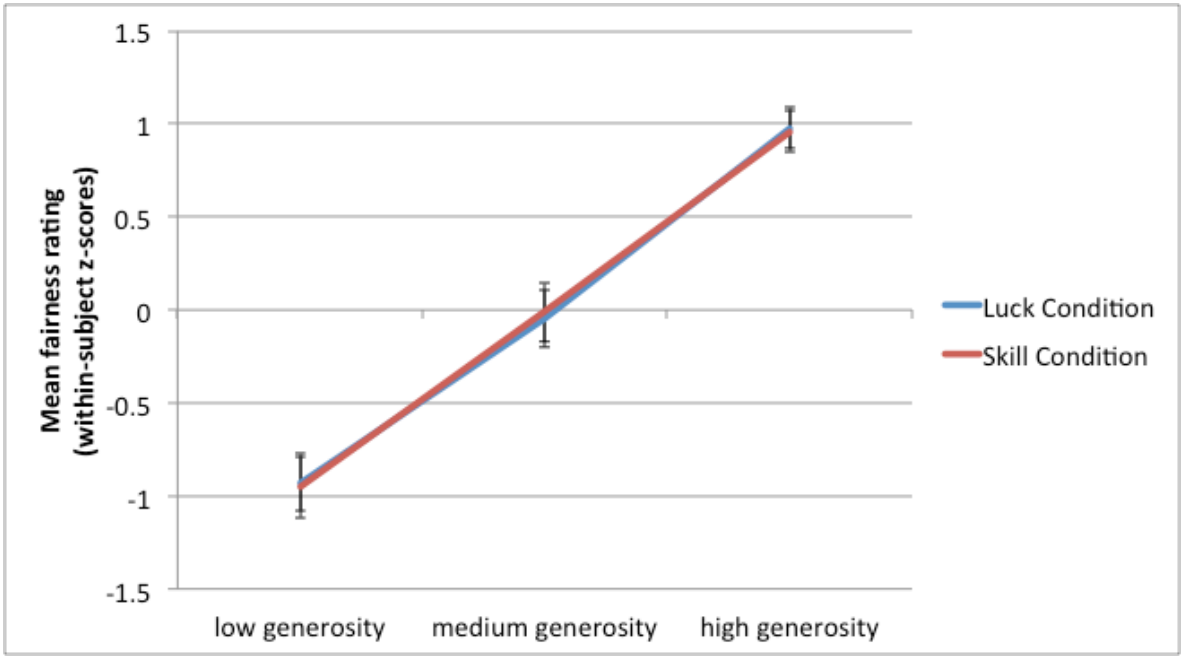

Figure 10. Condition by generosity interaction predicting fairness judgments (study 4). Y axis represents means of within-subject z-scores. Error bars are 95% CI.

3.3.2.4. Partner choice decisions: How are the preferences for productivity and generosity integrated?

In a model with productivity and generosity predicting partner choice decisions (table 14, model 5; figure 11), each additional increment of productivity increased the odds of retaining a partner by 124% (OR = 2.24, $p < .001$, 95% CI = 1.89 – 2.67), while each additional increment of generosity increased the odds of retaining a partner by 1,438% (OR = 15.38, $p < .001$, 95% CI = 12.27 – 19.28). This shows that people preferred productive partners, but the preference for generous partners was much stronger, even though productivity and generosity contributed equally to game earnings. Adding an interaction term to this model reveals a significant interaction between productivity and generosity (OR = 1.34, $p = .024$, 95% CI = 1.04 – 1.72; Table 14, model 6). As Figure 11 shows, productivity had weak effects at high and low generosity, but had a clear, step-wise positive effect at medium generosity.

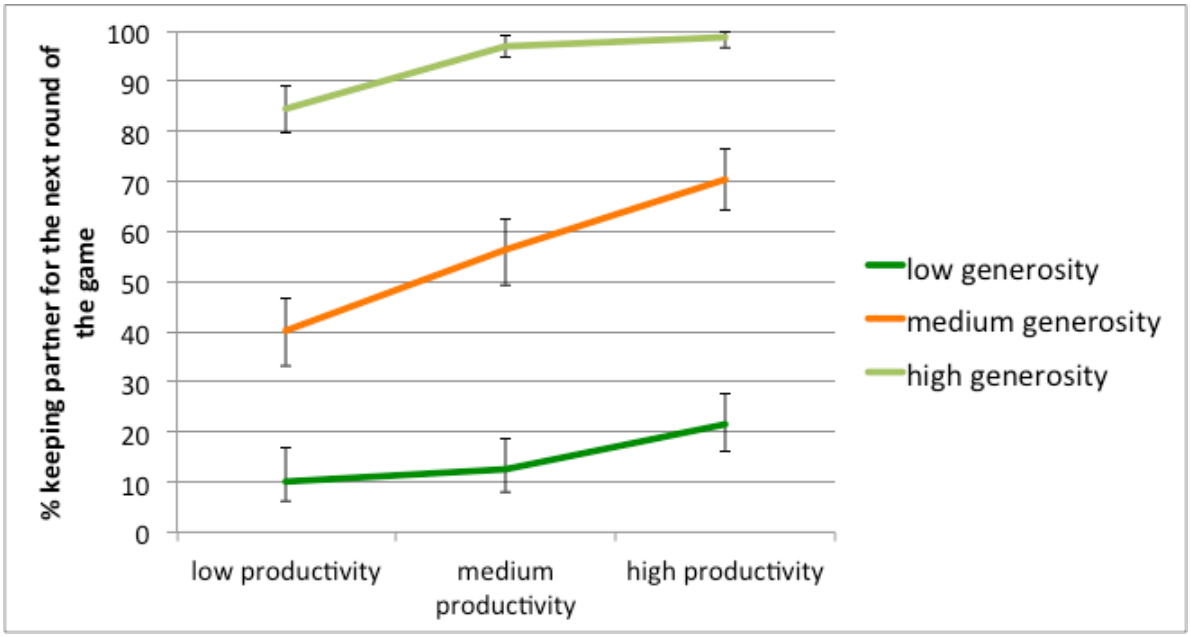

Figure 11. Effects of productivity and generosity on decisions to play another round with a partner (study 4). Error bars are binomial 95% CI based on 1000 bootstrap samples.

3.3.2.5. Partner choice decisions: H1 – Do men care more about productivity than women do?

Sex did not moderate the effect of productivity on decisions to keep a partner for the next round of the game, but sex did moderate the effect of generosity such that women's decisions to keep a partner were more sensitive to generosity than men's were (coeff = 1.59, p = .050, 95% CI = 1.00 – 2.52; Table 14, model 7; Figure 12). While we framed H1 in terms of productivity, this result is consistent with our prediction that women's partner choice decisions would give greater relative weight to generosity and men's would give greater relative weight to productivity.

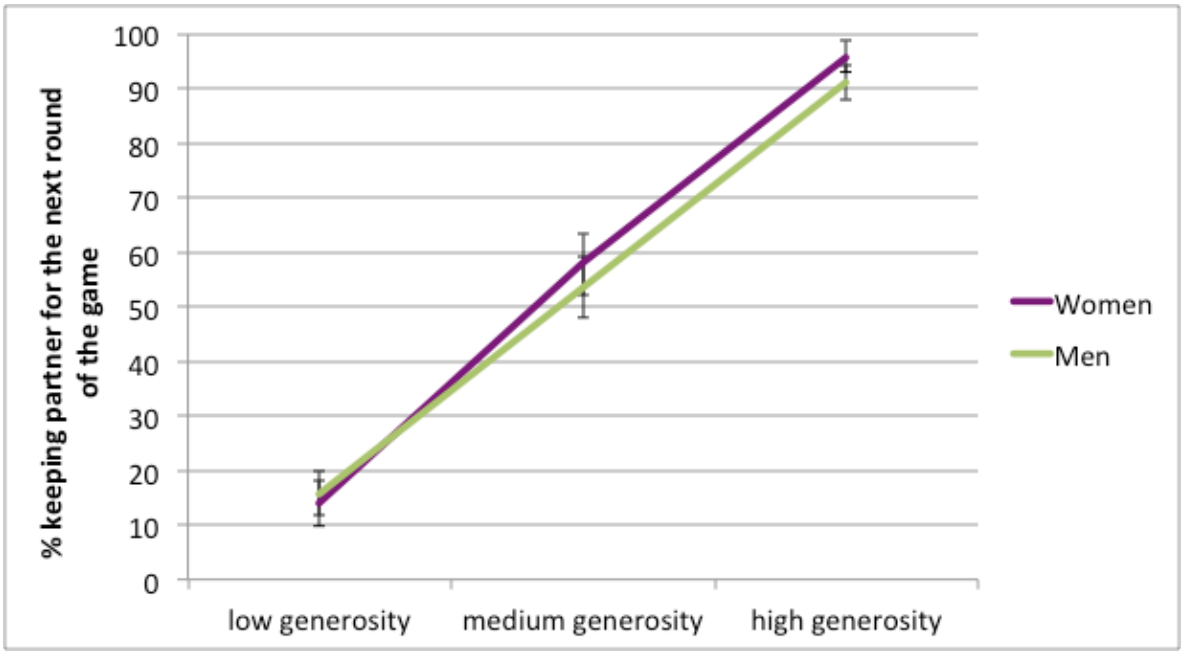

Figure 12. Sex x generosity interaction predicting decisions to keep a partner for the next round of the game (study 4). Error bars are binomial 95% CI based on 1000 bootstrap samples.

3.3.2.6. Partner choice decisions: H2 – Does productivity matter more in the skill condition?

Condition marginally moderated the effect of productivity on decisions to keep a partner for the next round of the game, such that productivity had a stronger effect in the skill condition, supporting H2 (OR = 1.41, p = .053, 95% CI = 1.00 – 2.00; Table 14, model 8; Figure 13). This suggests that the preference for productive partners is sensitive to a partner's ability to generate benefits in the future, not merely to the partner's immediate ability to confer benefits, even though game payoffs were the same in both conditions. Condition did not moderate the effect of generosity on decisions to keep a partner for the next round.

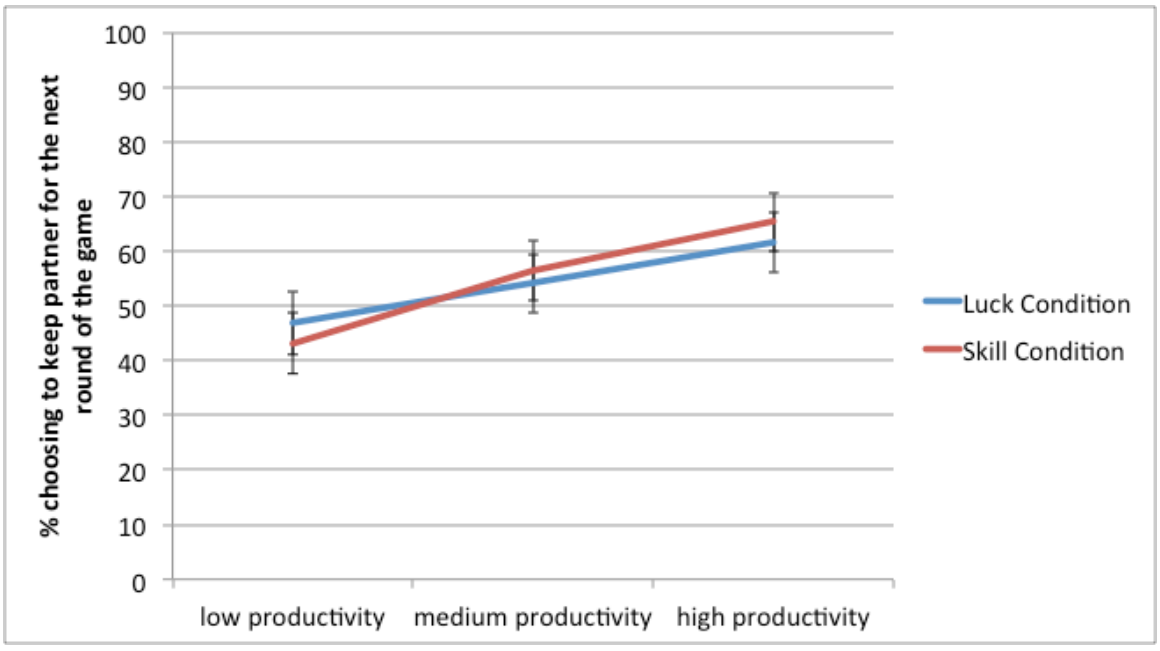

Figure 13. Condition by productivity interaction predicting decisions to keep a partner for the next round of the game (study 4). Error bars are binomial 95% CI based on 1000 bootstrap samples.

3.3.3. Study 4 Discussion

Study 4 provides a clearer picture of how the preference for productive partners is calibrated. Turning first to fairness judgments, both generosity and productivity had significant positive effects on fairness judgments. This shows that intuitions of fairness are not only based on quality of treatment (in this case, generosity), but also incorporate notions of different actors being entitled to different levels of selfishness, depending on their productivity. In effect, it was considered fairer for highly productive partners to offer selfish distributions than for unproductive partners to offer the exact same distributions. The effect of productivity on fairness judgments was stronger for men and stronger in the skill condition (supporting H1 and H2, respectively). These effects therefore suggest that fairness intuitions track cues of ancestral partner value, as predicted by biological market theory (Baumard, André & Sperber, 2013).

Turning to partner choice decisions, both productivity and generosity had significant positive effects, but generosity had a much larger effect (as in study 1). The criteria of partner choice appeared to be nuanced and dynamic, however. Though the effect of productivity was not stronger for men (our H1), the effect of generosity was stronger for women, which is consistent with the argument that cooperative partner preferences will correspond to sex-differentiated domains of cooperation. In addition, productivity had a stronger effect on partner choice decisions in the skill condition than in the luck condition, supporting H2. Recall that productivity in the skill condition was indicative of a partner's trait-like ability to generate benefits in the future, while productivity in the luck condition was not, even though productivity contributed equally to game payoffs in both conditions. This effect therefore suggests that people's partner choice decisions are sensitive to cues that

someone will be a productive long-term cooperative partner, rather than being driven solely by short-term material gains.

Finally, the effect of productivity on partner choice decisions was moderated by generosity. Highly generous partners were nearly always desired (with a slight decrease for the especially unproductive), and highly selfish partners were nearly always undesirable (with a slight increase for the highly productive), but productivity had a stronger effect among partners of medium generosity.

Note that in Study 3, productivity mattered most to fairness judgments at low generosity (but there was no productivity by generosity interaction predicting partner choice decisions), while in Study 4 productivity mattered most to partner choice decisions at medium generosity (but there was no productivity by generosity interaction predicting fairness judgments). The inconsistency of these effects across studies 3 and 4 suggests the importance of reexamining them in study 5.

3.4. Study 5

3.4.1. Study 5 Methods

3.4.1.1. Study 5 Participants

Amazon Mechanical Turk workers in the United States were recruited for this study, with the goal of having 50 men and 50 women in each condition. 242 people began the study, and 201 passed the comprehension check and successfully completed the study. There were 50 women in each condition, 50 men in the risk pooling condition, and 51 men in the collaboration condition. Mean age of the sample was 34.58 years (s.d. = 10.32). 10.4% of

the sample reported having a high school diploma or GED, 34.3% had some college education, 43.3% had completed college, and 11.4% had a graduate or professional degree.

3.4.1.2. Study 5 Design

Study 5 was designed to test whether productivity matters more to partner choice and fairness judgments in collaboration situations than in risk pooling situations. A task with the same underlying structure as studies 3 and 4 was used, but the surface features were revised in order to manipulate cues of collaboration vs. risk pooling. The task was for participants to imagine themselves as a hunter-gatherer choosing partners for either a collaborative foraging partnership or a risk pooling foraging partnership, depending on condition. The foraging partners varied in productivity (such that their partnerships typically produced 30, 40 or 50 pounds of food) and generosity (such that they typically shared 30, 40 or 50% of the food), so the hypothetical payoff structure of this game was the same as the payoff structures used in studies 3 and 4. Given the evidence from studies 3 and 4 that participant responses were not driven by monetary payoffs, we employed hypothetical rewards in study 5.

3.4.1.3. Study 5 Procedure and Materials

Subjects agreed to participate, and then read a framing passage that varied by condition. In the risk pooling condition, foraging partnerships ("Osotua partnerships") were presented as a way for partners to smooth out the variations in luck that foragers are vulnerable to, by pooling their gains. In the collaboration condition, foraging partnerships ("Asatua partnerships") were presented as a way for individuals to increase their productivity by working together. See Appendix C for full text of these framings. In both

conditions, the participants were told that the partnerships last for one day, the older of the partners always divides the total food between the two of them, it would be unthinkable for someone to cheat their partner, and that reputations for foraging skill and generosity are well-known and can be taken into account when deciding whether or not to partner with someone.

Immediately following this passage, participants were asked three multiple-choice questions to check their comprehension. Only participants who answered all three questions correctly were permitted to continue the study. Next, participants were instructed that their task would be to imagine themselves as a hunter-gatherer deciding whether or not to join a specific same-sex person's foraging partnership on different days.

Before making these decisions, participants completed an "introduction round" in which they were told the productivity and generosity reputations of each of the 9 people they would later make decisions about. Each person's information was presented on a separate screen in a random order, and said "One of the people is known as [a below-average forager / a roughly average forager / one of the best foragers in the group], and [he / she] usually gives [his / her] partner about [30 / 40 / 50%] of the total food acquired."

Following the "introduction round," participants proceeded to the "decision round." Each partner was presented on a separate screen, representing a different day on which the participant had been invited to join a different person's foraging partnership. For each partner, participants were told their productivity reputation (i.e. below-average, about average, or among the best in the group) and the amount of food that their partnerships thereby generate on a typical day (in pounds), and what percentage of the food they usually share with their partner. The participants then decided whether or not they would like to join

that person's foraging partnership for the day, and indicated on 7-point Likert-type scales how fair that person is in dividing the food with their partner, how grateful they felt towards that person for the invitation, and how angry they felt towards that person for the invitation. This was repeated for all 9 partners in a random order. Following this "decision round," participants provided demographic data, were debriefed that Osotua relationships exist among the Maasai but "Asatua" relationships were invented for this study, and consented to the use of their data. Before being debriefed, participants were asked to leave any other comments they had about the study; none of the participants expressed suspicion regarding the manipulation.

3.4.1.4. Study 5 Analysis

The same analysis strategy as in studies 3 and 4 was used. A sex by productivity interaction would support H1, and a condition by productivity interaction would support H3.

3.4.2. Study 5 Results

Judgments of fairness, gratitude and anger (reverse-coded) were highly inter-correlated (Cronbach's alpha = 0.84), so their mean was used as the fairness DV.

3.4.2.1. Fairness judgments: How are the preferences for productivity and generosity integrated?

In a model predicting fairness judgments, productivity (coeff = 0.58, $p < .001$, 95% CI = 0.53 – 0.63) and generosity (coeff = 1.39, $p < .001$, 95% CI = 1.34 – 1.44) both had significant, positive effects (Table 16, model 1; Figure 14). As in studies 3 and 4, fairness

judgments were sensitive to a partner's productivity (increasing by 0.58 points for each additional increment of productivity), but were much more sensitive to a partner's generosity (increasing by 1.39 units for each additional increment). There was no interaction between productivity and generosity on fairness judgments (Table 16, model 2).

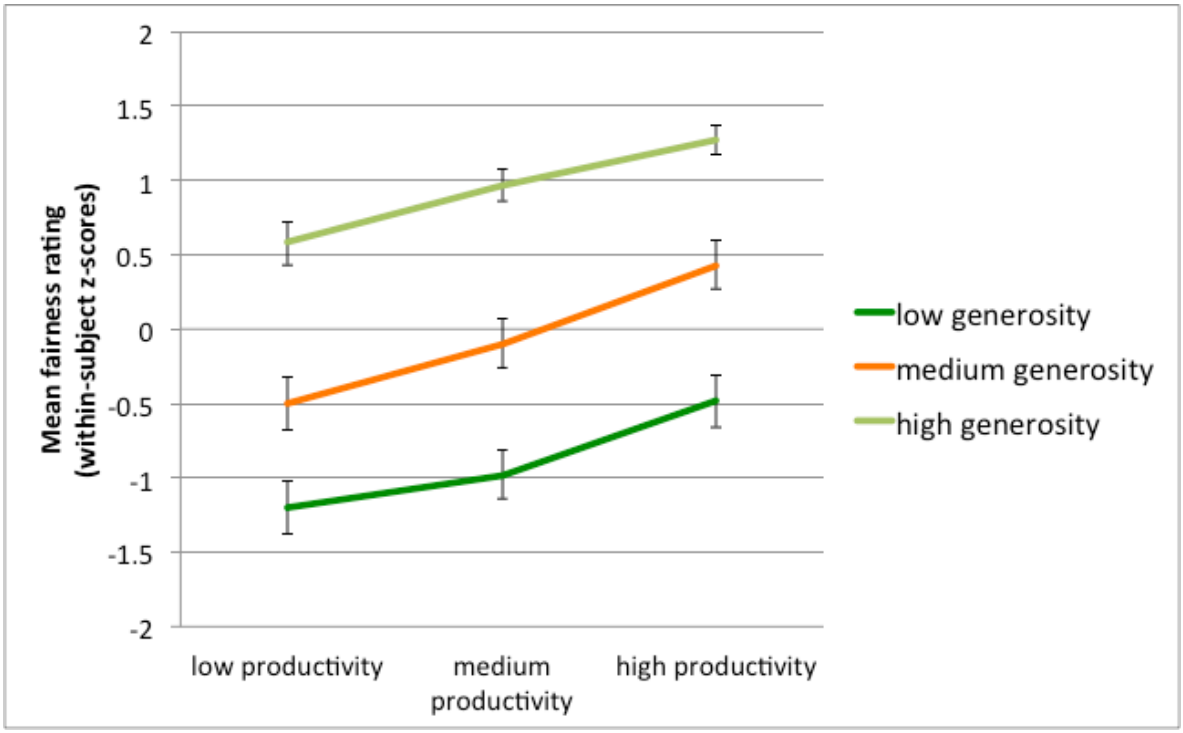

Figure 14. Effects of productivity and generosity on fairness judgments (study 5). Y axis represents means of within-subject z-scores. Error bars are 95% CI.

Table 16
Regression results for study 5

Model	DV	IV	Coefficient or Odds Ratio	p	95% CI
1	Fairness	Productivity	0.58	.000	0.53 – 0.63
		Generosity	1.39	.000	1.34 – 1.44
2	Fairness	Productivity	0.58	.000	0.53 – 0.63
		Generosity	1.39	.000	1.34 – 1.44
		Productivity x Generosity	-0.03	.361	-0.09 – 0.03
3	Fairness	Productivity	0.65	.000	0.58 – 0.72
		Generosity	1.42	.000	1.35 – 1.49
		Female	0.33	.001	0.13 – 0.53
		Female x Productivity	-0.15	.004	-0.25 – -0.05
		Female x Generosity	-0.06	.257	-0.16 – 0.04
4	Fairness	Productivity	0.57	.000	1.40 – 1.54
		Generosity	1.47	.000	0.50 – 0.65
		Risk pooling Condition	0.21	.042	0.01 – 0.42
		Risk pooling Condition x Productivity	0.00	.971	-0.10 – 0.10
		Risk pooling Condition x Generosity	-0.17	.001	-0.26 – -0.07
5	Join partner	Productivity	6.10	.000	4.96 – 7.51
		Generosity	11.94	.000	9.49 – 15.02
6	Join partner	Productivity	6.67	.000	5.31 – 8.36
		Generosity	12.87	.000	10.08 – 16.43
		Productivity x Generosity	1.37	.019	1.05 – 1.79
7	Join partner	Productivity	7.25	.000	5.32 – 9.89
		Generosity	13.89	.000	9.86 – 19.56
		Female	1.09	.723	0.67 – 1.78
		Female x Productivity	0.72	.129	0.48 – 1.10
		Female x Generosity	0.76	.242	0.48 – 1.21
8	Join partner	Productivity	7.13	.000	5.25 – 9.69
		Generosity	13.23	.000	9.46 – 18.50
		Risk pooling Condition	1.44	.141	0.89 – 2.35
		Risk pooling Condition x Productivity	0.75	.168	0.49 – 1.13
		Risk pooling Condition x Generosity	0.84	.452	0.53 – 1.33

Note. When the DV is fairness, a coefficient is used. When the DV is the choice to Join the partner for the next round of the game, an odds ratio (reflecting the change in the odds of choosing to Join the partner) is used.

3.4.2.2. Fairness judgments: H1 – Do men care more about productivity than women do?

Sex moderated the effect of productivity on fairness judgments, such that men's fairness judgments were significantly more influenced by a partner's productivity than women's were (coeff = 0.15, p = .004, 95% CI = 0.05 – 0.25; Table 16, model 3; Figure 15), supporting H1.

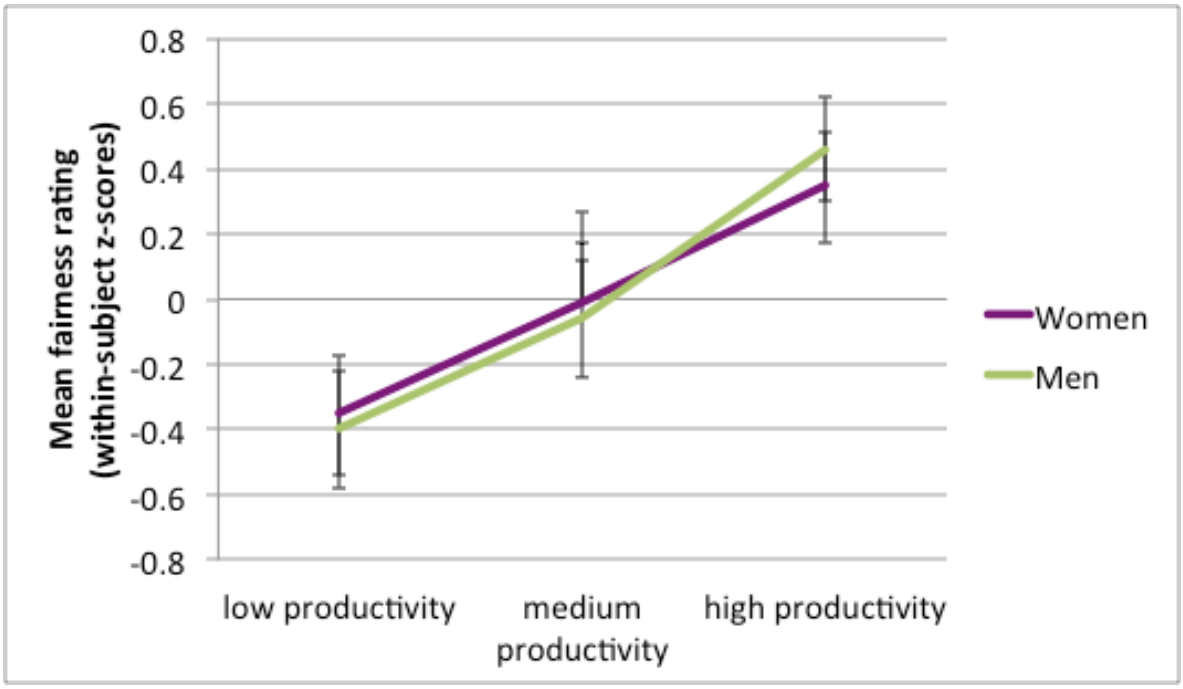

Figure 15. Sex by productivity interaction predicting fairness judgments (study 5). Y axis represents means of within-subject z-scores. Error bars are 95% CI.

3.4.2.3. Fairness judgments: H3 – Does productivity matter more in the collaboration condition?

Condition did not moderate the effect of productivity on fairness judgments. Condition moderated the effect of generosity on fairness judgments such that generosity had a stronger effect on fairness judgments in the collaboration condition than in the risk pooling condition (coeff = 0.17, p = .001, 95% CI = 0.07 – 0.26; Table 16, model 4; Figure 16).

Even though H3 was framed in terms of productivity, this is conceptually contrary to prediction.

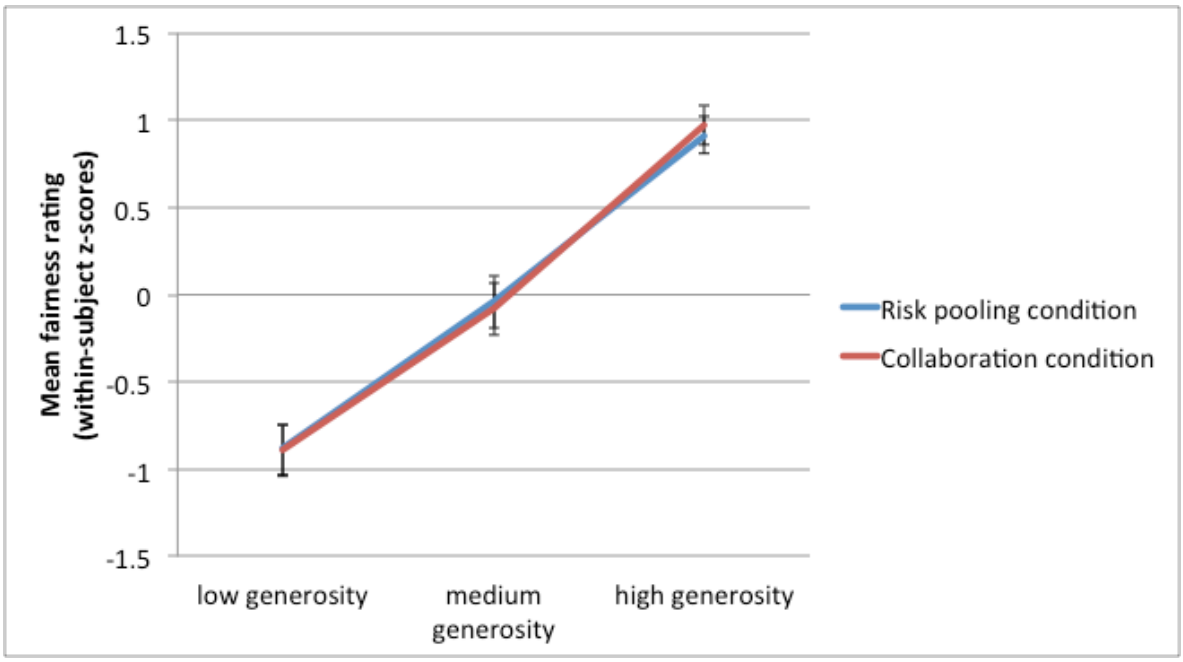

Figure 16. Condition by generosity interaction predicting fairness judgments (study 5). Y axis represents means of within-subject z-scores. Error bars are 95% CI.

3.4.2.4. Partner choice decisions: How are the preferences for productivity and generosity integrated?

As in studies 3 and 4, participants preferred to join productive partners, but had a much stronger preference for generous partners (Table 16, model 5; Figure 17). For each additional increment of partner productivity, the odds of joining a partnership increased by 510% percent (OR = 6.10, $p < .001$, 95% CI = 4.96 – 7.51), while each additional increment of generosity increased the odds of joining a partnership by 1094% (OR = 11.94, $p < .001$, 95% CI = 9.49 – 15.02).

There was a significant interaction between productivity and generosity predicting decisions to join a partner (OR = 1.37, $p = .019$, 95% CI = 1.05 – 1.79; Table 16, model 6).

Figure 17 shows that productivity mattered most for medium-generosity partners, as in study 4. There is also evidence that high productivity compensates for low generosity: there was almost no effect of going from medium to high productivity among high-generosity partners, but a large effect of going from medium to high productivity among low-generosity partners.

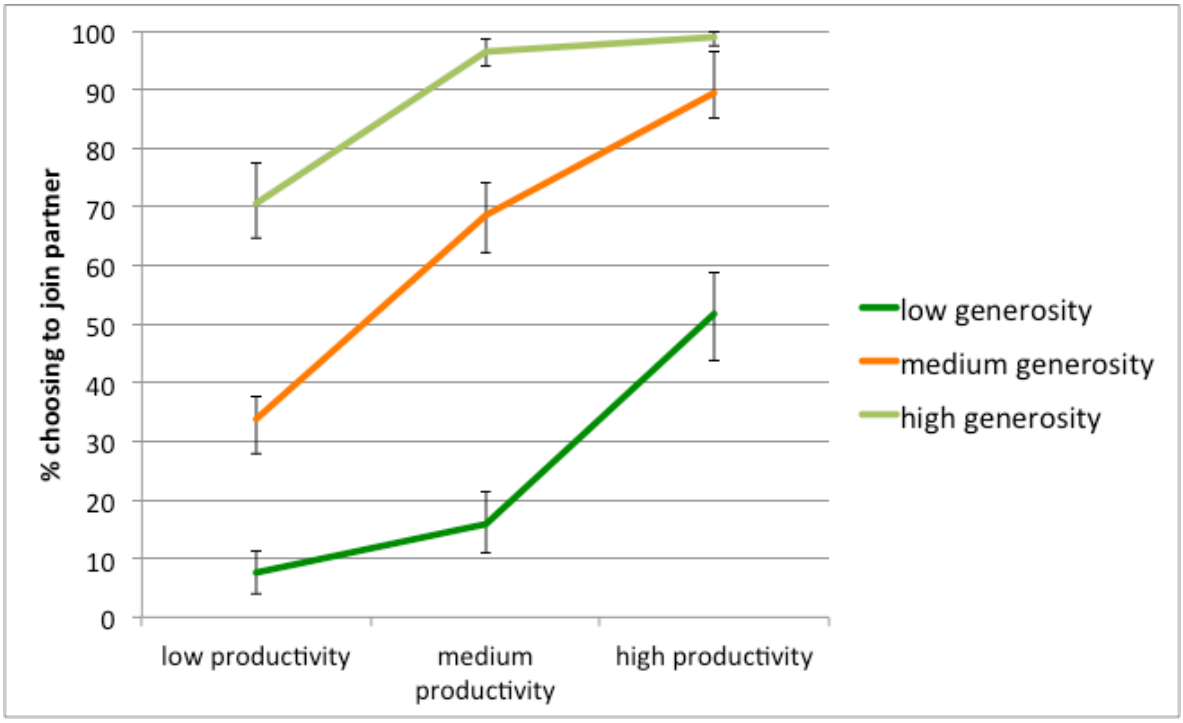

Figure 17. Effects of productivity and generosity on decisions to join a partner (study 5). Error bars are binomial 95% CI based on 1000 bootstrap samples.

3.4.2.5. Partner choice decisions: H1 – Do men care more about productivity than women do?

Sex did not moderate the effect of either productivity or generosity on decisions to join a particular foraging partnership (Table 15, model 7), failing to support H1.

3.4.2.6. Partner choice decisions: H3 – Does productivity matter more in the collaboration condition?

Condition did not moderate the effect of productivity or generosity on decisions to partner with a particular person (Table 15, model 8), failing to support H3.

3.4.3. Study 5 Discussion

Study 5 did not support the hypothesis regarding collaboration vs. risk pooling, but was in other ways consistent with the results of studies 3 and 4. Looking first at partner choice decisions, there were significant positive effects of both productivity and generosity, but the effect of generosity was much stronger (as in studies 3 and 4). The effect of productivity on partner choice decisions was not moderated by either sex or condition (failing to support H1 and H3), but was moderated by generosity: Productivity had its strongest effect among medium-generosity partners (as in study 4), and going from medium to high productivity had a marked effect among low-generosity partners. Together with the results of study 4, these results suggest that productivity is most important to partner choice decisions when generosity does not provide a clear signal of partner value, and that high productivity can partially restore a stingy partner's value.

Turning to fairness judgments, as in studies 3 and 4, productivity had a significant positive effect and generosity had a much stronger positive effect. The effect of productivity was moderated by sex, such that productivity had a stronger effect on men's fairness judgments than on women's, supporting H1. However, productivity did not matter more to fairness judgments in the collaboration condition, failing to support H3; in fact, generosity

had a stronger effect on fairness judgments in the collaboration condition than in the risk pooling condition, which was unexpected.

3.5. General Discussion of Trust Game Results

Across three studies, I tested how partner productivity and generosity jointly affect people's choices of cooperative partners and judgments of the fairness of resource divisions. Even though the participants were anonymous players in a brief game with real incentives, their behavior did not correspond to the payoff structure of the game. Instead, there was mixed evidence that participant behavior conformed to the hypothesized demands of an ancestral biological market of long-term cooperative partners. Specifically, participants cared about a partner's productivity as well as their generosity, productivity had a positive effect on fairness judgments – showing that more productive partners were seen as more entitled to selfish behavior, consistent with biological market theory – and the calibration of the preference for productivity suggests specialization for an ancestral environment. Since productivity is a relatively new area in partner choice research (see Chapter II; Macfarlan & Lyle, 2015), these findings may represent an important contribution to the literature.

Table 17 presents a summary of hypothesis tests regarding the design of the preference for productive partners. Though results were mixed, several patterns emerge: First, results were stronger for fairness judgments than for partner choice decisions. This may be because fairness was measured continuously, while partner choice decisions were binary. If generosity is the primary criterion for partner choice, then the binary nature of this choice may mask any variations in the relative importance of productivity and generosity,

while the continuous nature of the fairness judgments may be more sensitive to these variations.

Table 17
Summary of hypothesis tests (studies 3-5)

	Study 3	Study 4	Study 5
Fairness judgments:			
Productivity x Sex	No	Yes	Yes
Productivity x Condition	Yes	Yes	No
Partner choice decisions:			
Productivity x Sex	No	No	No
Productivity x Condition	No	Yes	No

Note. "Yes" indicates that a hypothesis was supported; "No" indicates that a hypothesis was not supported.

Second, partner choice decisions and fairness judgments appear to be sensitive to the degree to which productivity is based on skill (and thus reveals the ability to generate benefits in the future), but not to cues of a risk pooling vs. collaborative relationship. In Study 3, the framing manipulation contrasted skill/collaboration with luck/risk-pooling, in Study 4 the manipulation contrasted skill vs. luck, and in Study 5 the framing contrasted collaboration with risk-pooling. An interaction between productivity and framing condition on fairness judgments was thus found each time that skill vs. luck was part of the manipulation, but was absent in a pure manipulation of collaboration vs. risk-pooling. Future studies may be able to produce an effect of cooperation type using stronger manipulations (see below), or it may be the case that partner evaluation heuristics are not calibrated by this variable. Note that the skill vs. luck manipulation is different from past studies that manipulated entitlement to a resource based on either having completing a task vs. receiving the resource as a windfall (e.g. Cherry, Frykblom & Shogren, 2002), or manipulations that allocate a favorable position between two participants based on relative performance on a

task (e.g. Fleiß, 2015). In this design, all partners completed the foraging task, and all thereby "earned" their productivity level via performance. The only difference between the conditions is the extent to which that performance is revealing of the ability to generate benefits in the future, so the present results therefore suggest specialization for long-term cooperative relationships.

Third, men and women show subtle differences in their cooperative partner choices and fairness judgments that suggest evolution in different cooperative domains. In addition to the sex by productivity interactions listed in table 17, there was a three-way interaction in study 3 such that men's but not women's fairness judgments were more sensitive to productivity among stingy partners, and women's partner choice decisions in study 4 were more sensitive to generosity than were men's. The repeated emergence and directional consistency of these sex differences (productivity mattering relatively more to men, generosity mattering relatively more to women), gives moderate confidence in their reliability. I suggest that men place greater weight on partners' productivity due to selection pressures from cooperative large-game hunting and warfare, in which there is wide variance in both outcomes and partner skill (see Chapter I).

The integration of productivity and generosity cues to produce partner choice decisions and fairness judgments is also revealing. Generosity consistently had a much larger effect on both partner choice decisions and fairness judgments than productivity did, even though productivity and generosity contributed equally to earnings. In studies 4 and 5, there was a similar interaction between productivity and generosity on partner choice decisions, such that productivity mattered most at medium generosity. Taken together, these patterns suggest sophisticated heuristics for evaluating potential cooperators: When

choosing partners, generosity is paramount, with highly generous partners nearly always desired and stingy partners generally avoided. Medium generosity, however, is an ambiguous cue. Therefore, the effect of productivity on a partner's desirability may be elevated when their generosity level is neither high enough nor low enough to itself determine their partner value, in order to compensate for the ambiguous generosity cue. This conditional weighting of cooperative partner choice criteria adds nuance to the primacy of warmth-related (vs. competence-related) traits that is typically discussed in the social cognition literature (e.g. Fiske et al, 2007; Wojciske, 2005). Possible reasons for the greater importance of warmth over competence in social partner selection will be discussed in chapter V.

One possible limitation of this research pertains to the salience of the manipulated cues. Productivity, generosity, and types of cooperation and productivity (skill vs. luck) were cued by brief, verbal information, but the relevant psychological mechanisms are likely designed to take much richer inputs. Given that most production in the real world likely involves both skill and luck, and most cooperative relationships likely involve elements of both risk pooling and collaboration, sex differences may be subtle and it may take very strong cues to substantially shift people's partner evaluation heuristics. Nonetheless, brief, verbal cues were used because they allow for perfectly independent manipulations of productivity and generosity (in contrast, for example, to the confounds inherent in faces; see tables 1 and 6), and for the payoff structure of the game to be held constant across all conditions. Therefore, the present results are a well-controlled proof of concept, but a challenge for future research will be to use richer cues of partner value and context (e.g.

actual cooperative interactions, social/reputation information, and anthropometric cues of partner value) without confounding cues or altering incentive structures.

Cooperative partner choices and (especially) fairness judgments did not match the incentive structure of the present games, but instead appear calibrated for a biological market of long-term cooperative relationships: The preference for generosity was consistently much stronger than that for productivity, but a partner's productivity mattered most at medium generosity; participants were more sensitive to productivity when it was revealing of the future ability to create benefits rather than luck; and men were more reliant on productivity information than were women. Given that most partner choice research has focused on dispositional cooperativeness, these findings on how the preference for partner productivity is calibrated may be an important addition to the literature.

IV: Specialized Productivity Preferences in Friend Choice

Studies 1-5 showed that people prefer to cooperate with partners who possess cues of the likelihood of providing benefits over the course of a relationship, and view those partners as entitled to more advantageous resource divisions, suggesting that people's partner choice psychology is calibrated for long-term cooperative relationships in an ancestral marketplace. Each of these studies utilized an economic game with explicit terms of exchange and exogenously-imposed rules. In the real world, however, a great deal of cooperation likely takes place without such explicit accounting and rules. For example, friendships are likely to be long-standing cooperative relationships in which the division of benefits is not explicitly quantified and negotiated (e.g. Barclay, 2016; Fiske, 1990; Seyfarth & Cheney, 2012; Tooby & Cosmides, 1996). Study 6 will test whether judgments of friend desirability reflect specialized mechanisms for long-term cooperative partner choice.

Sex differences in same-sex friendship (SSF) preferences and dynamics suggest that SSFs conform to the hypothesized demands of ancestral forms of cooperation (Lewis, 2011; Vigil, 2007). Both men and women prioritize cooperativeness and agreeableness in a friend, but men more so than women report engaging in athletic activities with their SSFs (Lewis et al, 2011). Women report greater expectations of communion and symmetrical reciprocity from their SSFs, while men have higher expectations of agency (Hall, 2011, 2012; Lusk, MacDonald & Newman, 1998 report similar results). Consistent with this, men prefer less intimate and more activity-focused friendships, while women prefer fewer, closer friendships (Aukett, Ritchie & Mill, 1988; Caldwell & Peplau, 1982; Vigil, 2007). These findings support the idea that SSFs function as standing cooperative relationships, but note that this model of friendship does not exclude other functions that friends may serve, e.g. as

allies in social conflicts (DeScioli & Kurzban, 2009) or as sources of emotional regulation (Cheung, Gardner & Anderson, 2015).

One limitation of the existing studies on SSF preferences is that they rely on self-reports of preferences, or reports of actual existing friendships. Existing relationships may not clearly reveal preferences, since relationship formation is constrained by mutual availability and interest. Self-reports of preferences may also be inadequate, since people may not have conscious access to the cognitive mechanisms that generate those preferences (e.g. Nisbett & Wilson, 1977). For example, self-reports of mate preferences have been found to poorly predict actual mate choices in some settings (e.g. Eastwick & Finkel, 2008; Todd, Penke, Fasolo & Lenton, 2007). Therefore, directly measuring the cues that predict attraction to particular individuals as SSFs (i.e. a policy-capturing method, e.g. Wiederman & Dubois, 1998) may be a more informative way to test whether SSF preferences match the demands of ancestral forms of cooperation.

Studies 1-5 have identified the ability to create material benefits ("productivity") as a desired feature in cooperative partners. There is some evidence that judgments of productivity are specialized to the environment of our ancestors: items that appear irrelevant for contemporary cooperation nonetheless predict behavior in the ultimatum game (studies 1 & 2; see Appendix A for item text), and both productivity and partner choice decisions are more influenced by the stable ability to generate benefits than by incidental productivity (study 4). One limitation of these studies, however, is that they did not compare perceptions of ancestral productivity with perceptions of contemporary productivity. Therefore, it is not clear that people's partner preferences are based on cues of ancestral productivity in particular, rather than any available cue of competence.

Study 6 will therefore use a policy-capturing method to test whether judgments of desirability as a SSF reflect specialized heuristics for cooperative partner choice. I predict that men's SSF desirability judgments will be more influenced by productivity than women's will (H1), and that SSF desirability will be affected by perceptions of the ancestral, rather than contemporary, ability to generate benefits (H2).

4.2. Study 6 Methods

4.2.1. Study 6 Design

Faces were rated for desirability as a friend, prosociality, ancestral productivity, and the contemporary ability to produce benefits.

4.2.2. Study 6 Participants

161 undergraduates at UCSB participated in return for course credit. 100 participants were male, 60 were female, and 1 did not report their sex. Average age of the sample was 19.25 years (s.d. = 1.68).

4.2.3. Study 6 Materials

The target faces that were rated were the same faces used in studies 1 and 2 (83 male target faces and 100 female target faces). The faces were rated on desirability as a friend, 3 prosociality items (kindness, trustworthiness, and cooperativeness), and 3 productivity items (success surviving on a desert island, success on a long camping trip, and productivity as a hunter-gatherer). These items were identical to those used in studies 1 and 2, so their full text can be found in Appendix A. In addition, the faces were rated for estimates of the

target's high school grade point average (GPA), on a 7-point scale ranging from far below average to far above average. High school GPA positively predicts both college completion rates and college GPA (and is a better predictor than standardized tests; Geiser & Santelices, 2007), negatively predicts later substance abuse (Schulenberg, Bachman, O'Malley & Johnston, 1994), and each 1-point increase in high school GPA predicts approximately a 13% increase in adult annual income (French, Homer, Popovici & Robins, 2015). Therefore, if SSF preferences were attuned to the contemporary ability to generate benefits, perceptions of high school GPA could be expected to have a positive effect on friend desirability.

4.2.3.4. Study 6 Procedure

Participants consented to participate in the study, and then rated 3 or 4 blocks of items (a block refers to one of the questions described above, applied to either male or female targets). Target faces were randomized within blocks. If a participant made friend desirability ratings, these were done first (in order to prevent friend desirability rating from being affected by other ratings), but all other blocks were in a random order. Participants rated only same-sex targets on friend desirability, but all other items were rated by both sexes.

4.2.3.5. *Study 6 Analysis*

Bivariate correlations were used to test the zero-order correlations between friend desirability, prosociality, productivity, and high school GPA. Regressions were used to test the simultaneous effects of prosociality, productivity and high school GPA on friend desirability, and to test for sex differences in these effects. Variables were standardized

within each sex before being entered into regressions, in order to correct for different distributions; specifically, there was less variance in ratings of female productivity than male productivity, though both appeared normally distributed.

4.3. Study 6 Results

Intraclass correlations for each rated item are presented in Appendix A; all intraclass correlations were .75 or higher, suggesting strong rater consensus. The three prosociality items and the three productivity items were strongly intercorrelated (Cronbach's alphas = .951 and .917, respectively), so their means were used as composite variables.

4.3.1. Are men's SSF preferences more influenced by productivity than women's?

Table 18 shows the zero-order correlations between ratings of friend desirability, prosociality, productivity and high school GPA, separately for men and women. Using the Fisher r-to-z- transformation, the difference in the correlation between friend desirability and productivity among men vs. women is marginally-significant in a one-tailed test, but not significant in a two-tailed test ($z = 1.53$, one-tailed $p = .063$, two-tailed $p = .126$).

Table 18
Zero-order correlations between ratings of friend desirability, prosociality, productivity and high school GPA, for women (above the diagonal) and men (below the diagonal)

Trait	1	2	3	4
1. Friend desirability		.85***	.60***	.38***
2. Prosociality	.83***		.53***	.57***
3. Productivity	.73***	.46***		.52***
4. GPA	.22*	.33**	-.03	

Note. * indicates $p < .05$, ** indicates $p < .01$, *** indicates $p < .001$)

Controlling for prosociality reveals a significant sex difference, however. The partial correlation between productivity and friend desirability (controlling for prosociality) among men (partial $r(80) = .711$, $p < .001$, 95% CI = 591 - .795) is significantly greater than the partial correlation among women (partial $r(97) = .338$, p=.001, 95% CI = .200 - .478). (Confidence intervals were generated using a bootstrapping procedure with 1000 samples.) This analysis reveals that productivity explains 50.5% of the variance in friend desirability in men (controlling for prosociality), but only about 11.4% in women, and this is a significant difference in unique variance explained.

A regression approach reveals the same sex difference. Among women, productivity ($b = .213$, $t(97) = 3.542$, $p = .001$) and prosociality ($b = .732$, $t(97) = 12.169$, $p < .001$) both have significant simultaneous effects on friend desirability. Among men, productivity ($b = .445$, $t(80) = 9.049$, $p < .001$) and prosociality ($b = .628$, $t(97) = 12.788$, $p < .001$) also both have significant simultaneous effects on friend desirability. However, a regression including both male and female targets, with prosociality, productivity, sex, prosociality x sex and productivity x sex predicting friend desirability revealed a significant productivity by sex interaction, such that the effect of productivity was greater among men ($b = .231$, $t(177) = 2.930$, $p = .004$). There was not a significant interaction between sex and prosociality. Figure 18 depicts the relationship between productivity and friend desirability among men and women, controlling for prosociality.

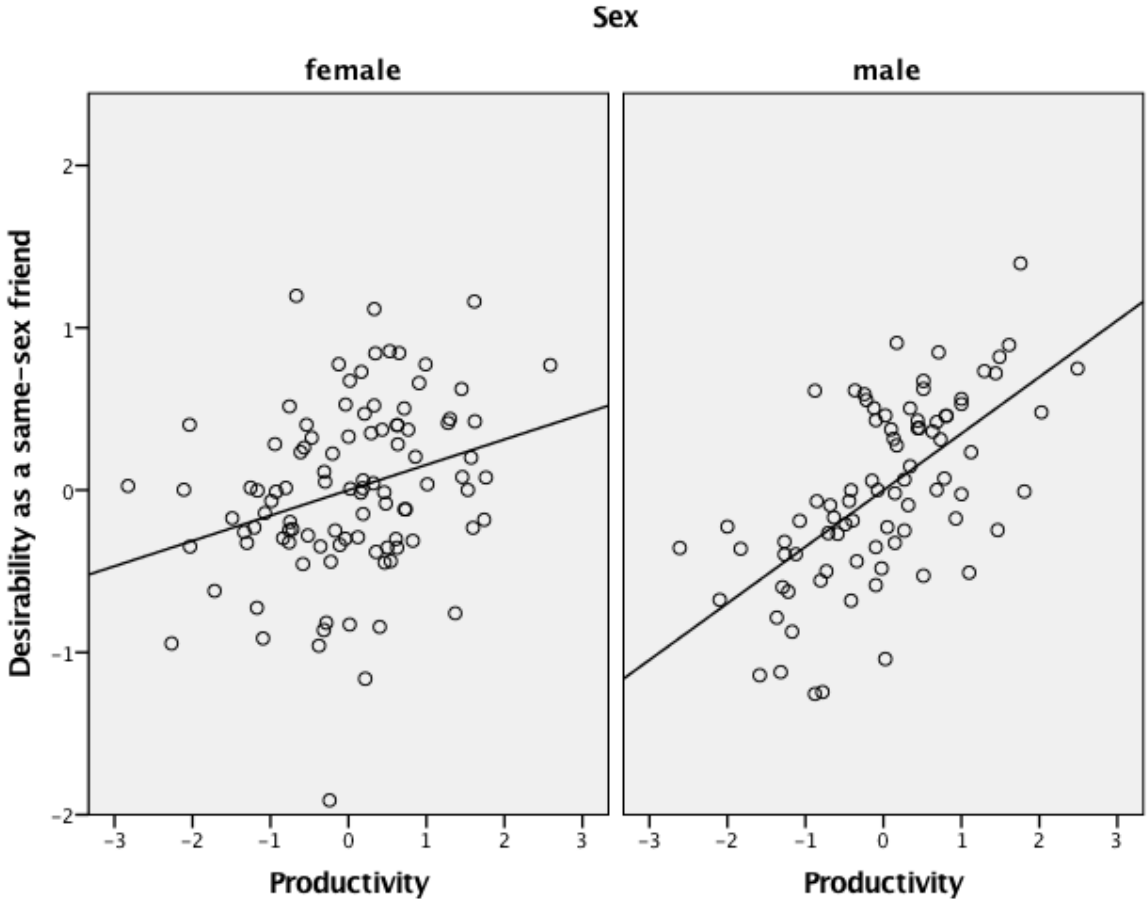

Figure 18. The relationship between productivity and desirability as a same-sex friend (residual from regressing friend desirability on prosociality). All variables are within-sex z-scores.

4.3.2. Are friend preferences tuned to the ancestral or contemporary ability to create benefits?

Pooling across men and women, ancestral productivity ratings had a significantly stronger bivariate correlation with friend desirability ratings ($r(181) = .61$, $p < .001$) than GPA estimates had with friend desirability ratings ($r(181) = .35$, $p < .001$; $z = 3.19$, one-tailed $p < .001$, two-tailed $p = .014$).

In a regression with GPA estimates and ancestral productivity ratings predicting friend desirability ratings, both had significant unique effects (GPA: $b = .142$, $t(180) =$

2.491, $p = .014$; productivity: $b = .623$, $t(180) = 10.931$, $p < .001$), but the effect of ancestral productivity ratings was much stronger. Adding prosociality to this model causes GPA to have a weak negative effect, while productivity and prosociality retain significant positive effects (GPA: $b = -.115$, $t(179) = -3.008$, $p = .003$; productivity: $b = .330$, $t(179) = 8.404$, $p < .001$; prosociality: $b = .728$, $t(179) = 17.100$, $p < .001$).

4.4. Study 6 Discussion

Study 6 suggests that same-sex friendships may have evolved as standing cooperative relationships, because the predictors of SSF desirability match the hypothesized criteria of ancestral cooperative partner selection. Specifically, men care significantly more about a potential SSF's productivity than women do, though both men and women appear to care about prosociality even more. This sex difference is consistent with the results of studies 1, 2, 4 & 5 (potentially study 3 as well, though the sex difference in study 3 is more qualified).

In addition, the preference for SSFs who can generate benefits appears to be sensitive to *ancestral* productivity, rather than more contemporary cues of success (e.g. high school GPA). Ancestral productivity predicted friend desirability judgments more strongly than GPA estimates did, and ancestral productivity, but not GPA, retained a unique positive effect on friend desirability when both were entered into a model with prosociality. This suggests that the mechanisms that identify valuable cooperative partners are specialized for the human ancestral environment, rather than relying on estimates of the present ability to create benefits or responding to any positively-valenced cues. This gives greater credence to the productivity effect found in studies 1 & 2, and complements the finding from studies 3 &

4 that cues of intrinsic productivity are more important than incidental, short-term productivity.

There are many avenues for future research applying a cooperative partner choice perspective to same-sex friend preferences. Faces are salient, information-rich stimuli (e.g. Willis & Todorov, 2006), but cues of different partner-choice-relevant traits are typically confounded within faces (see tables 1, 6 & 17). One interesting method may therefore be to digitally alter faces in order to manipulate their levels of relevant traits, for example productivity. Even if traits cannot be manipulated entirely in isolation, such a manipulation would more clearly establish a causal relationship between the perception of specific traits and judgments of friend desirability. Another way to test the specialization of the partner choice psychology to an ancestral environment would be to use data collected among hunter-gatherers or in other small-scale societies. For example, friendship preferences within a small-scale community might be predicted by actual, publicly-known variance in hunting ability or prosociality, or pictures of hunter-gatherers (whose actual productivity and prosociality are known) could be evaluated for friendship desirability by subjects in industrialized communities.

V: Adaptations for cooperative partner choice in a biological market – Conclusions and future directions

The present studies provide evidence of two design features of the human mind that suggest adaptation for a biological marketplace of long-term cooperative relationships. The first is that humans have preferences that identify valuable cooperative partners, and these preferences are sensitive to ancestrally-valid cues of value as a long-term cooperator, rather than to cues of contemporary value or to positively-valenced cues in general. The second is that human intuitions about how cooperatively-produced resources should be divided are sensitive to partner value cues, such that more valuable partners are viewed as entitled to more favorable resource allocations. This chapter will review the evidence from studies 1-6 for these two design features, will discuss limitations of the present research, and will then discuss future directions for research applying the logic of biological markets to human social cognition.

5.1. Identifying valuable partners

Studies 1-6 reveal cooperative partner preferences centered around two major traits: productivity, or the ability to produce material benefits, and generosity, or the inclination to share those material benefits. These traits are major determinants of partner value (e.g. Barclay, 2013), and are the main dimensions of person perception (e.g. Fiske et al, 2007). In studies 1-6, participants consistently preferred partners who were higher in productivity and generosity. Several lines of evidence indicate that these preferences are based on evolved heuristics for choosing long-term cooperative partners, rather than attempts to maximize earnings in the task at hand.

First, in studies 1, 2, 4, 5 & 6, productivity perceptions were measured or manipulated using items that specifically referred to ancestral forms of productivity, especially the ability to forage successfully (studies 1, 2, 4, 5 & 6) and survive in the wilderness (studies 1, 2 & 6). Given the types of tasks in which the participants typically cooperate in their real lives (e.g. collaborating on a school project), it is striking that such seemingly-irrelevant traits had a strong effect on partner preferences. In fact, study 6 tested the effects of both ancestral productivity and the contemporary ability to create benefits (in the form of high school GPA) on same-sex friend desirability ratings, and found that ancestral productivity was the far stronger predictor. Furthermore, the stronger effect of productivity when it reflected stable skills rather than luck (studies 3 and 4) shows that people are sensitive to a potential partner's ability to create benefits over the course of a long relationship, not just to their contribution in any specific interaction. These results suggest that estimates of a cooperative partner's ability to create benefits, and their partner value more broadly, are made by cognitive machinery specialized for an ancestral ecology of long-term relationships, rather than by domain-general mechanisms calibrated to modern conditions.

Secondly, sex differences in the relative importance of productivity and generosity suggest specialized partner preferences. Such sex differences were observed in studies 1 and 2 (viewed together), study 4 (on partner choice decisions and fairness judgments), study 5 (on fairness judgments), and study 6. The observed sex differences were directionally consistent; all suggested either that men were more influenced by a partner's productivity, or that women were more influenced by a partner's generosity. Given that men and women faced the same incentive structures in the present studies, these sex differences may be most

explicable by ancestral sex differences in domains of cooperation. Since large game hunting and coalitional violence were nearly exclusively male pursuits, while direct childcare was primarily a female domain (e.g. Hrdy, 2000; Marlowe, 2007, 2010; Wrangham, 1999), men likely evolved to care relatively more about a partner's productivity, while women care more about warmth-related traits (see chapter I). These sex differences match those observed in person perception (e.g. Fiske, Cuddy & Glick, 2007) and in self-reported friend preferences (e.g. Vigil, 2007), suggesting that sex differences in social cognition more broadly may have roots in sexually dimorphic adaptations for cooperation.

Finally, the observed preferences for productivity and generosity were not well-suited to the incentive structures of the economic games used in studies 1-5, suggesting that they were not produced by domain-general income-maximizing mechanisms. In study 1, male participants pursued the opposite of the income-maximizing strategy, by making lower offers to targets expected to make higher demands. In addition, participant earnings were negatively correlated with sensitivity to target traits, suggesting that men engaged in economically costly partner choice. In study 2, female participants showed a weak effect whereby they made higher offers to targets expected to make higher demands (the income-maximizing strategy), but the effects of target traits were robust to controlling for this strategy. In studies 3-5, the effects of generosity on partner choice decisions was consistently much stronger than the effect of productivity, even though productivity and generosity contributed equally to earnings in the game. In addition, sex moderated the effect of generosity on partner choice decisions in study 4, and the effect of productivity on fairness judgments in studies 4 and 5, even though sex did not change the incentive structure of the game. Finally, condition (the skill vs. luck manipulation) moderated the effects of

productivity on fairness judgments and generosity on partner choice decisions in study 3, and the effects of productivity on fairness judgments and partner choice decisions in study 4, even though condition did not affect the incentive structure of the game. Therefore, it seems that the observed preferences for productive and generous partners were not driven by general-purpose income-maximizing mechanisms, and the observed partner preferences may have even been counterproductive with respect to income maximization in some cases. While this is inconsistent with short-term income maximization, it may be the output of evolved mechanisms designed to selectively establish long-term cooperative relationships, since the long-run gains of a relationship with a valuable partner may outweigh the costs incurred in establishing that relationship (see Delton & Krasnow, et al, 2011).

5.2. Attracting valuable partners

Identifying valuable partners is only half the battle, however. Since humans cooperate in an ecology of mutual partner choice (e.g. Barclay, 2013), people are forced to bid for cooperative relationships. Biological market theory therefore predicts that the division of resources within cooperative relationships that are seen as "fair" will track each partner's value as a cooperative partner (Baumard, André, & Sperber, 2013). Studies 1-5 provide evidence that people's intuitions about how cooperatively-produced resources ought to be divided do in fact track cues of their partner's value as a long-term cooperative partner.

In studies 1 and 2, both men and women made higher ultimatum game offers to partners who looked more valuable (e.g. healthier, more productive, more prosocial). Men (study 1) also made lower demands towards more apparently-valuable partners, suggesting an overall strategy of generosity towards more valuable cooperative partners, as predicted by

biological market theory. Women (study 2) made higher demands to more apparently-valuable partners, suggesting either that women have a greater insistence on reciprocity within a relationship than men do (see chapter I), or that competition with attractive rivals constrains the ability to bid for cooperative relationships (contrast table 7 with table 8, which presents the effects of target traits controlling for attractiveness). In studies 3-5, a partner's productivity consistently had a positive effect on fairness judgments, showing that it was considered fairer for a more-productive partner to exhibit any given level of selfishness than for a less-productive partner to do so. In effect, more productive partners were viewed as more entitled to be selfish, supporting biological markets theory. In addition, skill-based productivity had a stronger effect on fairness judgments than did luck-based productivity (studies 3 & 4), suggesting that perceived entitlement to a resource is calibrated to value as a long-term cooperative partner, not merely to contribution to the present resource.

5.3 Limitations

In each of the present studies, a trade-off was made between the salience of the stimuli and the ability to independently manipulate partner traits. In studies 1, 2 and 6, faces were used to represent cooperative partners. Faces are salient stimuli from which people rapidly draw rich trait information (e.g. Willis & Todorov, 2006), but trait perceptions are confounded within faces (e.g. more productive faces also look more prosocial, see tables 1, 6 and 17). While partial correlations and multiple regression can be used to identify the effects of specific traits, it is impossible to completely isolate the effect of one trait from those of known or unknown confounds. On the other hand, verbal cues of partner traits (such as those used in studies 3-5) can be precisely and independently manipulated, but they may

be less salient and impactful than other types of partner information. Combining studies that use both types of cues may yield a valid estimate of the effects of different partner traits, but an important challenge for future research in this field will be to deliver strong and ecologically-valid cues of partner value in ways that do not confound partner traits or inadvertently alter incentive structures.

The issue of salience also pertains to the framing manipulations used in studies 3-5. Merely being told that performance in a task is reflective of luck or skill may not trigger the same recalibration of partner value criteria that actually watching a person skillfully or luckily produce a resource would, for example. Therefore, the effect of the luck vs. skill manipulation (shown most clearly in study 4) may actually be an underestimate of the true effect of this variable. Similarly, the risk pooling vs. collaboration framing manipulation (study 5) was very subtle – the conditions differed only by a few sentences. Therefore, the null effect of this manipulation may show that humans do not have different heuristics for estimating partner value and dividing resources in these two types of cooperation, or these differences may exist but this manipulation was too weak to elicit them. These subtle, verbal manipulations were chosen because they allow for precise, independent manipulations without implicitly altering incentive structures, but researchers may wish to pursue more ecologically-valid, salient manipulations.

5.4. Future Directions

Adaptations for cooperative partner choice in a biological market may underlie several aspects of social psychology (Barclay, 2016), so this perspective creates rich opportunities for future research. Four areas of research suggested by the present studies are

friendship preferences, the psychology of punishment, organizational and economic decision-making, and the cause of the greater importance of a partner's generosity than their productivity.

Self-report studies (e.g. Lewis et al, 2011; Vigil, 2007) have found that same-sex friend preferences are similar to the criteria of ancestral cooperative partner value, supporting the hypothesis that same-sex friendships evolved as ongoing cooperative relationships (e.g. Barclay, 2016; Tooby & Cosmides, 1996). Study 6 also found support for this hypothesis using a policy capturing method, and showed that perceptions of productivity are specific to the ancestral, not contemporary, ability to create benefits. This research could be extended with experimental policy capturing methods, in which cues of cooperative partner value are manipulated and desirability as a same-sex friend is then measured. Anthropological work may be important as well, to test whether more valuable cooperative partners are preferred as friends in small-scale societies, and whether Westerners' perceptions of ancestral productivity accurately tracks actual productivity in ancestral-like environments.

The present findings may have implications for the psychology of punishment. One proposed function of punishment is to improve future treatment within the context of an ongoing relationship, by recalibrating one party's understanding of the type of treatment to which the other party is entitled (Krasnow, Cosmides, Pedersen & Tooby, 2012; McCullough, Kurzban & Tabak, 2013; Petersen, Sell, Tooby & Cosmides, 2012). In a biological market, the quality of treatment each party is entitled to is based on their respective cooperative partner values (see chapter I), which suggests that punishment decisions should be sensitive to the cooperative partner values of both the punisher and the

punished. The finding that more valuable partners are offered more of the benefits generated by the relationship (studies 1 & 2), but are allowed to be more selfish before being punished or rejected (study 1), supports this prediction. The finding that any given level of selfishness is considered fairer when it comes from a more productive partner (studies 3-5) – effectively, the more productive a partner is, the more their selfishness is tolerated – supports this view even more directly. This approach may help to explain apparent biases in punishment decisions, for example the observations that attractive plaintiffs are more likely to win in small claims court (Zebrowitz & McDonald, 1991) and that convicted murderers are less likely to be sentenced to death if they look trustworthy (Wilson & Rule, 2015, 2016). While these effects may represent serious failings of the justice system, they are sensible as the outputs of psychological mechanisms designed to regulate access to and treatment by potential cooperators on the basis of ancestral cues of partner value. One important area of future research will be better understanding how evolved preferences for cooperative partners influence punishment decisions.

Studies 1-5 showed the ability of biological market theory to predict behavior in economic games, but the theory may be applied to organizational behavior and economic decision-making more broadly. Decisions related to investment, hiring and compensation are likely made by psychological mechanisms designed for an ancestral cooperative marketplace, so this evolutionary history may therefore explain many otherwise-anomalous behaviors. For example, research has shown that people are more likely to invest in hedge funds with managers whose faces appear trustworthy, even though their funds achieve worse returns (Pareek & Zuckerman, 2014), and there is evidence that attractive people earn higher wages (e.g. Hamermesh & Biddle, 1993; see also Eisenbruch, Lukaszewski & Roney, 2017;

Maestripieri, Henry & Nickels, 2017). In addition, people appear to attend to the percentage of a discount (perhaps a cue of caring or dispositional cooperativeness), rather than the absolute amount of money saved (Azar, 2011; Tversky & Kahneman, 1981). While these effects are irrational with respect to resource maximization, they may be sensible as outputs of adaptations designed to pursue cooperative partners with ancestrally-valid cues of productivity and dispositional cooperativeness. One avenue for future research could be developing techniques for overcoming the mismatch between our evolved psychology and the demands of contemporary economic decision-making. For example, there may be situations in which having *less* information (e.g. *not* knowing what a person looks like) leads to more profitable decisions.

Finally, the present finding that people are much more sensitive to a partner's generosity than to their productivity (clearest in studies 3-5) is consistent with past research on partner choice (e.g. Delton & Robertson, 2012; Raihani & Barclay, 2016) and a broad body of social perception research showing that warmth information has primacy over competence information (see Fiske et al, 2007; Wojciske, 2005 for review). The common explanation (e.g. Fiske et al, 2007; Wojciske, Bazinska & Jaworski, 1998) characterizes warmth-related traits (e.g. the intention to help) as benefitting others, while competence-related traits (e.g. the ability to act on one's intentions) are seen as primarily benefitting the self. Therefore, self-interest guides person A to care more about person B's warmth than about their competence, because it is primarily B's warmth and intentions that will affect A's welfare. I am skeptical of this reasoning on two grounds. First, it could be argued that intentions only matter among those with the competence to implement them, so perceptions of competence should be primary instead, and warmth should matter only when competence

is above some threshold. Secondly, the characterization of warmth and competence as being other- and self-beneficial, respectively, overlooks the importance of cooperation in the human ecology. Cooperation allows productive ability to be shared and creates mutual interdependence, so competence may be profoundly "other-beneficial."

Instead of this account, I propose two speculative, non-exclusive possibilities for why generosity has a stronger effect than productivity in the present data (clearest in studies 3-5), and by extension, why warmth matters more than competence in person perception more generally. First, it may be the case that there is more variance between people in their dispositions or intentions towards a specific person (revealed by their generosity) than in their productivity. Intuitively, dispositions can range from all-consuming love to all-consuming hatred, while there is a narrower range of likely levels of productivity (i.e. most adults are somewhat productive, but there is an upper limit on how productive any one person can be). Insofar as preferences are an evolved response to variance (McNamara, Barta, Fromhage & Houston, 2008; McNamara & Leimar, 2010; McNamara, Stevens, Dall & Houston, 2009), the greater variance in intentions among possible social partners – rather than its greater absolute importance – may drive the stronger preference for generosity over productivity. Second, humans cooperate in multiple different domains (e.g. Jaeggi, Hooper, Beheim, Kaplan & Gurven, 2016), meaning that a person's productivity may be local to some particular domain of cooperation (e.g. a good hunter may or may not be good at fighting or taking care of kin). However, how much somebody cares about a person's welfare (cued by their generosity) predicts their treatment across cooperative domains (see Peysakhovich, Nowak & Rand, 2014; Tooby & Cosmides, 1996 for related arguments). Therefore, people may prioritize a partner's generosity over their productivity because it

predicts the flow of benefits across a wider range of situations. These explanations are speculative, but modeling and anthropological data may be used to test their feasibility. Generally, the framework of cooperative partner choice and biological market theory may be useful to the study of social perception and preferences more broadly.

5.5. Conclusion

Studies 1-6 provide convergent evidence of human adaptations for cooperative partner choice in a biological market. Humans appear to have evolved mechanisms for estimating a person's value as a long-term cooperative partner. The observed sex differences and the nature of the cues to which these mechanisms are sensitive (e.g. strength among men, ancestral but not contemporary productivity, skill- rather than luck-based production) suggest that these mechanisms are specialized for long-term relationships in an ancestral environment. In addition, human intuitions regarding the resource divisions to which others are entitled appear calibrated to perceptions of cooperative partner value, as predicted by biological market theory. The present research therefore supports biological market theory, and suggests the importance of cooperative partner choice for explaining human social behavior and cognition.

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Appendix A

All items rated from 1 (far below average) to 7 (far above average)

Attractiveness items

How attractive is this man (woman)?

Study 1 (first batch of target ratings) ICC = .970
Study 1 (second batch of target ratings) ICC = .941
Study 2 ICC = .887

How attractive is this man (woman) as a short-term mate?

Study 1 (first batch of target ratings) ICC = .967
Study 1 (second batch of target ratings) ICC = .935
Study 2 ICC = .880

How attractive is this man (woman) as a long-term mate?

Study 1 (first batch of target ratings) ICC = .967
Study 1 (second batch of target ratings) ICC = .945
Study 2 ICC = .878

Prosociality items

How kind does this person look?

Study 1 (first batch of target ratings) ICC = .947
Study 1 (second batch of target ratings) ICC = .945
Study 2 ICC = .815
Study 6 ICC (female targets) = .908
Study 6 ICC (male targets) = .873

How cooperative does this person look?

Study 1 (first batch of target ratings) ICC = .946
Study 1 (second batch of target ratings) ICC = .940
Study 2 ICC = .834
Study 6 ICC (female targets) = .903
Study 6 ICC (male targets) = .892

How trustworthy does this person look?

Study 1 (first batch of target ratings) ICC = .951
Study 1 (second batch of target ratings) ICC = .923
Study 2 ICC = .774
Study 6 ICC (female targets) = .887
Study 6 ICC (male targets) = .903

Dominance items

How dominant does this person look?

Study 1 (first batch of target ratings) ICC = .977
Study 1 (second batch of target ratings) ICC = .935

How masculine does this person look?

Study 1 (first batch of target ratings) ICC = .982
Study 1 (second batch of target ratings) ICC = .952

How aggressive would this person be if provoked?

Study 1 (first batch of target ratings) ICC = .960

Study 1 (second batch of target ratings) ICC = .922

Health item

How healthy does this person look?

Study 1 (first batch of target ratings) ICC = .981
Study 1 (second batch of target ratings) ICC = .922
Study 2 ICC = .761

Productivity items

If this person were stranded on a desert island, how good do you think he (she) would be at getting food (compared to the average man (woman))?

Study 1 ICC = .679
Study 2 ICC = .728
Study 6 ICC (female targets) = .791
Study 6 ICC (male targets) = .878

Imagine that this person lived 100,000 years ago, when humans had to hunt or gather food and find or build shelter. Compared to the average man (woman), how productive a member of his (her) group would this person have been?

Study 1 ICC = .789
Study 2 ICC = .822
Study 6 ICC (female targets) = .769
Study 6 ICC (male targets) = .886

Imagine that this person went on a long camping trip, where they had to find their own food, make tools, etc. Compared to the average man (woman), how well do you think this person would do on this camping trip?

Study 2 ICC = .712
Study 6 ICC (female targets) = .746
Study 6 ICC (male targets) = .876

Dangerousness items

Imagine that this man (woman) is selling something valuable to him (her). Compared to the average man (woman), how likely would he (she) be to start a fight if he (she) received an offer that he (she) thought was too low?

Study 1 ICC = .644
Study 2 ICC = .732

If this man (woman) was in a fight, how likely do you think he'd (she'd) be to win (compared to the average man (woman))?

Study 1 ICC = .804
Study 2 ICC = .790

Imagine that this man (woman) is selling something valuable to him (her). Compared to the average man (woman), how physically dangerous would he (she) be if he (she) received an offer that he (she) thought was too low?

Study 1 ICC = .591
Study 2 ICC = .732

Desirability as a friend item

How much would you like to be friends with this man (woman)?

Study 1 ICC = .715

Study 6 ICC (female targets) = .956

Study 6 ICC (male targets) = .914

Social status items

How much do you think this person is respected by his (her) peers?

Study 1 ICC = .877

Study 2 ICC = .773

How often do you think this person gets what they want when they disagree with their friends?

Study 1 ICC = .894

Study 2 ICC = .758

How much do you think this person's friends look to them as a leader?

Study 1 ICC = .905

Study 2 ICC = .726

How many friends do you think this person has?

Study 1 ICC = .877

Study 2 ICC = .795

How popular do you think this person is within their peer group?

Study 1 ICC = .902

Study 2 ICC = .887

How easy do you think it would be for this person to find a partner for a cooperative project (e.g. carpooling, a roommate, starting a small business together, etc.)?

Study 1 ICC = .897

Study 2 ICC = .790

If other people were choosing partners for a cooperative project (e.g. carpooling, a roommate, starting a small business together, etc.), how in-demand would this person be?

Study 1 ICC = .899

Study 2 ICC = .774

Estimated Ultimatum Game Behavior

If this man (woman) were the Proposer in the Ultimatum Game with another man (woman), how much do you think he (she) would offer ($0-$10)?

If this man (woman) were the Responder in the Ultimatum Game with another man (woman), how much do you think he (she) would demand ($0-$10)?

High School GPA item

How high was this person's high school GPA, compared to their peers?

Study 6 ICC (female targets) = .876

Study 6 ICC (male targets) = .912

Appendix B

Study 3 framings

In the risk pooling condition, participants read the following introduction to the game: "You are going to play a game called the Osotua game. This game is modeled on the custom of Osotua among the Hadza, a hunter-gatherer population in Tanzania. Osotua refers to a type of relationship in which one partner gives resources to the other whenever they need help. Osotua relationships are considered sacred, and can last over the individual's entire lifetime. Osotua relationships provide a kind of social insurance against hard times, and allow the Hadza to survive in a harsh environment."

In the collaboration condition, participants read the following introduction to the game: "You are going to play a game called the Asatua game. This game is modeled on the custom of Asatua among the Hadza, a hunter-gatherer population in Tanzania. Asatua refers to a type of relationship in which partners work together in order to create resources that neither one would be able to create on their own. For example, two people might hunt large animals together, or work together to make specialized tools or gather difficult-to-reach plants. Asatua relationships increase the overall productivity of individuals, and allow the Hadza to survive in a harsh environment."

Appendix C

Study 5 framings

In the risk pooling condition, participants read the following passage: "The Hadza are a group of hunter-gatherers who live in Tanzania. They have to forage for all of their food (for example, kill animals, find and collect plant foods). There is a lot of luck involved in foraging: on any given day, a person could acquire a lot of food, or none at all. In order to stabilize their food supply, they often form foraging partnerships for a day, called *Osotua* partnerships. The idea is that by sharing their gains, a person who had a lucky day can help out a person who had an unlucky day. The *Osotua* system helps the Hadza survive in a harsh environment. The way it works is that two people agree to form an *Osotua* partnership for the day. Each person goes out and forages on their own, and then both people bring all the food they acquired back to camp."

In the collaboration condition, participants read the following passage: "The Hadza are a group of hunter-gatherers who live in Tanzania. They have to forage for all of their food (for example, kill animals, find and collect plant foods). There is only so much that one person can forage on their own, so in order to increase their productivity they often form foraging partnerships for a day, called *Asatua* partnerships. The idea is that by working together, two people can hunt larger animals, reach better fruits, etc. than either person would be able to on their own. The *Asatua* system helps the Hadza survive in a harsh environment. The way it works is that two people agree to form an *Asatua* partnership for the day. They leave camp and work together on things like hunting animals, gathering fruits, digging up tubers, and other forms of foraging."