Why Hunt? Why Gather? Why Share? Hadza assessments of foraging and food-sharing motive.

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Abstract

Over the last half century, anthropologists have vigorously debated the adaptive motivations underlying food acquisition choices and food-sharing among hunter-gatherer groups. Numerous explanations have been proposed to account for high-levels of generosity in food-sharing, including self- and family-provisioning, reciprocity, tolerated theft and pro-social- or skill-signaling. However, few studies have asked foragers directly and systematically about the motivations underlying their foraging and sharing decisions. We recruited 110 Hadza participants and employed a combination of free-response, yes/no, ranking and forced-choice questions to do just this. In free-response answers, respondents typically gave outcome-oriented accounts of foraging motive (e.g., 'to get food') and moralistic accounts of sharing motive (e.g., 'I have a good heart'). In ranking tasks, participants gave precedence to reciprocity as a motive for sharing food beyond the household. We found small but clear gender differences in foraging motive, in line with previous predictions: women were more likely than men to rank family-provisioning highly whereas men were more likely than women to rank skill-signaling highly. However, despite these gender differences, the relative importance of different motivations was similar across genders and skill-signaling, sharing and family-provisioning were the most important motivators of foraging activity for both men and women. Contrary to the expectations of tolerated theft, peer complaints and requests for food ranked very low. There are several compelling reasons that evolutionary thinkers, typically interested in ultimate-level adaptive processes, have traditionally eschewed direct and explicit investigations of motive. However, these data may yet provide important insights.

Keywords: Hunter-Gatherers, Food-sharing, Costly Signaling, Reciprocity, Cooperation

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1. Introduction

Contemporary hunter-gatherer groups are far from homogeneous. They live in varied environments and pursue diverse sets of resources (Marlowe, 2005b; Kelly, 2013). In many respects, foragers exhibit as much diversity as do any other populations. However, some patterns of behavior appear common to many contemporary forager groups, independent of historical link. Of particular interest to anthropologists is the fact that, among many populations, including the Martu (Bliege Bird & Power, 2015), Aché (Hawkes et al., 1991; Gurven et al., 2000), !Kung (Wiessner, 2002), Agta (Smith et al., 2019) and Hadza (Marlowe, 2010; Blurton Jones, 2016), generous redistribution of food is endemic. People often pursue resources that are widely shared beyond their households. Furthermore, many forager populations have a sexual division of labor (Marlowe, 2007; Codding et al., 2011); men appear to systematically prioritize widely-shared resources, often including game animals (Hawkes et al., 2018), while women typically pursue more reliable and less widely-shared resources, often (Marlowe, 2007) though not exclusively (Bliege Bird & Bird, 2008) plant-based.

Many evolutionary or economic anthropologists expect that individuals should seek to maximize foraging returns for themselves or their families. For this reason, endemic generosity and the sex-biased targeting of widely-shared food items (Bliege Bird & Bird, 2008; Hawkes et al., 2018) are both puzzles. This is especially true where few nutritional benefits can be identified for the households of high producers (Kaplan & Hill 1985; Hawkes 1991b; Bliege Bird & Power 2015; Blurton Jones 2016; Stibbard-Hawkes et al. 2020, though see Wood & Marlowe 2013, 2014). Such patterns appear to violate expectations of self-interest, economic rationality and, ultimately, fitness maximization (Kaplan & Hill, 1985; Cashdan, 2013; Henrich, 2018; Stibbard-Hawkes, 2019). To address these puzzles, a number of adaptive motives have been proposed, including self- and family-provisioning, reciprocal exchange, risk-reduction reciprocity, tolerated theft/demand sharing and pro-social- or skill-signaling. We outline each theory briefly, although each are discussed in more detail elsewhere (e.g., Winterhalder, 1996; Gurven, 2004b; Smith & Bliege Bird, 2005; Gurven & Hill, 2009; Kelly, 2013; Hawkes et al., 2018; Stibbard-Hawkes, 2019).

The nuclear-family-provisioning hypothesis has a long history (e.g., Washburn & Lancaster, 1968; Lee & DeVore, 1968). Proponents of the family-provisioning model view sex differences in foraging strategy as labor specialization: Couples cooperate by concentrating on activities which either are or aren't compatible with nursing (Kelly, 2013, P.218). Much research among the Hadza has stressed the important role that men play in provisioning their families (Marlowe, 2003; Wood & Marlowe, 2013, 2014). Moreover, much research concerning the sexual division of labor (Bird, 1999; Marlowe, 2007; Bliege Bird & Bird, 2008; Codding et al., 2011) or the showing-off/signaling hypothesis (Hawkes et al., 2010), despite highlighting disparities in foraging motivation between sexes (Hawkes, 1991b; Hawkes et al., 1991, 2010, 2018), has cast women's foraging either primarily (Hawkes, 1996) or among other concerns (Bliege Bird & Bird, 2008; Codding et al., 2011), as a means of reliably acquiring food for dependent offspring.

A second key hypothesis is that food-sharing, or targeting widely-redistributed

resources, is motivated by reciprocity, especially in environments with high daily variance and risk of individual shortfall (i.e., 'risk-reduction reciprocity', see: Smith, 1990; Winterhalder, 2001; Gurven et al., 2015). Studies among many populations, including the Aché, Hiwi, Lamalera, Tsimané, and Ye'kwana, show clear contingency in sharing (Gurven et al. 2000; Gurven 2004a,b; Hames & McCabe 2007; Nolin 2010, but see Hawkes et al. 2010). Moreover, two recent analyses of large cross-cultural datasets showed that risk in resource acquisition increases degree of food-sharing beyond the household (Ember et al., 2018; Ringen et al., 2019). In no studies of reciprocal sharing did food-givers expect a 1:1 return on their investment (e.g., Gurven, 2004b, T2). However, food in a time of hunger may be more valuable to the receiver than excess food in a time of plenty. Reciprocity need not necessarily be in-kind as generosity can be repaid in other ways (e.g., social support, allocare, advice). Moreover reciprocal exchange relationships can take place over years, while studies of reciprocity typically happen over weeks or months.

Reciprocity does require individuals to remember and not renege on obligations, even where they would benefit. An explanation for food-sharing, which does not necessitate accounting, is tolerated theft. This theory posits that when one individual has excess food and is sated, hungry peers have a greater incentive to take the food than the procurer has to defend it (Blurton Jones, 1984; Winterhalder, 1996; Kaplan et al., 2018), especially where food is perishable. The tolerated theft hypothesis is consistent with reports of frequent and vociferous food demands among numerous forager populations (Peterson, 1993), along with accounts of frequent complaints concerning others' 'stinginess' (Endicott, 1988; Marlowe, 2010). It is also analogous to accounts of food-sharing from the broader evolutionary sciences (e.g., see Brown, 2004). The extent to which food producers control food distributions is debated both among the Hadza (Hawkes et al., 2014; Wood & Marlowe, 2014; Stibbard-Hawkes & Attenborough, 2021) and elsewhere (reviewed by Kaplan & Gurven, 2005). Moreover, a key limitation of tolerated theft is that it does not explain why individuals target foods that they know will be widely shared, rather than prioritizing foods they can monopolize (Hawkes et al., 2014). For this reason, some researchers see tolerated theft as compatible with signaling (Hawkes et al., 2018).

One final proposed motivator is the notion that foraging skill may play a role in mate choice (Kaplan & Hill, 1985) and that foraging might be a form of 'costly signaling' or 'showing-off'[1] (Hawkes, 1991a; Hawkes & Bird, 2002). These hypotheses predict that individuals forage and share food to advertise to peers their otherwise hidden qualities (Hawkes & Bird, 2002), and pay a caloric cost (or opportunity cost) to do so (Hawkes et al., 2018). They are supported by widespread evidence of a positive correlation between measures of hunting success and measures of lifetime reproductive success (e.g., Kaplan & Hill 1985; Gurven & von Rueden 2006a; Smith 2004 though see

[1]Smith & Bird (2000) have distinguished these two hypotheses on several bases including that 'costly signaling' hinges on the possibility of signalers being 'reliably ranked in quality' (p.258). However, in practice the two terms are often employed in similar contexts (e.g., Hawkes et al. 2018; and see discussion in Stibbard-Hawkes 2019)

Kraft et al. 2019). Evidence that forager food acquisition and redistribution is indeed costly or suboptimal has been disputed (e.g. see Wood & Marlowe, 2013; Hawkes et al., 2014), especially when accounting for reciprocal sharing and other forms of cooperation (e.g. see Gurven, 2004b; Gurven & Hill, 2009; Hawkes et al., 2010). The utility of hunting as an efficient skill signal has also been questioned (Stibbard-Hawkes et al., 2018), as has the use of costs as evidence for signalling (Stibbard-Hawkes et al., 2020).

In addition to skill signalling, many studies have stressed that individuals might be motivated to share or target widely-redistributed food-items to advertise their generosity or pro-sociality (Bliege Bird & Bird, 2008; Bliege Bird & Power, 2015; Stibbard-Hawkes et al., 2018; Hawkes et al., 1991; Gurven et al., 2000; Smith, 2004).

Not all of these explanations are mutually exclusive. As noted, many view the costly signalling and tolerated theft hypotheses as synergistic (Hawkes et al., 2018). Others see foraging motives as multicausal, arguing that reputational, reciprocal, nutritional and mating concerns each play a variable and overlapping role in shaping foraging behavior (Gurven & von Rueden, 2006b; Gurven & Hill, 2009). Kaplan et al. (2000; 2005; 2009) have further proposed that a uniquely human pattern of cooperative familial provisioning, coupled with reciprocal risk mitigation, and the cooperative exploitation of high quality food items, underlies many derived aspects of human cognition and life history - technological sophistication, long childhoods, and large brains.

These explanations have been investigated among the Hadza and other populations using diverse methods, including food returns (Hawkes, 1991b; Marlowe, 2003; Bliege Bird & Power, 2015), food-sharing (Hawkes et al., 2001b; Gurven, 2004a; Wood & Marlowe, 2013; Bliege Bird & Power, 2015) and food consumption (Berbesque et al., 2016) measures. These data may be augmented with experiments (Walker et al., 2002; Blurton Jones et al., 2002; Kaplan et al., 2018; Stibbard-Hawkes et al., 2018) or resource allocation games (e.g., Marlowe, 2004b; Marlowe et al., 2005; Apicella et al., 2012; Smith et al., 2019). Modeling approaches have also often been utilized (e.g., Smith, 1990; Winterhalder, 1996; Gintis et al., 2001; Lewis et al., 2014), as have large cross-cultural analyses (e.g., Ember et al., 2018; Ringen et al., 2019) and longitudinal network analyses (von Rueden et al., 2019). Interview methods are often used, for example, for collecting demographic information (Blurton Jones, 2016), self-report food-sharing data (Nolin, 2010) and peer-rankings of skill or generosity (e.g., Blurton Jones et al., 2002; Marlowe, 2010; Blurton Jones, 2016; Stibbard-Hawkes et al., 2018; Smith et al., 2019; Smith & Apicella, 2020b). However, where interviews are used to investigate foraging or sharing motivation, it is usually elicited indirectly rather than explicitly (e.g., Wood & Hill, 2000; Gurven et al., 2000; Wood, 2006; Nolin, 2010).

This may reflect general skepticism from evolutionary scientists towards self-reports. Individuals may only report their proximate-level motivations (e.g., 'I hunt to get food') or may restate questions (e.g., Q: 'Why won't you eat honey with hyena meat in it?'; A: 'Because there is hyena meat in it'; see Apicella et al. 2018). Moreover, there are numerous barriers to introspectively accessing motive (e.g., Libet, 1985; Frith & Haggard, 2018; Nisbett & Wilson, 1977) and, in some cases, self-deception may even be adaptive (Wrangham, 1999; Trivers et al., 2006). However, there are also compelling reasons for asking about foraging and sharing motive directly.

First, most of the above theories are derived from data-informed theorizing by non-local scholars. They are generated by careful observation of and engagement with forager lifeways, and are often augmented by first-hand discussions with participants (e.g., Wiessner, 2002; Bliege Bird & Bird, 2008; Wood & Marlowe, 2013), derived from accounts of decision-making processes in experiments (e.g., Smith et al., 2019) and informed by ethnography (e.g., Gurven, 2004b; Hawkes et al., 2018). However, such theories have seldom been suggested or sometimes even considered by local participants. This does not mean that they are wrong. However, there is room for cross-cultural researchers to more thoroughly involve participants in theory-generation (e.g., Broesch et al., 2020), and it would be enlightening to know whether individuals from forager populations endorse or recognize all motives that have been ascribed to them.

Second, non-local researchers, being only secondarily involved in food-getting and food-sharing, may miss important contextual knowledge. Participants are often well-placed to assess, first-hand, what motivates people to act. Moreover, attention to motive is probably heightened for salient activities like food-sharing which, in a resource-limited environment, is of primary importance and generates much attention and discussion (Endicott, 1988; Peterson, 1993; Hawkes & Bird, 2002; Marlowe, 2010). It is therefore probable that foragers themselves will have informed opinions of why people hunt, why they gather and why they so generously share the foods they subsequently attain. Accessing this knowledge may shed further light on old questions.

Third, cross-cultural researchers are placing increasing emphasis on the utility of mixed-methodologies. 'Findings are more convincing when they are based on diverse sources of evidence, multiple sources of data and different research methods' (Berry et al., 2013, p.25). Where theories are contested (e.g., see Hawkes et al., 2010; Wood & Marlowe, 2014; Stibbard-Hawkes, 2019), consilience between results derived from diverse methods can break theoretic deadlocks. Moreover, recent discussions in social psychology and the evolutionary human sciences have stressed that over-reliance on experiments and other quantitative metrics can, at times, trade off against context sensitivity (Rozin, 2001) and 'empirical representativeness' (Barrett, 2020). Free-response data, especially, provide opportunities to explore phenomena from a bottom up perspective, rather than putting theory first. In short, despite the limitations of self-report data, it is useful to collect and consider them alongside other data types.

In this study we aimed to i) find out whether Hadza foragers report foraging and sharing motivations that match or overlap with those suggested by researchers and, ii) see which motivations appear more salient or important. To do this, we employed structured interviews, involving free-form response questions, yes/no questions, ranking tasks and forced-choice tasks. Free-response questions aimed to capture people's own assessments of their motives. The yes/no task sought to assess which theory-derived motives were perceived as important and which weren't. The ranking task aimed to assess the relative importance of different theory-derived motives. Finally, the forced-choice tasks aimed to elicit high resolution data on the importance of theoretically derived motives pairs.

Given the notable differences between the food items collected by men and women (Marlowe, 2010; Crittenden et al., 2013), and accompanying sex-structured differences in acquisition variance and in sharing breadth (Hawkes et al., 1991; Wood & Marlowe,

2013; Hill & Kintigh, 2009) many researchers predict sex-differences in foraging motive. For example, the show-off hypothesis (see Hawkes et al., 2018) predicts that men are more likely than women to prioritise signalling (but see Barker et al. 2019. To assess whether men's and women's motives were indeed divergent, we included participant gender as a predictor in our analysis. Many theories further predict that foraging has a role in marriage prospects, partner preferences (Kaplan & Hill, 1985; Marlowe, 2004a; Hawkes & Bird, 2002) or nuclear-family provisioning (Wood & Marlowe, 2013). For this reason we also assessed the impact of marital status on foraging motive.

2. Methods

2.1. Study Population

The Hadza are an ethnolinguistic group of ∼1000 speakers, most of whom live in the Eyasi basin and surrounding regions in Northern Tanzania. Traditionally the Hadza have subsisted as full-time foragers (Marlowe, 2010), with high residential mobility (Blurton Jones, 2016; Smith et al., 2018), an egalitarian ethos (Woodburn, 1982; Marlowe, 2010) and habitual generous food-sharing (Woodburn, 1998; Hawkes et al., 2018; Marlowe, 2010). As recently as the early 2000s it was estimated that some 150-250 Hadza still foraged for ≥95% of their diet (Marlowe, 2010). In recent years, both tourist agencies and missionaries have made inroads deeper into Hadza territory (Apicella, 2018; Stagnaro et al., 2021), bringing grain and cash. Many Hadza, even in remote camps, now have significant grain in their diet. However, many still continue to forage for the majority of food, and even those living in market-adjacent camps continue to regularly forage (Pollom et al., 2020, 2021).

Hadza hunting is generally solitary. Only a minority of trips (11%) involve ≥2 people (Berbesque et al., 2016). Classic accounts (e.g., Hawkes et al., 1991, 2001b) have stressed that men preferentially target large-bodied (≥65kg) animals, although recent evidence has also highlighted the importance of small game (Wood & Marlowe, 2014). Men also collect honey which is either shared in camp (Wood & Marlowe, 2013; Marlowe et al., 2014b) or eaten by the procurer (Marlowe et al., 2014b; Berbesque et al., 2016). Historically it has been reported that men receive no more of the meat they procure than others in camp (Woodburn, 1998; Hawkes et al., 2018; Stibbard-Hawkes et al., 2020), though some contend that a hunter's nuclear and extended family do receive a preferential share (see Wood & Marlowe, 2013; Hawkes et al., 2014; Wood & Marlowe, 2014, for discussion). Women typically forage in groups and primarily target plant-based resources (Marlowe & Berbesque, 2009). Plant-derived resources are habitually shared, though less widely than meat (Marlowe, 2010; Berbesque et al., 2011).

Previous work has cast Hadza food acquisition patterns as a self (Berbesque et al., 2016), spousal/nuclear family (Marlowe, 2003, 2007) or extended family (Wood & Marlowe, 2013) provisioning strategy, a signaling strategy (Hawkes & Bird, 2002; Hawkes et al., 2018), a reciprocal or risk-minimization strategy (Gurven, 2004b), especially where food will rot/spoil, or a response to demands from camp-mates (Blurton Jones, 1984). Data from the Hadza have rightly (Marlowe, 2005b; Bird & O'Connell, 2006;

Marlowe, 2010; Conolly, 2017; Lavi & Friesem, 2019) or wrongly (e.g., Wobst, 1978; Wilmsen et al., 1990; Lieberman et al., 2007; Singh & Glowacki, 2021) been used to inform our understanding of forager food-procurement and sharing in the deep past.

2.2. Sampling and Demographics

Fieldwork was conducted between September and October, 2019. We used snowball sampling, where participants directed us to other camps. We surveyed all consenting adults in all camps visited. The present study recruited 110 Hadza participants, 56 women and 54 men. Mean participant age was 38 (SD = 14, range = 18-70). Thirty-one participants were unmarried, 78 were married, and one declined to answer. Children were excluded.

2.3. Motive Categories and Illustrations

We chose seven salient motives for foraging and seven for sharing, each with a basis in anthropological theory (see Table 1 for motives and associated references). Certain authors see foraging and sharing motives as inextricably linked; people forage knowing food will be shared (Hawkes et al., 2018). Others have conceptualized foraging and food-sharing differently, assuming that producers have a choice to either share food or keep it (e.g. Gurven, 2004b; Wood & Marlowe, 2014). In the present paper we chose some overlapping sharing and foraging motives, and some unique ones. For example, 'because it would otherwise rot' makes sense as a motive for sharing, but not getting food. Similarly 'self-provisioning' and 'family-provisioning' might motivate food-getting but, as we defined food-sharing as sharing outside the household, it did not make sense to list these as sharing motives. For foraging motive questions we construed sharing beyond the family broadly as 'food-sharing' while for sharing motives we examined 'requests', 'reciprocity' and 'generosity-signaling' independently.

To provide a reference point for interviewees we created images illustrating different motive categories. We adapted character assets created by Science Animated for a previous project (Smith et al., 2018). We used these because images 1) were in illustrator format and easily manipulable; 2) clearly depicted people in Hadza dress; 3) were visually simple and easy to interpret. We created 18 images (Figure 1) to illustrate each of the categories in Table 1 with some overlap. With two exceptions (Figure 1) images shown to female participants depicted female actors and plant-based resources, while those shown to male participants depicted male actors and meat. For 'avoid complaints' and 'food will otherwise rot' we showed the same picture to all participants. All illustrations were printed to 6.5 by 8.85in dimensions and laminated.

2.4. Structured Interview Procedure

Participants were invited to a location where interviews could not be overheard. English and Swahili interview scripts are provided as ESM §1. We conducted two rounds of questioning, following the same format, the first concerning foraging motive, the second sharing motive. In the foraging round, there were small differences in wording for male and female respondents (Table 1): we asked women about motives for gathering, and men about motives for hunting. To facilitate comprehension, all

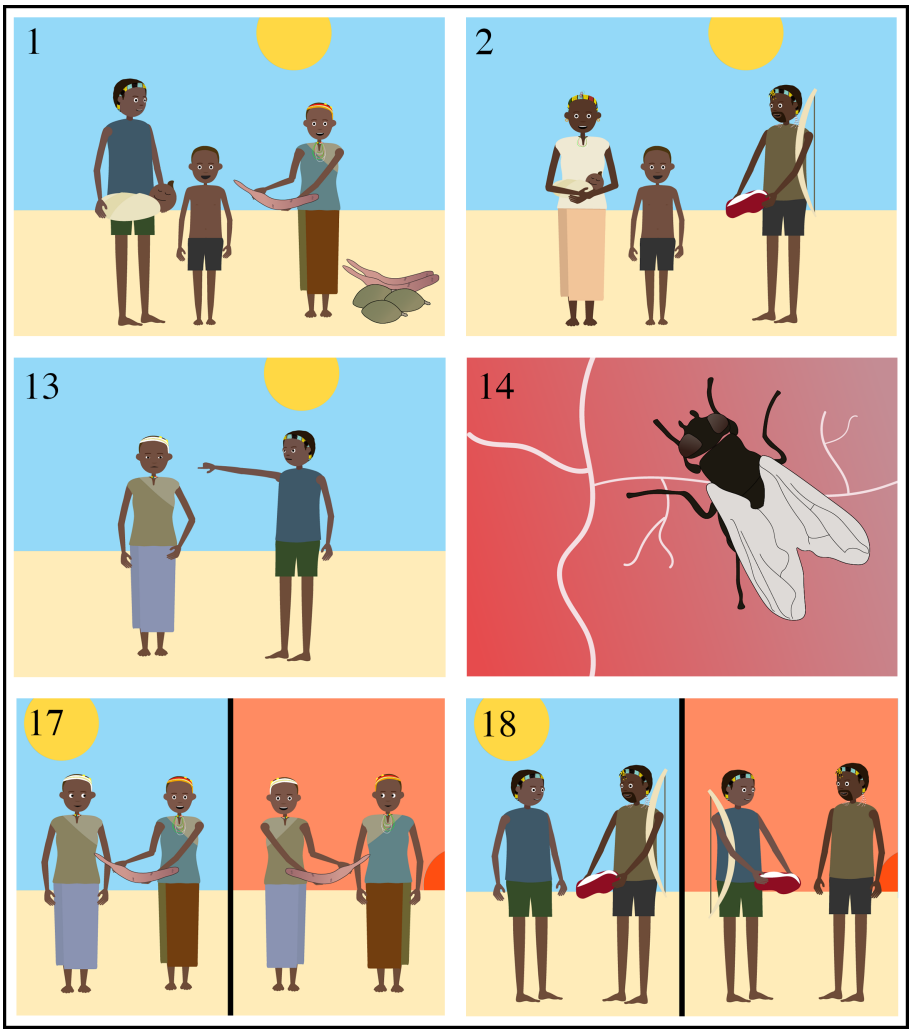

Figure 1: Six of 18 pictures used to illustrate different foraging and sharing motives, with number references corresponding to Table 1. Top row depicts nuclear-family-provisioning for women (left) and men (right), middle row depicts complaints (left) and rot (right), bottom row depicts reciprocal sharing for women (left) and men (right).

Table 1: English wording of Foraging (Hunting/Gathering) and Sharing tasks with shorthand designation, example citation and number reference for the associated illustration. All illustrations are provided in ESM §2. Full Swahili wording and protocols are accessible in ESM §1

English Wording	Motive Category	Example Citation	Picture #
1.1 Foraging			
I [hunt/gather] because I want to get food for my [wife/husband] and children.	Nuclear-family-provisioning	Wood & Marlowe 2013	1, 2
I [hunt/gather] because I enjoy it.	Enjoyment	NA	3, 4
I [hunt/gather] because I want to get food for myself.	Self-provisioning	Berbesque et al. 2016	5, 6
I [hunt/gather] because I want to get food for beautiful [women/men]	Opposite-sex Recipient	Kaplan & Hill 1985	7, 8
I [hunt/gather] because I want to show everyone I am skilled.	Demonstrate Skill	Hawkes et al. 2001b	9, 10
I [hunt/gather] because I want to get food for others.	Food-sharing	Various	11, 12
I [hunt/gather] because others will complain if I do not.	Complaints	Blurton Jones 1984	13
1.2 Sharing			
I share food with others because I want to share food with beautiful [women/men].	Opposite-Sex Recipient	Kaplan & Hill 1985	7, 8
I share food with others to show people I am good at getting food.	Demonstrate Skill	Hawkes et al. 2001b	9, 10
I share food with others because I want to show others I am generous.	Demonstrate Generosity	Bliege Bird & Power 2015	11, 12
I share food with others because people will complain if I do not share.	Complaints	Blurton Jones 1984	13
I share food with others because I get too much for myself and it will rot.	Rot	Blurton Jones 1987	14
I share food with others because they ask for food.	Requests	Peterson 1993	15, 16
I share food with others because if I share food now, they will share with me later.	Reciprocity	Gurven 2004b	17, 18

questions involved first-order beliefs (e.g. why do *you* hunt). Interviewees were given the choice to hear questions in either Swahili or Hadzane. All opted for Hadzane.

Foraging and sharing interviews followed the same structure. We first asked people, in their own words 'Every day you go out to get food. What primarily motivates you to hunt/gather?' for foraging and 'What primarily motivates you to give food to people who are not your wife and children?' for sharing.

We next asked seven yes/no questions, showing the accompanying illustration (Table 1). After explaining each, we asked whether each participant foraged/shared because of that motivation. Question order was the same for all participants.

We next conducted a ranking task. We first reviewed each motive then asked participants to select the picture they considered most important in motivating foraging/sharing. We removed that picture and repeated the question. To avoid fatigue, we collected the top three of seven options.

Finally, we conducted a forced-choice task, where we selected seven pairs of pictures and asked participants to indicate which of the two motives was more important to them. Guided by existing literature we selected three choices for foraging and four for sharing: We asked participants to indicate whether they were more motivated to go out foraging in order to A) provision their family or attractive opposite-sex recipients, B) get food to share with others or because people would complain if they stayed at home, C) Get food to eat themselves or get food to share with others. We asked participants to indicate whether they were more motivated to share food beyond their households in order to A) avoid complaints or in order to share widely, B) Give food to others who would reciprocate or provision attractive opposite-sex recipients, C) avoid complaints or provision attractive opposite-sex recipients, D) signal generosity or skill to peers.

Structured interviews were conducted by two Tanzanian research assistants, one Hadza, who spoke Swahili, English and Hadzane and one Sukuma (Bantu) who spoke Swahili and English. The Hadza research assistant lead the interview and was blind to the expectations of theory. The Sukuma research assistant recorded responses. Both research assistants were male and aged 30-35.

2.5. Categorizing Free-Response Answers

In line with previous methods (Marlowe, 2004a; Apicella et al., 2018), free-response answers were condensed into discrete categories to allow easier interpretation of findings. Responses were categorized by the first author and independently by a research assistant. Agreement was high (93%). This process was blind to personal or demographic identifiers. Most answers fell into clear categories. For foraging, answers such as, 'to get food', were categorized as 'food-getting recipient unspecified', answers such as 'to share with others' were categorized as 'sharing motivated' and answers such as 'food for my kids' were categorized as 'family-provisioning motivated'. For sharing, answers such as 'I have a good heart' and 'I am a good person' were categorized as 'personal morality', answers such as 'only share with my friends' were categorized as 'friendship/familiarity' motivated etc.

In three cases, sharing motives defied straightforward categorization: 'because of love' and 'I like everyone to have something' were both categorised as 'enjoyment' while

'because they are human like me' was categorized as 'others' virtue'. Only one foraging motive, 'to get Hadza food', was difficult to categorize and was ultimately categorized as 'sharing motivated'. Responses and associated categorizations are available in the supplementary material.

2.6. Data Availability and Ethics

Research was approved by the IRB at the University of Pennsylvania. We received permission to conduct this research in Tanzania from the Commission for Science and Technology (COSTECH). Permission to work in every camp was granted in a group-level meeting. Verbal consent was obtained from each participant individually. Anonymous data (excluding identifiers), R code and supplementary material are available from: https://bit.ly/2QfMxIm

3. Results

3.1. Free-Response Results

Categorized free-response results and associated proportions are provided in Table 2. A greater diversity of motivations were provided for sharing (12) than foraging (7). Foraging free-response answers had few apparent gender differences. Gender differences were more apparent in sharing responses: 21.8% women listed friendship/familiarity as a sharing motive compared to only 8.8% of men. Two men highlighted the importance of others requests and complaints while no women did. Sample sizes were too low to run meaningful statistical analyses.

3.2. Yes/No Results

For each motive category in the Yes/No task, across both foraging (hunting/gathering) motive and sharing motive, most answers were 'Yes' for every question. With the exception of one individual who answered 'No' to seven of 14 questions, 'No' responses were evenly distributed across interviewees: the second highest number of 'No' answers from a single interviewee was 4/14 and no other participant gave more than three 'No' answers. The maximum proportion of 'No' answers for any one motive category across both tasks was four (3.64%). Only one participant answered 'don't know' to one question. Foraging results are summarized in Table 3.1 and sharing results in Table 3.2. There was too little variability in responses either to meaningfully disaggregate these data further (e.g., by gender) or to run statistical analyses on them.

3.3. Ranking Task Results

3.3.1. Hunting/Gathering

Raw count and proportion data (Table 4) showed family-provisioning, skill-signaling, and sharing were most often listed as top-three motives for foraging. We estimated the probabilities of participants listing each of seven potential sharing motives as top-three motive in a binomial (Bernoulli) regression. Analyses were conducted in R and STAN using the Bayesian Regression Models (BRMs) package. We chose to include the top three, rather than simply the first ranked category, in order to maximize our sample

Table 2: Free-Response Counts for Foraging (2.1) and Sharing (2.2) Motives with counts followed by percentages in parentheses ordered by combined frequency.

Table #	Category	Both Sexes	Men	Women
2.1: Foraging				
	Food-getting (unspecified recipient)	48 (42.1%)	23 (41.1%)	25 (43.1%)
	Family-provisioning	29 (25.4%)	13 (23.2%)	16 (27.6%)
	Hunger/Taste	22 (19.3%)	12 (21.4%)	10 (17.2%)
	Normativity	6 (5.3%)	3 (5.4%)	3 (5.2%)
	Enjoyment	4 (3.5%)	3 (5.4%)	1 (1.7%)
	Sharing Motivated	4 (3.5%)	1 (1.8%)	3 (5.2%)
	Signalling Motivated	1 (0.9%)	1 (1.8%)	0 (0%)
2.2: Sharing				
	Personal Virtue	29 (25.9%)	12 (21.1%)	17 (30.9%)
	Friendship/Familiarity	17 (15.2%)	5 (8.8%)	12 (21.8%)
	Reciprocity	17 (15.2%)	7 (12.3%)	10 (18.2%)
	Help Those in Need	13 (11.6%)	8 (14%)	5 (9.1%)
	Normativity	8 (7.1%)	4 (7%)	4 (7.3%)
	Others' Requests	8 (7.1%)	8 (14%)	0 (0%)
	Enjoyment	7 (6.2%)	5 (8.8%)	2 (3.6%)
	Others' Virtue	5 (4.5%)	2 (3.5%)	3 (5.5%)
	Does not share	3 (2.7%)	1 (1.8%)	2 (3.6%)
	For Family	2 (1.8%)	2 (3.5%)	0 (0%)
	Others' Opinion/Complaint	2 (1.8%)	2 (3.5%)	0 (0%)
	Supernatural Punishment	1 (0.9%)	1 (1.8%)	0 (0%)

of responses[2]. We also fit three other models assessing the impact of gender, marital status, and both marital status and gender (the full model) on probability of listing each foraging motive among the top three.

The model which included gender was allotted most Akaike weight, followed by the baseline model (Table 5). Model weightings for the two models including marital status approximated zero, though only a minority of respondents (28.5%) were unmarried, potentially obfuscating small effects. We constructed a weighted-average posterior of the gender and baseline models (McElreath, 2016), presented in Table 6.

The probability of any particular category being chosen as a top-three motive by chance was 42.85%. Three categories - family-provisioning, skill-signaling and sharing - were chosen as top-three motives above chance by respondents of both genders (Figure 2). Additionally, women, but not men listed self-provisioning as a top-three foraging motive above chance. There were clear gender differences in these responses. Those categories with the largest absolute gender differences (Table 6) were, in order, family-provisioning (female μp 18 percentage-points higher), provisioning attractive opposite-sex recipients (male μp 14 percentage-points higher), self-provisioning (female mean p 14 percentage-points higher) and skill-signaling (male μp 13 percentage-points

[2]Results were typically ordered similarly in first ranked responses.

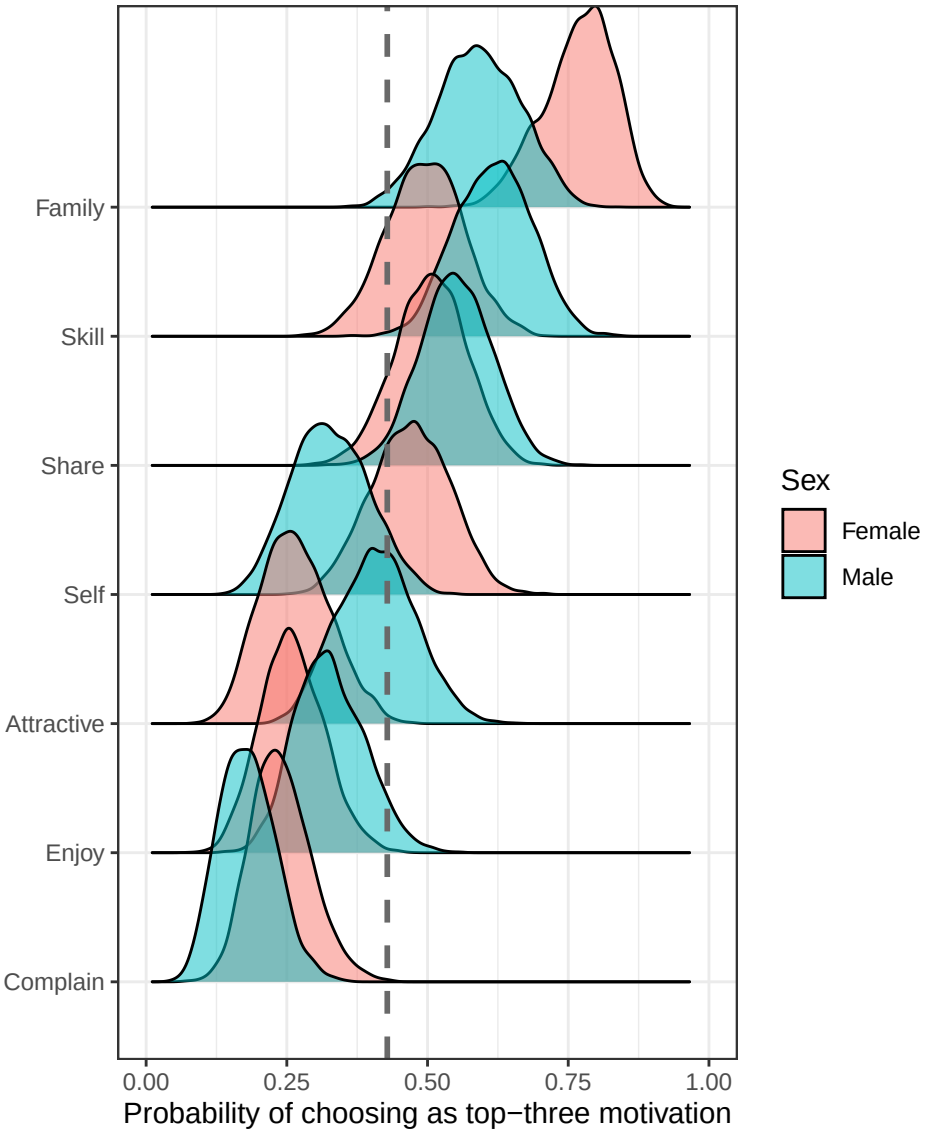

Figure 2: Ridge plot showing weighted-average posterior probability densities for all seven motive categories of being listed as a top-three foraging motive, ordered high to low by combined probabilities and disaggregated by gender. Dashed lines represent probability of choosing by chance.

Table 3: Yes/No/Don't Know Counts for Foraging (3.1) and Sharing (3.2) Motives

Table #	Motive	No	Yes	Don't Know
3.1: Foraging Motive				
	Enjoyment	1	109	0
	Complaints	2	108	0
	Demonstrate Skill	0	110	0
	Attractive Recipient	3	107	0
	Family-provisioning	1	109	0
	Self-provisioning	2	107	1
	Share With All	4	106	0
3.2: Sharing Motive				
	Reciprocity	1	109	0
	Complaints	4	106	0
	Demonstrate Generosity	1	109	0
	Demonstrate Skill	2	108	0
	Rot	1	109	0
	Requests	2	108	0
	Attractive Recipient	4	106	0

higher). The remaining categories had male and female mean probabilities within seven percentage-points of one another. With the exception of self- and opposite-sex provisioning, those categories that performed close to or above chance and those that performed below chance were the same across genders.

3.3.2. Sharing

Count and proportion data, presented in Table 7, showed that reciprocity was more often listed as a top-three motive than were all other motive categories. As with foraging, we ran a binomial (Bernoulli) regression estimating the probabilities of motive categories being listed among the top three. We fit three further models assessing the impact of gender, marital status and the full model on probability of listing each foraging motive among the top three. In a WAIC model selection Akaike weight was split between the baseline model and the model including marital status (Table 5), and the baseline model commanded the majority of Akaike weight. The model including gender and the full model had weights close to zero indicating that there were few important gender differences in self-reported sharing motive[3]. We constructed a weighted-average posterior of the baseline and marital status models (McElreath, 2016) which we analyze further (Table 8).

Three motive categories had above-chance (>42.85%) mean probabilities of being

[3]When considering first choices only, there were small gender differences in response (e.g. complaints and attractive recipients were chosen twice as often by men than women, while women were more likely to list others' requests (Table 7). However, there were too few observations to conduct meaningful statistical analysis on these data.

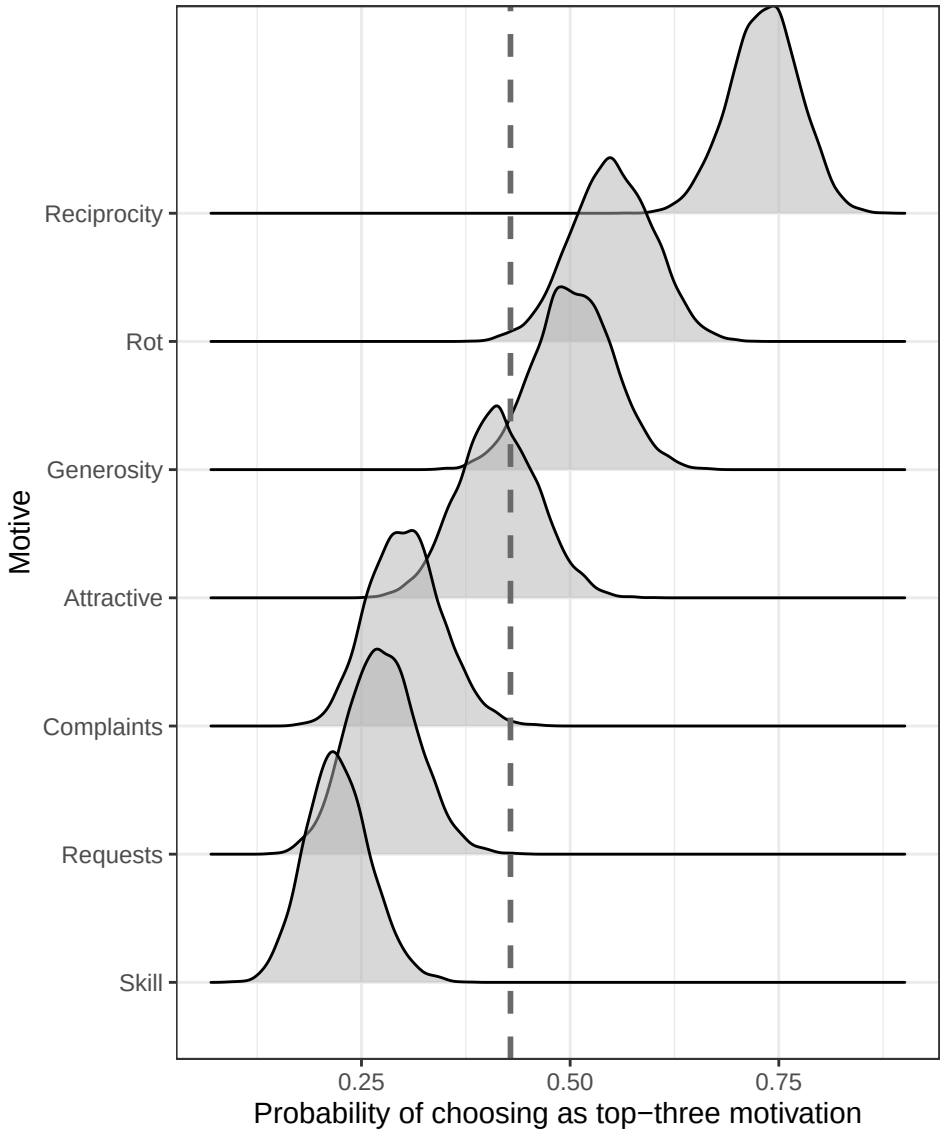

Figure 3: Ridge plots showing weighted-average posterior probability densities across all respondents for all seven motive categories of being listed as a top-three sharing motive, ordered high to low by combined probabilities. Dashed line represents probability of choosing by chance.

Table 4: Hunting and Gathering (Foraging) motivation ranking test results for for men (n= 54), women (n=56), married and all participants together (n = 110), with counts followed by row percentages in parentheses. First set of three rows shows first rated motive category, second set of three rows shows aggregated counts for first, second and third rankings.

	Family	Skill	Share	Self	Attractive	Enjoy	Complain
Women 1st	16 (28.6%)	13 (23.2%)	9 (16.1%)	9 (16.1%)	2 (3.6%)	3 (5.4%)	4 (7.1%)
Men 1st	9 (16.7%)	18 (33.3%)	7 (13%)	4 (7.4%)	7 (13%)	8 (14.8%)	1 (1.9%)
Unmarried 1st	6 (19.4%)	6 (19.4%)	5 (16.1%)	6 (19.4%)	2 (6.5%)	4 (12.9%)	2 (6.5%)
Married 1st	18 (23.1%)	25 (32.1%)	11 (14.1%)	7 (9%)	7 (9%)	7 (9%)	3 (3.8%)
All 1st	25 (22.7%)	31 (28.2%)	16 (14.5%)	13 (11.8%)	9 (8.2%)	11 (10%)	5 (4.5%)
Women Top 3	44 (78.6%)	27 (48.2%)	28 (50%)	27 (48.2%)	14 (25%)	14 (25%)	14 (25%)
Men Top 3	31 (57.4%)	34 (63%)	30 (55.6%)	17 (31.5%)	23 (42.6%)	18 (33.3%)	9 (16.7%)
Unmarried Top 3	19 (59.4%)	17 (53.1%)	19 (59.4%)	13 (40.6%)	15 (46.9%)	7 (21.9%)	6 (18.8%)
Married Top 3	56 (71.8%)	44 (56.4%)	39 (50%)	31 (39.7%)	22 (28.2%)	25 (32.1%)	17 (21.8%)
All Top 3	75 (68.2%)	61 (55.5%)	58 (52.7%)	44 (40%)	37 (33.6%)	32 (29.1%)	23 (20.9%)

Table 5: WAIC model selection results ordered by Akaike weights for Binomial regression models of probability of being rated a top-three motive category for i) foraging and ii) sharing.

	Model	WAIC	SE_{WAIC}	$_{PWAIC}$	Model Weights
5.1 Foraging Models					
	Gender	985.55	20.37	14.11	0.85
	Baseline	989.18	18.62	7.11	0.14
	Marital Status	995.65	19.56	13.95	0.01
	Full	996.65	22.17	27.57	0.00
5.2 Sharing Models					
	Baseline	966.30	19.85	7.14	0.81
	Marital Status	969.39	20.90	13.91	0.17
	Gender	973.92	20.76	14.07	0.02
	Full	983.22	22.59	27.73	0.00

listed as a top-three sharing motive (Figure 3). Reciprocity was overwhelmingly likely to be listed as a top-three motive category by all participants with a likelihood 19 percentage-points higher than the second most likely option. The risk of food rotting was the second most likely to be chosen as a top-three motive category, while the desire to demonstrate generosity was the third most likely category. Similar to the complaints motive in the foraging ranking task, both complaints and requests were unlikely to be listed and both had a probability of being chosen well below chance. In contrast to the high, above chance probability of skill being listed as a top-three motive for foraging, skill-signalling was the least likely category to be listed as a motivation for sharing. Responses between married and unmarried individuals were generally similar. In most cases mean probability of listing a particular motive category were within a percentage-point (Table 8). However, married individuals were slightly more likely to list the risk of food rotting as a top-three motive for sharing (1.4 percentage-points), whereas unmarried individuals were slightly more likely to list others' requests as a top-three motivation (1.2 percentage-points).

Table 6: Weighted-average mean posterior probabilities with 90% confidence intervals and %>chance of each motive category being chosen as a top-three foraging motive by all respondents combined, women and men.

	Combined			Women			Men		
	μP	90%HDI	%>.43	μP	90%HDI	%>.43	μP	90%HDI	%>.43
Family	0.68	0.47-0.86	99.4	0.77	0.64-0.88	100	0.59	0.45-0.73	98.7
Skill	0.56	0.39-0.73	91.4	0.49	0.36-0.63	83.0	0.62	0.49-0.75	99.8
Share	0.53	0.40-0.66	92.9	0.51	0.38-0.63	88.6	0.55	0.42-0.67	97.2
Self	0.40	0.22-0.58	39.6	0.47	0.34-0.60	71.7	0.33	0.20-0.46	7.5
Attractive	0.34	0.16-0.52	20.3	0.27	0.14-0.38	0.4	0.41	0.28-0.54	40.1
Enjoy	0.29	0.16-0.43	3.0	0.26	0.15-0.37	0.2	0.33	0.21-0.45	5.9
Complain	0.21	0.10-0.32	0.0	0.24	0.14-0.35	0.1	0.18	0.08-0.27	0.0

Table 7: Sharing motivation ranking test results for for men (n= 54), women (n=55) and all participants together (n = 109), with counts followed by row percentages in parentheses. First ranked motives above, top three ranked motives below.

	Reciprocity	Generosity	Rot	Attractive	Complaints	Requests	Skill
Women 1st	21 (38.2%)	8 (14.5%)	9 (16.4%)	3 (5.5%)	3 (5.5%)	7 (12.7%)	4 (7.3%)
Men 1st	20 (37%)	10 (18.5%)	7 (13%)	6 (11.1%)	6 (11.1%)	1 (1.9%)	4 (7.4%)
Unmarried 1st	7 (22.6%)	8 (25.8%)	3 (9.7%)	1 (3.2%)	4 (12.9%)	6 (19.4%)	2 (6.5%)
Married 1st	33 (42.9%)	10 (13%)	13 (16.9%)	8 (10.4%)	5 (6.5%)	2 (2.6%)	6 (7.8%)
All 1st	41 (37.6%)	18 (16.5%)	16 (14.7%)	9 (8.3%)	9 (8.3%)	8 (7.3%)	8 (7.3%)
Women Top 3	41 (74.5%)	23 (41.8%)	32 (58.2%)	25 (45.5%)	17 (30.9%)	17 (30.9%)	10 (18.2%)
Men Top 3	39 (72.2%)	32 (59.3%)	28 (51.9%)	20 (37%)	16 (29.6%)	13 (24.1%)	14 (25.9%)
Unmarried Top 3	21 (65.6%)	15 (46.9%)	13 (40.6%)	14 (43.8%)	11 (34.4%)	13 (40.6%)	9 (28.1%)
Married Top 3	59 (76.6%)	40 (51.9%)	47 (61%)	31 (40.3%)	22 (28.6%)	17 (22.1%)	15 (19.5%)
All Top 3	80 (73.4%)	55 (50.5%)	60 (55%)	45 (41.3%)	33 (30.3%)	30 (27.5%)	24 (22%)

3.4. Forced-Choice Results

3.4.1. Hunting/Gathering

We conducted three forced-choice tasks relating to foraging motive. For each we estimated the probabilities of participants listing one of the motive categories over the other in a binomial regression. We fit three further models assessing the impact of gender, marital status and both gender and marital status on this choice. We compared model weights for each set of forced-choice results and created weighted averaged models from the best models for each. Results were consistent with those from the foraging motive ranking task.

A majority (66.4%) of respondents reported that the desire to share food with everyone in camp was a more important motivator than the desire to avoid complaints (Table 9). For this choice, the model including marital status was attributed the most model weight (0.54), followed by the full model (0.21), the baseline model (0.18) then the model including sex (0.07). We constructed a weighted averaged posterior across all four models. Unmarried men and women were 6% and 4% more likely than chance to choose sharing over complaints, while married men and women were 21% and 20% more likely (Table 10.1).

A minority (28.2%) reported that procuring food for attractive opposite-sex recip-

Table 8: Weighted-average mean posterior probabilities with 90% confidence intervals and %>chance of each motive category being chosen as a top-three sharing motive by all respondents combined, by unmarried respondents and by married respondents.

	Combined			Unmarried			Married		
	μP	90%HDI	%>.43	μP	90%HDI	%>.43	μP	90%HDI	%>.43
Reciprocity	0.73	0.63-0.83	100	0.72	0.59-0.83	99.9	0.74	0.65-0.82	100
Rot	0.54	0.40-0.67	94.1	0.53	0.35-0.65	88.9	0.56	0.46-0.67	99.4
Generosity	0.50	0.40-0.61	92.2	0.50	0.38-0.60	89.9	0.51	0.41-0.60	94.5
Attractive	0.41	0.32-0.52	38	0.42	0.31-0.54	40.2	0.41	0.32-0.51	35.7
Complaints	0.30	0.21-0.41	1.8	0.31	0.21-0.42	3.2	0.30	0.21-0.39	0.4
Requests	0.28	0.17-0.40	2.6	0.29	0.18-0.44	5.1	0.27	0.18-0.35	0.1
Skill	0.23	0.13-0.32	0.3	0.23	0.14-0.35	0.6	0.22	0.14-0.30	0.0

ients was more important than family-provisioning (Table 9). The baseline model was attributed most model weight (0.53), followed by the model including marital status (0.21), the model including gender (0.19), and the full model (0.07). We constructed a weighted averaged posterior across all four models. Mean probabilities were similar across all four categories: Unmarried men were 22% less likely than chance to choose provisioning opposite-sex recipients over family-provisioning, as were married men and married women. Unmarried women were 21% less likely (Table 10.2). Although more unmarried individuals reported that family-provisioning was more important than provisioning potential partners than expected, it should be noted that 18/31 unmarried participants had living children and 24/31 reported a household size of two or more (including siblings and sometimes close friends).

Forty six percent reported that getting food to share with others was a more important foraging motivation than getting food for themselves (Table 9). For this choice, the model including gender (0.38) and the baseline model (0.31) were attributed most Akaike weight, with the remainder split between the full model (0.16) and the model including marital status (0.15). We constructed a weighted averaged posterior across all four models. Here single men were only 1% less likely than chance to choose sharing over self-provisioning, married men were 1% more likely, single women were 9% less likely, and married women were 7% less likely (Table 10.3).

3.4.2. Sharing

We conducted four forced-choice tasks relating to sharing motive. As above we compared four models and created a weighted average model from the best. Results were consistent with those from the foraging motive ranking task.

The majority (78%) of respondents reported that reciprocity was a more important motivation than the desire to avoid complaints (Table 9). Here the model including marital status was allotted the most model weight (0.55) followed by the full model (0.21) the baseline (0.18) and the model including gender (0.06). Both single men and women were 18% more likely than chance to choose reciprocity. Both married men and married women were 32% more likely than chance to choose reciprocity (Table 10.4).

Table 9: Forced-choice task results for three pairs of foraging motives (#1-3) and four pairs of sharing motives (#4-7), both combined and nonsegregated by respondent gender. Raw counts, followed by percentages in parentheses. Results for choice 1 first, followed by those for choice 2.

		Choice 1			Choice 2		
#	Choice	All	Men	Women	All	Men	Women
1	Share (1) or Complain (1)	73 (66.4%)	37 (68.5%)	36 (64.3%)	37 (33.6%)	17 (31.5%)	20 (35.7%)
2	Opposite Sex (1) or Family (2)	31 (28.2%)	15 (27.8%)	16 (28.6%)	79 (71.8%)	39 (72.2%)	40 (71.4%)
3	Share (1) or Self Provision (2)	51 (46.4%)	29 (53.7%)	22 (39.3%)	59 (53.6%)	25 (46.3%)	34 (60.7%)
4	Reciprocity (1) or Complaints	85 (78%)	42 (77.8%)	43 (78.2%)	24 (22%)	12 (22.2%)	12 (21.8%)
5	Reciprocity (1) or Opposite Sex (2)	68 (62.4%)	35 (64.8%)	33 (60%)	41 (37.6%)	19 (35.2%)	22 (40%)
6	Complaints (1) or Opposite Sex (2)	46 (42.2%)	17 (31.5%)	29 (52.7%)	63 (57.8%)	37 (68.5%)	26 (47.3%)
7	Show Generosity (1) or Show Skill (2)	63 (57.8%)	33 (61.1%)	30 (54.5%)	46 (42.2%)	21 (38.9%)	25 (45.5%)

Table 10: Weighted-average mean posterior probabilities with 90% confidence intervals, and % of distribution >.5 for first-listed motive being chosen over second-listed motive in all seven forced choice tasks, by sex and marital status.

Table #	Category	μP	90%HDI	%p>.5
Foraging Choices				
10.1 Share over Complaints				
	Single Men	0.56	0.36-0.73	69.9
	Married Men	0.71	0.6-0.82	100
	Single Women	0.54	0.36-0.73	65.7
	Married Women	0.7	0.59-0.81	99.9
10.2 Opposite Sex over Family				
	Single Men	0.28	0.16-0.4	0.3
	Married Men	0.28	0.19-0.38	0
	Single Women	0.29	0.18-0.41	0.2
	Married Women	0.28	0.19-0.38	0
10.3 Share over Self				
	Single Men	0.49	0.33-0.66	43.3
	Married Men	0.51	0.38-0.65	50.8
	Single Women	0.41	0.25-0.55	13.2
	Married Women	0.43	0.3-0.57	16.4
Sharing Choices				
10.4 Reciprocity over Complaints				
	Single Men	0.68	0.5-0.85	96.2
	Married Men	0.82	0.72-0.91	100
	Single Women	0.68	0.51-0.85	96.6
	Married Women	0.82	0.73-0.91	100
10.5 Reciprocity over Opposite Sex				
	Single Men	0.58	0.38-0.73	80.1
	Married Men	0.65	0.54-0.77	99.3
	Single Women	0.56	0.38-0.72	76.9
	Married Women	0.64	0.51-0.75	98.7
10.6 Complaints over Opposite Sex				
	Single Men	0.36	0.2-0.52	5.6
	Married Men	0.33	0.2-0.48	1
	Single Women	0.52	0.36-0.7	60.2
	Married Women	0.5	0.35-0.65	49.9
10.7 Show Generosity over Skill				
	Single Men	0.59	0.45-0.72	92.2
	Married Men	0.59	0.48-0.7	94.6
	Single Women	0.57	0.43-0.7	86.3
	Married Women	0.57	0.46-0.68	88.5

The majority (62.4%) reported that reciprocity was a more important motivator than provisioning attractive opposite-sex recipients. The model including marital status was allotted most model weight (0.36) followed by the baseline model (0.35) followed by the models including gender (0.15) and the full model (0.15). Single men were 8% more likely than chance to choose reciprocity, single women 6% more likely, married men 15% more likely and married women 14% more likely (Table 10.5).

A minority (42.2%) reported that complaints were a more important motivator for sharing than was provisioning attractive opposite-sex recipients. The gender model commanded the most model weight (0.56), followed by the full model (0.26), the baseline model (0.12) and the marital status model (0.06). Single men were 14% less likely than chance to choose complaints, married men 17% less likely. Married women were no less likely chance to choose complaints while single women were 2% more likely (Table 10.6).

Finally, the majority (57%) reported that generosity-signaling was a more important motive for sharing than skill-signaling. Here the baseline model was allotted most Akaike weight (0.51), followed by the gender model (0.23), the marriage model (0.18) and the full model (0.08). Single men and married men were both 9% more likely than chance to choose generosity-signaling, while single and married women were 7% more likely (Table 10.7).

4. Discussion

This study yielded five important findings. First, we found good evidence that many of the motives generated by theorists were endorsed and often independently mentioned by participants. Second, we found that, while there were clear gender differences in foraging motive, mens' and women's responses were more similar than different. Third, we found good evidence that reciprocity was seen as an important motivation for sharing across tasks. Fourth, few participants perceived requests and complains as an important motive for either foraging or sharing. Finally, free-response questions yielded several other motive categories which are less often considered. We discuss these findings in turn.

4.1. Were Motives Endorsed by Participants?

The first study aim was to ascertain whether adaptive motives attributed to foragers by evolutionary theorists were endorsed by participants. The free-response task provided good evidence that most were. The majority of respondents reported the proximate goal of foraging - to get food - without specifying a reason or a recipient, a common trend in Hadza self-report data (e.g., Apicella et al., 2018). However, except for 'opposite-sex provisioning' and 'complaint' motives, each foraging motive (Table 2) was independently mentioned in the free-response task. Similarly, all sharing motives were provided at least once except for 'signaling', 'opposite-sex provisioning', and 'food spoiling'. Participants also provided some additional motives in free-response tasks, including appeals to morality (personal virtue) and normativity. We discuss these further in Sections 4.3 and 4.5.

In the yes/no task the preponderance of 'Yes' responses was far above chance (Table 1). These findings could suggest that participants recognized and endorsed key theory-derived motives. However we could not rule out the possibility that informants were answering 'Yes' to most questions, regardless of content.

4.2. Cooperation, Conflict and Bateman's Principle

The second study aim was to examine self-reported gender differences in foraging motive. Many forager populations, including the Hadza, have strong gender differences in resource acquisition. Men in many populations systematically target resources that are more prone to daily shortfall, while women often (Codding et al., 2011) though not exclusively (Starkweather et al., 2020) prioritize more reliably-attained resources. Among the Hadza, women acquire most plant-based resources, including tubers, berries, and fruit, while men acquire the majority of game (large and small) and most honey. Honey and meat are not only typically more widely shared than plant foods, they are also less reliably attained. While estimates vary, large game are brought into camp on only 0.97-3% of days (Hawkes, 1991a; Wood & Marlowe, 2013). Honey is acquired more often - once every 2.7 days and 9.3 days in the wet and dry seasons respectively (Wood & Marlowe, 2014) - but is still less reliably attained than most plants. Differences in both resource acquisition patterns (Crittenden et al., 2013; Lew-Levy et al., 2018) and proclivity for risk-seeking (Apicella et al., 2017) are apparent among Hadza children from a young age.

Many have proposed that such differences are due to gendered asymmetries in foraging fitness payoff (Kaplan & Hill, 1985; Hawkes, 1991b, 1996; Hawkes et al., 2018). It has been proposed that men have more to gain by signaling or redistributing resources widely relative to women (Hawkes et al., 2018), due to a higher potential reproductive rate and a lower direct cost of reproduction (i.e., Bateman's principles). Other authors have cast the sexual division of foraging labor as an example of inter-sexual cooperation, not competition: Men and women specialize in diverse sets of resources to best provision their own households (Marlowe, 2003; Wood, 2006; Wood & Marlowe, 2013; Kelly, 2013; Wood & Marlowe, 2014). Moreover, some recent research has questioned the universal explanatory power of Bateman's principle(s) in studies of human behavior (Brown et al., 2009; Mulder & Ross, 2019) and the universality of gendered risk preferences (Starkweather et al., 2020). Finally, much research has proposed that women may also be motivated by signaling (e.g., Bliege Bird & Power, 2015; Barker et al., 2019). Our findings lend credence to both sides of this debate.

Gender differences in response are almost exactly in line with predicted gendered asymmetries in fitness payoff (e.g., Hawkes, 1991b, 1996; Hawkes et al., 2018): Women are more likely to list family-provisioning as a top motivator than men. Moreover, men are more likely to highlight the importance of skill-signaling and of provisioning attractive opposite-sex recipients than are women (Figure 2) both in the ranking task and when compared to 'complaints' in a forced-choice task. Furthermore, men were less likely than women to list self-provisioning as an important motive.

However, although these gender differences were statistically real, they were not large. Overall, men and women's reported motivations were more similar than different. Family-provisioning, although less important for men than women, was still the

second most important of all motive categories for men in both ranking and forced-choice tasks and was the second most frequently mentioned by both sexes in the free-response task. This finding runs contrary to research that has identified few benefits for the families of good Hadza hunters (e.g., Hawkes et al., 1991; Blurton Jones, 2016; Stibbard-Hawkes et al., 2020). Furthermore, household provisioning and skill-signaling have often been presented as competing and, perhaps, mutually exclusive motives (Hawkes et al., 2001b; Wood, 2006; Wood & Marlowe, 2014; Hawkes et al., 2018). However, in our study, 32% of men listed both skill-signaling *and* family-provisioning as a top-three motivation. It appears probable, from current findings, that men's foraging patterns may be motivated by *both* family-provisioning and signaling concerns - and hunting and sharing decisions may not be 'monocausal' (Gurven & Hill, 2009, p.62).

Moreover, although skill-signaling was less important for women than for men, it was still the third most important motive for women's foraging overall, similarly important to sharing. Many have proposed that foraging may have signaling value for women (Bliege Bird & Power, 2015; Barker et al., 2019). Current results support this possibility. This aligns with previous reports that Hadza men place high value on the foraging skills of a prospective partner (35% of Hadza men cited 'good forager' as an important partner trait, while only 7% would prefer an attractive partner over a good forager, see Marlowe 2004a; Apicella & Crittenden 2015). This finding is especially noteworthy as Hadza women's foraging is typically a group activity (Berbesque et al., 2016; Stibbard-Hawkes et al., 2018) where foraging proficiency can be directly observed by peers and may thus be signaled more reliably.

Finally, we note that, while skill signalling has traditionally been framed as antithetical to family provisioning (e.g. Hawkes et al., 2018), in the context of serial monogamy, there may yet be benefits in directing skill signalling effort towards one's spouse or affines (Dyble et al., 2018). This may be especially true of resources foraged by women, which are often less widely shared beyond the household, though there is contested evidence that Hadza men's families get a preferential share of his hunting income also (Wood & Marlowe 2013 but see Blurton Jones 2016; Stibbard-Hawkes et al. 2020). Although our method stressed generalised skill signalling ('I hunt/gather because I want to show *everyone* I am skilled'), present results leave open the possibility that family provisioning and skill signalling may not be wholly mutually exclusive.

4.3. Reciprocity and Needs-Based Sharing

A third study aim was to assess the importance placed by participants on reciprocity (Trivers, 1971) as a motive for sharing. The extent to which reciprocity motivates food-sharing has been debated. Reciprocal sharing requires contingency, i.e., the expectation that food given will be repaid. Many authors have contended that for the Hadza, food is a 'public goods' (Woodburn, 1998; Hawkes et al., 2010, 2018) and thus cannot be 'exchanged'. There is evidence of reciprocity in Hadza food allocation tasks (Apicella et al., 2012). Moreover, Gurven (2004b), in a reanalysis of data collected by Hawkes et al. (2001b), reported contingency in Hadza food-sharing (Gurven & Hill, 2009). However, Hawkes et al. (2010) demonstrated, with a straightforward mathematical model, that this finding was an artifact of observation bias at the camp

level. The true extent of reciprocity in Hadza food-sharing is unknown. As reciprocity requires that people keep track of obligations, it likely to be salient and is a good target for direct inquiry.

In the current study, we found that participants placed great importance upon reciprocal exchange as a food-sharing motive. This was clear in the free-response task where reciprocity was the joint second most common reason for sharing after personal virtue and in line with friendship/familiarity. It was also apparent in the ranking task where individuals of both genders were more likely to choose reciprocity as a motivation for sharing than any other motive. The images used to illustrate reciprocity (Figure 1) clearly depicted like-for-like reciprocal exchanges, where donors were repaid in kind. The wording also emphasized in-kind reciprocity.

Helping those in need has often been conceptualized as a form of 'risk-reduction reciprocity' (Winterhalder, 2001) - food given to others can act as an insurance policy and debts can be recalled when the producer suffers a shortfall. However, some researchers avoid using terms like 'generalized reciprocity' because although the terms 'overlap with some cases of need-based transfer, they do not describe the kinds of formal, contractual risk-pooling arrangements' observed in many populations (Cronk et al., 2019, p.36). While the ranking and forced choice task did not distinguish needs-based transfers from other forms of sharing (Table 1), 11% of respondents in the free-response task stated that they shared food to help those in need (e.g., 'I share with hungry people'; 'I help [those] who do not have food').

Finally 15.2% of respondents reported that they liked to share with their friends, or individuals beyond their nuclear families who were familiar to them (e.g., 'because we like each other', 'because we are friends'). This corresponds with evidence that food-sharing helps maintain friendships (Kent, 1993; Wiessner, 2002), fosters cooperative relationships (Smith et al. 2018, though contra Smith et al. 2019; Smith 2019), increases interaction rates (Hill et al., 2014) and bolsters the sharer's position in a social network (Bird et al., 2012).

It is argued that reciprocity cannot exist under a system where individual producers maintain little control over the distribution of their own foraging returns (Bliege Bird & Power, 2015; Hawkes et al., 2014). In the current study, although we did not ask directly about producer control, no-one took issue with the idea that people could share the food they had procured. In free responses, people stressed the importance of in-kind reciprocity, need-based giving and giving to friends, while three respondents stated that they did not share food at all. Current findings do not provide granular differences (e.g., Smith et al., 2019) between the relative importance of in-kind reciprocity, need-based sharing and affiliative sharing. However, each of these motives was clearly perceived as important.

4.4. Demand-Sharing

Finally, we also assessed the perceived importance of 'demand sharing'. Reports of 'demand sharing' (Peterson, 1993) are commonplace both in accounts of Hadza food redistribution (Woodburn, 1982; Marlowe, 2010; Lewis et al., 2014) and more broadly (Lee, 1979; Wiessner, 2009; Kelly, 2013). The tolerated theft hypothesis (Blurton

Jones, 1984), also predicts that food-sharing is motivated by demands from hungry peers (Blurton Jones, 1991).

Each of the authors has independently witnessed Hadza demand sharing first-hand, and have observed that requests for food can be both vociferous and successful. Moreover, instances of demand-based sharing were observed during the study period.

Others' requests and others' complaints were highlighted as a motive for sharing by a number of respondents in the free-response task. It is surprising, therefore, that in the present study, 'requests' and 'complaints' were uniformly the lowest chosen options in both ranking tasks. Moreover, complaints were always the least chosen options in all three forced-choice tasks in which they appeared (Table 9), and notably low compared to reciprocity (see Kaplan et al., 2018). It is possible that demands from peers are so commonplace that they are not salient. It is further possible that participants did not wish to cast aspersions on camp-mates, although elsewhere Hadza participants have typically been willing to speak their minds (e.g., Marlowe, 2010). It is additionally possible that, in the context of an interview, participants may not wish to endorse appeasing complainants, even though complaints do shape real-world behavior. Weariness of demand-sharing has been proposed to account for historically low modal offers in dictator and ultimatum games (Marlowe, 2005a), which also diverge from real-world food-sharing patterns.

It should be emphasized that both ranking and forced-choice tasks provided perceived *relative* importance of hunting and sharing motives. Although complaints and demands were seen as less important than other motives, both may still motivate sharing.

4.5. Additional Motives

In addition to need-based and affiliative sharing, the free-response task also revealed several further categories of foraging and sharing motive not included in the ranking tasks.

The most often highlighted motives for both hunting and sharing were moralistic (e.g., 'because I have a good heart'[4]) or appeals to normativity (e.g., 'because I am [a] man'; 'that is [the] Hadza way'). Additionally, five respondents highlighted the importance of sharing to reward others' virtue. Although moral norms are extensively considered in theoretical accounts of the cultural evolution of human cooperation (reviewed by Apicella & Silk, 2019; Smith, 2020; Henrich & Muthukrishna, 2021), human behavioral ecologists have often preferred accounts of behavior that invoke individual utility (e.g., see Pinheiro, 2021; Stibbard-Hawkes & Attenborough, 2021).

Relatedly, one respondent highlighted supernatural punishment as a motivator for sharing. Much research has linked supernatural punishment to cooperation (Henrich et al., 2010; Purzycki et al., 2016) and there is some evidence that exposure to Abrahamic religions is associated with a slight decrease in proclivity for rule-bending among the study population (Apicella, 2018), although elsewhere evidence for a link between

[4]A good heart is a general Hadza moral character trait (Smith & Apicella, 2020a). The heart is also the body part most associated with hunting skill (Apicella, 2014).

missionary exposure and cooperativeness has been equivocal (Stagnaro et al., 2021). As only one respondent highlighted supernatural punishment, it is not of primary importance, though merits consideration.

Data collection was almost exclusively conducted in bush camps. However, informal discussions with individuals in market adjacent camps indicated that many hunting trips are primarily conducted with tourists as a money-making exercise. This will continue to have impacts on traditional hunting and sharing practices. Subsistence transitions, both among the Hadza (Pollom et al., 2020) and elsewhere (Gurven et al., 2002; Page et al., 2016), merit continued scholarly attention.

With these exceptions, we are content that the ranking and forced-choice tasks captured the most important foraging and sharing motivations - although the additional findings highlight the benefit of free-response tasks in assessments of motive.

4.6. Limitations

4.6.1. Participant Comprehension and Interpretation

We had three concerns related to participant comprehension. First, the field investigator noticed that in several cases participants were disengaged with the yes/no task. We have interpreted yes/no results with caution.

Second, while we explained each motive in detail, multiple times, we included no comprehension checks. As wording was simple and straightforward, we are confident that participants broadly understood the motive categories. However, to further address this concern, we conducted two internal validity checks. The first compared the ordering of motives on the ranking task to decisions on the forced-choice task. Here, participants who gave preference to one motive over another on the ranking task were substantially more likely to give preference to that same motive on the forced-choice task. The second validity check, compared the results of the free-response and ranking tasks. We found that those who listed reciprocity as a sharing motive or family provisioning as a foraging motive in the free-response task were slightly more likely to list these as top 3 motives in the ranking task (although distributions substantially overlapped). Validity-check results are reported and discussed further in ESM §3. While these validity checks do not demonstrate that every participant interpreted every motive category in the same way as all other participants, they imply that participants' mental models were consistent between tasks.

Third, to minimize participant fatigue, we did not ask follow-up questions. For this reason, present data cannot address some issues of interpretation. For example, we cannot comment on how participants interpreted 'foraging skill' or others' 'complaints'. When we used broad designations for sharing and signalling recipients (i.e., 'others', 'everyone') we cannot be sure that participants interpreted these broadly, as intended, or more narrowly. Moreover, although study materials pictured men acquiring/sharing large game meat and women acquiring/sharing boabab pods and tubers, we do not know whether participants interpreted questions as referencing these particular resources. As, for example, honey, small game and large game are each attained and shared somewhat differently, (Hawkes et al., 2001a; Wood & Marlowe, 2014; Marlowe et al., 2014a) this is potentially significant. Issues of interpretation are not exclusive

to the present study, and are, to a degree, unavoidable. However, they yet represent an important limitation.

4.6.2. Causation and Introspective Access

There are two important reasons that evolutionary researchers seldom ask participants to comment directly on the motives underlying behavior. Firstly, there is an extensive literature demonstrating that people have only imperfect access to the processes of their own decision-making (Libet, 1985; Frith & Haggard, 2018) and may systematically create post-hoc rationalizations (i.e., confabulation) for their own actions (Nisbett & Wilson, 1977; Wrangham, 1999; Trivers et al., 2006) and/or be blind to numerous hidden biases that cryptically influence decision making (Nisbett & Wilson, 1977). Secondly, 'motivation' may be considered at various levels of causality, both proximate and ultimate (see Bateson & Laland, 2013). Proximate motivations are generally more salient to decision-makers themselves. However evolutionary scientists are often concerned with answering 'ultimate'-level questions about the adaptive function of behavior.

Both these are valid reasons to treat self-reported motives with caution. However, neither obviate direct assessments of motive. First, although individuals have *imperfect* access to their own motivations, none have claimed that individuals have 'no' access (Nisbett & Wilson, 1977). Indeed, recent research has found that people do have some introspective access to the processes underlying their own decision making (Reyes & Sackur, 2018). The proximate 'emotive' mechanisms that regulate our behavior can often be introspectively identified as can the current utility. Indeed, some limited introspective access to one's own motives is of clear adaptive utility, for example in working towards desired future outcomes, communicating intent, and recognizing the intentions and predicting the behavior of others.

We do not claim that current responses are definitive, nor that respondents have perfect access to their own motives, either proximate or ultimate. The current study asked about first order beliefs only - why do *you* hunt, gather and share. This made questions direct and easy-to-answer, but also risked introducing biases and social desirability effects. It would be enlightening to investigate second-order beliefs (e.g., what motivates others to share?; Do men hunt to impress women?). It would further enable us to directly address theoretically important trade-offs (e.g., why do women primarily gather instead of hunting?). This may be a fruitful avenue for future research.

Despite these limitations, we yet contend that self-reports of motive should be seriously considered alongside other categories of evidence. In addition to moral imperatives for involving participants in theory generation (e.g., Broesch et al., 2020), there are good scientific reasons to do so (Berry et al., 2013), especially where findings support existing research.

5. Conclusions

The current study yields several important findings. Responses confirm that many of the motives drawn from the academic literature on Hadza hunting, gathering and

sharing were recognized and often independently suggested. Rankings of foraging motive showed clear gender differences, supporting the prediction that at least some of the differences between men's and women's resource prioritisation and risk tolerance (see Codding et al., 2011; Crittenden et al., 2013; Apicella et al., 2017) are structured by non-overlapping incentives (Hawkes et al., 2018). However, although these trends were real and in the expected directions, contrary to the expectation that men and women had entirely conflicting motivations, gender differences were small: Men and women both placed substantial importance on skill-signaling, nuclear-family-provisioning and sharing beyond the household. Results suggest that sex-differences in motive are genuine, yet may have historically been overemphasized.

In both free-response, ranking and forced-choice tasks, respondents perceived foraging and sharing motive very differently. Skill-signaling was a key motive for foraging across genders, but was the least likely motive to be listed as a reason for sharing, substantially behind generosity-signaling. In-kind reciprocity was a greatly more important motivator for food-sharing across all respondents than was any other motive. Ranking and forced-choice tasks did not allow participants to choose between in-kind reciprocity, need-based sharing and sharing based on friendship/familiarity, although free-response questions revealed that each was important. Many models stress the importance of reciprocity (Gurven, 2004b; Crittenden & Zes, 2015), needs-based sharing (Smith et al., 2019; Cronk et al., 2019) and cooperative production (Kaplan et al., 2009). Present results suggest that these emphases are warranted.

Finally, contrary to numerous reports of 'demand sharing' and against the expectations of the authors, neither complaints nor requests for food were perceived as relatively important motivators of either foraging or food-sharing.

Present findings support several sometimes-competing theories of foraging and sharing motivation, including both the family-provisioning *and* skill-signaling models of foraging effort, as well as theories of reciprocal food-sharing. The plurality of motives support those models which emphasize that people face multiple sometimes competing incentives and trade-offs (e.g. Gurven & Hill, 2009). While self-report accounts of motivation are subject to error and bias, the present study yet supports the idea that foraging and food-sharing are multi-causal.

Despite some barriers to interpretation, the findings highlight the value of mixed methods in addressing unresolved questions. In future research, similar methodologies may prove useful in addressing other important academic debates. For example, to what extent do food producers feel able to control the distributions of their production, and does this differ by resource type (see Kaplan & Gurven, 2005; Hawkes et al., 2014)? By their own accounts, do men deliberately prioritise larger game animals (Hawkes et al., 2018) or do they try to maximise meat acquisition (see Wood & Marlowe, 2014)? Given the choice, would foragers prefer to direct resources towards the common pot (Hawkes & Bird, 2002), or preferentially provision their nuclear families (Wood & Marlowe, 2013)? Of course, self-report data cannot substitute rigorous experimental, and cross-sectional quantitative research. Instead, such methods are complimentary. They afford participants a voice in research, offer a valuable and rich source of local contextual information and create opportunities for new discoveries.

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