

ORIGINAL ARTICLE

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Male care and mating effort among Hadza foragers

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Abstract Paternal care figures prominently in many scenarios of human evolution. Recently, however, such scenarios have been challenged on two scores. First, the level of male contribution may be insignificant. Second, male care may be provided as a form of mating effort, rather than parenting effort. In theory, since men can enhance their Darwinian fitness both by providing care to their own offspring if this raises offspring fitness and by pursuing additional mates if this leads to additional offspring, men should respond to payoffs from both mating and parenting effort. If men respond to payoffs from parenting effort, paternity ought to make a difference. And if men respond to payoffs from mating effort, mating opportunities ought to make a difference. I analyzed the impact of these two factors on variation in male care among the Hadza, a foraging society in Tanzania. Two predictions were tested: (1) biological children will receive more care than stepchildren, and (2) men will provide less care to their biological children as their mating opportunities increase. Both predictions were supported. These results suggest men provide care, in part, as parenting effort, and that they trade off parenting effort for mating effort when they have greater mating opportunities.

Key words Male care · Parenting effort · Mating effort · Resource acquisition · Foragers

Introduction

Parental investment in offspring may enhance the fitness of a parent if it raises offspring survivorship, but the cost

of such investment is reduced time and energy available to invest in additional offspring and in pursuit of mates. There should, therefore, be a trade-off between parenting and mating effort (Trivers 1972). Some anthropologists, however, have recently suggested that the care men give their children, which may appear to be parenting effort, is simply a form of mating effort (Hawkes et al. 1995; van Schaik and Paul 1996). To test whether male care is partly parenting effort that is traded off for mating effort, I investigated male care among the Hadza, a foraging society in Tanzania. I will show that Hadza men appear to alter their level of care in response to potential payoffs from both parenting and mating effort.

If males provide care in order to benefit young, we would expect them to direct their care to their own offspring, (or close relatives). There is some evidence that paternity confidence influences male parental behavior among birds (Møller and Birkhead 1993; for a review see Westneat and Sargent 1996). There is also evidence that men interact more with biological children than stepchildren (Flinn 1992), and that men are more likely to abuse stepchildren (Daly and Wilson 1985). However, males may provide care for other reasons. Care provided to a known stepchild, for example, might be exchanged for sexual access to the child's mother, and thus be considered as mating effort. Based on the results of several primate studies, Smuts and Gubernick (1992) concluded that friendships between males and females (which often led to future mating) predicted male caring behavior better than did likelihood of paternity.

In theory, men stand to gain fitness benefits by providing care to their own children. Consequently, we might expect men's behavior to vary in response to the paternity status of children. Men also stand to gain fitness benefits by pursuing additional mates as the number of potential mates increases. Therefore, we might expect men's behavior to vary in response to the number of potential mates present (Hurtado and Hill 1992). Time spent pursuing mates should subtract from the time available for parenting effort (if such exists). Consequently, men might spend less time providing care to

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their own children where they have more potential mates.

This study was designed to test whether men's behavior is influenced by payoffs from both mating and parenting effort, what could be called, "the parenting *and* mating effort hypothesis" as opposed to "the all mating effort hypothesis." If male care were given only as mating effort, we would not expect biological children to receive any more care than stepchildren. However, as long as care is provided in part as parenting effort, one can predict:

- (1) Biological children will receive more male care than stepchildren, all else being equal.

This is because a man providing care to his biological children can receive fitness payoffs not only from continued access to his mate, but also from the enhanced fitness of his offspring. A man providing care to his stepchildren receives fitness payoffs only from continued access to his mate. "All else being equal," assumes age of child and residence are controlled. If biological children receive more care than stepchildren, male care must be partly parenting effort.

But do men respond to potential payoffs from extramarital mating effort? If so, as potential payoffs from mating effort increase, so should men's allocation of time to mating effort. If we assume that all of a man's budget (excluding somatic effort) is allocated either to parenting or mating effort, and that these are mutually exclusive, then if care is provided, in part, as parenting effort, one can also predict:

- (2) Men will provide less care to their biological children as their mating opportunities increase, all else being equal.

The reason for this can be appreciated with a thought experiment. Imagine a man has a biological child but no mating opportunities: he and his child are alone on an island. As long as care enhances the fitness of his child, he should invest in parenting up to the point of no marginal benefit. As the number of women arriving on the island increases, he should allocate more and more of his time and energy budget to mating effort. Thus, his level of paternal care should drop, the lower limit being the point at which no children survive without his care.

Parental care can be divided into direct care, involving direct interaction between parent and child, and indirect care, involving such things as resource acquisition (Kleiman and Malcolm 1981). I measured both time spent in direct care and time spent foraging, as well as weight and calories of food brought into camp by men. If men who spend more time interacting with their children also spend less time and effort acquiring food for their children, it would be difficult to assess the overall amount of care given by men. Consequently, I tested whether men who gave more direct care also gave more or less indirect care, as measured by estimating the maximum caloric contribution from men (see Methods). Provisioning is difficult to measure because food distribution is

rapid and chaotic. And provisioning effort is difficult to measure because foraging time may include resting, visiting, or foraging for someone other than the children in one's household. In addition, it is easy to imagine how the level of indirect care could vary with a man's hunting ability as much as his motivation; it is harder to imagine how the level of direct care could vary with a man's ability, e.g., any man can hold a child. Direct care is, thus, a better measure of a man's motivation and the actual effort he allocates. For this reason, predictions 1 and 2 apply specifically to direct care. Due to the difficulties assessing indirect care, resource acquisition data were used only to test for negative correlations.

Methods

Study population

The Hadza are hunter-gatherers who live in northern Tanzania. Their camps are somewhat flexible in composition and move seasonally, primarily in response to the availability of water and certain plant foods. There is a long dry season from June to November and a wet season from December to May during which about 300–600 mm of rain falls. Women forage for berries, baobab (*Adansonia digitata*), and tubers. Men collect honey and use bows and arrows to hunt a variety of game from dik-dik (*Rhynchotragus* spp.) to giraffe (*Giraffa camelopardalis*). When not out hunting, men spend much of their time at the men's place, especially in large camps. The men's place is usually the best shade tree where adult males rest, talk, and work on arrows. Camps tend to be larger in the dry season when people congregate at the few permanent waterholes and men wait all night to ambush animals coming to drink. Although there are no rules, in about 60% of Hadza marriages, the couple lives in a camp where the wife's parents live (Woodburn 1968). Polygynous marriages are rare but divorce is common, resulting in a high degree of serial monogamy. Consequently, about one-third of men with children at home have young stepchildren.

For 1 year, I collected data while living in six Hadza camps ranging in population from 12 to 108. Even though there is a seasonal effect on camp demographics, it would appear to play little role in this study because camp size does not correlate with season (Table 1). The sample consists of nearly all Hadza who were still living as foragers and includes 223 people, with the primary focus on men who have children 8 years old and younger living with them. Living with a child refers to sleeping at the same hearth, which corresponded with being the primary adult male caregiver. The sample includes 32 such men with 53 children. Of these children, 34 were biological children of the man, 11 were stepchildren, and 8 were some other category, such as grandchild. However, a few people appear in more than one camp, and must be treated differently in testing the two predictions (see Appendix for explanation of sample sizes). Three men were excluded because they were disabled and so could not forage. Their three children were, therefore, also excluded.

Observations of behavior were used for time allocation analysis (Altmann 1974). I conducted instantaneous scan observations hourly from sunrise to sunset. Direct care was measured both (1) as a percentage of all scans during which any dependents of the man were resident, which can include time a man is out foraging, and (2) as a percentage of the time dependents were resident and the man was actually present in camp. A total of 34,312 person scans were conducted.

For all men who had at least one child 8 years of age or younger living with them, I conducted 30-min focal individual follow observations, using the "one-zero recording rule" (Martin and Bateson 1986). Within each minute, an act was scored as having occurred or not, with a maximum possible score of 30 per 30-min

Table 1 Camp population, season, mating opportunities, and resource allocation

	Que Tklako	Balai	Bashana	Umbeya	Tikichia	Sanola
Population	12	14	24	29	36	108
Season	Dry	Wet	Wet	Dry	Dry	Wet
Women per man	0.50	1.00	1.50	1.00	1.13	1.23
Single women	0	2	1	5	3	10
Mean percent of daytime spent foraging by fathers	40 (<i>n</i> =2)	58 (<i>n</i> =2)	65 (<i>n</i> =2)	54 (<i>n</i> =2)	65 (<i>n</i> =4)	63 (<i>n</i> =9)
Mean daily calories brought to camp by fathers	3420 (<i>n</i> =2)	3888 (<i>n</i> =2)	264 (<i>n</i> =2)	854 (<i>n</i> =2)	427 (<i>n</i> =4)	2962 (<i>n</i> =9)
Mean daily meat calories brought to camp by fathers	490 (<i>n</i> =2)	609 (<i>n</i> =2)	88 (<i>n</i> =2)	679 (<i>n</i> =2)	99 (<i>n</i> =4)	445 (<i>n</i> =9)

follow. The day was broken into three equal parts of 4 h each. In addition, night follows were done after dark. Consequently, for each man four time periods were sampled randomly until all men had a minimum of one follow in each period, or a minimum of 120 min. Any variable could, therefore, occur at least 120 times. A total of 14,820 min of focal samples of men with young children were conducted.

Paternity assignment

Paternity status of a child refers to the child's status with respect to the male head of the child's household. Since paternity exclusion tests were not feasible, paternity was established using several sources of information. There is a tendency for the Hadza to claim stepfathers are fathers. Therefore, I pursued the question informally whenever there was an opportunity. If the child in question was old enough, I asked the child directly. During formal interviews, I asked all adults to name the biological fathers of all children in camp. Paternity assignments were also checked with a Hadza man who keeps track of Hadza births and deaths for demographic researchers (Blurton Jones et al. 1992). These updated demographic data were also used to determine who the husband was at the time of a child's birth. All men counted as biological fathers were men who claimed paternity and were also identified by every other source as the biological father. By the end, there was only one doubtful case. One man claimed to be the biological father of a child who was identified as his stepchild by every other source. This child was counted as a stepchild.

Mating opportunities

In general, mating opportunities should be positively correlated with camp population size because there should be more potential mates in larger camps. To more precisely measure mating opportunities, however, three proxies were used. Mating opportunities in each camp were measured by (1) the absolute number of reproductive-age women (henceforth, fertile women), (2) the absolute number of reproductive-age, unmarried women (henceforth, single women), and (3) the number of reproductive-age women per reproductive-age man (henceforth, women per man). Reproductive age was defined as 15–45 years for women and 18–60 years for men. These ages seem to represent the period of mating competition for the Hadza, and are comparable to ages used in other studies of foragers (Hurtado and Hill 1992). The absolute number of fertile and single women should reflect the number of potential mates in camp but ignores the effect of male-male competition. The number of women per man should more accurately reflect the average man's mating opportunities given competition for women.

Direct care

The variables used to measure direct care were those which emerged as salient (with a discernible function and occurring with

some regularity) during a pilot study. These were later condensed into the following list:

- (1) nurturing: carrying, holding, cleaning, feeding, pacifying.
- (2) play: bouncing, chasing, wrestling.
- (3) communication: talking, listening, exchanging non-food items.
- (4) near: within 3 m, but excluding instances counted by other variables.
- (5) contact: all instances of actual touching, which may overlap with 1, 2, and 3.

All variables apply to children 8 years and younger, except for nurturing which applies only to children 5 years and younger. The variables are mutually exclusive within categories. For example, nurturing is scored as occurring once if within a single scan or follow minute any one of the acts such as holding or cleaning occurred, but not counted twice if both occurred. However, within 1 follow minute, play and nurturing may occur, so variables 1–5 are not mutually exclusive. Scans count daytime hours only, while follows include evening hours as well. Because 13 instantaneous observations per day accurately measure a man's presence or absence from camp, and his proximity to children, but miss many other activities, scans were used primarily for proximity and foraging time. Follows were used for all other direct-care variables.

Indirect care (resource acquisition)

I weighed ad libitum all food resources brought into camp by anyone, and recorded the person who acquired them. Weights were adjusted for the percentage of total weight that was edible, using others' estimates for this study site (Hawkes et al. 1991). Adjusted weights were then multiplied by calories per kilogram as listed elsewhere (Blurton Jones et al. 1989, 1996; Ulene 1995). The total amount of food a man brought into camp was used as a maximum estimate of his household provisioning. I assumed that each child in the household, whether biological or stepchild, received an equal share. Ignoring child age, it seems likely that each child acquires the same amount of food because the eagerness with which food is grabbed, and the apparent reluctance or inability to refuse anyone, insures food is pretty equally shared within households. Resource acquisition is, therefore, expressed as per capita calories, i.e., the number of calories a man brings in divided by the number of all children (biological and stepchildren, 8 years and under) in his household. Children older than eight are ignored because they are much more likely to sleep in a separate household or move between households, and because they are quite capable foragers.

Resource acquisition should not be read as a measure of food each child actually received from father or stepfather, which would be extremely difficult to measure. Rather, it is only an estimate of what each child could have received if all of the food went to the household and was shared equally among children (8 years and under) in the household. This estimate ignores the degree of food sharing outside the household, which often depends on the type of food, with meat usually shared more widely (Kaplan and Hill 1985; Hawkes 1993). Meat returns were, therefore, also treated separately.

All *P*-values reported are for two-tailed tests except those for direct care. Direct-care tests are reported as significant with one-tailed tests (and so noted) since the direction of difference was predicted.

Results

Table 2 shows how the Hadza compare with other foragers. Hadza fathers hold their biological infants (9 months old and under) 2.5% of the time (19.5 min) during daylight hours. They hold their infants 5.6% of the time (in focal follows) during daylight and evening hours. Because Hadza men sleep beside the children in their households, they are in close proximity to such children from around 9:00 p.m. to 7:00 a.m., or about 10 additional hours per day beyond the time analyzed here.

Paternity as predictor of direct care

Prediction 1 states that biological children will receive more male care than will stepchildren. The dependent variable was the level of direct care a child received from father or stepfather. The independent variable was the child's status as biological child or stepchild.

Most direct-care variables were significantly correlated with child age, and mean age was significantly older for stepchildren (4.57 years, $n = 11$; for nurturing $n = 6$) than for biological children (2.64 years, $n = 30$; for nurturing $n = 26$). Therefore, for most direct-care variables, it was necessary to control for age. However, for those forms of direct care which were not correlated with age and not normally distributed, Mann-Whitney *U*-tests were used. Men were near their biological children more than they were near their stepchildren ($U = 96$, $P = 0.017$, one-tailed, $n = 41$; Fig. 1a). As a percent of time they were present in camp, men were also more often near their biological children ($U = 94.5$, $P = 0.015$, one-tailed, $n = 41$).

Play was negatively correlated with age for biological children. However, since stepfathers never played with their stepchildren, age could not be controlled. After excluding children older than 5 years, there was no correlation with age for biological children, and fathers played with biological children more than with stepchildren ($U = 42$, $P = 0.027$, one-tailed, $n = 31$) (Fig. 1b).

If care is depreciable, a man's care would have to be more divided up in households with more children. Therefore, multiple regression was used for those forms of direct care that were correlated with age, and normally distributed. The direct-care variables were first regressed on child age and number of all children (biological and step) in the household, and then on paternity status.

Controlling for age and number of all children at home, men communicated more with their biological children than with their stepchildren ($\beta = 0.3034$, $P = 0.042$, one-tailed, $df = 37$; Fig. 1c). Controlling for age and number of all children at home, biological children also received more nurturing from their fathers than did stepchildren from their stepfathers ($\beta = 0.2948$, $P = 0.043$, one-tailed, $df = 27$; Fig. 1d). The results of testing prediction 1 show that Hadza men did provide more direct care to their biological children than to their stepchildren, implying that direct care is provided partly as parenting effort (see Fig. 1).

Mating opportunities as predictor of care

Prediction 2 states that men will provide less care to their biological children as their mating opportunities increase, so direct care was predicted to be negatively related to all three measures of mating opportunities. The sample consisted of all men who had at least one biological child 8 years and under at home. There were 21 such men, with 31 biological children (26 of whom were under 5 years of age; Table 1).

The dependent variable was the total amount of direct care a man provided to his biological children. It was calculated by (1) regressing the level of direct care each child received on the child's age, (2) saving the residuals from the regression and summing them for all of a man's biological children 8 years old and under (5 years for the measure of nurturing), and (3) regressing the summed residuals on the number of the man's biological children. The residual from this line gives an index of total direct care a man provided, controlled for number and ages of biological children, or the *per unit investment* in direct care of biological children. The per unit investment was then regressed on mating opportunities.

The number of single women and the number of fertile women both predicted a man's proximity to his

Table 2 Holding of infants among the Hadza compared with other foraging societies. Data on Hadza are for biological fathers only; data on other societies are from Hewlett (1992), presumably also for biological fathers only

Population	Age of infants (months)	Father holding (% of time)	Source
Aka pygmies	1-4	22.0	Hewlett 1991
Efe pygmies	1-4	2.6	Winn et al. 1990
Gidgingali	0-6	3.4	Hamilton 1981
!Kung San	0-6	1.9	West and Konner 1976
Hadza ($n=8$) (scans)	0-9	2.5	This study
Hadza ($n=8$) (% present)	0-9	5.4	This study
Hadza ($n=8$) (follows day and evening)	0-9	5.6	This study

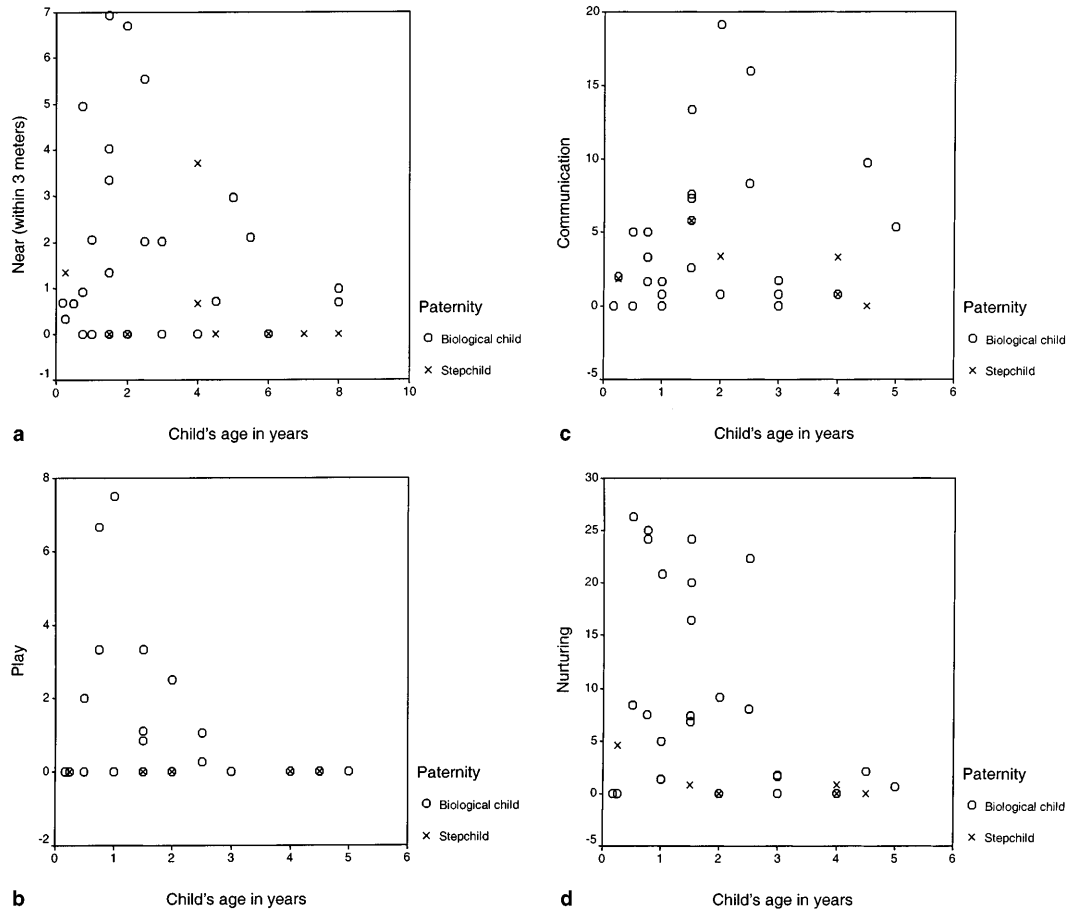


Fig. 1 **a** Percentage of time (daylight hours) men spent near (father and child within 3 m of each other) their biological children and stepchildren of different ages. Data taken from daily scans. **b** Percentage of time (in focal follows) men spent playing (e.g., bouncing, chasing, and wrestling) with their biological children and stepchildren of different ages. **c** Percentage of time (in focal follows) men spent communicating (talking, listening, or exchanging non-food items) with their biological children and stepchildren of different ages. **d** Percentage of time (in focal follows) men spent nurturing (carrying, holding, cleaning, feeding, or pacifying) their biological children and stepchildren of different ages

children, but fertile women was the stronger predictor. The more fertile women in a camp, the less time men spent near their children ($\beta = -0.4899$, $P = 0.014$, one-tailed, $df = 20$; Fig. 2a). As a percent of the time men were present in camp, they were also near their children less in camps where there were more fertile women ($\beta = -0.4834$, $P = 0.013$, one-tailed, $df = 20$).

Play was predicted by all three measures of mating opportunities but was most strongly predicted by single women: the more single women in camp, the less men played with their children ($\beta = -0.6630$, $P = 0.001$, one-tailed, $df = 20$; Fig. 2b). The more women per man in camp, the less contact (actual touching) men had with their children ($\beta = -0.5331$, $P = 0.008$, one-tailed, $df = 20$; Fig. 2c). Finally, the more women per man in camp, the less time men spent nurturing their children ($\beta = -0.4485$, $P = 0.023$, one-tailed, $df = 20$; Fig. 2d). It is clear that the more fertile women to men in camp,

or the more in absolute numbers, the less direct care men provided to their biological children (see Fig. 2).

Resource acquisition

Before drawing any conclusions about the overall level of care children received, it is necessary to consider, for both predictions 1 and 2, how much they may have been provisioned. Men can be biological fathers and stepfathers at the same time. Therefore, I divided men into two categories: those who had only biological children at home, which I will call biological fathers, and those who had at least one stepchild at home (whether they also had a biological child at home or not), which I will call stepfathers. After classifying men this way, biological fathers brought back more food. The mean per capita overall daily calories for biological fathers was 1901 and for stepfathers, 877. The mean per capita daily meat calories for biological fathers was 349 and for stepfathers, 63. Most calories are therefore, from non-meat items: 1552 per capita daily calories for biological fathers and 814 for stepfathers. These figures, it should be noted, are much lower than those reported in Hawkes et al. (1991) using data from 1985–1986, which supports Hadza claims that wildlife numbers have decreased due to encroachment by herders and farmers. Biological fathers brought in significantly more per capita daily meat calories ($t = 2.84$,

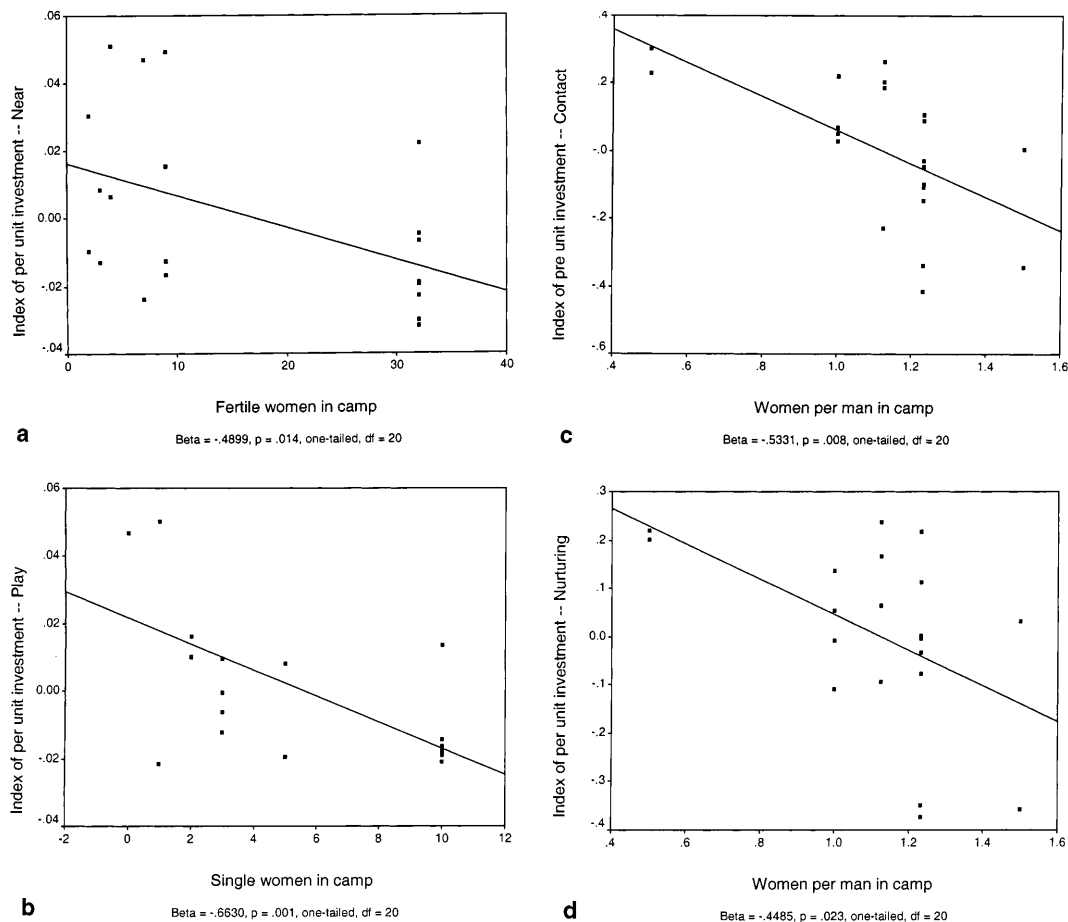


Fig. 2 **a** Per unit investment of time (daylight hours) men spent near (the father and child being observed within 3 m of each other) their biological children as predicted by the number of fertile women in a man's camp. Per unit investment is an index of the total direct care a man gives, controlled for the number and ages of his biological children. Data taken from daily scans. **b** Per unit investment of time (in focal follows) men spent playing (e.g., bouncing, chasing, wrestling) with their biological children as predicted by the number of fertile single women in a man's camp. **c** Per unit investment of time (in focal follows) men spent in contact (father and child touching each other) with their biological children as predicted by the number of fertile women per man in a man's camp. **d** Per unit investment of time (in focal follows) men spent nurturing (carrying, holding, cleaning, feeding, or pacifying) their biological children as predicted by the number of fertile women per man in a man's camp

$P = 0.012$, $df = 16$, unequal variances) and had a higher per capita hourly meat return rate ($t = 2.54$, $P = 0.023$, $df = 15.1$, unequal variances) than stepfathers.

If men cannot control the allocation of food within their household, they may be less motivated to provision if they have a stepchild, even when they also have a biological child. A man with one biological child and one stepchild will receive only half the payoff of a man with two biological children and may, therefore, be only half as motivated to forage for them, choosing instead to pursue other benefits. Correlation was, therefore, also used to test for the effect of the number of stepchildren on a man's per capita resource acquisition. The number

of stepchildren is negatively correlated with men's per capita daily overall calories ($r = -0.40$, $P = 0.048$, $n = 25$), per capita daily meat calories ($r = -0.42$, $P = 0.036$, $n = 25$), and hourly return rate ($r = -0.41$, $P = 0.044$, $n = 25$).

Using men as the unit of analysis ignores any effect child age might have on men's provisioning. I therefore controlled for child age and number of all children in the household in a multivariate analysis. Assuming my estimate of maximum possible provisioning is valid, biological children likely received more daily calories ($\beta = 0.3682$, $p = 0.022$, $df = 37$), and more daily meat calories ($\beta = 0.4422$, $P = 0.006$, $df = 37$) than stepchildren, even though their providers were gone from camp about the same amount of time ($\beta = -0.0838$, $P = 0.612$, $df = 37$). Of course, within a household, I assumed equal shares for biological children and stepchildren, but since stepfathers brought back less food, stepchildren had a higher chance of being in a household receiving less food.

But did men who brought back more food provide less direct care? In other words, is there a problem assessing overall care due to negative correlations between direct and indirect care? Using children as the unit of analysis and controlling for child age, there were no negative correlations between any measure of direct care received and any measure of father's or stepfather's per

capita resource acquisition. On the contrary, because there were some positive correlations, men who provided more direct care tended to bring back more food. Since there were no negative correlations between indirect and direct care, it is clear that resource acquisition does not negate the relationship found between direct care and paternity status.

With the sample of men used to test prediction 2, there were no correlations between per unit investment in any form of direct care and any measure of per capita resource acquisition, even when controlling for child age and number of biological children. Men who provided more direct care did not bring back less food per child, nor was their per capita resource acquisition correlated with any measure of their mating opportunities. Therefore, it is clear that resource acquisition also does not cancel out the relationship found between direct care and mating opportunities. In sum, when resource acquisition is added to direct care to assess overall care provided, it does not negate the results of testing predictions 1 and 2.

Discussion

Both predictions were supported. Within the household, men did provide more overall care to their biological children than to their stepchildren. And men did provide less overall care to their biological children when they had greater mating opportunities, suggesting they were allocating more time to mating effort. Men's behavior, therefore, appears to vary in response to potential fitness payoffs from both parenting and mating effort.

The fact that biological children receive more care than stepchildren suggests that men provide care, at least in part, as parenting effort, which refutes the argument that male care is mating effort only. I, none the less, have to assume that some of male care is mating effort, for why else would men provide any care to stepchildren? And part of the care men provide to their own children may be mating effort in the form of inducement to keep their wives from leaving. On the other hand, some have argued that what appears to be mating effort may actually be paternal investment. For example, courtship feeding, even before copulation and conception, could be paternal investment if it leads to increased survivorship of a male's future offspring (Gwynne 1986, 1988). Therefore, it is possible that by providing care to a stepchild, a man frees up his wife to allocate resources to his biological child, even if such a child is not yet born. It seems reasonable, however, to count any investment in stepchildren as mating effort rather than parenting effort, since there is the possibility that the man's wife will not even conceive a child with him.

The fact that men provided less overall care to their biological children when they had greater mating opportunities suggests that men allocated more time to mating effort and so had less time for parenting effort.

However, other interpretations are possible. The prediction that men will provide less care to their biological children when they have greater mating opportunities might hold even if male care were all mating effort. Where there are more women in competition, the price (in terms of care) they can charge men for sexual access might drop. If the price drops, it might pay men to spread their care around to gain access to more women. This would mean that the level of care a man provides to his own household should drop. Yet this would not be because he is shifting from parenting to mating effort but because he is spreading his mating effort more thinly. Of course this drop would apply to stepchildren as well as biological children. This possibility will be tested in future analyses of the data.

The negative relationship between proximity to child and mating opportunities does not result from an obvious allocation of time to overt flirtation. It is almost certainly a reflection of time men spend congregated at the men's place in large camps (since mating opportunities covary with population). In small camps, there is often no men's place and no segregation by gender. Because men in larger camps allocate less time to being with children, and more to being with other men at the men's place, it is tempting to view time at the men's place as male-male competition. Men do not engage in agonistic encounters in the men's place, quite the opposite. Yet even if competition is primarily in the form of a popularity contest, it may pay off in terms of fitness. Other men may help in various ways, for example when conflicts do arise. The time men save by not providing direct care to their children where there are more potential mates is, therefore, possibly allocated to mating effort in the form of acquiring allies and winning tolerance or concessions from other men.

In conclusion, contrary to the view that all male care is mating effort, paternity predicted the level of direct male care. Direct care is probably a more reliable measure of a man's effort than is resource acquisition, which may reflect hunting ability as much as motivation to provision others. Men also provided less care when they had greater mating opportunities, which is consistent with the interpretation that they were investing less in parenting effort and more in mating effort.

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Appendix

Explanation of sample sizes

Although the numbers in the sample are first reported as 32 men with 53 children, 1 man and 2 children appeared in more than one

camp, so the actual number is 31 men and 51 children. The man who appeared twice is the only man with two wives. In one camp he was with his younger wife, one biological child, and one stepchild. In the other camp, he was with his older wife who has no children, but for a while his younger wife and his biological child came to live with him.

In testing prediction 1, this man's biological child was treated as one child even though she appeared twice, because it would have inflated the effect of paternity to treat her as two different cases. The care she received from her father in both camps was averaged to produce one score. Therefore, $n = 30$ biological children (25 for nurturing) in testing prediction 1. In testing prediction 2, however, this child and this man were treated as two different dyads, as it would have created a problem using two different camp demographics (mating opportunities) for one dyad. Therefore, $n = 31$ biological children (26 for nurturing) in testing prediction 2. Whenever the unit of analysis was men, the father was counted as two people, a stepfather and biological father in the first camp, but only a biological father in the second camp since his stepchild was not there.

There were 21 men with a biological child, and a total of 31 biological children (30 for prediction 1). There were 10 men with a stepchild, and a total of 11 stepchildren (6 for nurturing). There were 15 men with biological children only. When men with either biological or stepchildren are used $n = 25$.

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