Partner choice in human evolution: The role of cooperation, foraging ability, and culture in
Hadza campmate preferences

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Abstract

The ability to choose the partners we interact with is thought to have been an important driver in the evolution of human social behavior, and in particular, our propensity to cooperate. Studies showing that humans prefer to interact with cooperative others is often cited as support for partner choice driving the evolution of cooperation. However, these studies are largely drawn from Western samples, where conditions for partner choice to operate may be especially favorable. Here, we investigate qualities associated with being a preferred partner (i.e., campmate) in Hadza hunter-gatherers of Tanzania in 2016 and 2019. A total of 156 Hadza participants from 17 camps ranked their campmates on generosity, foraging ability, and their preference for them as future campmates. In 2016, Hadza preferred more generous people and better hunters as campmates, with evidence suggesting a stronger preference for better hunters; however, the relationship between generosity and being a preferred campmate was greater in 2019 than in 2016, such that the preference for generous people was stronger than the preference for better foragers, suggesting that campmate preferences are changing. These new findings contrast with reports on data from nearly a decade ago, suggesting that the Hadza do not prefer more cooperative campmates. Further, in 2019, there was anecdotal evidence that Hadza with greater exposure to outside cultural institutions (e.g., schooling, having a job, or living in a village) had a stronger preference for generous campmates than those with less exposure. Taken together, the results suggest that preferences for social partners may, in part, be culturally shaped.

Keywords: hunter-gatherers, social selection, partner choice, character, reputation, cooperation

1. Introduction

Group living affords many benefits to animals (van Schaik, 1983). It offers protection from predators, access to mates, opportunities for collaborative foraging, and the potential exchange of resources, among other benefits. However, social living also introduces competition for valuable partners (i.e., individuals who provide the most benefits) (Crook, 1972; West-Eberhard, 1979, 1983). Valuable partners become a resource to compete over when the most valuable individuals can choose their partners, and when they too want the most valuable partners (Noë & Hammerstein, 1994). This competitive market is commonly observed in the context of mate choice, where the most prized males and females will pair (Buston & Emlen, 2003), often resulting in the sexual selection of traits that provide an advantage over same-sex competitors. However, sexual selection is a form of social selection: animals can compete for access to valuable partners in a number of domains, leading to the evolution of diverse costly morphological and behavioral traits (Lyon & Montgomerie, 2012; West-Eberhard, 1983).

Social selection may have been important in human evolution, and in particular, the evolution of cooperation (Barclay, 2016b; Baumard et al., 2013; Tooby & Cosmides, 1996). While mutual cooperation benefits both partners, cooperation risks costly exploitation. However, theoretical and experimental work suggests that when people have the option to leave exploitative partners for cooperative ones, cooperation can be a stable strategy (Aktipis, 2011; Rand et al., 2011). Moreover, biological markets may generate increased levels of cooperation as individuals compete for access to highly cooperative partners (Barclay, 2016a; Noë & Hammerstein, 1994). And, over time, selection for cooperation can evolve as individuals reap the fitness benefits of being in highly cooperative partnerships. Empirical support for partner choice models for the evolution of cooperation include studies showing that humans track the

cooperative reputations of others and are motivated to interact with those who are most cooperative (Barclay, 2016b).

There is considerable evidence that people prefer to interact with people who are generous and cooperative. In the US, when considering the ideal partner for a variety of relationships, students and online workers identify cooperative traits, such as trustworthiness and fairness, as being most important (Cottrell et al., 2007; Goodwin et al., 2014; Landy et al., 2016). In economic games, US and UK students preferentially choose to interact with and give more money to partners who were cooperative in a previous game (Barclay & Willer, 2007; Sylwester & Roberts, 2010). Among Dominican horticulturalists and Quechuan agro-pastoralists, those with cooperative reputations have more social ties (Lyle & Smith, 2014; Macfarlan et al., 2012, 2013). And when the Martu foragers of Australia select hunting partners, they prefer to hunt with people who share more food, regardless of their actual hunting ability (Bliege Bird et al., 2012; Bliege Bird & Power, 2015).

There is also evidence that the psychology underlying decisions of when to cooperate are shaped by partner choice concerns. For example, models suggest that being biased toward always cooperating, even in possible one-shot interactions, could be advantageous to being selected as a social partner in repeat interactions (Delton et al., 2011; Hoffman et al., 2015). The advantage of always erring on being seen as a cooperator may explain why adults in Western populations are cooperative even in anonymous games (Hagen & Hammerstein, 2006). When anonymity in games is removed, US and UK students behave even more cooperatively, especially if they can be chosen as interactants in future games, indicating people adjust their cooperation competitively to be chosen as social partners (Barclay & Willer, 2007; Sylwester & Roberts, 2010). Similarly, US adults cooperate more in economic games when people gossip

about others' behavior, and when defectors are ostracized from the group, they give as much as cooperators to repair their damaged reputations (Feinberg et al., 2014). On the other hand, people cooperate less when reputation is not at stake. For example, US students choose to “opt out” of economic games, paying a small cost to keep most of their endowment but not telling their partner there was even a game to play (Dana et al., 2006). And a meta-analysis suggests that people are more likely to perform an immoral act if they improved their reputation through a moral act (i.e., moral licensing) (Blanken et al., 2015), as if people are willing to be exploitative if they can afford a penalty to their reputation (Barclay, 2016b). Taken together, these studies are consistent with the hypothesis that humans have evolved a partner choice psychology adapted to finding and obtaining the most cooperative social partners.

Research examining partner preferences has largely been conducted in laboratory settings with samples drawn from Western, Educated, Industrialized, Rich, and Democratic—or WEIRD—populations (Henrich, Heine, et al., 2010). This restricted focus may lead to a deficient, or even erroneous, understanding of how human cooperation evolved. Indeed, most people in the world are not WEIRD. Moreover, the evolution of human cooperation is argued to be best understood within the context of hunter-gatherer life, characterized by small, mobile, residential groups and group-wide food sharing (Apicella & Silk, 2019). Yet, the lives of individuals from WEIRD populations contrast markedly to the lives of hunter-gatherers. Lessons from the recent expansion of psychology research into non-WEIRD populations suggests that human psychology and behavior varies considerably across populations (Henrich, Heine, et al., 2010). This also includes cooperative behavior. For example, the amount of giving and punishment in economic games vary within and between populations (Henrich et al., 2001, 2005, 2006). And, some of this variation is explained by cultural institutions and norms such as market

integration and adherence to religious beliefs (Boesch & Berger, 2019; Henrich, Ensminger, et al., 2010; Purzycki et al., 2016, 2018; Rustagi et al., 2010). Thus, it is possible that our partner choice psychology is also shaped by culture.

Social relationships – who people interact and cooperate with – are influenced by cultural institutions and norms that regulate processes such as group identity, alliance formation, residence patterns, and marriages. In many populations, social networks are primarily organized around kinship and this has been the pattern for the majority of human history (Henrich & Muthukrishna, 2020; McNamara & Henrich, 2017). However, a feature characteristic of WEIRD societies is greater relational freedom, whereby individuals are able to freely choose their own friends, spouses, neighbors, and so on. One explanation for this greater relational freedom is that voluntary associations outside of extended kin became more prevalent in the West with the rise of the Roman Catholic Church, which promulgated rules and policies that dissolved intensive kinship, including prohibiting cousin marriage and impelling neolocal residence (Schulz et al., 2019). Markets, too, may promote voluntary relationships at the expense of kin relations. For example, people from countries with more urbanization and market integration have less contact with kin (Höllinger & Haller, 1990) and in rural Poland, greater market integration is associated with less kin-dense social networks (Colleran, 2020). Importantly, reduced kinship intensity has been associated with a sundry of psychologically “WEIRD” phenomena, including increased individualism, greater dispositional thinking and increased trust, fairness, and cooperation with strangers (Henrich, 2020; Schulz et al., 2019). Thus, current descriptions of our partner choice psychology may also be peculiar to WEIRD populations. Indeed, both relational freedom and market integration could affect how discriminating individuals are on their choice of partners, as well as the importance they place on certain traits like cooperativeness and trust.

Some cultural institutions and practices may also create conditions that are unusually favorable to partner choice. For example, an important assumption of partner choice models is that there should be enough variation on a desired trait to adequately discriminate between partners and make informed decisions (Barclay, 2013, 2016a; Noë & Hammerstein, 1994). Yet, insights in cross-cultural psychology suggest that trait expression may depend on details particular to locality. For instance, personality dimensions, which have been thought to be innate and universal, may instead arise from the availability of economic opportunities in a population (Gurven, 2018; Smaldino et al., 2019). Specifically, industrialization, market expansion, and urbanization increase the number and type of occupational niches available to people, providing individuals a multitude of ways to succeed. Greater niche diversity, in turn, allows individuals the ability to differentiate their social and occupational roles and more freely express whatever psychological tendencies they may have. Indeed, more personality dimensions and variation on those dimensions are observed in countries with more occupational niches (Gurven et al., 2013; Lukaszewski et al., 2017). Notably, small-scale societies with subsistence economies have much fewer opportunities for specialization. For instance, aside from the sexual division of labor, the Hadza do not have no role specialization, can perform all tasks, and are largely self-reliant (Marlowe, 2010). While it is not currently known whether the expression of other traits, such as cooperativeness, are similarly affected by niche diversity, there is some evidence to suggest that cooperativeness is correlated with personality (McAuliffe et al., 2018; Thalmayer et al., 2019). Thus, it is possible that niche diversity generates the necessary variation on which to select cooperative partners. In this way, conditions in small-scale societies may be less favorable to partner choice relative to WEIRD societies, where partner choice studies have been predominantly conducted.

Moreover, other features common to the lives of hunter-gatherers may point to additional obstacles for partner choice. For example, strong norms of egalitarianism, camp-wide food sharing, and communal cooperation found in most extant hunter-gatherers (Apicella & Crittenden, 2016; Gurven, 2004; Marlowe, 2005) may further reduce variation in cooperativeness. These features of hunter-gatherers may further diminish the importance of choosing a generous social partner, especially relative to other obvious fitness-consequential traits, such as choosing partners who are good at procuring foods (Apicella et al., 2012; Smith et al., 2018). Likewise, living in small groups - another feature of hunter-gatherer life (Marlowe, 2005) - may also reduce variation in cooperation, because small groups allow for more effective monitoring and enforcement of cooperation (Agrawal & Goyal, 2001; J. P. Carpenter, 2007). Finally, contemporary hunter-gatherers are also highly mobile with large, dispersed social networks (Bird et al., 2019; Hill et al., 2014). While high mobility may provide additional opportunities for cooperators to form ties with other cooperators and sever ties with defectors, defectors can also more easily evade the costs of a bad reputation, continuously exploiting new social partners and thus undermining cooperation (Dugatkin & Wilson, 1991). To the extent that these lifeways also typify humans further back in time, they may undermine the role of partner choice as a mechanism for shaping the evolution of human cooperation. For this reason, research with populations whose socioecological environments more closely resemble our hunter-gatherer ancestors can help to provide insight into our evolved psychology as well as the forces that shaped our cooperative behavior.

Here we turn to research with Hadza, hunter-gatherers of Tanzania, whose way of life more closely approximates life before the advent of agriculture (Marlowe, 2005). A social network analysis of the Hadza on data collected in 2010 finds no evidence that individuals prefer

to live with, or give gifts to, the most cooperative individuals, as measured by a single one-shot public goods game (Apicella et al., 2012). In fact, there was a slight negative relationship between a person's cooperativeness and the number of items gifted to them by others. We expand on this research by examining the role of cooperative character in partner choice among Hadza participants. Instead of relying on anonymous, economic games to measure cooperation, we ask participants to rank their current campmates by who is the most generous and best at hunting or gathering, as well as who they would most like to live with. We then compare their preference for more generous campmates to their preference for better foragers, which could potentially be a more important criterion for choosing social partners in their environment. Because the Hadza are becoming less isolated and more integrated in village life, we also explore how varying levels of exposure to non-Hadza cultural institutions might moderate campmate preferences.

2. Method

2.1. Population

The Hadza are a group of nomadic hunter-gatherers living along the Central Rift Valley in northern Tanzania. There are approximately 1000 people who identify as Hadza, but much fewer Hadza still maintain a hunter-gatherer lifestyle (Marlowe, 2010). While Hadza are becoming more reliant on domesticated foods (Pollom, Cross, et al., 2020; Pollom, Herlosky, et al., 2020), our research focuses on the subset of Hadza still predominantly subsisting by hunting and gathering. However, even among Hadza who are characterized as full-time foragers, there is increasing access to cultivated food – a dietary shift associated with changes in health (Crittenden et al., 2017; Pollom, Cross, et al., 2020) and foraging behavior (Pollom, Herlosky, et

al., 2020). Also, the number of aid workers, missionaries, and ethnotourists visiting Hadza continue to rise each year (Apicella, 2018; Apicella et al., 2014; Marlowe, 2010; Pollom, Cross, et al., 2020; Pollom, Herlosky, et al., 2020). Strikingly, the data we present here suggest that this is a population in transition (see Table 1). About 40% of Hadza report having lived outside of Hadzaland, 25% have said they held a job that pays money, and nearly 60% claim to have heard of the former United States President, Barack Obama.

Hadza life is marked by a sexual division of labor where men spend time hunting and collecting honey and women spend time gathering plant resources such as berries and tubers. Food, and in particular meat and items requiring extended processing (e.g., tubers), is widely shared among camp members (Marlowe, 2010), though producers may be able to direct some of the food to their kin (Wood & Marlowe, 2013). The Hadza have no formal status hierarchies, and Hadza are largely autonomous and able to make their own decisions.

The Hadza live in temporary camps of about 30 adults and children, typically consisting of a few unrelated nuclear families. Like most other hunter-gatherers, average relatedness within camps is low and Hadza live with only a few primary kin and have a multilocal resident pattern (Hill et al., 2011). Living arrangements are fluid. Entire camps shift locations every four to eight weeks in response to local resource availability. Membership within camps also change regularly, with individuals or families freely relocating to other camps (Hill et al., 2014). In a longitudinal census across years, people on average were only living with about one in five of their campmates from previous years (Smith et al., 2018). This fluid social structure means the Hadza are regularly choosing new campmates to live with and can freely leave campmates they no longer want to live with.

The Hadza have high rates of morbidity and mortality, and approximately 40% of children born will die before reaching the age of five (Blurton-Jones, 2016). Fresh water is scarce and hunger is a concern. Over 80% of Hadza report being concerned with having enough food to eat (Apicella, 2018). Hadza life is built on high levels of cooperation – food, protection, and childcare is shared between campmates (Apicella & Crittenden, 2016; Crittenden & Marlowe, 2008).

The Hadza do not have formal sanctioning mechanisms for norm violations. Historically, the Hadza have had little to no interaction with authoritarian government institutions such as a police force, court system, or prisons. Though Hadza do have beliefs in gods, they generally do not ascribe to them moralistic concerns or the ability to detect and punish transgressions (Apicella, 2018; Purzycki et al., 2016), though there is evidence this is changing. And in economic games, the Hadza have low rates of second- and third-party punishment (Henrich et al., 2006). These conditions—relying on campmates to cooperate, frequent movement and changing of campmates, and little threat of institutional punishment—make the Hadza an ideal population to study the role of cooperative reputation in partner choice.

2.2. Sample

We collected data in 2016 and 2019. In 2016, we visited 11 camps¹ during the dry-season in August-September using a snowball sampling procedure; after visiting one camp, members of that camp would direct us toward the nearest camp. We collected data until we could not identify any more camps. Distance between camps varied, but camps were at least distant enough that we

¹ We visited two additional camps. One camp had 36 adults and the task of ranking all campmates was arduous. We had participants rank the top twelve campmates instead. However, we decided to not include these data because of continued difficulty with the task. Data for this camp were never entered or analyzed. The other camp had only three people and reviewers raised concern that this camp may not be informative. Including this camp does not change any results.

could identify a discrete camp (i.e., at least a 30-minute walk away).² The number of adults in each camp ranged from five to twelve. We had 94 subjects ranked by their campmates and 91 judges completed the ranking task. We removed two subjects with missing demographic information, and we removed two judges because they refused to rank their campmates on honesty, insisting everyone lies. Another judge refused to rank more than two campmates on preferred future campmates. Our final sample for 2016 had 92 subjects ranked by 88 judges for $n = 683$ observations. In 2019, we visited 11 camps during the end of the dry season in September-October. Due to time constraints only 6 camps completed the ranking task. The number of adults in each camp ranged from eleven to twenty. We had 91 subjects ranked by their campmates and 87 judges completed the ranking task. We removed a judge because he refused to rank their campmates on hard work, saying that no one in the camp worked to bring food for others. We removed another judge who had been living in a local village until recently and told us he was not familiar with any of his campmates, though judges who ranked him said they were familiar with him. We removed one subject who was ranked seven times before discovering he had an intellectual disability. Our final sample for 2019 had 91 subjects ranked by 85 judges for $n = 673$ observations. There were 20 subjects and 17 judges that participated in both years. Our final sample had 163 subjects and 156 judges (76 women, 110 married, mean estimated age 36.9 years-old) for $N = 1,366$ observations.

2.3. Procedures

2.3.1. Ranking task

Upon entering a camp, headshots were taken of each participating adult approximately 2 meters away, using a Fujifilm Instax Mini 90 Classic Instant Film Camera which printed $1.8 \times$

² More precise information about the location of each camp is not available. In 2016 the first author left the GPS device at a lodge and in 2019 GPS devices were confiscated at some point during air travel.

2.4- inch images. In separate interviews, a research assistant would shuffle the photographs of a judge's campmates and randomly array the photographs in front of the judge. The interviewer then asked, "Who is the most generous?" After the judge chose a person in the array, the interviewer removed the person who was selected, collected all the photographs, shuffled them, and laid them out again in front of the judge before repeating the question. This was repeated until all campmates were ranked. Judges also ranked themselves among their campmates on all dimensions except preferred campmate; however, because our research questions are about preferred campmates, we removed self-rankings and entered rankings as if the judges did not rank themselves. In 2019, to control for differences in camp sizes and to keep the task from being too onerous, we randomly assigned each judge to rank 8 of their campmates on all the traits instead of ranking their entire camp. All interviews were conducted in Swahili by a Tanzanian research assistant and overseen by the first author. The Hadza have previous experience in ranking their campmates (Apicella, 2014; Smith et al., 2017; Stibbard-Hawkes et al., 2018).

We asked all participants to rank their campmates on five traits, in the same order. These were generosity ("Who is the most generous? For instance, they will share their food even if they are very hungry."), effort ("Who works the hardest to get food? They don't have to be good at hunting [gathering] but they have to try very hard."), honesty, ("Who is the most honest? Who tells the fewest lies?"), foraging ability, ("Who is the best hunter/gatherer?"), and who they prefer to live with ("Who would you most like to live with if you were to move camp tomorrow?"). We chose to ask about generosity, effort, and honesty because previous interviews suggest these to be important character traits to the Hadza (Purzycki et al., 2018). These are all behaviors in which a person chooses to pay a cost, such as food or time, that delivers a benefit to

others. In 2016, only men were ranked on foraging ability, specifically hunting ability. In 2019, men were ranked on hunting ability and women on foraging ability. We use these latter rankings as a measure of a person's ability to produce benefits that the person may (or may not) share with others. We chose to ask about campmate preference as a measure of partner choice because most Hadza cooperation happens at the camp level, so deciding who to live with is deciding who to cooperate with. We focus here on the relationships between generosity or foraging and campmate preference; in the ESM we present analyses using effort or honesty rankings to show that our results are qualitatively similar when using other measures of cooperative character, though as noted throughout, results of moderation are notably weaker for effort compared to generosity and honesty.

2.3.2. Cultural exposure survey

In 2019, we interviewed each participant to measure their exposure to non-Hadza cultural institutions. During the interview, participants were asked how many years of formal schooling they had, whether they have ever been employed, and lived outside Hadzaland. We also asked several general knowledge questions to measure outside cultural exposure, such as who is the current president of Tanzania? The full set of questions and responses can be found in Table 1.

Table 1. Descriptive Statistics of the Cultural Exposure Survey

Question	Value
Have you attended school ?	0.37
Median number of years of school completed	5
Have you worked a job for money?	0.25
Can you count past zero in Swahili?	0.79
Median highest number can count to	20
What is the capital city of Tanzania?	0.09
Who is the Tanzanian president ?	0.51
Who is the US president?	0.03
Have you heard of Barack Obama ?	0.58
Have you heard of Nelson Mandela ?	0.36
Have you heard of Mahatma Ghandi ?	0.19
Have you visited Arusha ?	0.41
Have you lived outside of Hadzaland ?	0.37

Note. Values are proportion answering yes or correctly, except where noted. Words used to represent the questions in further analyses are bolded. For count, participants were stopped at 20 as the maximum value.

2.3.3. *Demographics and relationship*

We collected demographic information in separate interviews. Previous census data was used to infer age, and when unavailable, it was estimated based on appearance, using relative ages of known campmates to increase precision. Still, age estimates and its effects may be noisy. After the rankings, we asked the participants to explain their relationship with each campmate.

We recorded spousal relationships and classified a pair as kin if both participants named each other as primary genetic kin (siblings or parent-child). We restricted our category to primary kin because of difficulties in verifying more distant relationships. In the analyses, we analyzed kin and spouse together as “close relationships”, to simplify the model and add fewer parameters.

2.4. Data analysis and software

We analyzed the data using multilevel Bayesian regression models. Bayesian analyses produce posterior distributions for parameters describing the likelihood that a particular value of the parameter would generate the observed data, conditional on the prior probability and assumptions within the model (Kruschke & Liddell, 2018b; McElreath, 2016). Our goal in the study was to estimate the relationship between rankings on the various traits and describe the uncertainty around those estimates; Bayesian analyses provide a framework for quantifying these values in the posterior distributions (Kruschke & Liddell, 2018a). As such, we emphasize describing the posterior distributions rather than explicit hypothesis testing.

We combine this approach with model selection and averaging. Fitting multiple models risks overfitting and finding spurious relationships that may not generalize; further, multiple competing models may fit nearly equally well, and there may be no principled way to choose between competing models. Bayesian model averaging allows us to incorporate the uncertainty between which model fits better into the uncertainty of our estimates (Draper, 1995), and such model averages produce better estimates than any single model, which often have too narrow of estimation ranges (Hoeting et al., 1999). We use this approach to compare the fit of models with and without the parameter of interest and then weight each model’s estimates based on their relative fit. Specifically, we sample estimates from the posterior of each model, using their relative fits as measured by the Akaike weight to determine what proportion of the average-

weighted posterior comes from each model. When a model does not include a variable (e.g., when sampling the interaction between generosity and year from the model without that interaction), a zero is sampled instead. This shrinks the mean estimates from the posterior of that effect; this shrinking accounts for uncertainty arising from the models' fit statistics and corrects for overestimation. This is a conservative procedure and only produces estimates as large or smaller than from any single model (McElreath, 2016). This procedure is mathematically equivalent to spike-and-slab priors, which are widely used in Bayesian hypothesis testing and estimation, and function to put extra prior weight on there being no effect (Kiers & Tendeiro, 2019; Rouder et al., 2018; van den Bergh et al., 2019); in essence, we require extra evidence that our parameters of interest relate to Hadza campmates preferences. To help readers understand this method has on estimates, we include estimates from each separate model in regression tables in the supplementary information (SI). Throughout we report the ratio of the model weights to describe the relative probability of the models (Wagenmakers & Farrell, 2004) and provide discrete labels for the strength of the evidence (e.g., anecdotal, moderate, or strong) based on guidelines provided for Bayes Factors (Vandekerckhove et al., 2015). These categorical descriptions are provided as heuristics though, and the strength of the evidence should be interpreted continuously.

Ranking data present special challenges in analysis. Ranks may not have equal scaling between values, and responses are dependent on other responses. The data are further complicated by the fact that participants are ranking different sets and different-sized sets. Approaches for ordinal data, such as ordered logistic regressions, do not handle these assumptions, and other approaches for ranked data do not handle the additional challenges our data present. We decided to analyze the data with a Gaussian regression (i.e., as a normal

distribution). This did not produce predicted values outside of the possible ranges and produced qualitatively similar results when analyzed with an ordered logistic regression and the Gaussian regression are more easily interpreted and familiar to readers; however, we recognize the limit to statistical validity with the current approach.

In all analyses, we use multilevel models to better pool information across clusters, such as camps, subjects, and judges, and to address imbalances in sample sizes across clusters (McElreath, 2016). We used weakly regularizing priors; these are priors that are centered at zero and function to avoid overfitting and improve computation (McElreath, 2016). For coefficients, the priors were a normal distribution with $\mu = 0$, $\sigma = 1.5$ and the priors for the standard deviations in varying effects were half-Cauchy distributions with $\mu = 0$, $\sigma = 1.5$. However, because we use Bayesian model averaging over models with and without parameters, these regularizing priors essentially have extra weight at zero. Increasing or decreasing the sigma values for priors had minimal effect on the estimates. Formal notation of the full models in each section are presented in the SI.

We conducted the analyses in R (R, 2017) using the ‘brms’ (Bürkner, 2017) package for estimation, the ‘tidybayes’ (Kay, 2018) package for summaries of posterior distributions, and the ‘tidyverse’ (Wickham, 2017) package for data wrangling and visualization. The ‘brms’ package uses the programming language Stan (B. Carpenter et al., 2017) to implement Monte Carlo Markov Chains to sample estimates from the posterior distribution. For Stan parameters, all models used two chains of 10,000 iterations, and 5,000 of those iterations were warmup, with a step parameter of $\delta = 0.99$. None of the models had divergent transitions, and all models for every parameter had $N_{Effective}/N > 0.10$ samples and $\hat{R} = 1.00$.

3. Results

Before inferential analyses, we examined zero-order correlations between the rankings. We computed correlations between each variable at the individual observation level, ignoring clustering within camps, judges, and subjects. All rankings were standardized within the set of campmates a judge ranked. Table S1 in the SI presents the correlations. All variables were moderately correlated with each other at about the same range of values, $r_s = 0.27 - 0.37$.

3.1. Do Hadza prefer campmates ranked higher on generosity?

We first examined whether Hadza prefer to live with people they rank higher on generosity. In the full model, we regressed the campmate preference ranking standardized within each judge's set of people they rank, on demographics of the judge, the judge's ranking of the subject on generosity standardized within each judge's set, and the interaction between the generosity ranking and year. In this model, we included random intercepts for subject, and random slopes for the generosity ranking coefficient for subject, judge, and camp. Note the model did not include a population intercept or random intercepts for judge and camp because these were set to zero in the data by standardizing the rankings. For demographics, we included terms for subject's sex, estimated age standardized within each year, and marital status, as well as whether the subject and judge were the same-sex, similar in age (the interaction between judge's and subject's ages), and close relationship. We include controls of same sex and similar age because previous research found Hadza prefer people who are similar to them as campmates (Apicella et al., 2012). We also fit two simpler models, a model excluding the interaction between year and generosity ranking and a model with demographics only. We compare the fit of the three models.

To assess fit, we computed out-of-sample predictive fit using leave-one-out (LOO) cross-validation to the LOO information criterion (Vehtari et al., 2018), in which a lower value indicates lower deviance between predictions and observations and a better fitting model. Table S2 presents the estimated LOO_{IC} and its sampling error, the estimated penalty for effective number of parameters (p) and its sampling error, and the Akaike weight. The Akaike weight is the estimated probability that a model would best predict a new sample of data within the given set of models (McElreath, 2016). The best fitting model was the full model including the interaction between year and generosity ranking, which had 69% of the weight; the model containing the interaction was 2.2 times as likely to fit a new set of data than the model without an interaction, providing anecdotal evidence that the interaction term improved the fit of the model. We constructed an average-weighted posterior to examine the coefficient estimates, sampling zero for any parameter that is not in the model being sampled from. Estimates from each individual model is in Table S3.

Table 2 presents the model estimates for the demographic effects, the generosity effect, and the interaction between generosity and year from the weighted-average posterior. There was strong evidence that participants preferred to live with women, older people, people of similar age and sex, and their spouses or kin (close relationships). There was also strong evidence that people preferred to live with people they ranked higher on generosity, with anecdotal evidence this relationship was weaker in 2016, $\beta = 0.19$ [95% HPDI: 0.06, 0.32], than in 2019, $\beta = 0.32$ [95% HPDI: 0.17, 0.47].³ Similar results are obtained when regressing preferred campmate ranking on honesty, with anecdotal evidence of a weaker relationship between honesty and

³ When presenting slopes for different years or comparing coefficients, we first compute the value throughout the posterior and then compute the mean and 95% HDI values; these values may differ from simply adding or subtracting the computed mean values of the effects.

preferred campmate ranking in 2016, $\beta = 0.22$ [95% HPDI: 0.10, 0.34] than in 2019, $\beta = 0.32$ [95% HPDI: 0.19, 0.46]; however, there was anecdotal evidence against a difference between 2016 and 2019 in the relationship between effort and preferred campmate ranking (see Tables S4 – S9). Figure 1 presents the probability distributions for each coefficient from the weighted-average posterior (see Figures S1 and S2 for corresponding plot with effort and honesty).

Table 2. Model Estimates Regressing Campmate Preference on Generosity Ranking from Weighted-average Posterior

Effect	β	95% HPDI	% $</> 0$
Subject sex (male = 1)	-0.12	-0.23, -0.01	98.6%
Subject standardized age	0.07	0.01, 0.13	99.0%
Subject marital status (married = 1)	0.01	-0.09, 0.10	57.9%
Judge and subject are same sex	0.10	0.01, 0.19	99.1%
Judge standardized age $\times$ Subject standardized age	0.04	0.00, 0.09	97.9%
Judge and subject relationship (kin or spouse = 1)	0.20	0.07, 0.34	99.8%
Generous	0.19	0.06, 0.32	99.7%
Generous $\times$ 2019	0.13	0.00, 0.32	68.1%

Note. The standardized coefficient estimate is the mean of the posterior distribution. The 95% highest posterior density interval (HPDI) is the narrowest interval containing 95% of the posterior, or the 95% most plausible coefficient estimates. The last column is the percent of the posterior greater than (or less than in the case of subject sex) zero.

Figure 1. Posterior distributions of the standardized effect size for each coefficient from the weighted-average posterior regressing preferred campmate ranking on generosity by year. The interaction between generosity and year is bimodal because we averaged over models that do include that term. Estimates from individual models with that term were unimodal.

3.2. Do Hadza prefer productive or generous campmates?

We next examined whether rankings on campmate preference were more associated with rankings on foraging ability or rankings on generosity. For these analyses, in 2016, only men were ranked on foraging ability and so female subjects from 2016 were excluded from the

analyses, resulting in $n = 1,013$ observations. We fit eight models regressing campmate preference ranking on some combination of foraging ability and generosity ranking and their interactions with year. The first model included only the demographic variables, the second model included only generosity, the third model included only foraging ability, the fourth model included foraging ability and an interaction with subject sex, the fifth model included both generosity and foraging ability, the sixth model included an interaction term for generosity and year, the seventh model included an interaction term for foraging ability and year, and the eighth model included the interaction term for both rankings. The random effects in this model were the same as the ones used in the previous section. Again, rankings for generosity, foraging, and campmate were standardized within each judge's ranking set.

Table S10 presents the model fit statistics for the eight models. Note the model including an interaction term between foraging and subject sex had none of the Akaike weight, suggesting foraging ability was equally important when evaluating men and women as potential campmates. The best fitting model was the model containing an interaction term only for generosity and year, which accounted for 52% of the Akaike weight; when combined with the full model also containing the interaction between generosity and year, models including the interaction accounted for 72% of the Akaike weight and were 2.6 times as likely to better fit new data than models not containing the interaction, providing anecdotal evidence that the interaction term improved the fit of the model. The model containing the interaction term between foraging ability and year and the full model accounted for 34% of the Akaike weight; models containing the interaction between foraging ability and year were 0.5 times as likely to better fit new data than models not containing the interaction, providing anecdotal evidence that the interaction term did not improve the fit of the model. Because the Akaike weight was distributed between

multiple models, we again computed a weighted-average posterior, sampling zero for a parameter that is not included in a model being sample from. Table S11 presents the estimates for each separate model with Akaike weight > 0.05 .

Table 3 presents the model estimates from the weighted-average posterior. In these models with women subjects from 2016 excluded, there was strong evidence that Hadza preferred to live with women, married people, people of the same sex, people of similar age, and close relations. There was strong evidence that higher rankings on generosity and foraging ability was associated with higher rankings on preferred campmate. Comparing the two coefficients directly, there was moderate evidence for a greater relationship between preferred campmate for foraging ability than generosity in 2016, $\Delta \beta_{2016} = 0.10$, 95% HPDI: $[-0.11, 0.29]$, $\Delta \beta_{2016} > 0$: 82.5% of the posterior, but in 2019, there was anecdotal evidence for a weaker preference for foraging ability compared to generosity, $\Delta \beta_{2019} = -0.06$, 95% HPDI: $[-0.25, 0.12]$, $\Delta \beta_{2019} < 0$: 74.6% of the posterior. There was moderate evidence that the difference between foraging and generosity was smaller in 2019 than 2016, $\Delta \beta_{2019} - \Delta \beta_{2016} = -0.16$, 95% HPDI: $[-0.41, 0.06]$, $\Delta \beta_{2019} - \Delta \beta_{2016} < 0$: 80.4% of the posterior. Figure 2 presents the probability distributions for each coefficient from the weighted-average posterior.

Table 3. Model Estimates Regressing Campmate Preference on Generosity and Foraging Rankings from Weighted-average Posterior

Effect	β	95% HPDI	% $</> 0$
Subject sex (male = 1)	-0.19	-0.29, -0.09	100%
Subject standardized age	0.01	-0.05, 0.06	60.2%
Subject marital status (married = 1)	0.07	-0.03, 0.17	92.6%
Judge and subject are same sex	0.13	0.04, 0.22	99.7%
Judge standardized age $\times$ Subject standardized age	0.05	0.00, 0.10	97.8%
Judge and subject relationship (kin or spouse = 1)	0.19	0.03, 0.34	99.1%
Generosity	0.12	-0.04, 0.27	93.3%
Generosity $\times$ 2019	0.14	0.00, 0.35	70.8%
Foraging ability	0.22	0.12, 0.33	100%
Foraging ability $\times$ 2019	-0.02	-0.18, 0.06	25.0%

Note. The standardized coefficient estimate is the mean of the posterior distribution. The 95% highest posterior density interval (HPDI) is the narrowest interval containing 95% of the posterior, or the 95% most plausible coefficient estimates. The last column is the percent of the posterior greater than (or less than in the cases of subject sex and Foraging ability $\times$ 2019) zero.

Figure 2. Posterior distributions of the standardized effect size for each coefficient from the weighted-average posterior regressing preferred campmate ranking on generosity and foraging ability by year. The interaction between generosity and year is bimodal because we averaged over models that do include that term. Estimates from individual models with that term were unimodal.

3.3. Does exposure to other cultures moderate the relationships between trait and preferred campmate rankings?

We next examined whether, within the 2019 sample, Hadza with more exposure to outside cultural institutions, as measured by our survey, show a stronger preference for generous people as campmates. For the exposure survey, $N = 137$ adults in $k = 11$ camps completed the survey.

3.3.1. Exposure to other cultures

Table 1 presents the descriptive statistics for each of the questions asked on the survey. There was some variation on most of the questions, except for the question about who the current US president is, which only 3% of participants answered correctly. Because of this low response rate, and arguably its irrelevance to the surrounding cultures, we dropped this question from further analyses. We log-transformed and z-scored the number of years at school and coded “count” as -1 if they could not count to 10, 0 if they could count to 10, and 1 if they could count to twenty in Swahili (other coding schemes produce qualitatively similar results). All other questions were coded as 0 if no and 1 if yes. Table S12 presents the correlations between each item; no items were negatively correlated, most items were moderately correlated, and the largest correlation was between having worked a job and visited Arusha.

We then conducted an exploratory factor analysis to determine whether the cultural exposure items are measuring a single process of exposure. Figure S3 presents a scree plot displaying the eigenvalues for each number of factors; at more than two factors, the eigenvalue fell below one, suggesting no information was gained with three or more factors. We conducted a factor analysis with varimax rotation specifying two factors. Table S13 presents the factor loadings for each item on each onto each factor. Most of the items, except for items about

international figures, loaded on to Factor 1 more than Factor 2, with the highest loading items being whether the participant has visited Arusha or worked a job. We constructed a cultural exposure score by sum-weighting all the items using their factor loadings for Factor 1 and *z*-scoring the resulting values.

We next examined the distribution of the exposure scores across camps and its relationship with demographic variables. Figure 3 presents the exposure score by each camp, with color indicating the region for each camp. In previous research (Apicella et al., 2014; Smith et al., 2018), Hadza camps located near markets in the Mangola region were categorized as high exposure. However, measuring individual level variation shows that there is variation within each region and within each camp.⁴ This means that exposure in the camps visited in 2019 is not necessarily confounded with location and ecology. Individual exposure was not related to age, $r = 0.03$, $n = 137$, but did differ between men and women; exposure scores were much higher in men ($M = 0.40$, $SD = 0.94$) than women ($M = -0.43$, $SD = 0.88$), with 75% of men having higher scores than 60% of women.

⁴ Camp K, as presented in Figure 3, works with one of the more established tourist companies and receives many visits. In camps H and I, several individuals in both camps report that they are normally village dwellers in the Mangola region but have moved further into Hadzaland due to limited access to water in the village.

Figure 3. Boxplots of exposure scores by camp arranged by median exposure score within each camp. The Mangola region camps are closer to markets, more accessible, and generally receive more tourist traffic than Yaeda region camps. Only camps A, C, D, F, H, and I completed the ranking task.

3.3.2. Analysis

We next examined whether cultural exposure scores moderated the relationships between preferred campmate rankings and rankings of generosity or foraging ability. For these analyses, there are $n = 673$ observations. We fit seven models. The first model regressed preferred campmate ranking on subject demographics, generosity ranking, and foraging ranking. The second model added an interaction term between generosity ranking and exposure while the third model added an interaction term between foraging ability ranking and exposure. The full model included interaction terms for both rankings. The other three models included the interaction

between generosity or foraging ranking and the judge's sex to control for the sex-difference in exposure. Again, rankings of generosity, foraging ability, and campmate preference were standardized within each judge's set.

Table S14 presents the model fit statistics for the seven models. The four models including a term for the interaction between generosity and exposure accounted for 69% of the Akaike weight; models containing the interaction were 2.2 times as likely to better fit new data than models not containing the interaction, providing anecdotal evidence that the interaction term improved the fit of the model. Models including the interaction between foraging ability and exposure accounted for 67% of the Akaike weight; models containing the interaction were 2.0 times as likely to better fit new data than models not containing the interaction, providing anecdotal evidence that the interaction term improved the fit of the model. Because the Akaike weight was distributed between multiple models, we again computed a weighted-average posterior, sampling a zero for a parameter when sampling from a model that does not include that parameter. Estimates from each separate model with an Akaike weight > 0.05 are presented in Table S15.

Table 4 presents the models estimates from the weighted-average posterior. There was anecdotal evidence that Hadza with greater exposure had a stronger association between generosity and preferred campmate rankings; people one standard deviation below the mean exposure had a slope of $\beta = 0.22$, 95% HPDI: [0.00, 0.43], whereas people one standard deviation above the mean exposure had a slope of $\beta = 0.35$, 95% HPDI: [0.12, 0.57]. There was also only anecdotal evidence that Hadza with greater exposure had a stronger association between foraging ability and preferred campmate rankings; people one standard deviation below the mean exposure had a slope of $\beta = 0.13$, 95% HPDI: [-0.04, 0.29], whereas people one

standard deviation above the mean exposure had a slope of $\beta = 0.20$, 95% HPDI: [0.02, 0.39].

There was moderate evidence of exposure moderating the relationship between honesty and preferred campmate ranking, $\beta = 0.09$, [95% HPDI: 0.00, 0.19], but anecdotal evidence against exposure moderating the relationship between effort and preferred campmate ranking, $\beta = 0.03$, [95% HPDI: -0.01, 0.13] (see Tables S16 – S21). Figure 4 presents the probability distributions for each coefficient from the weighted-average posterior (see Figures S4 and S5 for similar figures with effort and honesty).

Table 4. Model Estimates Regressing Campmate Preference on Generosity and Foraging Rankings in 2019 from Weighted-average Posterior

Effect	β	95% HPDI	% $</> 0$
Subject sex (male = 1)	-0.21	-0.34, -0.09	100%
Subject standardized age	-0.06	-0.13, 0.01	94.6%
Subject marital status (married = 1)	-0.01	-0.12, 0.11	54.2%
Judge and subject are same sex	0.20	0.08, 0.32	97.9%
Judge standardized age $\times$ Subject standardized age	0.07	0.01, 0.13	98.7%
Judge and subject relationship (kin or spouse = 1)	0.21	0.01, 0.40	97.9%
Generosity	0.28	0.10, 0.48	99.3%
Generosity $\times$ Judge's standardized exposure	0.06	0.00, 0.16	66.9%
Generosity $\times$ Judge sex (male = 1)	0.01	-0.10, 0.15	18.7%
Foraging ability	0.16	0.00, 0.30	97.6%
Foraging ability $\times$ Judge's standardized exposure	0.04	-0.04, 0.14	57.4%
Foraging ability $\times$ Judge sex (male = 1)	0.07	0.00, 0.28	41.5%

Note. The coefficient estimate is the mean of the posterior distribution. The 95% highest posterior density interval (HPDI) is the narrowest interval containing 95% of the posterior, or the 95% most plausible coefficient estimates. The last column is the percent of the posterior greater

than (or less than in the cases of subject sex, subject age, and subject's marital status) zero. Close relationship is whether the subject and judge were spouse or primary kin.

Figure 4. Posterior distributions of the standardized effect size for each coefficient from the weighted-average posterior regressing preferred campmate ranking on generosity and foraging ability by judge exposure. The interactions are bimodal because we averaged over models that do include those terms. Estimates from individual models with that term were unimodal.

4. Discussion

We examined campmate preferences, among the Hadza, a group of mixed-subsistence foragers living in Tanzania, in two separate years over a three-year period. In 2016, Hadza participants preferred social partners who were both more generous and better hunters, with evidence suggesting that hunting ability is a more important criterion for selecting campmates. However, three years later, there was some evidence that the relationship between generosity and being a preferred campmate strengthened, while the relationship between being foraging ability and being a good campmate weakened. These findings, coupled with data collected a decade earlier, which reported a weak but negative relationship between an individual's level of cooperativeness and the number of times they were chosen as a campmate (Apicella et al 2012), suggest that partner preferences may be changing as the Hadza become less isolated and transition out of their hunter-gatherer lifestyle. Further substantiating this conjecture, in 2019, we also found that individuals with greater exposure and knowledge to outside cultural institutions, including formal education and market economies, showed a stronger preference for generous campmates, though the evidence was anecdotal. Together, these patterns suggest that generosity and productivity are both valued traits in social partners among the Hadza, but the desire for generous partners may reflect recent cultural change.

Past research, using a variety of methods, suggest that partner choice was an unlikely mechanism for maintaining cooperation in the Hadza. Prior research found that the Hadza do not prefer more cooperative people as campmates, as measured by economic gameplay (Apicella et al., 2012). Second, a longitudinal study tracking individuals over a 6-year period found that people who contribute more in a public good game do not live with more cooperative people in

the future as predicted by partner choice (Smith et al., 2018). This same study also found no evidence that individual cooperative behavior is stable over time. Further evidence suggests that people may, in fact, be observing different levels of cooperativeness in others across time and situations; there is considerable disagreement between participants on who are the most generous or moral campmates (Smith & Apicella, 2020). Behavioral persistence is necessary for partner choice to maintain cooperation—without it, a person’s current willingness to cooperate provides no information about whether that person will cooperate in the future.

Despite their status as hunter-gatherers, the Hadza are a population in transition. Thus, while it is possible that differences in methods account for the discrepant findings from the data collected nearly a decade ago, it is also plausible that they reflect the changing nature of Hadza psychology. Facilitated in part by development of paved roads throughout the region, the last decade has seen a steady rise in the number of tourists, missionaries, and aid workers visiting the Hadza, including visits to camps once considered “remote” (Apicella, 2018; Apicella et al., 2014; Pollom, Cross, et al., 2020; Pollom, Herlosky, et al., 2020). Aid workers and missionaries distribute food and supplies during their visits, and money is given as remuneration for tourist visits (Apicella, 2018). As a result, market participation has increased, as has reliance on domesticated plant foods. It is worth noting that our cultural exposure survey paints a very different picture of the Hadza compared to how they have been previously described in ethnographies. Contrary to being relatively “isolated”, Hadza are becoming increasingly exposed to the market economy and spending more time outside of Hadzaland. Our data also suggest that access to formal education has increased. In previous reports, only about 20% of Hadza less than 60 years old have attended some school, usually for only 1 to 2 years (Blurton Jones & Marlowe, 2002), yet in 2019, we found that 37% of participants reported having attended school, with the

median number of years completed, 5. Finally, our data suggest that dichotomies contrasting village-adjacent bush camps (i.e., camps near the Mangola village) to camps further inside Hadza territory may no longer be relevant; Hadza in all regions report substantial exposure to non-Hadza culture.

The importance of generosity in Hadza partner selection appears to be increasing over time. At the same time, the Hadza are slowly transitioning out of their hunter-gatherer lifestyle and becoming more integrated in village life. That said, the evidence that self-reported exposure to non-Hadza cultural institutions moderate preferences for generous campmates was anecdotal. This may be due, in part, to the relatively small sample size of judges ($n = 85$); a larger sample of judges or a more fine-grained measure of exposure may help reduce the uncertainty in the estimates for better evidence. Also, the relationship is correlational and alternative explanations may account for the result. For instance, people with greater exposure may have understood the task better, making the observed relationship between generosity and preferred campmate larger. It is also possible that people who prefer generous individuals find it easier to navigate situations with strangers and are more open to outside cultural influences. This, however, would raise the question of where the initial variation in preferences originates. Future work identifying and testing specific mechanisms of whether and how cultural institutions and norms shapes partner choice psychology may help rule out these alternative explanations.

Even if we assume that data collected from Hadza a decade ago is more representative of the past, we still cannot rule out the possibility that partner choice was an important driver of the evolution of human cooperation further back in time. For example, it could be argued that partner choice selected for cooperative individuals over many generations, thereby reducing observable variation in levels of cooperation on which to select partners. In other words, over

time, directional selection, may have greatly reduced or eliminated diversity in cooperation by going to fixation. If cooperation went to fixation, individuals would no longer benefit from discriminating between partners and the preference for cooperative partners would weaken or disappear (with enough time). Thus, it is possible that the lack of preference for cooperative campmates observed in 2010 or even the disagreement observed in our current ranking data (Smith & Apicella, 2020) may reflect a long history of partner choice.

We believe this fixation account to be unlikely for several reasons. First, GWAS studies suggest heritable variation is present in virtually every psychological and behavioral trait studied (Visscher et al., 2017) and twin studies examining the heritability of cooperation also find genetic variation (Cesarini et al., 2008; Wallace et al., 2007). Second, recent insights in the field of genetics suggest that most human traits are genetically complex and are underpinned by aggregate variations from a very large number of genes. The law of large numbers alone implies that it would take a long time to eliminate any polygenic signal, and this perhaps would be virtually impossible due to other evolutionary processes, such as pleiotropy and mutation (Chabris et al., 2013). Third, many traits, including those intimately tied to fitness, such as hunting ability, have continued to exhibit substantial variation (Apicella, 2014; Stibbard-Hawkes et al., 2018). The fixation account would require some explanation for why there is maintenance in variation in other psychological and behavioral traits, but not cooperation. Here, we argue that the lack of preference for cooperative campmates in 2010 was more likely due to the unique ecological and cultural features (e.g., small groups, egalitarian norms, absence of markets) characteristic of ancestral hunter-gatherers. And indeed, the fact that we are now observing shifts in preferences for cooperative others, suggests that the fixation account does not explain previous findings among Hadza.

We suggest future work continue to investigate partner choice psychology in small-scale societies. As outlined earlier, many features present in WEIRD societies may be unusually favorable for choosing cooperative partners. Greater relational mobility and freedom to both form and sever relationships may allow for more discriminating choices. Increased participation in and reliance on commercial markets may result in greater emphasis and value placed on cooperative traits, such as honesty, generosity, and fairness – indeed, market integration is associated with higher levels of impartial giving, cooperation and trust (Boesch & Berger, 2019; Henrich, Ensminger, et al., 2010; Rustagi et al., 2010). And, similar to findings in personality (Lukaszewski et al., 2017), greater social niches and occupations available in WEIRD societies may impact the expression of cooperative traits, leading to greater diversity on which to select partners. Further, features common to the lives of hunter-gatherers, including egalitarianism, camp-wide food sharing, and small group sizes, which are conducive to monitoring and enforcing cooperation, may effectively reduce variation in levels of cooperation. This, in turn, diminishes the importance of selecting cooperative campmates, especially relative to selecting skillful foragers. Models show that the value placed on generosity or productivity when choosing partners depends on the variation in available partners along these dimensions (Barclay, 2016a). If potential partners are all similarly generous, then productivity becomes more valued than generosity.

Foraging ability is an important criterion for Hadza choosing campmates. In 2016, there was evidence that this preference was stronger than the preference for generous campmates. These findings are consistent with prior research showing that people prefer to live with more physically fit others (Apicella et al., 2012), which may be a reliable cue of hunting ability (Apicella, 2014; Stibbard-Hawkes et al., 2018) and that Hadza men prefer to live in hypothetical

camp with better hunters (Wood, 2006). There is also some evidence in other populations that productivity is also important for choosing social partners. For example, US participants prefer to continue relationships with productive partners, especially when productivity is indicative of future ability to generate benefits (Eisenbruch & Roney, 2017). Even partners who are simply perceived to be more productive are preferred more as social partners (Eisenbruch et al., 2016) and receive more in economic games (Eisenbruch et al., 2019). And in several non-Western societies, productive people receive a number of social benefits. For example, among Aché forager-horticulturalists, productive hunters receive more food transfers when sick than less productive hunters (Gurven et al., 2000). In Dominican and Peruvian villages, people with reputations for being productive have more cooperative relationships (Macfarlan & Lyle, 2015). These findings suggest future research, in non-WEIRD and WEIRD populations, may benefit from further investigating the role perceptions of productivity play in social cognition and behavior.

Partner choice has recently gained popularity as a mechanism for explaining the evolution of human cooperation. However, the evidence supporting these claims come mostly from WEIRD populations, who live in conditions much different from ancestral hunter-gatherers. Consistent with predictions from models of partner choice, and data from WEIRD subjects, we find evidence that Hadza hunter-gatherers do prefer to live with people they deem as more cooperative. These results contrast with results from several papers citing little evidence for partner choice maintaining cooperation in the Hadza, including a lack of preference for more cooperative campmates (Apicella et al., 2012; Smith et al., 2018; Smith & Apicella, 2020). We also find that while the preference for generous campmates has strengthened, the preference for productive foragers has weakened. While the data suggest that recent ecological and cultural

shifts may be responsible for the observed changes, more work is necessary. More convincingly though, the findings suggest that partner choice psychology is not fixed and that preferences change, possibly adaptively.

Data availability

De-identified data and scripts are available at: <https://osf.io/8sxmlw/>

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Supplementary Information for *Partner choice in human evolution: The role of cooperation, foraging ability, and culture in Hadza campmate preferences*

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[Figure S1. Posterior distributions of the standardized effect size weighted-average posterior regressing preferred campmate ranking on effort by year](#)

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[Figure S5. Posterior distributions of the standardized effect size weighted-average posterior regressing preferred campmate ranking on honest and foraging ability by judge exposure](#)

Full Model Regressing Preferred Campmate on Generosity by Year

Ranking of subject i by judge j in camp k on preferred campmate was modeled as:

$$campmate_{ijk} \sim Normal(\mu_{ijk}, \sigma)$$

$$\mu_{ijk} = \alpha_i + \beta_1 Male_i + \beta_2 Age_i + \beta_3 Married_i + \beta_4 Same_sex_{ij} + \beta_5 Age_similarity_{ij} \\ + \beta_6 Close_relationship_{ij} + \beta_{7,ijk} Generosity_{ij} + \beta_8 (Generosity_{ij} \times Year_{ijk})$$

$$\beta_{7,ijk} = \beta_7 + b_{7,i} + b_{7,j} + b_{7,k}$$

$$\alpha_i \sim Normal(0, \sigma_{0,i})$$

$$b_{7,i} \sim Normal(0, \sigma_{7,i})$$

$$b_{7,j} \sim Normal(0, \sigma_{7,j})$$

$$b_{7,k} \sim Normal(0, \sigma_{7,k})$$

$$[\beta_1; \beta_2; \beta_3; \beta_4; \beta_5; \beta_6; \beta_7; \beta_8] \sim Normal(0, 1.5)$$

$$[\sigma_{0,i}; \sigma_{7,i}; \sigma_{7,j}; \sigma_{7,k}] \sim Cauchy(0, 1.5)$$

Full Model Regressing Preferred Campmate on Generosity by Year and Foraging by Year

Ranking of subject i by judge j in camp k on preferred campmate was modeled as:

$$campmate_{ijk} \sim Normal(\mu_{ijk}, \sigma)$$

$$\begin{aligned} \mu_{ijk} = & \alpha_i + \beta_1 Male_i + \beta_2 Age_i + \beta_3 Married_i + \beta_4 Same_sex_{ij} + \beta_5 Age_similarity_{ij} \\ & + \beta_6 Close_relationship_{ij} + \beta_7 Generosity_{ij} + \beta_8 (Generosity_{ij} \times Year_{ijk}) \\ & + \beta_9 Foraging_{ij} + \beta_{10} (Foraging_{ij} \times Year_{ijk}) \end{aligned}$$

$$\beta_{7,ijk} = \beta_7 + b_{7,i} + b_{7,j} + b_{7,k}$$

$$\beta_{9,ijk} = \beta_9 + b_{9,i} + b_{9,j} + b_{9,k}$$

$$\alpha_i \sim Normal(0, \sigma_{0,i})$$

$$b_{7,i} \sim Normal(0, \sigma_{7,i})$$

$$b_{7,j} \sim Normal(0, \sigma_{7,j})$$

$$b_{7,k} \sim Normal(0, \sigma_{7,k})$$

$$b_{9,i} \sim Normal(0, \sigma_{9,i})$$

$$b_{9,j} \sim Normal(0, \sigma_{9,j})$$

$$b_{9,k} \sim Normal(0, \sigma_{9,k})$$

$$[\beta_1; \beta_2; \beta_3; \beta_4; \beta_5; \beta_6; \beta_7; \beta_8; \beta_9; \beta_{10}] \sim Normal(0, 1.5)$$

$$[\sigma_{0,i}; \sigma_{7,i}; \sigma_{7,j}; \sigma_{7,k}; \sigma_{9,i}; \sigma_{9,j}; \sigma_{9,k}] \sim Cauchy(0, 1.5)$$

Full Model Regressing Preferred Campmate on Generosity by Exposure and Foraging by Exposure

Ranking of subject i by judge j in camp k on preferred campmate was modeled as:

$$campmate_{ijk} \sim Normal(\mu_{ijk}, \sigma)$$

$$\begin{aligned} \mu_{ijk} = & \alpha_i + \beta_1 Male_i + \beta_2 Age_i + \beta_3 Married_i + \beta_4 Same_sex_{ij} + \beta_5 Age_similarity_{ij} \\ & + \beta_6 Close_relationship_{ij} + \beta_{7,ijk} Generosity_{ij} \\ & + \beta_8 (Generosity_{ij} \times Exposure_j) + \beta_{9,ijk} Foraging_{ij} \\ & + \beta_{10} (Foraging_{ij} \times Exposure_j) + \beta_{11} (Generosity_{ij} \times Male_j) \\ & + \beta_{12} (Foraging_{ij} \times Male_j) \end{aligned}$$

$$\beta_{7,ijk} = \beta_7 + b_{7,i} + b_{7,j} + b_{7,k}$$

$$\beta_{9,ijk} = \beta_9 + b_{9,i} + b_{9,j} + b_{9,k}$$

$$\alpha_i \sim Normal(0, \sigma_{0,i})$$

$$b_{7,i} \sim Normal(0, \sigma_{7,i})$$

$$b_{7,j} \sim Normal(0, \sigma_{7,j})$$

$$b_{7,k} \sim Normal(0, \sigma_{7,k})$$

$$b_{9,i} \sim Normal(0, \sigma_{9,i})$$

$$b_{9,j} \sim Normal(0, \sigma_{9,j})$$

$$b_{9,k} \sim Normal(0, \sigma_{9,k})$$

$$[\beta_1; \beta_2; \beta_3; \beta_4; \beta_5; \beta_6; \beta_7; \beta_8; \beta_9; \beta_{10}; \beta_{11}; \beta_{12}] \sim Normal(0, 1.5)$$

$$[\sigma_{0,i}; \sigma_{7,i}; \sigma_{7,j}; \sigma_{7,k}; \sigma_{9,i}; \sigma_{9,j}; \sigma_{9,k}] \sim Cauchy(0, 1.5)$$

Table S1. Zero-Order Correlations Between Character and Preferred Campmate Rankings

	Effort	Generosity	Honesty	Foraging	Preferred campmate
Effort	1	0.32	0.27	0.37	0.28
Generosity		1	0.30	0.29	0.30
Honesty			1	0.28	0.28
Foraging				1	0.30
Preferred campmate					1

Note. Values are Pearson's r values. Foraging reputation only includes men being ranked in 2016.

Table S2. Fit of Models Regressing Preferred Campmate Rankings on Generosity Ranking

Model	LOO _{IC}	LOO _{SE}	p	p_{SE}	Akaike weight
Demographics	3572.6	36.3	84.3	2.2	0.00
Generous	3467.9	38.9	126.8	3.9	0.31
Generous × Year	3466.3	38.9	125.9	3.8	0.69

Note. LOO is the leave-one-out cross-validation information criterion estimate; a lower number indicates a better fitting model, p is the effective number of parameters in the model, and the Akaike weight is computed from LOO.

Table S3. Estimates for Each Model Regressing Campmate Preference on Generosity**Ranking**

Effect	Demographics	Generous	Generous $\times$ Year
Subject sex (male = 1)	-0.18 [-0.30, -0.05]	-0.12 [-0.23, -0.01]	-0.12 [-0.23, -0.01]
Subject standardized age	0.10 [0.03, 0.17]	0.07 [0.01, 0.13]	0.07 [0.01, 0.13]
Subject marital status (married = 1)	0.03 [-0.08, 0.13]	0.01 [-0.08, 0.10]	0.01 [-0.08, 0.10]
Judge and subject are same sex	0.17 [0.08, 0.26]	0.10 [0.02, 0.19]	0.10 [0.02, 0.19]
Judge standardized age $\times$ Subject standardized age	0.06 [0.01, 0.11]	0.04 [0.00, 0.09]	0.04 [0.02, 0.09]
Judge and subject relationship (kin or spouse = 1)	0.24 [0.10, 0.38]	0.20 [0.07, 0.34]	0.20 [0.07, 0.33]
Generous		0.25 [0.15, 0.35]	0.17 [0.06, 0.29]
Generous $\times$ 2019			0.18 [0.01, 0.35]

Note. Values are standardized coefficient for each effect in each model; values in brackets are 95% HDI intervals.

Table S4. Fit of Models Regressing Preferred Campmate Rankings on Effort Ranking

Model	LOO _{IC}	LOO _{SE}	p	p_{SE}	Akaike weight
Demographics	3572.9	36.3	84.0	2.2	0.00
Effort	3480.8	39.0	122.9	3.7	0.50
Effort $\times$ Year	3480.8	39.1	123.2	3.7	0.50

Note. LOO is the leave-one-out cross-validation information criterion estimate; a lower number indicates a better fitting model, p is the effective number of parameters in the model, and the Akaike weight is computed from LOO.

Table S5. Model Estimates Regressing Campmate Preference on Effort Ranking from Weighted-average Posterior

Effect	β	95% HPDI	% $</> 0$
Subject sex (male = 1)	-0.19	-0.30, -0.09	100%
Subject standardized age	0.06	0.00, 0.12	97.8%
Subject marital status (married = 1)	0.02	-0.07, 0.12	67.3%
Judge and subject are same sex	0.16	0.08, 0.25	100%
Judge standardized age $\times$ Subject standardized age	0.05	0.00, 0.09	97.8%
Judge and subject relationship (kin or spouse = 1)	0.17	0.04, 0.31	99.2%
Effort	0.25	0.14, 0.35	100%
Effort $\times$ 2019	0.04	-0.05, 0.20	41.3%

Note. The standardized coefficient estimate is the mean of the posterior distribution. The 95% highest posterior density interval (HPDI) is the narrowest interval containing 95% of the posterior, or the 95% most plausible coefficient estimates. Close relationship is whether the subject and judge were spouse or primary kin. The last column is the percent of the posterior greater than (or less than in the case of Male) zero.

Table S6. Estimates for Each Model Regressing Campmate Preference on Effort Ranking

Effect	Demographics	Effort	Effort $\times$ Year
Subject sex (male = 1)	-0.18 [-0.30, -0.05]	-0.19 [-0.30, -0.08]	-0.19 [-0.30, -0.09]
Subject standardized age	0.10 [0.03, 0.17]	0.06 [0.00, 0.12]	0.06 [0.00, 0.12]
Subject marital status (married = 1)	0.03 [-0.08, 0.13]	0.02 [-0.08, 0.12]	0.02 [-0.08, 0.12]
Judge and subject are same sex	0.17 [0.08, 0.26]	0.16 [0.07, 0.25]	0.16 [0.07, 0.25]
Judge standardized age $\times$ Subject standardized age	0.06 [0.01, 0.11]	0.05 [0.00, 0.09]	0.05 [0.00, 0.09]
Judge and subject relationship (kin or spouse = 1)	0.24 [0.10, 0.38]	0.17 [0.03, 0.31]	0.17 [0.04, 0.30]
Effort		0.27 [0.18, 0.36]	0.23 [0.13, 0.35]
Effort $\times$ 2019			0.07 [-0.09, 0.23]

Note. Values are standardized coefficient for each effect in each model; values in brackets are 95% HDI intervals.

Table S7. Fit of Models Regressing Preferred Campmate Rankings on Honest Ranking

Model	LOO _{IC}	LOO _{SE}	p	p_{SE}	Akaike weight
Demographics	3573.7	36.3	84.1	2.2	0.00
Honest	3450.4	40.5	135.0	4.3	0.33
Honest $\times$ Year	3448.9	40.6	134.5	4.3	0.67

Note. LOO is the leave-one-out cross-validation information criterion estimate; a lower number indicates a better fitting model, p is the effective number of parameters in the model, and the Akaike weight is computed from LOO.

Table S8. Model Estimates Regressing Campmate Preference on Honest Ranking from Weighted-average Posterior

Effect	β	95% HPDI	% $</> 0$
Subject sex (male = 1)	-0.13	-0.23, -0.02	98.9%
Subject standardized age	0.08	0.02, 0.14	99.7%
Subject marital status (married = 1)	0.01	-0.09, 0.10	55.0%
Judge and subject are same sex	0.12	0.04, 0.21	99.8%
Judge standardized age $\times$ Subject standardized age	0.04	0.00, 0.09	97.7%
Judge and subject relationship (kin or spouse = 1)	0.17	0.02, 0.29	99.2%
Honest	0.22	0.10, 0.33	99.9%
Honest $\times$ 2019	0.10	0.00, 0.30	65.3%

Note. The standardized coefficient estimate is the mean of the posterior distribution. The 95% highest posterior density interval (HPDI) is the narrowest interval containing 95% of the posterior, or the 95% most plausible coefficient estimates. Close relationship is whether the subject and judge were spouse or primary kin. The last column is the percent of the posterior greater than (or less than in the case of Male) zero.

Table S9. Estimates for Each Model Regressing Campmate Preference on Honest Ranking

Effect	Demographics	Honest	Honest $\times$ Year
Subject sex (male = 1)	-0.18 [-0.30, -0.05]	-0.13 [-0.23, -0.02]	-0.13 [-0.24, -0.02]
Subject standardized age	0.10 [0.03, 0.17]	0.08 [0.02, 0.14]	0.08 [0.02, 0.14]
Subject marital status (married = 1)	0.03 [-0.08, 0.13]	0.01 [-0.09, 0.10]	0.01 [-0.09, 0.10]
Judge and subject are same sex	0.17 [0.08, 0.26]	0.12 [0.03, 0.21]	0.12 [0.04, 0.21]
Judge standardized age $\times$ Subject standardized age	0.06 [0.01, 0.11]	0.05 [0.00, 0.09]	0.04 [0.00, 0.09]
Judge and subject relationship (kin or spouse = 1)	0.24 [0.10, 0.38]	0.16 [0.03, 0.30]	0.17 [0.03, 0.30]
Honest		0.26 [0.17, 0.35]	0.20 [0.08, 0.31]
Honest $\times$ 2019			0.16 [-0.01, 0.33]

Note. Values are standardized coefficient for each effect in each model; values in brackets are 95% HDI intervals.

Table S10. Fit of Models Regressing Preferred Campmate Rankings on Generosity and Foraging Rankings

Model	LOO _{IC}	LOO _{SE}	p	p_{SE}	Akaike weight
Demographics	2592.4	32.8	60.4	1.9	0.00
Generosity	2513.8	34.4	83.8	3.1	0.00
Foraging	2541.1	35.0	73.2	2.9	0.00
Foraging × Sex	2543.1	35.0	73.7	2.9	0.00
Generosity + Foraging	2479.8	35.6	110.8	4.4	0.14
Generosity × Year	2477.1	35.6	110.7	4.3	0.52
Foraging × Year	2479.8	35.7	111.4	4.4	0.14
Full	2479.1	35.7	109.3	4.3	0.20

Note. LOO is the leave-one-out cross-validation information criterion estimate; a lower number indicates a better fitting model, p is the effective number of parameters in the model, and the Akaike weight is computed from LOO.

Table S11. Estimates for Each Model Regressing Campmate Preference on Generosity and Foraging Ranking

Effect	Generosity + Foraging	Generosity × Year	Foraging × Year	Full
Subject sex (male = 1)	-0.19 [-0.29, -0.09]	-0.19 [-0.29, -0.09]	-0.19 [-0.29, -0.09]	-0.19 [-0.29, -0.08]
Subject standardized age	0.01 [-0.05, 0.06]	0.01 [-0.05, 0.07]	0.01 [-0.05, 0.06]	0.01 [-0.05, 0.07]
Subject marital status (married = 1)	0.07 [-0.02, 0.17]	0.07 [-0.03, 0.17]	0.07 [-0.03, 0.17]	0.07 [-0.03, 0.17]
Judge and subject are same sex	0.13 [0.04, 0.23]	0.13 [0.04, 0.23]	0.13 [0.04, 0.23]	0.13 [0.03, 0.22]
Judge standardized age × Subject standardized age	0.05 [0.00, 0.10]	0.05 [0.00, 0.10]	0.05 [0.00, 0.10]	0.05 [0.00, 0.10]
Judge and subject relationship (kin or spouse = 1)	0.19 [0.03, 0.35]	0.19 [0.03, 0.35]	0.19 [0.02, 0.35]	0.19 [0.03, 0.35]
Generous	0.20 [0.08, 0.30]	0.10 [-0.05, 0.23]	0.20 [0.08, 0.30]	0.09 [-0.05, 0.23]
Generous × 2019		0.19 [0.01, 0.38]		0.20 [0.01, 0.39]
Foraging	0.21 [0.12, 0.30]	0.21 [0.12, 0.29]	0.24 [0.10, 0.37]	0.25 [0.11, 0.38]
Foraging × 2019			-0.04 [-0.21, 0.13]	-0.07 [-0.23, 0.10]

Note. Values are standardized coefficient for each effect in each model; values in brackets are 95% HDI intervals.

Table S12. Correlations Between Items on Cultural Exposure Survey

	School	Job	Count	Capital	President	Obama	Mandela	Ghandi	Arusha	Hadzaland
School	1.00	0.18	0.36	0.20	0.42	0.26	0.36	0.28	0.47	0.40
Job		1.00	0.33	0.18	0.32	0.24	0.19	0.20	0.58	0.42
Count			1.00	0.25	0.49	0.27	0.25	0.09	0.38	0.33
Capital				1.00	0.31	0.21	0.15	0.04	0.27	0.24
President					1.00	0.41	0.39	0.22	0.52	0.39
Obama						1.00	0.57	0.34	0.40	0.34
Mandela							1.00	0.54	0.39	0.32
Ghandi								1.00	0.24	0.17
Arusha									1.00	0.49
Hadzaland										1.00

Note. Values are Pearson's r values.

Table S13. Factor Loadings for Each Item on Cultural Exposure Survey

Item	Factor 1	Factor 2
School	0.49	0.29
Job	0.62	0.08
Count	0.53	0.16
Capital	0.37	0.09
President	0.61	0.30
Obama	0.35	0.54
Mandela	0.19	0.94
Ghandi	0.13	0.55
Arusha	0.76	0.26
Hadzaland	0.58	0.23

Note. Bolded values indicate which factor each item better load on.

Table S14. Fit of Models Regressing Preferred Campmate Rankings on Generosity and Foraging Rankings in 2019

Model	LOO _{IC}	LOO _{SE}	p	p_{SE}	Akaike weight
Generosity + Foraging	1659.5	29.2	60.3	2.8	0.01
Generosity $\times$ Exposure	1653.1	29.3	58.3	2.7	0.21
Generosity $\times$ Exposure	1654.2	29.4	59.8	2.8	0.12
w/ control					
Foraging $\times$ Exposure	1655.1	29.4	57.5	2.7	0.07
Foraging $\times$ Exposure	1652.8	29.9	56.2	2.7	0.24
w/ control					
Full	1653.5	29.4	58.2	2.7	0.17
Full w/ control	1653.2	29.8	58.5	2.8	0.19

Note. LOO is the leave-one-out cross-validation information criterion estimate; a lower number indicates a better fitting model, p is the effective number of parameters in the model, and the Akaike weight is computed from LOO. Control was an interaction term between judge's sex and generosity or foraging ability ranking.

Table S15. Estimates for Each Model Regressing Campmate Preference on Generosity and Foraging**Ranking by Exposure**

Effect	Generosity × Exposure	Generosity × Exposure w/ control	Foraging × Exposure	Foraging × Exposure w/ control	Full	Full w/ controls
Subject sex (male = 1)	-0.22 [-0.34, -0.09]	-0.22 [-0.32, -0.10]	-0.21 [-0.34, -0.08]	-0.21 [-0.33, -0.08]	-0.21 [-0.34, -0.09]	-0.21 [-0.34, -0.09]
Subject standardized age	-0.05 [-0.12, 0.01]	-0.05 [-0.12, 0.02]	-0.06 [-0.13, 0.01]	-0.06 [-0.13, 0.01]	-0.06 [-0.13, 0.01]	-0.06 [-0.13, 0.01]
Subject marital status (married = 1)	0.00 [-0.12, 0.11]	0.00 [-0.12, 0.11]	0.00 [-0.12, 0.11]	-0.01 [-0.12, 0.11]	-0.01 [-0.12, 0.11]	-0.01 [-0.12, 0.10]
Judge and subject are same sex	0.20 [0.08, 0.32]	0.21 [0.09, 0.33]	0.19 [0.08, 0.31]	0.20 [0.08, 0.31]	0.20 [0.09, 0.32]	0.20 [0.09, 0.32]
Judge standardized age × Subject standardized age	0.07 [0.01, 0.13]	0.07 [0.01, 0.13]	0.07 [0.01, 0.12]	0.06 [0.00, 0.12]	0.07 [0.01, 0.13]	0.07 [0.01, 0.13]
Judge and subject relationship (kin or spouse = 1)	0.21 [0.01, 0.40]	0.21 [0.01, 0.40]	0.21 [0.02, 0.41]	0.21 [0.02, 0.40]	0.21 [0.00, 0.40]	0.20 [0.00, 0.40]
Generous	0.29 [0.11, 0.46]	0.26 [0.05, 0.46]	0.28 [0.11, 0.46]	0.28 [0.09, 0.48]	0.29 [0.11, 0.47]	0.28 [0.08, 0.49]
Generous × Exposure	0.11 [0.03, 0.19]	0.10 [0.01, 0.18]			0.09 [0.00, 0.17]	0.09 [-0.00, 0.18]
Generous × Judge sex (male = 1)		0.06 [-0.10, 0.22]				0.00 [-0.16, 0.17]
Foraging	0.19 [0.08, 0.31]	0.19 [0.08, 0.31]	0.21 [0.10, 0.32]	0.12 [-0.02, 0.27]	0.20 [0.08, 0.31]	0.12 [-0.03, 0.26]
Foraging × Exposure			0.09 [0.01, 0.17]	0.06 [-0.02, 0.15]	0.06 [-0.03, 0.14]	0.02 [-0.07, 0.12]
Foraging × Judge sex (male = 1)				0.16 [0.00, 0.32]		0.16 [-0.02, 0.34]

Note. Values are standardized coefficient for each effect in each model; values in brackets are 95% HDI intervals.

Table S16. Fit of Models Regressing Preferred Campmate Rankings on Effort and Foraging Rankings in 2019

Model	LOO _{IC}	LOO _{SE}	p	p_{SE}	Akaike weight
Effort + Foraging	1655.8	30.3	67.0	3.2	0.03
Effort $\times$ Exposure	1664.0	30.6	63.7	3.1	0.08
Effort $\times$ Exposure w/ control	1664.5	30.5	63.8	3.1	0.06
Foraging $\times$ Exposure	1662.8	30.5	62.1	3.0	0.14
Foraging $\times$ Exposure w/ control	1660.8	30.8	61.1	3.0	0.39
Full	1662.7	30.6	61.9	3.0	0.15
Full w/ control	1662.7	30.8	62.6	3.0	0.15

Note. LOO is the leave-one-out cross-validation information criterion estimate; a lower number indicates a better fitting model, p is the effective number of parameters in the model, and the Akaike weight is computed from LOO. Control was an interaction term between judge's sex and generosity or foraging ability ranking.

Table S17. Model Estimates Regressing Campmate Preference on Effort and Foraging Rankings in 2019 from Weighted-average Posterior

Effect	β	95% HPDI	% $</> 0$
Subject sex (male = 1)	-0.33	-0.45, -0.20	100%
Subject standardized age	-0.07	-0.14, 0.01	96.5%
Subject marital status (married = 1)	0.02	-0.09, 0.15	64.3%
Judge and subject are same sex	0.28	0.16, 0.40	96.6%
Judge standardized age $\times$ Subject standardized age	0.07	0.01, 0.13	98.1%
Judge and subject relationship (kin or spouse = 1)	0.19	-0.01, 0.39	96.6%
Effort	0.27	0.09, 0.45	99.4%
Effort $\times$ Judge's standardized exposure	0.03	-0.01, 0.14	40.7%
Effort $\times$ Judge sex (male = 1)	0.00	-0.13, 0.08	12.5%
Foraging ability	0.16	-0.02, 0.32	95.9%
Foraging ability $\times$ Judge's standardized exposure	0.06	-0.02, 0.16	76.8%
Foraging ability $\times$ Judge sex (male = 1)	0.09	0.00, 0.30	52.1%

Note. The coefficient estimate is the mode of the posterior distribution. The 95% highest posterior density interval (HPDI) is the narrowest interval containing 95% of the posterior, or the 95% most plausible coefficient estimates. The last column is the percent of the posterior greater than (or less than in the cases of subject, subject age, and Effort $\times$ judge sex) zero. Close relationship is whether the subject and judge were spouse or primary kin. In the interactions, male refers to judge's sex, whereas male as a main effect refers to subject's sex.

Table S18. Estimates for Each Model Regressing Campmate Preference on Effort and Foraging Ranking by Exposure

Effect	Effort × Exposure	Effort × Exposure w/ control	Foraging × Exposure	Foraging × Exposure w/ control	Full	Full w/ controls
Subject sex (male = 1)	-0.33 [-0.46, -0.20]	-0.33 [-0.46, -0.20]	-0.33 [-0.45, -0.20]	-0.33 [-0.45, -0.20]	-0.32 [-0.46, -0.20]	-0.33 [-0.45, -0.20]
Subject standardized age	-0.06 [-0.13, 0.01]	-0.06 [-0.13, 0.01]	-0.07 [-0.14, 0.01]	-0.07 [-0.14, 0.00]	-0.07 [-0.14, 0.00]	-0.07 [-0.14, 0.00]
Subject marital status (married = 1)	0.03 [-0.09, 0.14]	0.03 [-0.09, 0.14]	0.02 [-0.09, 0.14]	0.02 [-0.10, 0.14]	0.02 [-0.09, 0.14]	0.02 [-0.10, 0.13]
Judge and subject are same sex	0.27 [0.16, 0.39]	0.27 [0.15, 0.39]	0.28 [0.16, 0.40]	0.28 [0.16, 0.40]	0.28 [0.16, 0.39]	0.28 [0.16, 0.40]
Judge standardized age × Subject standardized age	0.07 [0.00, 0.13]	0.07 [0.00, 0.13]	0.07 [0.01, 0.13]	0.07 [0.00, 0.13]	0.07 [0.01, 0.13]	0.07 [0.00, 0.13]
Judge and subject relationship (kin or spouse = 1)	0.19 [-0.02, 0.39]	0.19 [-0.01, 0.38]	0.19 [-0.01, 0.39]	0.18 [-0.01, 0.38]	0.19 [-0.01, 0.39]	0.18 [-0.02, 0.38]
Effort	0.27 [0.09, 0.47]	0.26 [0.06, 0.46]	0.27 [0.10, 0.45]	0.27 [0.11, 0.44]	0.27 [0.10, 0.45]	0.29 [0.10, 0.49]
Effort × Exposure	0.08 [0.00, 0.16]	0.08 [-0.01, 0.16]			0.05 [-0.03, 0.14]	0.06 [-0.03, 0.15]
Effort × Judge sex (male = 1)		0.02 [-0.15, 0.19]				-0.04 [-0.22, 0.14]
Foraging	0.20 [0.06, 0.36]	0.20 [0.04, 0.35]	0.21 [0.08, 0.33]	0.12 [-0.04, 0.29]	0.21 [0.06, 0.35]	0.12 [-0.06, 0.29]
Foraging × Exposure			0.10 [0.02, 0.18]	0.07 [-0.02, 0.15]	0.08 [-0.01, 0.16]	0.04 [-0.05, 0.14]
Foraging × Judge sex (male = 1)				0.16 [-0.01, 0.33]		0.17 [-0.01, 0.35]

Note. Values are standardized coefficient for each effect in each model; values in brackets are 95% HDI intervals.

Table S19. Fit of Models Regressing Preferred Campmate Rankings on Honest and Foraging Rankings in 2019

Model	LOO _{IC}	LOO _{SE}	p	p_{SE}	Akaike weight
Honest + Foraging	1639.2	31.4	79.0	4.0	0.03
Honest $\times$ Exposure	1636.3	31.9	74.5	3.9	0.15
Honest $\times$ Exposure w/ control	1637.4	31.9	75.1	3.9	0.09
Foraging $\times$ Exposure	1638.1	31.6	75.4	3.9	0.06
Foraging $\times$ Exposure w/ control	1636.6	32.0	75.6	4.0	0.13
Full	1636.1	31.9	73.0	3.8	0.17
Full w/ control	1634.5	32.2	73.9	3.9	0.37

Note. LOO is the leave-one-out cross-validation information criterion estimate; a lower number indicates a better fitting model, p is the effective number of parameters in the model, and the Akaike weight is computed from LOO. Control was an interaction term between judge's sex and generosity or foraging ability ranking.

Table S20. Model Estimates Regressing Campmate Preference on Honest and Foraging Rankings in 2019 from Weighted-average Posterior

Effect	β	95% HPDI	% $\leq/\geq$ 0
Subject sex (male = 1)	-0.23	-0.36, -0.11	100%
Subject standardized age	-0.04	-0.10, 0.03	84.2%
Subject marital status (married = 1)	-0.02	-0.13, 0.09	64.4%
Judge and subject are same sex	0.24	0.13, 0.36	93.5%
Judge standardized age $\times$ Subject standardized age	0.05	-0.01, 0.11	95.1%
Judge and subject relationship (kin or spouse = 1)	0.15	-0.05, 0.35	93.5%
Honest	0.31	0.17, 0.45	100%
Honest $\times$ Judge's standardized exposure	0.09	0.00, 0.19	77.1%
Honest $\times$ Judge sex (male = 1)	-0.02	-0.19, 0.12	31.0%
Foraging ability	0.16	0.00, 0.31	97.1%
Foraging ability $\times$ Judge's standardized exposure	0.03	-0.05, 0.13	59.1%
Foraging ability $\times$ Judge sex (male = 1)	0.09	0.00, 0.30	49.2%

Note. The coefficient estimate is the mode of the posterior distribution. The 95% highest posterior density interval (HPDI) is the narrowest interval containing 95% of the posterior, or the 95% most plausible coefficient estimates. The last column is the percent of the posterior greater than (or less than in the cases of subject, subject age, subject marital status, and Honest $\times$ judge sex) zero. Close relationship is whether the subject and judge were spouse or primary kin. In the interactions, male refers to judge's sex, whereas male as a main effect refers to subject's sex.

Table S21. Estimates for Each Model Regressing Campmate Preference on Honest and Foraging Ranking by Exposure

Effect	Honest × Exposure	Honest × Exposure w/ control	Foraging × Exposure	Foraging × Exposure w/ control	Full	Full w/ controls
Subject sex (male = 1)	-0.23 [-0.36, -0.11]	-0.23 [-0.35, -0.11]	-0.23 [-0.36, -0.11]	-0.23 [-0.35, -0.11]	-0.23 [-0.36, -0.11]	-0.23 [-0.35, -0.11]
Subject standardized age	-0.03 [-0.10, 0.04]	-0.03 [-0.10, 0.04]	-0.03 [-0.10, 0.04]	-0.03 [-0.10, 0.04]	-0.04 [-0.10, 0.03]	-0.04 [-0.10, 0.03]
Subject marital status (married = 1)	-0.02 [-0.13, 0.09]	-0.02 [-0.13, 0.09]	-0.02 [-0.13, 0.10]	-0.02 [-0.13, 0.09]	-0.02 [-0.13, 0.09]	-0.02 [-0.14, 0.09]
Judge and subject are same sex	0.24 [0.13, 0.36]	0.24 [0.13, 0.36]	0.24 [0.12, 0.35]	0.24 [0.13, 0.35]	0.25 [0.13, 0.36]	0.25 [0.13, 0.36]
Judge standardized age × Subject standardized age	0.05 [-0.01, 0.11]	0.05 [-0.01, 0.11]	0.05 [-0.01, 0.11]	0.05 [-0.01, 0.11]	0.05 [-0.01, 0.11]	0.05 [-0.01, 0.11]
Judge and subject relationship (kin or spouse = 1)	0.15 [-0.04, 0.35]	0.15 [-0.04, 0.35]	0.17 [-0.03, 0.36]	0.13 [-0.04, 0.35]	0.16 [-0.04, 0.35]	0.15 [-0.05, 0.34]
Honest	0.30 [0.18, 0.42]	0.30 [0.14, 0.45]	0.29 [0.16, 0.42]	0.29 [0.16, 0.43]	0.29 [0.18, 0.41]	0.32 [0.17, 0.47]
Honest × Exposure	0.12 [0.04, 0.21]	0.12 [0.03, 0.21]			0.10 [0.02, 0.19]	0.12 [0.02, 0.21]
Honest × Judge sex (male = 1)		0.00 [-0.18, 0.18]				-0.05 [-0.24, 0.13]
Foraging	0.21 [0.08, 0.33]	0.21 [0.09, 0.33]	0.22 [0.10, 0.33]	0.13 [-0.02, 0.27]	0.21 [0.10, 0.33]	0.12 [-0.04, 0.27]
Foraging × Exposure			0.09 [0.01, 0.17]	0.05 [-0.03, 0.14]	0.06 [-0.02, 0.14]	0.02 [-0.07, 0.11]
Foraging × Judge sex (male = 1)				0.17 [0.00, 0.33]		0.18 [0.01, 0.35]

Note. Values are standardized coefficient for each effect in each model; values in brackets are 95% HDI intervals.

Figure S1. Posterior distributions of the standardized effect size for each coefficient from the weighted-average posterior regressing preferred campmate ranking on effort by year.

Figure S2. Posterior distributions of the standardized effect size for each coefficient from the weighted-average posterior regressing preferred campmate ranking on honest by year.

Figure S3. Scree plot displaying the eigenvalue for different number of factors in the cultural exposure survey.

Figure S4. Posterior distributions of the standardized effect size for each coefficient from the weighted-average posterior regressing preferred campmate ranking on effort and foraging ability by judge exposure.

Figure S5. Posterior distributions of the standardized effect size for each coefficient from the weighted-average posterior regressing preferred campmate ranking on honest and foraging ability by judge exposure.