The Goals of Direct Paternal Care Among a South Amerindian Population

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ABSTRACT

Evolutionary explanations for the high levels of parental involvement exhibited by men have traditionally focused on men's ability to enhance the quality of dependent offspring and marital productivity (provisioning model). Critics have argued that men in foraging populations employ foraging strategies that seem better suited to promoting self interests rather than provisioning a family. They contend that the benefits conferred to men by entering marriage and providing parental care are mainly in the form of access to fertility (mating effort model), as opposed to increased offspring wellbeing. Paternal investment is characterized as a commodity that is exchanged for future fertility. We investigate the ultimate goals of men's parental investments by exploring direct paternal care among the Tsimane of Central Bolivia. Specifically, we test whether Tsimane fathers bias the delivery of their care to when it has a greater impact on child wellbeing and the efficient functioning of the family or when it functions better at impressing wives and securing future fertility. All predictions derived from the provisioning model are supported, whereas none derived from the mating effort model are robustly supported.

The motivation behind men's willingness to enter marital unions and provide parental care has been the focus of much recent debate . Evolutionary explanations for the high levels of men's parental involvement have traditionally focused on men's ability to enhance the quality of costly offspring, as well as the productivity of the family unit. Some researchers, however, have forwarded the proposition that paternal involvement is a commodity that men offer in order to increase the chances of winning and maintaining a spouse. The extent to which securing future fertility is the main psychological motivation underlying men's parenting behavior versus the goal of directly enhancing offspring wellbeing remains an unanswered empirical question.

Much of the controversy concerning men's motivation to care for offspring among hunter-gatherers has focused on the spoils of men's work effort . In many small-scale societies where hunting is a common activity, meat tends to be shared widely. The relatively high levels of sharing to members of other families, and the high status and reproductive benefits that accrue to good hunters , have been used as evidence to question men's parenting motivations. The intended beneficiary of *direct* parental care—care that involves close physical proximity and direct interaction—is less ambiguous. Although direct care typically comprises only a small proportion men's parental investments, it is a conspicuous and unambiguous form of investment. There is no question as to the intended receiver of the care, and it involves activities that would not be performed in the absence of the child (unlike food procurement or house construction).

This paper has two main goals. The first is to describe the ways in which children are directly cared for and socialized among a group of forager-horticulturalists, the Tsimane of central Bolivia, and to situate the role that fathers play in this process. The second is to determine the motivation for the providing of direct paternal care with the assumption that this motivation

is a product of evolutionary forces that shaped ancestral psychology (and hence behavioral profiles) to maximize reproductive success. Rather than focus our attention on the relationship between father's behavior and some outcome measure of fitness, we instead attempt to gauge men's motivations by examining their behavior in reference to factors that alter the returns of fitness gains via the proposed pathways. We intend to test whether such care serves as a signal to the mother, designed to maintain access to her fertility, and without genuine concern for the welfare of the child, or if it functions as a means of directly investing in the quality of the child (or a combination of the two). This will be accomplished by testing whether men bias the delivery of care to (1) when it might prove more efficient in helping the child, such as when the mother or other caretakers are less able to provide care, (2) when it is more likely to have a greater impact on the mother's impression of the caregiver, such as when she is present to view such behavior, and (3) when there is more future fertility to secure by impressing the mother. If men's care primarily occurs under (2) and is modified by (3), we could then conclude that men's investments are motivated more to secure the future fertility of the mother of these children rather than directly benefit them.

Male parental care in humans: provisioning vs. mating effort

Human infants are born remarkably helpless, requiring a level of care that significantly reduces the foraging efficiency of the caretaker . Even after offspring are able to care for themselves, they remain economically dependent until their late teens . Despite the high dependency of human infants and children, women are able to maintain high fertility rates by weaning infants early, thus exhibiting inter-birth intervals that are significantly shorter than those observed in other great apes . The compound fertility involving simultaneous multiple

dependents could never have evolved in the absence of supplemental provisioning of mothers and offspring and/or alloparental caretaking by fathers and other kin .

Originally, it was argued that men, acting as husbands and fathers, filled the majority of the caloric and labor deficit (referred to here as the provisioning model) . The increased well of offspring need would have led to greater incentive for men to reduce investments in the pursuit of extra fertility and increase those to the enhancement of the quality of their existing children. Long-term pair bonds followed as the assured future fertility mediated the opportunity costs of paternal investment , greater paternity confidence allowed men to invest in children they knew to be theirs, and because they provided a means of increasing the efficiency of the delivery of bi-parental care and of household production .

The streamlining of production led to a division of labor—a strategic assignment of labor tasks based on gender-specific reproductive constraints . This typically resulted in women, constrained by pregnancy and lactation, focusing on childcare and labor conducive to childcare, and men focusing on riskier tasks that may involve greater physical exertion, traveling long distances or lengthy absences. By focusing on specific and exclusive tasks, men and women are able to attain much higher levels of efficiency through on-the-job training than would be possible if everyone had to become proficient in all tasks . Furthermore, focusing on different foodstuffs increases nutritional variety and might reduce variation in daily returns, as production is not as sensitive to the prevalence of a single food type . Implied within the logic of the provisioning model is that the primary benefits that men receive from parental investment are in the form of increased offspring quality and that the efficient delivery of biparental investment should be the ultimate goal of men’s parental behavior.

In the past decade, a number of researchers, following Hawkes , have criticized the provisioning model . The main criticisms are that 1) men's foraging strategies in hunter-gatherer populations may not be designed to optimize the amount of food going to the nuclear family, but rather to display their mate value and garner social and mating benefits, and 2) the absence of a father does not have a robust and substantial negative effect on offspring survival, and men's marital behavior does not appear linked to the magnitude of this effect . The first criticism stems from the observation that men in foraging populations tend to focus on the hunting of large game animals, a strategy often characterized by lower return rates, greater variance in daily success and widespread distribution of the spoils. This distribution, the critics maintain, is directed through tolerated-theft—a willingness of the acquirer to relinquish his catch to the more numerous and hungrier recipients . Acquirers and their family members thus are left with portions no greater than those of everyone else, rendering large-game hunting an inefficient means of provisioning a family. Critics of the provisioning model argue, however, that the successful capture of large game *can* provide an honest signal of overall fitness , and that the widespread sharing of the meat can provide social and mating benefits as well . Thus men, in forgoing less ostentatious but predictable foods, are sacrificing child wellbeing in order to garner personal fertility benefits. Men are argued to enter into long-term relationships with women not because of a greater ability to enhance offspring quality, but because the practice provides a solution to male-male competition , and/or because of the fertility benefits that the relationships confer . This argument has been referred to as the mating effort model elsewhere . In response, other researchers have countered that forager men do not exclusively focus on large game , hunting large game often provides comparable or higher returns than other foraging strategies ,

men often do have some control over the distribution of their production , and that meat is typically more highly valued than other foods .

Supporting Hawkes et al's argument, however, father presence does not seem necessary for the successful rearing of children in many populations . Reviews of the effects of father presence on mortality, development and reproductive success show great variation and often weak effects if any . In order to account for the provisioning of mothers and their offspring, necessary to maintain observed fertility rates, researchers pointed to the importance of investments by grandmothers and other kin . Winking (in press) argued that the lack of such a father effect may be an artifact of mothers (and maternal kin) compensating for father absence by increasing their own investments, ultimately resulting in lowered fertility for the mother. Under this scenario, men's investments may not result in net increases in child fitness, but may allow for greater fertility rates of the union.

Direct Care

Here we define direct care as any behavior aimed at protecting or enhancing child wellbeing that requires physical proximity and direct interaction, such as holding, feeding, playing, etc. . Although direct care is relatively rare among Tsimane fathers, we chose to examine this type of care because it is a conspicuous and unambiguous form of investment. Unlike economic production, each act of direct care consists of a clear care provider and a care recipient. It is also an activity that would not be performed in the absence of the child, unlike forms of indirect investment (economic production, house construction, community defense, etc.). Finally, supervision of most children does not necessarily require direct care, as they can be

placed on mats, in hammocks, or simply allowed to play under a watchful eye. Thus, direct care can serve as a measure of directed effort to care for the child.

Both models predict that women should provide the bulk of direct childcare, something that appears to be true cross-culturally . According to the logic of the provisioning model concerning the division of labor, mothers should be the main direct caretakers as they are the sole providers of breast milk, and direct childcare is presumed to be more compatible with (and a superset of) breastfeeding than it is with the more rigorous activities assigned to men. Furthermore, even when men are available for direct care, women might still be the primary providers as specialization allows for the development of better parenting skills. Finally, cultural norms might develop around these efficiency-enhancing strategies, further strengthening the divide by reinforcing the exclusivity of gender roles.

Proponents of the mating effort model, on the other hand, have proposed that direct care can serve as a commodity that men exchange for access to women's fertility . Step-parental care has long been viewed as such an exchange , establishing the fact that both men and women find the benefits of such an interaction as worthwhile. If the choosing of a husband (or short-term partner) is heavily influenced by the promise of parental care, and if the maintenance of a long-term relationship is heavily dependent on the continuation of such care, then it is entirely possible that each unit of investment provided by a man yields greater fitness benefits via greater *access* to fertility than it does via enhanced offspring fitness. An exchange of fertility for parental investment might be more easily maintained in humans because reproduction typically takes place in long-term iteroparous relationships. Furthermore, unlike any other ape, new offspring are born long before independence is achieved by previous offspring, allowing for a continuous exchange of the respective commodities. Based on this logic, men are expected to be most

concerned with maximizing their *perceived* investments in the eyes of their wives, and not maximizing the effectiveness of their investments on increasing offspring wellbeing (referred to here on as the signaling hypothesis).

Among stepfather/offspring relationships, one study provides evidence that men put on parental performances for their wives. Flinn found that stepfathers were more likely to be observed in agonistic interactions with stepchildren when their wives were not present to view the interaction. No such finding was found for biological fathers. In the primate literature, researchers found that subordinate vervet males, who were unlikely fathers of juveniles, behaved more benevolently towards juveniles when a plexiglass partition was placed between the male/juvenile dyad and the mother (i.e. the male knew the mother was watching) compared to when a metal partition separated the participants. No such effect was found for alpha males who were more likely to be the father .

While these studies are suggestive, the question remains, to what extent do the proposed fertility benefits motivate men's parental decisions towards resident biological children? Anderson and colleagues argued that the difference between investments offered to resident biological children and non-resident biological children (e.g. living with an ex-wife) was due to the loss of these associated fertility benefits . There are, however, a number of alternative explanations for such a decrease, such as the fact that fathers and children might live far away from one another and that each unit of investment thus becomes more costly. Additionally, fathers might no longer be concerned with costs mothers (or stepfathers) must incur to compensate for any decrease in their investments.

It is clear, however, in Anderson et al's analysis and others' that fathers tend to invest more and represent less of a threat to resident biological children than to resident stepfathers .

This counters the argument that men's parental investments towards biological children are solely based on benefits derived from securing future fertility, although it is still possible that such benefits represent the *primary* motivation for paternal care.

Predictions

According to the logic of the provisioning model, mothers would tend to be the de facto caregivers, as childcare is more conducive to infant care than it is to male-oriented tasks. Furthermore, this leads to parenting specialization through greater experience, meaning that mothers are more likely to provide care even when both parents are available. This logic leads to the predictions that (1) men should more likely be enlisted as direct care givers when mothers are unavailable for childcare (i.e. absent), or (2) occupied with other chores. Furthermore, we predict that (3) fathers will more often be assigned this role when there are fewer older daughters, as sisters commonly serve as allo-caretakers. Lastly, because mothers are the only ones capable of nursing and thus are frequently obligated to focus their parenting on infants and toddlers, (4) fathers' care will be directed more towards older children than mothers' care.

If, however, the main motivation behind men's direct parental investments is to enhance their reputation with their wives, as suggested by the signaling hypothesis, we expect that (1) fathers should bias their direct care to when mothers are present to view such care, (2) fathers should focus more on conspicuous forms of care, such as playing and feeding, than do mothers, and (3) conspicuous care should comprise a larger proportion of fathers' direct care in the presence of their wives than in their absence. Men should also take into account the amount of fertility they are securing when determining optimal investment levels. They should therefore try harder to impress a younger wife than impressing a post-menopausal one. There are a number of

reasons, however, why the amount of time men spend in direct care might change as they (and their wives) age. As men become older, the number of older daughters they have increases, the amount of time they spend in food production might change as dependency load grows, etc. Therefore, we will use the amount of time spent in direct care in the absence of wives as a baseline and predict that (4) men will spend comparatively less time in direct care in the presence of older wives.

METHODS

Population

Data were collected among the Tsimane of central lowland Bolivia. The Tsimane are forager-horticulturalists living mostly along the Maniqui River and its tributaries in the Beni Region, Bolivia. Roughly 8,000 individuals reside in some 80 villages comprised of multiple extended families (Instituto Nacional de Estadística, 2003). Such families tend to construct their houses together, typically forming well defined household clusters. They derive the majority of their calories from family-maintained fields consisting mainly of rice, plantains, corn and yucca. Agricultural food is subsidized with jungle game, fish, foraged fruits and varying levels of market goods (depending heavily on proximity to local markets).

Marriages are very stable among the Tsimane with roughly 20% of marriages ending in divorce . Nuclear families are typically the unit of production, particularly for garden foods. Husbands and wives spend considerable amounts of time clearing, planting, weeding and harvesting crops which are less widely shared among related households within a cluster. Men are typically the sole providers of game and the main providers of fish, while women are largely responsible for childcare, food processing, and household tasks.

Time Allocation Data

Observations were made in four communities between June 2002 and June 2003 and an additional two communities throughout 2005. In order to collect time allocation data, households were first divided into residential clusters (typically consisting of extended families). Each cluster was sampled randomly without replacement from 7:00 a.m. to 7:00 p.m. in three-hour time blocks (this was changed to two-hour blocks in 2005 season). During these time blocks, the activity, location and interactants of each individual were recorded every half-hour. If someone was absent during a scan, others were asked about the individual's whereabouts and activity. Child presence was defined as being in the same specific locale within camp (e.g. house, kitchen, yard). Observer presence was defined as being in the same homestead, so that an observer in a family's yard would be considered in the presence of a man in the family's house. This resulted in 836 individuals being observed for 52,802 person scans (averaging 63.2 scans per person).

Determining Ages

The level of accuracy for which Tsimane parents knew the age of their children varied greatly. Ages were estimated for young infants (approximately <6 months) by simply asking the parents. For many infants, their births were observed during the research period. For older children and adults, ages were determined by demographic interviews conducted by MG that employed a combination of methods. These included using well known dated events, relative age lists, formal records, photo comparisons, and cross-validation of information from independent interviews of kin. Methods are described at length in Gurven et al. .

Statistical Analysis

For tests utilizing the pooled sample over simple categorical variables, chi-square tests are employed. For multivariate tests that do not include time-varying predictors, allocations to particular activities are calculated as the percentage of observations a subject was engaged in that activity out of all observations. These percentages were then regressed on predictors using weighted general linear models, with the number of observations serving as a weighting. Finally, for multivariate tests that do include time-varying predictors, we employed the generalized estimating equations method (GEE). This method accounts for the correlated structure of dependent variables arising from repeated measures. All analyses (except those concerning the age of recipients of care) use a binary distribution, exchangeable correlation structure, and all parameter estimates are logit estimates. Analyses involving ages of recipients of care use a normal distribution, exchangeable correlation structure and identity link. All analyses were performed in SPSS 15.0.

RESULTS

Overview of Direct Care

Out of the sample of 836 individuals, 220 children age 5 and under were observed for a total of 13,188 person scans. Figure 1 shows the percentage of time children were cared for and by whom (from the child's perspective). Mothers provided 69.1% of all direct care in camp during the first six years, and 82.5% in the first six months. The next three highest contributors were sisters, who accounted for 9.8% of all care in the first six years, fathers, who accounted for 7.3%, and maternal aunts, who accounted for 3.7%. Differences among all three of these

categories are significant using chi-square analyses. All four grandparents accounted for only 3.3% of direct care, with the maternal grandmother providing 2.1% of direct care alone.

Figure 2 demonstrates the amount of time spent offering direct care to various kin while in camp from the caregiver's point of view. As this figure demonstrates, women spend substantially more time in direct care than men, and this trend is apparent from a very early age. Furthermore, while grandmothers may not be a significant source of direct care for any particular child, the fact that they are minor caregivers to a large number of grandchildren results in their spending a fair amount of time in grandparental care.

Because of the precipitous drop in amounts of direct care offered to children as they age, we limited our sample to parents with at least one child under age 4 for further exploration of parental care. We observed 93 fathers of young children for a total of 6,346 person scans and 102 mothers for 6,794 person scans. While in camp, mothers spent 65.4% of their time in the same immediate location as their small children, and 35.4% of their time in direct parental care. Men spent 51.0% of their time in camp in the same location as their small children and 8.4% of their time in direct care. These figures do not accurately reflect total amounts of time, however, as fathers spent only 31.1% of their time in camp, while mothers spent 61.1% of their time in camp (Figure 3). In order to estimate total amounts of time in these activities, we used in-camp figures as estimates for the amount of time spent in parenting activities while parents were outside of camp (not directly observed) but were recorded as being "with" their children. This calculation results in women spending a projected 58.4% of their total time in the same immediate location of their small children and 31.6% providing direct care. For men, these figures are 27.2% of their total time with their small children and 4.5% of their time in direct care.

Effect of Mother's Presence on Father's Care

In order to explore the effect of the presence of mothers on the probability of men providing any direct care, the sample was limited to cases in which men were directly observed in the presence of a child under 4 who was either being cared for by the man or was *available* for care (i.e. not being cared for by another individual). A total of 83 men were observed during 623 spot observations meeting these criteria. Of these, 535 were recorded while the mother was present, and 88 were recorded while the mother was absent. This means that men spent only 1.5% of their total time and 4.8% of the time in camp left alone with a small child in camp. Table 2 shows the results of the GEE analysis concerning the effect of the mother's presence on the probability of men engaging in direct parental care. Contrary to the prediction of the signaling hypothesis, and in support of the provisioning model, men are actually significantly *less* likely to provide direct care to an available child when the mother is present to witness the care (Table 1). Converting the logit estimates to probabilities (using average values for controls) shows that men were nearly twice as likely to engage in care when the mother was absent (14.7% for wife present, 28.5% for wife absent). Removing cases in which the children were sleeping did not change the significance of the effect of mother's presence (with same controls, B=-0.919, P=0.002). In a separate analysis, the effect of the number of adult in-laws present on the probability that men would provide direct care reached one-tailed significance (with same controls, B=0.176, P=0.071). There was no effect, however, of the number of unrelated adult women present (with same controls, B=0.227, P=0.361).

Effect of Mother's Activities on Father's Care

Figure 4 compares the percentage of time fathers spent in direct care based on whether mothers were engaged in various work activities. Only cases in which the father was also present in the camp were included. This resulted in a sample of 87 men who were observed for a total of 1667 scans. After controlling for community and the age of youngest child, fathers were found to be more likely to be engaged in direct care if the mother was engaged in food processing (GEE, B=0.672, Wald χ^2=8.424, P=0.004), marginally so for general household tasks (GEE, B=0.538, Wald χ^2=3.411, P=0.065), and more likely to be engaged in any household task (GEE, B=0.607, Wald χ^2=8.660, P=0.003). There was no significant effect on time spent in direct care by whether mothers were engaged in manufacture (GEE, B=-0.723, Wald χ^2=2.114, P=0.146).

Effect of Number of Older Daughters on Father's Care

There are a number of factors that could covary with both the number of older daughters and direct care, such as age, length of marriage, time spent in production, father involvement, etc. To isolate the effect of having more *daughters* we decided to review the effect of the percentage of resident children age seven and up that were daughters. Table 2 shows the result of a GEE analysis involving men who had at least one child less than four years of age and at least one resident child seven years old or older. One polygynously married outlier was removed from the sample as his 16 children ages seven and up doubled the next highest number. After controlling for the age of the youngest child, the age of the father, community, and the number of older children in the household (all of which were non-significant), the percentage of these older children that were daughters was significantly associated with fathers providing *less* direct care (GEE, B=0.008, Wald χ^2=4.446, P=0.035), supporting the prediction of the provisioning model. Thus, a father with two older children that are both sons spends an estimated 9.6% of his time in

camp engaged in direct care (using the averages of the control variables), while a father with two older daughters only spends 4.3% of his time in direct care.

Age of Children Receiving Mother's and Father's Care

After controlling for community and the age of the parent, the age of the recipient of direct care was significantly higher for recipients of fathers' care than those of mothers' care (GEE, Parent=Mother, B=-7.263, Wald χ^2=7.129, P=0.008, N=1735 observations, 158 individuals), supporting the provisioning model. This included care received by all children ages 18 and under. The estimated marginal means for the average age of the recipient child were 19.0 months for mothers and 26.2 for fathers. Removing instances of nursing increases the average age of recipient children to 20.0 months for mothers, although the effect remains significant.

Conspicuous Care

Figure 5 shows that after excluding nursing, both mothers and fathers spent the greatest amounts of time providing "passive" direct care to children 3 and under as opposed to the more active and "conspicuous" forms of care. Passive care includes holding (and not engaged in any other activity) and tending (swinging baby in hammock or in physical contact but not holding or engaged in any other activity). A chi-square run on all categories shows a significant difference in the distribution of care (χ^2=31.068, df=6, P<0.001, n=1021 observations for women, 156 for men). There is no difference, however, between the proportions of direct care that fathers and mothers dedicated to conspicuous care (grooming, feeding, playing and comforting) (N=1021 for women, 156 for men, χ^2=0.373, P=0.541), failing to support the prediction of the signaling hypothesis. Reviewing each category separately reveals that women spent significantly more

time grooming children than men (12.6% of mother's care, 5.1% of fathers care, χ^2=7.414, P=0.006). However, fathers focused significantly more of their care on playing with children (2.2% of mother's care, 7.7% of father's care, χ^2=14.792, P<0.001), and comforting them (2.5% of mother's care, 6.4% of father's care, χ^2=6.819, P=0.009).

There are no significant differences in the proportional contributions of the types of care that men provide in the presence or absence of a mother (see Figure 4 for categories). This is true when evaluating all categories (χ^2=5.792, df=6, P=0.447, N=145 observations in presence of mother, 48 in absence), and when reviewing each dyad individually. Futhermore, the prediction that men will focus more on conspicuous care when in the presence of mothers was not supported. Conspicuous forms of care accounted for 24.83% of care in the presence of mothers and 20.83% in their absence (χ^2=0.317, df=1, P=0.573, N=145 observations in presence of mother, 48 in absence). Because of the limited sample size, however, we cannot assert the null with great confidence.

Effect of Mother's Age on Father's Care

There was no significant negative interaction effect between the mother's age and her presence (with same controls as above and including mother's age, effect of mother's age x mother's presence, B=-0.051, P=0.166). This indicates that, relative to the amount of time men spend in direct care in the mother's absence, they do not spent comparatively *more* time in the presence of *younger* mothers.

DISCUSSION

While fathers provide much less direct care than do mothers, their direct investments are by no means insignificant. If we remove the advantage of numbers that sisters have (there is only one father) and focus on only the sister who provides the most care for each child, sisters account for 7.6% of children's direct care within camp in the first six years. This proportion is not significantly different from the amount fathers contribute (fathers=7.3%, χ^2=0.182, df=1, P=0.670). Therefore, from a child's point of view, fathers are essentially tied as the second highest single contributor of direct care. In other natural-fertility populations, resident biological fathers have been found to the second highest contributor as well . Whether or not men's direct care contributions are the result of efficiency-enhancing flexibility in the division of labor or men appealing to the expectations of wives in order to discourage them from leaving is discussed below.

It is important to note that the predictions derived from the two models are not entirely exclusive. Those factors that increase the effectiveness of direct paternal care may also be the factors that lead mothers to expect more parental help from fathers. Thus while such predictions are more directly derived from the logic of the provisioning model, their confirmation does not necessarily refute the signaling hypothesis. Similarly, even if we assume that both parents are equally concerned with the wellbeing of their children, men still might have reason for exaggerating their investments. Children represent a public good, and rearing them thus involves a cooperative endeavor . Each parent must decide how much to invest in personal versus family interests, and there is undoubtedly some negotiation that takes place between the parents. The difference in these two models, however, is that the provisioning model predicts that men will maximize the *sum* of the benefits to the wellbeing of self and the family, while the mating effort model proposes that men are indifferent to the wellbeing of the family.

Table 3 summarizes the various predictions and findings. The data provide support for all four of the predictions derived from the provisioning model. The average age of the recipients of fathers' care was significantly higher than those of mothers' care, even after removing instances of nursing. This suggests that men are focusing their investments on older children, as the disparity in parenting capabilities between father and mother is less substantial with older children. Fathers spend more time in direct care while in camp when fewer of their older children are daughters, suggesting that fathers are sensitive to the availability of other potential caretakers and adjust their levels of care accordingly. Similarly, fathers were more likely to be engaged in direct care when their wives were preoccupied with other household tasks. This indicates that fathers substitute for mothers and are more responsive to children when mothers are preoccupied. It also indicates that fathers' care can liberate mothers to engage in tasks that are not conducive to childcare.

While fathers were rarely left alone with young children (roughly 11 minutes a day alone with children in camp), during this time, men were nearly twice as likely to provide care than when the mother was present to view the care. This pattern supports the prediction of the provisioning model, that fathers would be more likely to be the responder to children in the absence of mothers. Furthermore, this contradicts the clear prediction of the signaling hypothesis —men do not appear to be biasing the delivery of their care to when it can have the most significant impact on their wives' impression. Men *were* significantly more likely to provide direct care in the presence of in-laws (one-tailed), however, suggesting that audience can have an impact on the amount care that fathers offer.

Contrary to the signaling hypothesis, fathers did not devote more of their direct care to more conspicuous activities than did mothers, and they both spent similar amounts of time in

"passive" forms of care. Men did devote proportionally more time to both playing and comforting, which might represent two of the more conspicuous forms of non-passive care. They did not, however, devote more care to conspicuous forms while in the mothers' presence compared to amounts provided in their absence, although the robustness of this finding was hampered by a small sample size.

Finally, compared to the time fathers devoted to direct care in the absence of mothers, men did not significantly increase the amount of time they spent in direct care in the presence of *younger* mothers. This is particularly revealing, as younger women not only have more future fertility to offer men, but they have less to lose from leaving them: they tend to have fewer children that they must take care of, and their possibility of remarriage is most likely greater at these ages .

Because these tests were observational, alternate explanations must be dealt with. For instance, it might be that mothers are more likely to leave their children alone with fathers who are more attentive, resulting in a spurious result of mother absence being associated with greater levels of direct care. However, the amount of time men spent in direct care in the wife's presence was not significantly associated with the amount of time they were left alone with children (WLS Regression, N=80, B=0.047, t=0.615, P=0.540). Similarly, absent mothers may not be totally unaware. Observers often abound and any gross dereliction is likely to be reported. There is, however, a great range in the degree of interaction during supervision, and it is difficult to imagine that mothers would be as well informed as when they could directly observe the care.

Overall, the provisioning model received the greatest support. Indeed, all four predictions derived from the provisioning model were supported. None of the predictions of the signaling hypothesis, however, were robustly supported. The effects of mother's presence and age, perhaps

the two variables most directly linked to the fitness pathway proposed by the mating effort model, were either non-significant (age) or significant in the opposite direction (mother's presence). Because the tests presented in this study were observational, we cannot infer the degree, if any, to which a desire to impress wives affects the delivery of men's care, we can only conclude that it does not appear to be the *primary* goal of men's direct care.

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LITERATURE CITED

TABLE 1. GEE analysis of effect of the percentage of older children that are daughters on the probability that a father of a small child (<4) will engage in direct parental care while in camp. N=46 men, 909 observations

Variables in Model	*B*	*df*	*Std. Error*	*p*
Number of Children >6	0.043	1	0.147	0.772
Percentage of Children >6 Daughters	-0.009	1	0.004	0.035
Age of Youngest Child	0.008	1	0.014	0.541
Age of Father	0.026	1	0.029	0.374
Community		5		0.353

TABLE 2. GEE analysis of effect of the presence of a child's mother on the probability that the father will engage in direct parental care. N=85 men, 641 observations

Variables in Model	*B*	*df*	*Std. Error*	*p*
Wife present	-0.841	1	0.275	0.002
Number of children < 4 present	-1.025	1	0.602	0.089
Average age of children < 4 present	-0.045	1	0.014	0.001
Community		5		0.005

TABLE 3. Predictions and results of the two models.

Prediction	*Direction*	*P value*	*Result*
Provisioning Model			
1) Men will provide more care when mother is absent	Predicted	0.002	Supported
2) Men will provide more care when mother is occupied	Predicted	0.003	Supported
3) Men will provide more care when there are fewer older daughters	Predicted	0.035	Supported
4) Men will focus there care towards older children	Predicted	0.028	Supported
Signaling Hypothesis			
1) Men will provide more care when mothers are present to view the care	Opposite	0.002	Not Supported
2) Men will focus on conspicuous types of care more than mothers	Predicted	0.541	Equivocal[a]
3) Men will focus on conspicuous types of care more when mothers are present	Predicted	0.573	Not Supported
4) Men will provide more care when *younger* mothers are present	Predicted	0.166	Not Supported

[a]Results were significant and in the predicted direction for two types of conspicuous care, but there was no overall effect.

Figure 1. *Percentage of daytime spent being cared for by various caretakers by age (N=220 children, 8019 observations while in camp).*

Figure 2. *Percentage of daytime spent providing care by recipient and by age of caregiver.*

Figure 3. *Percentage of daytime spent in camp.*

Figure 4. *Projected percent of daytime (controlling for community and age of youngest child) spent in direct care by fathers in camp by whether wives in camp are engaged in various activities.*

Figure 5. *Percentage of mothers' and fathers' care devoted to different activities.*

Figure 1

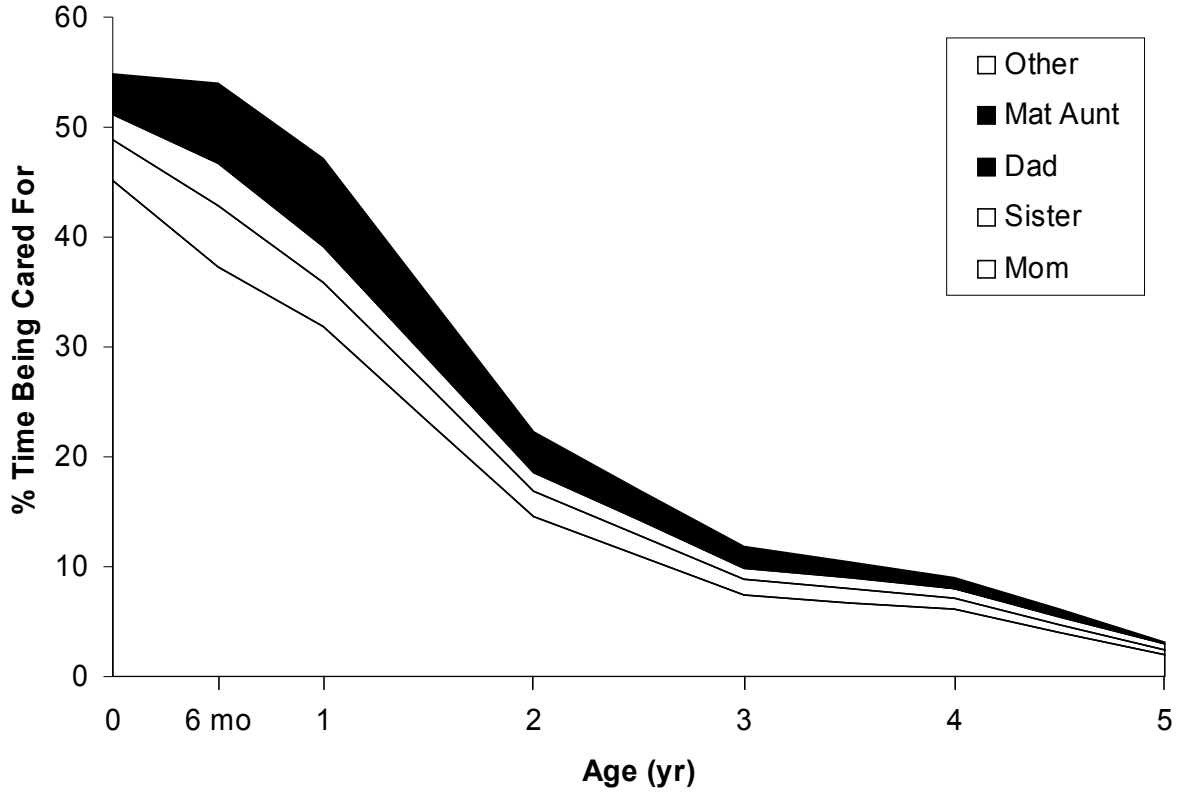

60
50
40
30
20
10
0
% Time Being Cared For
0
6 mo
1
2
3
4
5
Age (yr)
Other
Mat Aunt
Dad
Sister
Mom

Figure 2

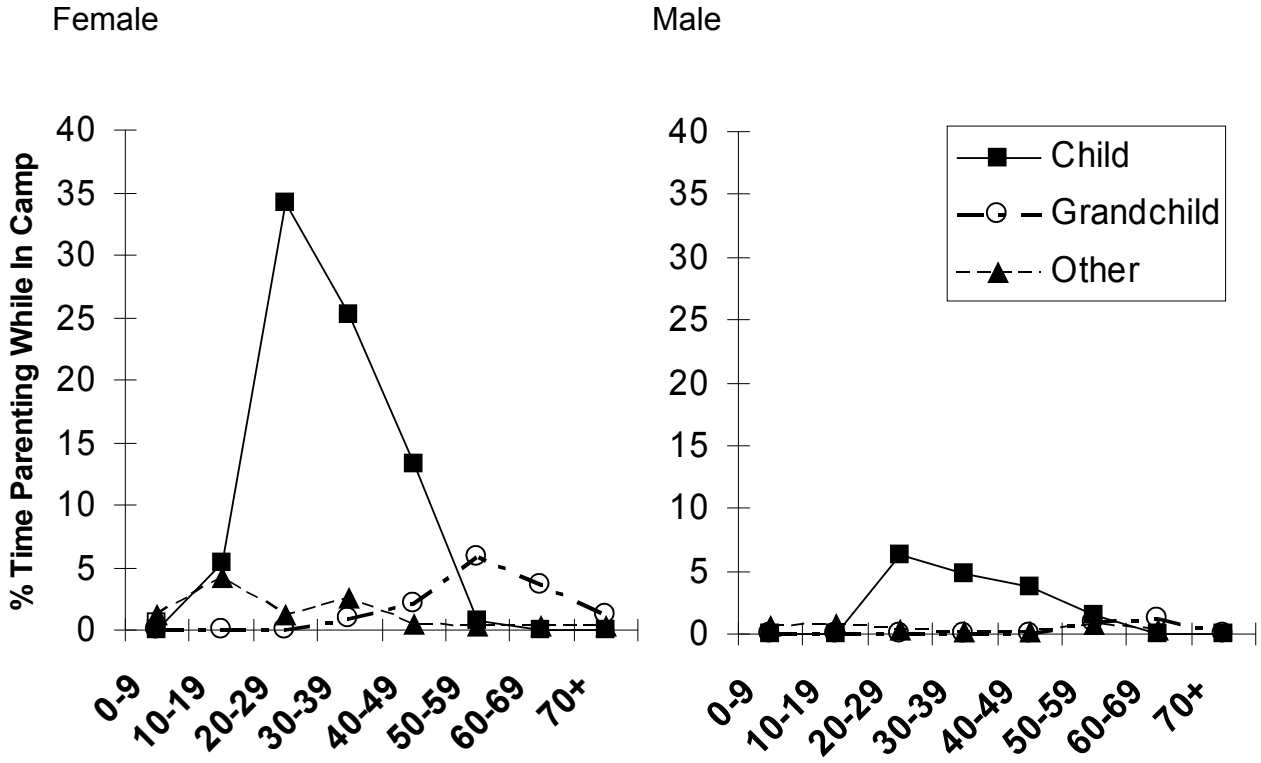

Female
Male
% Time Parenting While In Camp
40
35
30
25
20
15
10
5
0
0-9
10-19
20-29
30-39
40-49
50-59
60-69
70+
Child
Grandchild
Other

Figure 3

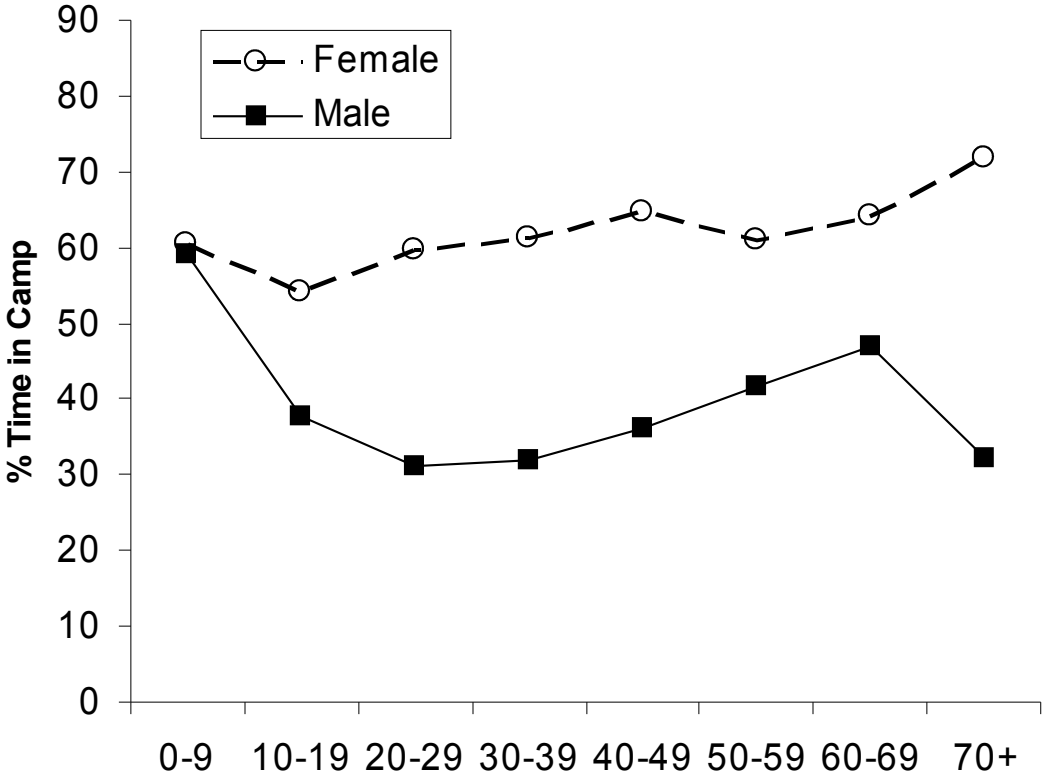
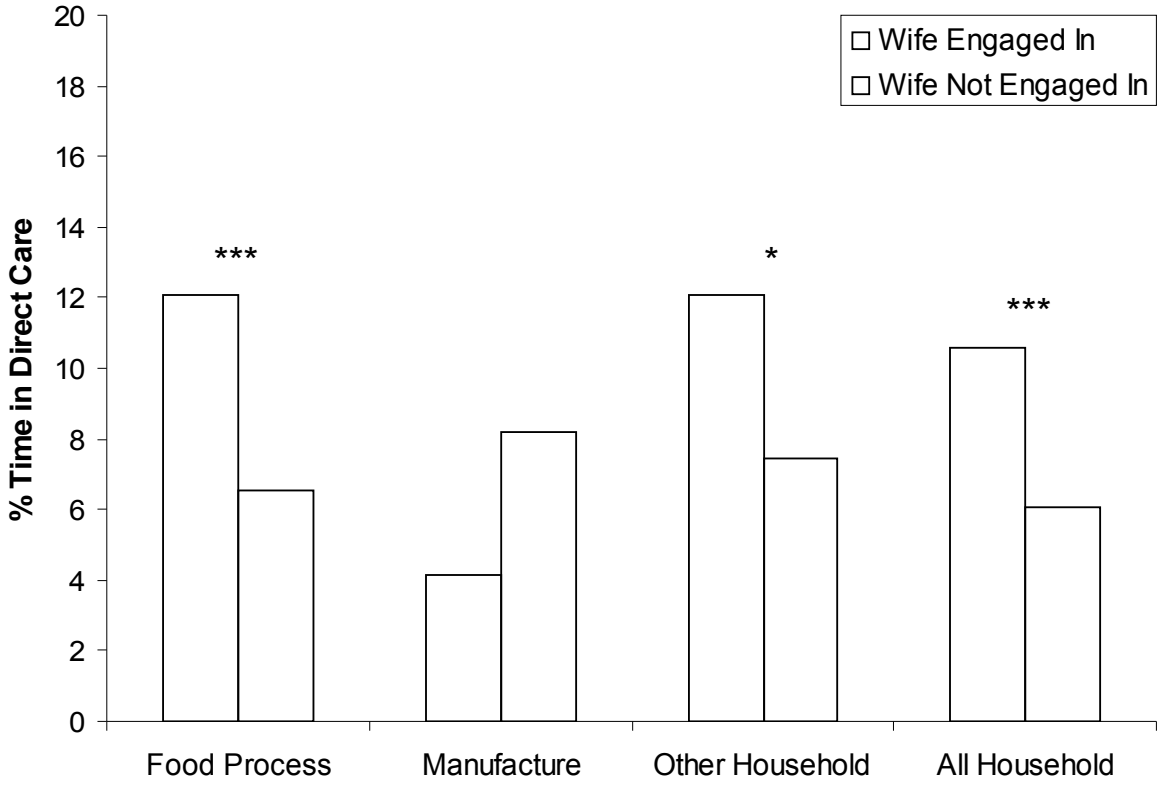
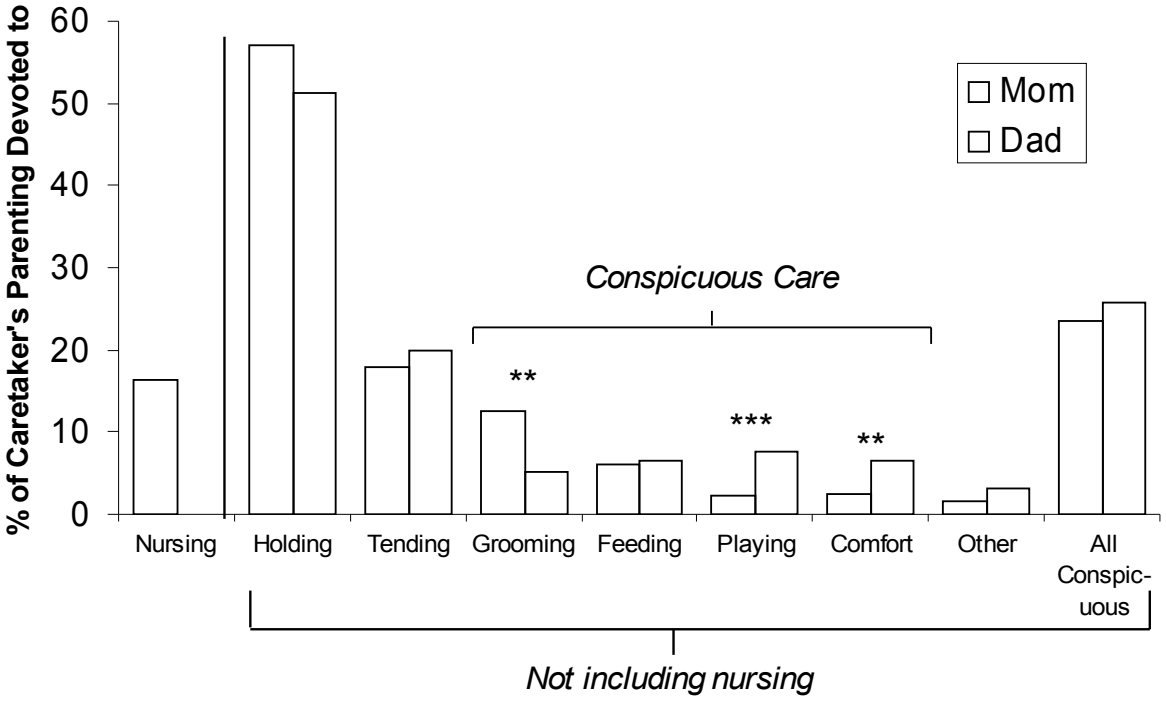

90
80
70
60
50
40
30
20
10
0
% Time in Camp
Female
Male
0-9
10-19
20-29
30-39
40-49
50-59
60-69
70+

Figure 4



* P<0.10 and in predicted direction; ** P<0.05; *** P<0.01

Figure 5



* P<0.10 and in predicted direction; ** P<0.05; *** P<0.01