

WOMEN'S WORK, CHILD CARE, AND HELPERS-AT-THE-NEST IN A HUNTER-GATHERER SOCIETY

Raymond Hames and Patricia Draper

University of Nebraska-Lincoln

Considerable research on helpers-at-the-nest demonstrates the positive effects of firstborn daughters on a mother's reproductive success and the survival of her children compared with women who have firstborn sons. This research is largely restricted to agricultural settings. In the present study we ask: "Does 'daughter first' improve mothers' reproductive success in a hunting and gathering context?" Through an analysis of 84 postreproductive women in this population we find that the sex of the first- or second-born child has no effect on a mother's fertility or the survival of her offspring. We conclude that specific environmental and economic factors underlay the helpers-at-the-nest phenomenon.

KEY WORDS: Fertility; Helpers-at-the-nest; Hunter-gatherers; Ju/'hoansi

Turke (1988) was the first anthropologist to employ "helpers-at-the-nest" (Emlen 1984) theory to investigate fertility differentials among women who had different sexual combinations of first- and second-born children (Turke 1988). He found that women who had firstborn girls had higher fertility than those who had firstborn boys. The enhancement was even more dramatic if a woman had two firstborn girls compared with two firstborn boys. Presumably, daughters reduced a mother's labor and childcare duties, leading to increased fertility.

Since Turke's 1988 study, several other studies have been conducted in different sociocultural settings to determine the extent to which helpers of various types contribute to the fertility of a woman and the survivorship of her children. These studies make interesting reading for they chart

Received March 24, 2003; accepted June 20, 2003; revised version received September 23, 2003.

Address all correspondence to Raymond Hames, Department of Anthropology and Geography, University of Nebraska-Lincoln, Lincoln, NE 68588. Email: rhames@unl.edu

Copyright © 2004 by Aldine Transaction, New Jersey

Human Nature, Vol. 15, No. 4, pp. 319-341.

1045-6767/98/\$6.00 + .15

a progressive and fruitful elaboration on the interrelation of such issues as inclusive fitness, anthropological demography, household organization, family structure, and subsistence economy. These are all issues that receive increasing play in anthropology. We review these studies briefly in a following section.

Our paper continues this line of investigation and makes two specific contributions. First we show that whether or not children can be employed as helpers depends on the socioeconomic context. When children have few opportunities to provide childcare for their siblings or engage in important economic activities, their presence will have no positive impact on either mother's fertility or the survivorship of her offspring. Second, we add a methodological refinement to assessing the impact of firstborns' effects on their mothers' fertility and survivorship of children. Turke's previous analysis of the relationship between sex of first- and second-borns and mother's fertility is potentially flawed because he did not exclude first- or second-borns who did not survive long enough to be of help to mothers. We deal with these two issues through an examination of data on Ju/'hoansi fertility, survivorship, birth order, and offspring sex collected by Draper in 1987–1988. The Ju/'hoansi, also known as !Kung, are a well-known population of former hunter-gatherers living in northwestern Botswana and eastern Namibia. The present paper is a continuation of earlier research (Draper and Hames 2000) on the role of birth order among these people.

THEORY

Research on helpers-at-the-nest (as it applies to helpers who are offspring) is based on ecological constraint theory, which predicts that reproductively capable offspring will remain at home when they can gain more in terms of fitness by assisting parents rather than establishing their own families. This stay-at-home behavior may be a consequence of (1) a lack of quality breeding territories; (2) increased mortality risks after leaving home; (3) lack of a suitable mating opportunities; or (4) poor probability of breeding once a reproductive relationship is established (Strassmann and Warner 1998:36). If dispersal or the establishment of a new mating arrangement is constrained, reproductive skew theory is applied (Emlen 1995). This theory "focuses our attention on the division of reproduction within an established group" through a specification of power relations among dominants and subordinates (Davis and Daly 1997:408). With few exceptions (Flinn 1989; Strassmann and Clarke 1998), anthropologists have not examined the dynamic relationships between dominants and

subordinates over reproductive roles. As we review below, most research examines the reproductive consequences of helpers-at-the-nest (hereafter referred to as helpers).

Before we begin with a review of the ethnographic literature on helpers it is important to note that there appears to be a fundamental difference between humans and all other organisms in the helpers-at-the-nest phenomenon: oftentimes human offspring helpers are too young to be capable of reproduction yet they are capable of helping. In contrast, offspring helpers among most other species are fully grown, independent of parental investment for their own maintenance, and reproductively capable (see Hrdy 1977 for an exception among langurs). Under specific circumstances (see above), however, they stay at home and help the parent at the expense of their own fitness. To the contrary, among humans, offspring helpers have not achieved full growth and are not independent of parental food provisioning and other forms of investment, nor are they reproductively mature. Despite these different dimensions of immaturity they are apparently able (e.g., Turke 1988) to aid their parents in childcare and economic activities without necessarily sacrificing their own fitness. It is also probable that care of a younger sibling enhances the older sibling's ability to care for his or her future offspring.

The difference lies in the life history contrasts between humans and nonhumans. In humans, as a consequence of slow maturation in both the timing of economic competence (the ability to feed oneself) and the ability to reproduce (Lancaster and Lancaster 1987) there is an exceptionally long juvenescence during which more than one child is dependent on parental investment. According to life history models applied to humans (Hill et al. 2000; Kaplan and Bock 2001), the payoff to slow reproductive and economic maturation is exceptionally high productivity and reproduction upon maturity, which in turn sets the stage wherein dependents or immature helpers-at-the-nest may be selected to assist their mothers' reproduction through care of siblings. Among foragers, the burden that highly dependent offspring place on a mother's ability to reproduce was first illustrated by Blurton Jones in a series of articles on San interbirth intervals, where he demonstrated that interbirth intervals were a function of childcare requirements (Blurton Jones and Sibly 1978; Blurton Jones 1987).

Whether or not immature children can serve as helpers depends on suitable ecological circumstances in which children can provide direct or indirect care to siblings and/or engage in easily learned economic pursuits that lower economic subsidies provided by parents to children. At first glance, it would seem that horticultural and agricultural peoples would

meet these conditions more consistently than mobile hunter gatherers. Semi-permanent to permanent residences and larger numbers of people living together promote safe areas in which younger siblings can be left in the care of older siblings. Certain tasks that are associated with food production are readily mastered, permitting older siblings to make economic contributions early in life. However, some mobile foraging peoples may live in environments where children can provide important help. To demonstrate this possibility, below we will compare Ju/'hoan and Hadza foragers.

PREVIOUS RESEARCH ON HELPERS

There are two general ways in which helpers can enhance the fitness of a reproductive female: (1) they can engage in alloparental care of infants and children who are not their own offspring but nevertheless are closely related to them; or (2) they can engage in economic pursuits whose fruits enhance either the fertility of the reproductive female or the dietary status of the offspring of the reproductive female. For humans, young helpers tend to be females. However, cases have been documented where helpers are young males (Hill and Hurtado 1996; Ember 1973). One way to classify the kinds of helpers is through their reproductive status as pre-reproductive, reproductive, or post-reproductive and their kinship relation to the reproductive female. This leads to a classification of helpers as offspring, siblings, and parents. We review the relevant research on human helping behavior using this scheme.

Offspring as Helpers

As mentioned above, Turke's (1988) pioneering study found that mothers with firstborn daughters had higher RS than women with firstborn sons, and the pattern was strengthened when the mother had two firstborn daughters compared with two firstborn sons or a firstborn son followed by a second-born daughter. It is important to remember that Turke's study was conducted among a Pacific Island agricultural people who subsisted on a mixture of root crops, raised mainly by women, and fishing, pursued by men. Turke argued that daughters would be more likely than sons to be helpers to their mothers because daughters would assume the work roles of their mothers and because the matrilineal postmarital residence rule insured that daughters would remain in the households of or in close proximity to their mothers. Further, Turk reported that the Ifalukese girls worked more than boys, and the work that girls did was directed toward

the household subsistence economy whereas resources produced by boys through fishing were widely distributed to other villagers and little went directly to their own households. Consequently, we have a household socioeconomic context in which little girls gardened, prepared food, cared for younger siblings, and engaged in other productive tasks while boys did not. This means that girls, but not boys, increased food income to the household and cared for dependent siblings, thereby reducing the amount of labor required by mothers.

Flinn's (1989) study of Trinidadian peasants was an attempt to replicate Turke's findings (Flinn 1989). Unlike Turke he found that sex of the firstborn offspring had no effect on mother's fertility. Nevertheless, he made a number of other findings consistent with helping theory: (1) women who had coresident but nonreproductive females (pre- or postmenopausal) had higher RS; (2) females with coresident daughters ceased reproduction earlier; (3) daughters never became pregnant while living with mothers until mothers ceased reproduction; and (4) daughters showed delayed reproduction when they were living with needy siblings. These findings led him to conclude that there was a "suppression of reproductive overlap between mothers and daughters" (Flinn 1989:217).

Recent work on rural Gypsies in Hungary found the following: (1) firstborn girls remained at home longer than firstborn sons or second-born daughters; (2) women with firstborn daughters had shorter birth intervals, a longer reproductive span, and higher fertility; and (3) time allocation data reveal that the mechanism for this reproductive enhancement is found in the greater amount of helping activity by daughters, such as housework and childcare (Bereczkei and Dunbar 2002). Furthermore, even when firstborn daughters married they were more likely to delay departure from the household than second-born daughters.

Analysis of the reproductive histories of 789 Berber Moroccan women by Crognier, Baali, and Hilali (2001) demonstrates that the presence of offspring helpers increases both a woman's fertility and survivorship of her offspring. Importantly, they demonstrate that this effect is not mediated through female offspring (2001:372) but rather through males or females and that the mechanism (e.g., childcare or food production) for this positive effect is unknown.

Finally, Kramer's study of household work patterns of Maya girls found that they became net food producers (producing more food than they consume) in their late teens (Kramer 2002). Boys made a net positive contribution to their households at a later age. During that period of positive net food production, girls stayed in their households for a number of years before leaving to marry, and they may have enhanced their mother's

reproduction by producing food for younger siblings. Importantly, Kramer comprehensively demonstrates through time allocation data on task assignments that the degree to which children can become helpers is critically dependent on the local economic system.

Siblings as Helpers

We know of two studies demonstrating that sisters of mothers can be helpers. Flinn's study of rural Trinidadians (1989), mentioned above, shows that females with coresident female siblings had higher fertility than those who did not. Bereczkei demonstrated that female Gypsies who had more sisters and long-lived grandparents had higher fertility than those who had few sisters or whose grandparents were not long-lived (Bereczkei 1998).

Grandmothers as Helpers

In a variety of publications Hawkes, Blurton Jones, and O'Connell have demonstrated that postreproductive Hadza women (Tanzania), through their foraging efforts, produce food that is shared with daughters, thereby enhancing the nutritional status of the grandchildren (Blurton Jones 2002; Hawkes, O'Connell, and Blurton Jones 1989, 1997; Hawkes et al. 1998; O'Connell et al. 1999). However, Ache hunter-gatherer data analyzed by Hill and Hurtado (1996) indicate that the presence of a postreproductive mother had no effect on the fertility of a daughter or the survivorship of her children. Other literature on grandmothers in more complex societies shows positive effects, particularly of maternal grandmothers on grandchild outcomes (Hrdy 1999:279–287; Leonetti et al. 2001, 2002; Mace and Sear 1997; Sear et al. 2000, 2002).

The above-described studies of helpers of different ages demonstrates that either their presence and/or care giving or their economic contributions may have positive effects on a recipient mother's fertility or the survivorship of her children. Most of the studies reviewed fail to specify the conditions under which potential helpers are more or less able to engage in activities that enhance a recipient's fertility and survivorship of her offspring. Clearly their presence in the household or settlement is a necessary condition for helping. Depending on environmental or residential circumstances helpers may not have the ability or opportunity to assist in activities that enhance survivorship or fertility (Heath 1999).

CONDITIONS UNDER WHICH CHILDREN CAN BE HELPERS

We propose that the role of children as helpers, either as child minders or in the work of adults, is shaped by the requirements of adult economic roles. Children are most likely to be put to work in agricultural and pastoral societies (Barry et al. 1959; Kramer 2002; Kramer and McMillan 1999; Munroe et al. 1984; Whiting and Whiting 1975; Whiting, Child, and Lambert 1966). In the case of agricultural societies, the location of the workplaces (agricultural fields) is often close enough that the mother can work and also keep track of what is going on at the home. When the fields are more distant, the mother may take a nursing infant with her to the fields, leaving older children in charge of younger siblings. Child minders are especially effective when the settlement size is large enough that, although one or both parents are temporarily absent, other adults are nearby to provide some supervision (Nerlove 1974; Nerlove et al. 1974). Children can also help their mothers in performing useful tasks, although this requires that the site of productive activities is close by and reasonably safe. Typical tasks absorbed by children of the 7- to 12-year-old age range are food processing, cooking, washing clothes, carrying water, and minding small livestock or the immature young of large animals who are separated from their mothers during the day. Children also work alongside their parents in gardens, weeding and harvesting (Whiting and Edwards 1988:18–84). These tasks are easily mastered and do not require adult strength (Bock 2002).

In many instances, girls are more likely to be helpers than boys in economic and childcare tasks. A number of studies in different kinds of societies show that the work of girls begins at younger ages, is of longer daily duration, and continues for more years in comparison with boys (Barry et al. 1957, 1959; Nag 1962). Such reports have been made anecdotally for many years and now have been backed up by empirical findings based on systematic observation (Ember 1973:426, 1981:540, 555; Nag et al. 1978; Whiting and Edwards 1988:177–182). These same sources report that girls, at earlier ages and in preference to boys, are recruited into work as child caretakers (Hames 1988).

Why girls are more likely to be helpers than boys is an interesting issue in and of itself. Girls accept or are appointed to work roles that they will later perform as women. Many of these tasks in agricultural societies (e.g., gathering or weeding) do not require great skill to accomplish with a reasonable degree of success. Boys, in contrast, are often required to begin mastering the pursuit of mobile prey resources through hunting and fishing, activities that are not fully mastered until middle adulthood (Kaplan

1994).¹ During this learning period their productivity is very low. As for childcare activities, cross-cultural research has consistently shown that girls are more motivated to engage in childcare than boys. Girls also tend to stay much closer to home while boys tend to roam at greater distances from home (Draper 1975; Ember 1981; Pasternak et al. 1997:48–65).

THE ETHNOGRAPHIC SETTING AND DATA

The Ju/'hansi (!Kung) have been the subject of a large number of publications in the past several decades. They are members of a larger cultural and linguistic grouping known as the Khoisan or Bushman populations of Southern Africa. At different times and places they have lived as hunter-gatherers, long-term clients to Bantu-speaking pastoralists, and in some cases by a mixture of strategies, sometimes camping with pastoralists, otherwise living in the bush when conditions supported an abundance of wild foods. Researchers have worked with these populations since the 1950s and late 1960s when members of the Marshall family studied Ju/'hoansi of Namibia and researchers belonging to the Harvard Kalahari Research Group worked among the Ju/'hoansi of Ngamiland, western Botswana (Marshall 1976). The populations described by the Marshalls and by the Harvard Group lived primarily by hunting and gathering. Important secular changes have taken place since then. In more recent years, Ju/'hoansi no longer hunted and gathered full time. Instead they were living in small villages clustered around sources of permanent water. People subsisted by a mixture of economic practices that included keeping small herds of animals, chiefly goats and cattle but also horses and donkeys used as pack animals. Hunting and gathering continued but in a much reduced form. These changes are well summarized in a variety of publications (Biesele 1997; Biesele et al. 1989; Howell 2000; Lee 1979, 1993; Wiessner 2002; Yellen 1990). The data we report in this paper are based on Draper's reproductive interviews conducted in 1987–1988 with postmenopausal women. Therefore, although at the time of data collection the Ju/'hoansi were no longer fully engaged in hunting and gathering, the older women whom Draper interviewed were largely dependent on foraged food at the time their families were being formed. In the analysis we report below we are concerned with Ju/'hoan children and the possibility that their economic contributions may have enhanced the fitness of their mothers.

The nature of the work roles of both men and women as foragers logistically excluded help from Ju/'hoan children. For example, the work of gathering and hunting was done at a long distance from camp. When they were out for a day's work, men and women were often gone for eight or

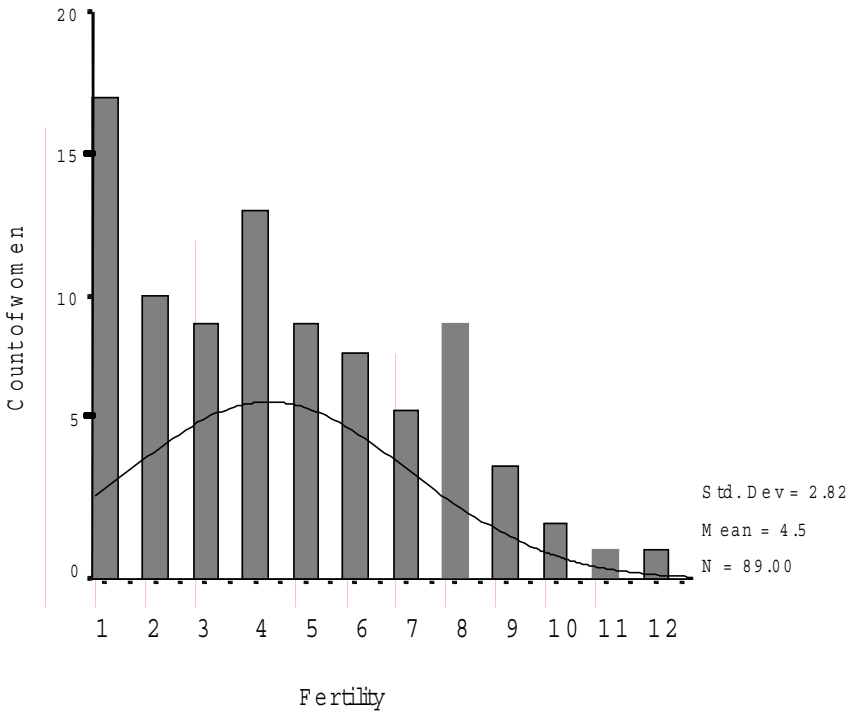
more hours. In some cases men camped out overnight before returning. Further, once the work groups set out, no one knew where they were, unless they were physically tracked by someone from the base camp. Therefore there was no opportunity for a parent to remain in contact with children left at home. The distances walked, and particularly the problem of carrying water for a child, discouraged parents from taking children on their outings. The work of hunting or gathering then, at a distant location, was excessively strenuous and potentially dangerous for a child. It was not “divisible” into component parts, some of which could be passed on to a child. Gathering or hunting was best done by a mature person who could scout for the resource, obtain it by killing or digging it, and transport it home at the end of the day.

The picture emerges of children who were more or less cut out of adult work, even in an assistant role. Ju/'hoansi adults were particularly wary of the possibility that children might become lost if they wandered off on their own to collect food, and they therefore discouraged children from leaving the camp. The reasons have to do with the particular combination of topographic features in the Kalahari and the rather dense stands of vegetation that made it difficult for children to keep oriented once they were far from camp (Blurton Jones, Hawkes, and Draper 1994a, 1994b). The presence of lion, cheetah, and leopard in the Kalahari as well as wild dog and hyena constitute additional threats. However, parents mention getting lost as the source of worry for children foraging alone. Adults typically did not work outside the camps on consecutive days. This meant that other adults were in camp while one or both parents were absent. Adults minded the children and did not impress older children into the role of routine child minder (Draper 1975).

METHODS AND ANALYSIS

Data on the reproductive histories of Ju/'hoan women were collected by Draper in two field sessions (1987–1988, 1990) while she was working on a larger, multi-site study funded by the National Institute of Aging. A total of 330 men and women were interviewed, of whom we report a segment—89 women over the age of 40, whose reproductive careers can be assumed to be essentially completed (Howell 1979). The eldest of these women would have been born in 1928 or before; the youngest would have been born in 1948. Many of the eldest women spent their childbearing years while living mainly as foragers, whereas more of the younger women spent their adult years in frequent or regular contact with the Bantu cattle posts and waterholes.

Figure 1. Fertility of Women (women who have had at least one live birth and are older than 39).



Our goal is to determine whether the sex of first-, second-, or third-born offspring had an effect on a woman's reproductive success or the survivorship of her offspring. For this analysis, we only examined those women who were older than 39 and who had had at least one live birth. This ensured that we gained a sample of women who had completed or nearly completed their fertility and who were most probably not affected by secondary infertility caused by STDs, a common problem in the area (Almagor 1982; Belsey 1976; Frank 1983). This procedure yielded a sample of 89 women who had a mean fertility of 4.5 (Figure 1).

Our hypothesis is that having firstborn daughters will not improve a woman's reproductive success. Our reasoning is based on two kinds of information. (1) Given the economy and environment in which Ju/'hoansi lived we do not expect parents to have profited from having early-born daughters. Neither girls nor boys were given tasks that could be construed as economically useful or helpful to mothers in the form of child-tending

(Draper and Cashdan 1988). (2) Previous ethnographic reports based on systematic observations of children of various ages specifically indicate that adults and not children are the primary caretakers of younger children (Draper 1976; Konner 1972, 1976, 1977).

We also concern ourselves with a methodological issue. A problem with the Turke analysis, which we hope to rectify here, is that he examined the fertility of women who bore girls or boys as firstborns and then various gender combinations of second borns (e.g., boy and boy versus girl and girl). In this approach the first- and second-born children may have died prior to beginning their own reproductive career, and therefore it is unlikely that they had any consistent impact as helpers on a mother's subsequent fertility or the subsequent survivorship of her children. To accurately assess the role of helping behavior retrospectively one must examine those cases in which a sibling was present while its mother was reproducing and/or caring for an offspring younger than the helper. Among the Trukese of Turke's study, survivorship of children was high; therefore his lack of statistical control over survivorship of potential helpers may have posed little problem even though his results may have been slightly inaccurate. However, in populations such as the Ju/'hoansi, who have infant mortality rates of 10% to 20%, controlling for the survivorship of helpers becomes critical (Howell 1979:81, 96). We control for this factor by looking at women whose children survived to various ages and thus were available to their mothers to function as helpers.

Since our goal is to evaluate the possible impact that children of various ages and sexes have on a mother's fertility and survivorship of her subsequent offspring, we need reasonable measures of offspring ages. All age measures for the Ju/'hoansi children of interviewed women are estimates based on Ju/'hoansi categories of human growth and development, and they represent the following age ranges and corresponding maturational characterizations:

- Infant, 12 month or less
- Toddler, 2–3 years
- Small child, 4–6 years
- Child, 7–9 years
- Old child, 10–12 years
- Adolescent, 13–17 years

Although these rank-orderings of developmental ages are not ideal, we believe they are accurate enough for the purposes of our analysis—a demonstration of the possible affects of offspring helpers.

RESULTS

Since the goal of our analysis was to measure the effect that surviving children had on a mother's subsequent fertility and the survivorship of her offspring, we decided to examine the effects of siblings who survived to various ages. Our first set of analyses, shown in Table 1a, compared sex of the firstborn child (boy or girl) who survived to the age of 4 to 6 years or more and the effect that the sex of that child had on its mother's fertility and the survivorship of her subsequent children. This was followed by looking at women who lost their first child before the age of 4 to 6 years but had a second child (boy or girl) who survived to the age of 4 to 6 years or greater. Finally the same analysis was performed for mothers who had lost their first and second children but had a third who survived to the age of 4 to 6 or beyond. As noted previously we did not have exact calendar years of birth so we used Ju/'hoansi age categories to classify children and then associated them with numerical ranges. One might suppose that children between the ages of four and six would probably provide little care for younger siblings. Nevertheless, cross-cultural evidence (Nag et al. 1978:294–296, Tables 1–6; Weisner and Gallimore 1977:175, Table 8) shows that young girls may engage in considerable childcare. As our Figure 2 and Table 1a indicate, having a firstborn girl surviving to ages 4–6 *had no affect on either a mother's fertility or the survivorship of her subsequent offspring* compared with the effect of having a firstborn boy.

The second and third set of analyses parallel the first except we set the survivorship of firstborns through third borns to age 7 to 9 (Table 1b) and 10 to 12 years (Table 1c) or beyond to assess the effects of offspring presence on the fertility and survivorship on a woman's subsequent children. As the tables show, having a firstborn girl surviving to ages 7 to 9 or beyond (Table 1b) or 10 to 12 years or beyond (Table 1c) *did not enhance a mother's fertility or the survivorship of her subsequent children* compared with having a boy. In these tables we performed 21 statistical tests *and all failed to yield significant results*.

We then sought to maximize the difference between the effects of boys or girls on a mother's fertility or survivorship of her children by comparing situations in which the first two offspring both survived beyond the age of 10–12 years (Figure 2 and Table 1d) or even 13–17 years (Table 1e). Again, we found no difference: a woman who had girls for her first and second births had no greater fertility or survivorship of her subsequent offspring than a woman who had boys for her first and second births and who had survived to or beyond the age categories mentioned above.

Table 1. Fertility and Survivorship of Children

A. Surviving to Age 4-6		N	Mean	Std.	T-value	Sig. (two-tailed)
First child surviving beyond age 4-6	Fertility				-.579	0.656
	Female	28	4.2	2.2		
	Male	35	4.6	2.9		
	Survivorship				-.278	0.782
	Female	28	69%	.32		
	Male	35	71%	.32		
First child dead but second survives beyond age 4-6	Fertility				.993	0.330
	Female	10	6.3	2.6		
	Male	15	5.2	2.5		
	Survivorship				1.059	0.301
	Female	10	63%	.249		
	Male	15	51%	.278		
First and second child dead but third survives to age 4-6 or beyond	Fertility				-.030	0.997
	Female	3	6.3	2.88		
	Male	5	6.4	3.04		
	Survivorship				.683	0.520
	Female	3	.50	.43		
	Male	5	.32	.32		

B. Surviving to Age 7-9		N	Mean	Std.	T-value	Sig. (two-tailed)
First child surviving to age 7-9 or beyond	Fertility				-.584	0.561
	Female	28	4.21	2.21		
	Male	37	4.59	2.85		
	Survivorship				-.445	0.658
	Female	28	72%	.303		
	Male	37	75%	.301		
First child dead but second survives to age 7-9 or beyond	Fertility				.994	.330
	Female	10	6.3	2.62		
	Male	15	5.2	2.49		
	Survivorship				.944	0.301
	Female	10	63.3%	.249		
	Male	15	51.7%	.278		
First and second child dead but third survives to age 7-9 or beyond	Fertility				-.030	0.977
	Female	5	6.33	2.88		
	Male	3	6.4	3.04		
	Survivorship				.683	0.520
	Female	5	50%	.433		
	Male	3	32%	.318		

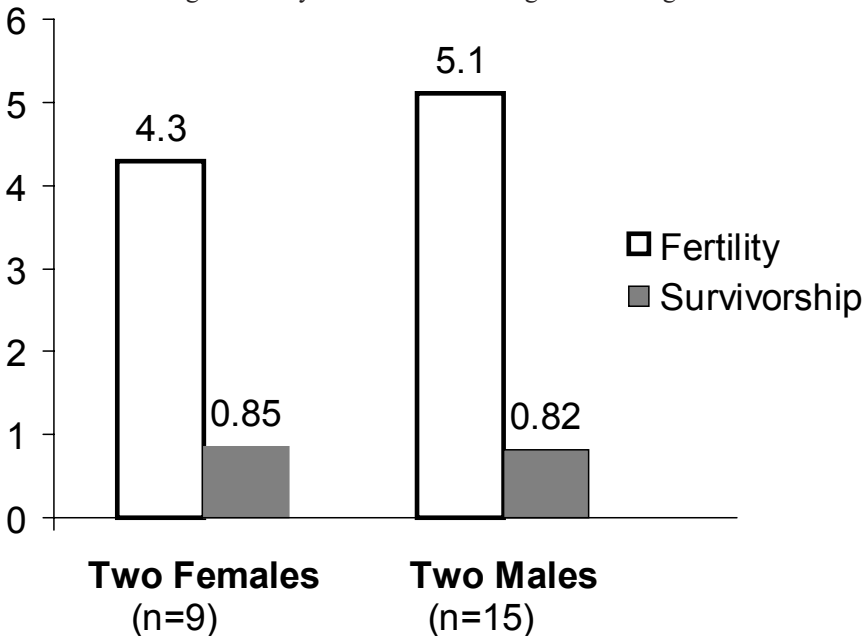
C. Surviving to Age 10-12		N	Mean	Std.	T-value	Sig. (two-tailed)
First child surviving to ages 10-12 or beyond	Fertility				-.476	0.684
	Female	26	4.3	2.25		
	Male	31	4.6	2.96		
	Survivorship				-.410	0.636
	Female	26	72%	.30		
	Male	31	75%	.31		
First child dies but second survives to ages 10-12 or beyond	Fertility				.103	0.315
	Female	10	6.3	2.62		
	Male	12	5.2	2.51		
	Survivorship				.148	.884
	Female	10	.633	.249		
	Male	12	.619	.188		
First and second children dead but third survives to ages 10-12 or beyond	Fertility				-.669	0.796
	Female	11	5.72	1.67		
	Male	6	6.50	3.14		
	Survivorship				.264	0.514
	Female	11	65%	.198		
	Male	6	62%	.311		

Table 1. Fertility and Survivorship of Children (continued)

D. First two children surviving to ages 10–12 or beyond	N	Mean	Std.	T-value	Sig. (two-tailed)
Fertility				-1.023	0.318
Female	9	4.3	1.73		
Male	15	5.1	1.92		
Survivorship				.436	0.667
Female	9	85%	.157		
Male	15	82%	.177		
<hr/>					
E. First two children surviving to ages 13–17 or beyond	N	Mean	Std.	T-value	Sig. (two-tailed)
Fertility				-1.44	0.164
Female	8	4.0	1.5		
Male	15	5.1	1.9		
Survivorship				.399	0.694
Female	8	85%	.167		
Male	15	82%	.177		

Note: We also examined fertility and survivorship for two children who had survived beyond age 17 and they were the same children who survived ages 13–16 or beyond. Consequently, the statistical results are identical to those who survived 13–16 or beyond.

Figure 2. Fertility and survivorship of children of women who had two consecutive girls or boys who survived to age 10–12 or greater.



DISCUSSION

Several issues ought to be addressed in the interpretation of our results. It is possible that older daughters, adolescents and young married women, not observed systematically by either Konner or Draper, provided important help to their mothers. Among Ju/'hoansi of the relevant time period, although girls married young, even premenarcheally, the custom of bride service practiced by the foraging Ju/'hoansi meant that girls and their husbands remained in the camps of the bride's parents (Marshall 1959). The period of bride service lasted several years, not only until the young bride matured and began to bear her own children but in many cases until two or three children were born. These older girls and young women (prior to giving birth to their own children) may have provided help to their mothers that improved the older women's fertility or survivorship of their children. This effect, if present, would not have been revealed in the behavior observations conducted on infants and toddlers (Konner) and on children 3–14 years of age (Draper 1972, 1975; Draper and Cashdan 1988; Konner 1972, 1976, 1977).

It is also possible that sex of child is not relevant to detecting a helper at the nest effect. It may simply be that, irrespective of their sex, having early borns surviving to an age at which they can assist a mother in care of younger siblings will positively affect the survival and reproduction of subsequent offspring. The potential problem with the current analysis is that it does not exclude several alternative hypotheses: for example, (1) women whose initial offspring survive long enough to become helpers are genetically healthier than women whose children die early as firstborns, or (2) such women are particularly effective care givers to their children. Notwithstanding these two potential confounds we examined the relationship between the survivorship of firstborns and a mother's fertility and average survivorship of her offspring. In a series of *t*-tests we found that women whose firstborns survived to age 4–6 or beyond, irrespective of sex, did not have higher fertility or survivorship of their children than women whose firstborns failed to reach age 4–6. The same non-significant result occurred when we compared women whose firstborns survived to age 7–9 or beyond with women whose firstborns failed to achieve this age category.

In summary, our findings are that the gender configuration of offspring sets did not influence mothers' fertility or their ability to keep their children alive. However, there is good reason to expect that other kinds of alloparents make a difference in child outcomes. Indeed, it may well be that among most hunters and gatherers, the most important

alloparenting comes from adult helpers such as grandparents, particularly grandmothers (e.g., Hawkes, O'Connell, and Blurton Jones 1995) but also adult female kin of the children's mothers and fathers (Draper and Hames 2000; Hrdy 2002).

CONCLUSION

As we predicted, sex of first, second, or third born children has no effect on a woman's fertility or the survivorship of her children. The environmental and economic conditions of a forager lifestyle in the Kalahari led us to believe that children cannot act effectively enough as helpers to their younger siblings, or in food gathering, or in other time-sparing or productive activities that have any effect on their mother's fertility or the survivorship of her offspring. In the area of childcare, recently weaned children were left in camp in the company of other children, some of whom may have been siblings. However, there were always one or more adults in the camp on such occasions who supervised care. Women as well as men appeared to reciprocate in babysitting duties: one day a mother stayed in camp and watched her children and the children of women who were foraging, and the following day the woman who acted as the camp babysitter foraged while the others replaced her as babysitters. Therefore, the presence of a capable older sibling was not relevant to the well-being of his or her younger sibling(s).

It is not until late adolescence that Ju/'hoansi children began to make important economic contributions (Draper 1976). In this way the !Kung contrast sharply with the Hadza, whose children were economic producers at a much earlier age than the Ju/'hoansi and whose mothers had significantly higher fertility (Hawkes et al. 1995). Analysis of the Hadza data by Kaplan et al. (2000:159) suggests that women are economically self-sufficient (caloric production begins to exceed caloric consumption) by age 15, and men by age 20. This suggests that environmental factors determine whether siblings can play the role of helpers-at-the-nest. These include the ability of children to navigate through the environment, presence of predators, distance of food resources from the camp, and the presence of resources that can be efficiently handled by children (Blurton Jones et al. 1994a, 1994b). Even more importantly, the Ju/'hoansi contrast markedly from agriculturalists such as the Maya and Trukese (Kramer 2002; Turke 1988), reviewed above, among whom girls make significant contributions to the household economy.

The results presented here and in the work we cite on helpers-at-the-nest may have implications for our understanding of the first demographic

transition. It is widely understood that the development of agriculture universally led to a dramatic increase in population growth. However, it is unclear whether this momentous growth was a consequence of increased fertility or decreased mortality or both, and what role agriculture played in effecting these two fundamental demographic parameters. Did the food supply become more stable and/or did caloric intake increase (Cohen 1989), or did fertility change little but survivorship increase significantly (Bentley et al. 1993)? Work on helpers reviewed above (e.g., Turke 1988; Crognier et al. 2001) suggests that a mother's older children may enhance her fertility by reducing interbirth intervals or increasing the fertility span. Alternatively, survivorship may increase.

We believe that three factors characteristic of horticulture and incipient horticulture may have led to children becoming helpers-at-the-nest and thereby positively influencing their mother's fertility or the survivorship of her offspring. These factors have to do with the propinquity of agricultural plots to residences, the integration of agricultural tasks, and the moderate skill and strength levels required in many agricultural tasks. A pivotal aspect of the transition to settled food producing was that the workplace and base camp became contiguous. These same elements of propinquity between residence and food-procurement loci that enabled contributions by child helpers would also have appeared among the archaic foragers who lived in highly abundant environments, such as the coasts of northwestern North America and southeast Australia (Kelly 1995; Lourandos 1997).

As another example, simple horticulturalists oftentimes have gardens within meters of their residences (Hames 1983). If gardens are distant, garden shelters may be constructed, allowing mothers to work and monitor young children who are cared for by older children in the shelter. Of course, productivity is also raised, thus providing a caloric basis for population growth. We do not wish to minimize this signal achievement. However, the nature of agricultural food production in general, in contrast with mobile foraging, is that the place where resources are captured is itself local, controlled, managed, and predictable. When the location of work is near where people live, and relatively safe because of the density of able-bodied adults and the nearness of permanent shelters, children can be transported easily to the workplace and mothers can work in the field while keeping an eye on older siblings who care for younger siblings.

Another aspect of agricultural production is that the component tasks can be broken down in temporal sequence and in level of complexity. Children can be assigned the familiar tasks of weeding, harvesting, etc., while being supervised by adults and more competent juveniles who are

also productively employed (Bock 2002). To a great extent, the labor of hunter gatherers, male or female, is usually “vertically integrated,” meaning that each worker embodies the skills and physical strength to carry out all phases of the work. When this condition is combined with the fact all foragers must face, namely that the place where resources can be captured is distant, not managed, and not predictable in its yields, we can see why the food-collecting work of children is less easily incorporated into the adult economy. Agricultural production, by contrast, oftentimes is “horizontally integrated.” Its components can be distributed over time and among laborers of different types and skills. As has been amply described elsewhere, agriculture achieves many efficiencies and along the way extracts labor from children.

We hope that our exercise in examining the relationship between the gender sequence of offspring sets and mothers’ fertility and mothers’ offspring survivorship will prompt other researchers to search for causal linkages in the context of different environmental and technological constraints.

The primary data presented here were gathered by Patricia Draper and funded by a grant from the National Institute of Aging (grant AG03110) to Christine Fry and Jennie Keith. The authors would like to thank Elizabeth Cashdan, Alice Schlegel, Donna Leonetti, and Sarah Hrdy for their insightful comments on the paper. This paper was originally presented at the Annual Meeting of the Human Behavior and Evolution Society, University College, London, England, June 13–17, 2001.

Raymond Hames is a professor in the Department of Anthropology at the University of Nebraska. His research interests are in behavioral and evolutionary ecology, exchange systems, and tropical forest peoples.

Patricia Draper is also a professor in the Department of Anthropology at the University of Nebraska. Her research interests are in cross-cultural human development, evolutionary theory, hunter-gatherer society, and comparative family organization.

NOTE

1. Boys, of course, while they are still young, could be put to work weeding and carrying water. But typically they are not. This poses an interesting theoretical question.

REFERENCES

- Almagor, U.
1982 A Note on the Fertility of the Mbanderu Women. *Botswana Notes and Records* 14:23–25.
- Barry, Herbert III, Margaret K. Bacon, and Irvin L. Child
1957 A Cross-Cultural Survey of Some Sex Differences in Socialization. *Journal of Abnormal and Social Psychology* 55:327–332.

- Barry, Herbert III, Irvin L. Child, and Margaret K. Bacon
1959 Relation of Child Training to Subsistence Economy. *American Anthropologist* 61:51–63.
- Belsey, M. A.
1976 The Epidemiology of Infertility: A Review with Particular Reference to Sub-Saharan Africa. *Bulletin of the World Health Organization* 54:319–341.
- Bentley, G. R., T. Goldberg, and G. Jasienska
1993 The Fertility of Agricultural and Non-agricultural Traditional Societies. *Population Studies* 47:269–281.
- Berezkei, Tamas
1998 Kinship Network, Direct Childcare, and Fertility among Hungarians and Gypsies. *Evolution and Human Behavior* 19:283–298.
- Berezkei, Tamas, and R. I. M. Dunbar
2002 Helping-at-the-nest and Sex-biased Parental Investment in a Hungarian Gypsy Population. *Current Anthropology* 43:804–812.
- Bieseke, Megan
1997 The Ju/'hoan Bushmen under Two States: Impacts of the South West African Administration and the Government of the Republic of Namibia. In *Hunters and Gatherers in the Modern World: Conflict, Resistance and Self-determination*, M. Bieseke, R. Hitchcock, and P. Schweitzer, eds. Pp. 305–326. Providence, RI: Berghahn Books.
- Bieseke, Megan, Robert Hitchcock, Richard Lee, Jean MacGreagor, and Mathias Guenther
1989 Hunters, Clients and Squatters: The Contemporary Socioeconomic Status of Botswana Basarwa. *African Study Monographs* 9(3):109–151.
- Blurton Jones, Nicholas G.
1987 Bushman Birth Spacing: Direct Test of Some Simple Predictions. *Ethology and Sociobiology* 8:183–204.
2002 Hadza Fathers and Grandmothers as Helpers: Residence Data. Paper presented at the Ninth Annual Conference on Hunting and Gathering Societies (CHAGS9), Heriot-Watt University, Edinburgh, Scotland.
- Blurton Jones, N. G., and R. M. Sibly
1978 Testing Adaptiveness of Culturally Determined Behaviour: Do Bushman Women Maximise Their Reproductive Success by Spacing Births Widely and Foraging Seldom? In *Human Behaviour and Adaptation*, N. Blurton Jones and V. Reynolds, eds. Pp. 135–158. Society for Study of Human Biology Symposium, No. 18. London: Taylor and Francis.
- Blurton Jones, N. G., K. Hawkes, and P. Draper
1994a Differences between Hadza and !Kung Children's Work: Original Affluence or Practical Reason? In *Key Issues in Hunter Gatherer Research*, E. S. Burch, ed. Pp. 189–215. Oxford: Berg.
1994b Foraging Returns of !Kung Adults and Children: Why Didn't !Kung Children Forage? *Journal of Anthropological Research* 50:217–248.
- Bock, John
2002 Learning, Life History, and Productivity: Children's Lives in the Okavango Delta, Botswana. *Human Nature* 13:161–197.
- Cohen, N.
1989 *Health and the Rise of Civilization*. New Haven: Yale University Press.
- Crognier, E., A. Baali, and M-K. Hilali
2001 Do "Helpers-at-the-nest" Increase Their Parents' Reproductive Success? *American Journal of Human Biology* 13:365–373.

- Davis, Jennifer Nerissa, and Martin Daly
1997 Evolutionary Theory and the Human Family. *Quarterly Review of Biology* 72:407–435.
- Draper, Patricia
1972 *!Kung Bushman Childhood*. Ph.D. dissertation, Harvard University, Cambridge.
1975 Cultural Pressure on Sex Differences. *American Ethnologist* 2:602–616.
1976 Social and Economic Constraints on Child Life among the !Kung. In *Kalahari Hunter-Gatherers*, R. B. Lee and I. DeVore, eds. Pp. 199–217. Cambridge: Harvard University Press.
- Draper, Patricia, and Elizabeth Cashdan
1988 Technological Change and Child Behavior among the !Kung. *Ethnology* 27:339–365.
- Draper, Patricia, and Raymond Hames
2000 Birth Order, Sibling Investment and Fertility among the Ju/'hoansi (!Kung). *Human Nature* 11:117–156.
- Ember, Carol R.
1973 Feminine Task Assignment and the Social Behavior of Boys. *Ethos* 1:424–439.
1981 A Cross-cultural Perspective on Sex Differences. In *Handbook of Cross-cultural Human Development*, R. H. Munroe, R. L. Munroe, and B. B. Whiting, eds. Pp. 531–580. New York: Garland.
- Emlen, Stephen T.
1984 Cooperative Breeding in Birds and Mammals. In *Behavioural Ecology: an Evolutionary Approach*, J. R. Krebs and N. Davies, eds. Pp. 245–281. Sunderland, Massachusetts: Sinauer.
1995 An Evolutionary Theory of the Family. *Proceedings of the National Academy of Science* 92:8092–8099.
- Flinn, M. V.
1989 Household Composition and Female Reproductive Strategy in a Trinidadian Village. In *The Sociobiology of Sexual and Reproductive Strategies*, A. E. Rasa, C. Voegl, and E. Voland, eds. Pp. 206–233. London: Chapman & Hall.
- Frank, O.
1983 Infertility and Sub-Saharan Africa: Estimates and Implications. *Population Development Review* 9:137.
- Hames, Raymond B.
1983 Monoculture, Polyculture, and Polyvariety in Tropical Forest Swidden Cultivation. *Human Ecology* 11:13–34.
1988 The Allocation of Parental Care among the Ye'kwana. In *Human Reproductive Behavior: A Darwinian Perspective*, L. Betzig, M. Borgerhoff Mulder, and P. Turke, eds. Pp. 237–252. Cambridge: Cambridge University Press.
- Hawkes, K., J. F. O'Connell, and N. G. Blurton Jones
1989 Hardworking Hadza Grandmothers. In *Comparative Socioecology: The Behavioural Ecology of Humans and Other Mammals*, V. Standen and R. A. Foley, eds. Pp. 341–366. Oxford: Blackwell Scientific.
1995 Hadza Children's Foraging: Juvenile Dependency, Social Arrangements, and Mobility among Hunter-gatherers. *Current Anthropology* 36:688–700.
1997 Hadza Women's Time Allocation, Offspring Provisioning, and the Evolution of Long Postmenopausal Life Spans. *Current Anthropology* 38:551–577.
- Hawkes, Kristen, James F. O'Connell, N. G. Blurton Jones, H. Alvarez, and E. L. Charnov

- 1998 Grandmothering, Menopause, and the Evolution of Human Life Histories. *Proceedings of the National Academy of Sciences* 95:1336–1339.
- Heath, Kathleen M.
1999 The Reproductive Payoffs of Kin Propinquity in a 19th Century American Frontier Population. Paper presented at the Annual Meeting of the Human Behavior and Evolution Society, Salt Lake City.
- Hill, K., and A. M. Hurtado
1996 *Ache Life History: The Ecology and Demography of a Foraging People*. Hawthorne, New York: Aldine de Gruyter.
- Hill, Kim, Hillard Kaplan, A. Magdalena Hurtado, and Jane Lancaster
2000 A Theory of Human Life History Evolution: Diet, Intelligence, and Longevity. *Evolutionary Anthropology* 9:156–185.
- Howell, N.
1979 *The Demography of the Dobe !Kung*. New York: Academic Press.
2000 *Demography of the Dobe !Kung*, second ed. New York: Aldine de Gruyter.
- Hrdy, Sarah B.
1977 *The Langurs of Abu: Female and Male Strategies of Reproduction*. Cambridge: Harvard University Press.
1999 *Mother Nature: A History of Mothers, Infants, and Natural Selection*. New York: Pantheon Books.
2002 Cooperative Breeding: An Evolutionary and Comparative Perspective. Paper presented at the Ninth International Conference on Hunting and Gathering Societies (CHAGS9), Heriot-Watt University, Edinburgh, Scotland.
- Kaplan, Hillard
1994 Evolutionary and Wealth Flows Theories of Fertility: Empirical Tests and New Models. *Population and Development Review* 20(1):753–791.
- Kaplan, Hillard S., and John Bock
2001 Fertility Theory: The Embodied Capital Theory of Human Life History Evolution. In *The International Encyclopedia of the Social and Behavioral Sciences*, N. J. Smelser and P. B. Baltes, eds. Pp. 5561–5568. Oxford: Elsevier Science.
- Kaplan, Hillard, Kim Hill, Jane Lancaster, and A. Magdalena Hurtado
2000 A Theory of Human Life History Evolution: Diet, Intelligence, and Longevity. *Evolutionary Anthropology* 9:156–185.
- Kelly, Robert L.
1995 *The Foraging Spectrum*. Washington, D.C.: Smithsonian Institution Press.
- Konner, Melvin J.
1972 Aspects of the Developmental Ethology of a Foraging People. In *Ethological Studies of Child Behavior*, N. G. Blurton Jones, ed. Pp. 285–304. Cambridge: Cambridge University Press.
1976 Maternal Care, Infant Behavior and Development among the !Kung. In *Kalahari Hunter-Gatherers: Studies of the !Kung San and Their Neighbors*, R. B. Lee and I. DeVore, eds. Pp. 218–245. Cambridge: Harvard University Press.
1977 Infancy among the Kalahari Desert San. In *Culture and Infancy: Variations in the Human Experience*, P. H. Leiderman, S. R. Tulkin, and A. Rosenfeld, eds. Pp. 287–328. New York: Academic.
- Kramer, Karen
2002 Variability in Juvenile Dependence: Helping Behavior among Maya Children. *Human Nature* 13:299–325.
- Kramer, Karen L., and Garnett P. McMillan
1999 Women's Labor, Fertility, and the Introduction of Modern Technology in a Rural Maya Village. *Journal of Anthropological Research* 55:499–520.

- Lancaster, J. B., and C. S. Lancaster
 1987 The Watershed: Change in Parental-Investment and Family-Formation Strategies in the Course of Human Evolution. In *Parenting across the Life Span: Biosocial Dimensions*, J. B. Lancaster, J. Altmann, A. S. Rossi, and L. R. Sherrod, eds. Pp. 187–205. Hawthorne, New York: Aldine de Gruyter.
- Lee, Richard B.
 1979 *The !Kung San: Men, Women and Work*. Cambridge: Cambridge University Press.
 1993 *The Dobe Ju/'hoansi*. Fort Worth: Harcourt Brace College.
- Leonetti, D. L., D. C. Nath, N. S. Hemam, and L. Rende Taylor
 2001 Is Female-biased Parental Investment Evident in Two Culturally Different Low Status Indian Ethnic Groups? Paper presented at the Annual Meeting of the Human Behavior and Evolution Society, University College, London.
 2002 Cooperative Breeding Effects among the Matrilineal Khasi of Northeast India. Paper presented at the Annual Meeting of the Human Behavior and Evolution Society, Rutgers University, New Brunswick, New Jersey.
- Lourandos, H.
 1997 *Continent of Hunter-Gatherers: New Perspectives in Australian Prehistory*. Cambridge: Cambridge University Press.
- Mace, R., and R. Sear
 1997 Birth Interval and the Sex of Children in a Traditional African Population: An Evolutionary Analysis. *Journal of Biosocial Sciences* 29:499–507.
- Marshall, Lorna
 1959 Marriage among the !Kung Bushmen. *Africa* 29:335–365.
 1976 *The !Kung of Nyae Nyae*. Cambridge: Harvard University Press.
- Munroe, R. H., R. L. Munroe, and H. S. Shimmin
 1984 Children's Work in Four Cultures: Determinants and Consequences. *American Anthropologist* 86:369–379.
- Nag, Moni
 1962 *Factors Affecting Human Fertility in Nonindustrial Societies: A Cross-Cultural Study*. New Haven: Human Relations Area Files.
- Nag, Moni, Benjamin N. F. White, and R. Creighton Peet
 1978 An Anthropological Approach to the Study of the Economic Value of Children in Java and Nepal. *Current Anthropology* 19:293–306.
- Nerlove, S. B.
 1974 Women's Workload and Infant Feeding Practices: A Relationship with Demographic Implications. *Ethnology* 13:207–214.
- Nerlove, S. B., J. M. Roberts, R. E. Klein, C. Yarborough, and J. P. Habicht
 1974 Natural Indicators of Cognitive Development: An Observational Study of Rural Guatemalan Children. *Ethos* 2:265–295.
- O'Connell, J. F., K. Hawkes, and N. G. Blurton Jones
 1999 Grandmothering and the Evolution of *Homo erectus*. *Journal of Human Evolution* 36:461–485.
- Pasternak, B., C. R. Ember, and M. Ember
 1997 *Sex, Gender, and Kinship: A Cross-Cultural Perspective*. Upper Saddle River, New Jersey: Prentice Hall.
- Sear, R., R. Mace, and I. A. McGregor
 2000 Maternal Grandmothers Improve the Nutritional Status and Survival of Children in Rural Gambia. *Proceedings of the Royal Society of London, Series B, Biological Sciences*, 267:1641–1647.

- Sear, R., F. Steele, I. A. McGregor, and R. Mace
2002 The Effects of Kin on Child Mortality in Rural Gambia. *Demography* 39:43–63.
- Strassmann, B., and A. Clarke
1998 Ecological Constraints on Marriage in Rural Ireland. *Evolution and Human Behavior* 19:33–55.
- Strassmann, Beverly I., and J. H. Warner
1998 Predictors of Fecundability and Conception Waits among the Dogon of Mali. *American Journal of Physical Anthropology* 105:167–184.
- Turke, Paul
1988 Helpers-at-the-Nest: Childcare Networks on Ifaluk. In *Human Reproductive Behavior: A Darwinian Perspective*, L. Betzig, M. Borgerhoff Mulder, and P. Turke, eds. Pp. 173–188. Cambridge: Cambridge University Press.
- Weisner, T. S., and R. Gallimore
1977 My Brother's Keeper: Child and Sibling Caretaking. *Current Anthropology* 18:169–190.
- Whiting, B. B., and J. W. M. Whiting
1975 *Children of Six Cultures: A Psycho-cultural Analysis*. Cambridge: Harvard University Press.
- Whiting, Beatrice, and Carolyn Edwards
1988 *Children of Different Worlds: The Formation of Social Behavior*. Cambridge: Harvard University Press.
- Whiting, John W. M., Irvin L. Child, William W. Lambert, et al.
1966 *Field Guide for a Study of Socialization*. New York: John Wiley and Sons.
- Wiessner, Polly
2002 Hunting, Healing, and *Hxaro* Exchange. A Long-Term Perspective on !Kung (Ju/'hoansi) Large-Game Hunting. *Evolution and Human Behavior* 23:407–436.
- Yellen, J. E.
1990 The Transformation of the Kalahari !Kung. *Scientific American* (April):96–105.