

Who Responds to Crying?

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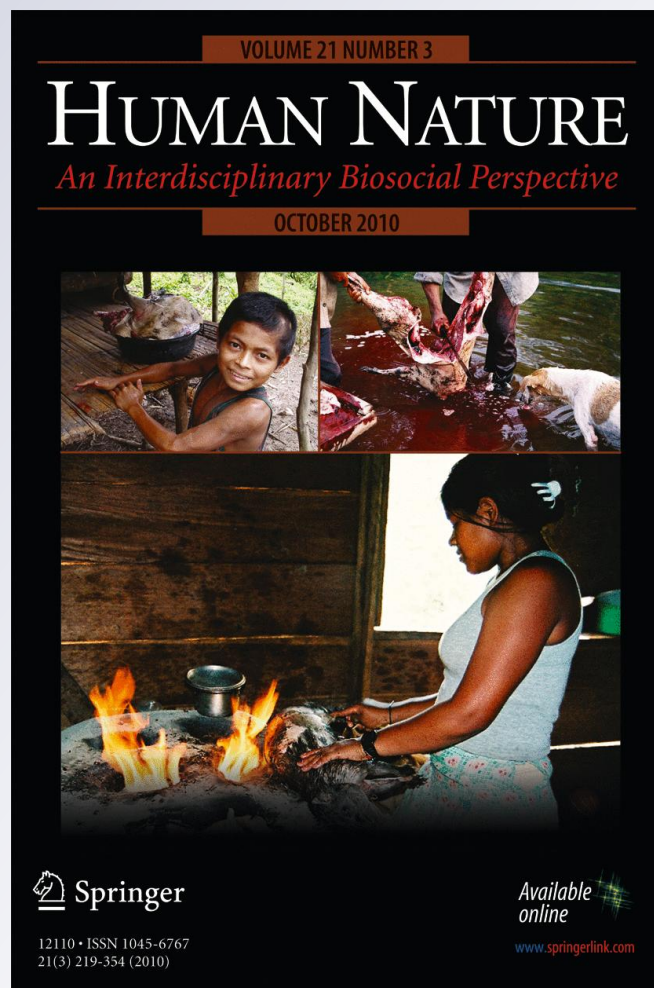
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Who Responds to Crying? Maternal Care and Allocare among the !Kung

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Abstract !Kung San (Bushman) hunter-gatherers have unusually high levels of mother-infant contact and represent one of the environments of human evolutionary adaptedness (EEAs). Studies among the !Kung show that levels of crying—the most basic sign of mammalian infant distress—are low, and response to crying is high, and some suggest that responses are overwhelmingly maternal. We show that although !Kung mothers respond to crying most often, one-third of crying bouts are managed solely by someone else. Mothers responded to all bouts lasting ≥ 30 s, but in half of these responses they were joined by one or more others. Mothers are the most consistent responders, but multiple caregiving is common. The mother is rarely alone when her baby cries; others often substitute or join her in interventions. This social support may facilitate the high levels of maternal responsiveness characteristic of the !Kung, and of hunter-gatherers generally, but it is also consistent with recent theory emphasizing nonmaternal care (allocare) and cooperative breeding.

Keywords Infancy · Crying · Maternal care · Allocare · Alloparental care · Cross-cultural research · Hunter-gatherers · Cooperative breeding

Recent thinking about the evolution of human reproductive adaptations has highlighted the possible role of cooperative breeding as a key factor in the success of our species. Grandmothers, other adult female relatives, fathers, and dependent children have all been viewed as contributing to the diffusion of infant and child care that may have played a role in hominization (Hawkes 2003; Hewlett 1991; Kaplan et al. 2000; Hrdy 2005, 2009; Kramer 2005; Robson and Wood 2008; Scelza 2009). If

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this is true, then cross-cultural research should show nonmaternal care or *allocare* to be widespread in human populations, and in particular among hunter-gatherers, often reported to have very intensive maternal care (Fouts and Lamb 2005; Hill and Hurtado 1996; Konner 2005) but also found to have substantial *allocare* (Ivey 2000; Meehan 2005; Tronick et al. 1992). If, as is certainly true in many species (Emlen 1995), reproductive success in humans is enhanced by “helpers at the nest,” this would add weight to the possible role of cooperative breeding in human evolution. Such effects have been shown for several traditional—although not hunter-gatherer—cultures, including Hungarian Roma (Gypsies) (Berezkei and Dunbar 2002), people on Ifaluk Island (Turke 1988), and villagers of rural Gambia (Sear et al. 2000).

Cross-cultural infancy and childhood studies have a long history (Barry and Paxson 1971; Kagan 1977; Leiderman et al. 1977; LeVine 1997; Monroe et al. 1981; Van IJzendoorn and Sagi 1999; Whiting and Whiting 1975) and are now widely recognized as vital in developmental research (Rogoff 1997; Rogoff and Morelli 1989). Hunter-gatherer infancy has been of special interest, based on the view that hunter-gatherers represent the range of environments of human evolutionary adaptedness (EEAs) (Hewlett and Lamb 2005; Konner 2005). The earliest extensive studies of hunter-gatherers focused on the !Kung San (Bushmen) of the Kalahari desert in sub-Saharan Africa. At least by the 1950s, ethnographers described !Kung infants as remaining physically close to their mothers and being highly indulged in every aspect of nurturance. Attachment theory influenced, and was later influenced by, studies of the !Kung, who are believed to have one of the closest mother-infant relationships ever studied.

Ethnographic descriptions of the !Kung were followed by quantitative research published in the 1970s and 1980s showing that !Kung infants had extremely high levels of skin-to-skin physical contact, mainly with the mother (Konner 1972). Newborns were carried upright in a sling on the mother's side, with no clothing between them. Breast-feeding occurred for a few minutes at a time, several times an hour, throughout the waking hours (Konner and Worthman 1980). !Kung infants slept with their mothers on the same mat and nursed during the night, often without waking their mothers. Weaning was gradual and generally took place during the mother's next pregnancy, at three to four years (Konner 1977). The !Kung pattern of infant care served as an initial model of what may have obtained in the EEAs and appeared to support the concept of maternal primacy—a strong tendency of infants to focus attachment on one primary caregiver (Van IJzendoorn and Sagi 1999).

Despite researchers' focus on the closeness of the !Kung mother-infant relationship, there was evidence that other caregivers were important as well. The milieu of development in the first year included many brief, intensive, face-to-face interactions between infants and other children, including mutual smiling and vocalization (Konner 1972). When not in the sling, infants were “passed from hand to hand around a fire for similar interactions with adults and children” (1972:292). When !Kung nonmaternal care was compared (Konner 1976) with care of professional and working-class ten-month-old girls in Boston (Tulkin 1970, 1977; Tulkin and Kagan 1972), physical contact with people other than the mother was found to be higher among !Kung infants than it was among either class in Boston. Furthermore, in a study of !Kung infants' joint attention to objects (Bakeman et al.

1990), no difference was found between mothers and others in their object-centered interactions with infants, and infants were just as likely to offer objects to non-mothers as to mothers. Individuals other than the mother entertained and directed vocalizations toward the infant more than mothers. Thus, !Kung infants develop in a rich social world, having extensive interactions with many individuals while maintaining close physical contact with the mother. Indeed, the high level of maternal indulgence among the !Kung has been explained in terms of the supportive social context (Konner 1977). The ongoing availability of caregiving partners was said to support the mother and make her better able to maintain sensitive responsiveness.

In addition to the !Kung, we now have good studies of hunter-gatherer infants among the Efe, Aka, Hadza, Ache, and other groups (Hewlett 1991; Hewlett et al. 1998; Hill and Hurtado 1999; Morelli and Tronick 1991; Tronick et al. 1987, 1992). These studies generally support the !Kung model of hunter-gatherer infancy (Konner 2005) with important exceptions. The Efe appeared to have much more nonmaternal involvement in caregiving (Morelli and Tronick 1991; Tronick et al. 1987, 1992). Observations of the Aka revealed that 55% of infants received some breastfeeding by women other than their mothers, although only in the first few months of life (Hewlett et al. 2000), and that fathers had an exceptionally large role (Hewlett 1991). Although there was considerable variation in allocare among the Aka, infants received a similar overall level of care (Meehan 2005).

In particular, the Efe, hunter-gatherers of the Central African forest, were said to provide a stark contrast to the !Kung in caregiving. People other than the mother accounted for about half of all social and physical contact. Many different people cared for each infant, and most infants were sometimes nursed by non-mothers (Tronick et al. 1987, 1992). The shift of emphasis in the research literature to provisioning infant care by non-mothers has challenged !Kung mother-infant closeness and maternal primacy as a paradigm for infant care in the EEAs.

To refine our understanding of these issues, we focused in some detail on how the !Kung, both mothers and non-mothers, care for infants in distress. In attachment theory, caregiver responsiveness to infant *distress* is central in the formation of the infant's internal working model of self and other. In our examination of responses to crying among the !Kung we elucidate *how* and *by whom* caregiving is carried out in situations that are important to attachment formation. Although data on overall responsiveness to crying in hunter-gatherers are available, to our knowledge the question of *who* responds has not been studied quantitatively in these cultures. Thus, the present reexamination of !Kung caregiving during infant distress may provide a more nuanced account of the roles of mothers and others in this population.

The infant distress call is a fundamental characteristic of mammals, perhaps 200 million years old (MacLean 1985; Zeifman 2001), and magnetic resonance imaging shows that human mothers hearing infant cries activate brain circuits that evolved with mammals (Lorberbaum et al. 2002). Crying in distress is basic to human infancy and seems to have the general function of eliciting care (Barr 1990a; Lummaa et al. 1998; Wolff 1969), although it may not always reflect a true need for care (Soltis 2004). While caregiver response may be partly biological, it is also

influenced by knowledge about infants and by the context of care (Wendland-Carro et al. 1999; Wood and Gustafson 2001).

Crying peaks in the early months, and there is cross-cultural evidence for a “normal crying curve” that rises from birth to two months, then slowly declines to a plateau for the rest of infancy (Baildam et al. 1995; Barr 1990a, b). Some investigators have claimed that responsiveness to crying reduces later crying (Bell and Ainsworth 1972), and others that it increases it (Gewirtz 1977); a more recent experiment suggests the latter (Van IJzendoorn and Hubbard 2000), although there is considerable evidence that greater maternal sensitivity predicts attachment security (Bakermans-Kranenburg et al. 2003). Whatever their long-term effects, caregiver interventions usually reduce crying in the event. Randomized controlled trials show that skin-to-skin contact is analgesic in newborns (Gray et al. 2000) and that holding young infants more hours per day reduces their overall level of crying (Hunziker and Barr 1986).

Crying in !Kung infants illustrates universal human tendencies and culturally specific variation. !Kung infants displayed the “normal crying curve” with a peak in the first three months, and also had the same number of crying bouts as infants in a Dutch sample, even though !Kung crying bouts were shorter and their total crying duration was about half that of Dutch infants (Barr et al. 1991). Caregivers respond promptly to distress in !Kung infants (Konner 1972), and the cultural difference in crying duration could be due to differences in caregiving, including physical contact and responsiveness.

The present study focuses in more detail on responses to crying in !Kung infants by mothers and other caregivers. Our analysis of archival data was directed toward three research questions. First, we examined the types of responses that were made by mothers and others in response to infant crying and how those may vary by infant age and length of crying bout. Second, we compared how often mothers versus others responded to crying. Third, to explore more thoroughly the concept of !Kung maternal sensitivity correlating with strong social support, we carefully catalogued incidents in which the mother was the sole responder to a crying infant.

Method

Original Procedure

The present analysis is based on systematic observations made by the second author among the !Kung San, or Bushmen, of Botswana, during 20 months from 1969 to 1971 and 6 months in 1975, when they were still mainly hunting and gathering for a living. The second author was a member of the Kahalari Research Group, which began studying the !Kung in 1963 and is still ongoing (Draper 1997; Draper and Harpending 1987; Lee 1979, 1984; Lee and Daly 1999; Lee and DeVore 1976). By the time of this data collection, the !Kung were well used to being investigated (in fact, they took it for granted that they were interesting). The second author was fluent in the Bushman language, acquainted with the mothers of the infants studied, and obtained their consent, as well informed as possible given the large cultural gap, before observing them.

The observation methodology had significant limitations owing to the difficult logistics of finding and observing infants in a sparse and nomadic population distributed over a wide geographic area; it was impossible to meet the usual standards for infant research in urban or suburban homes. However, the methodology was more rigorous than is common in anthropological studies of childhood even today. We believe (as have reviewers and editors of previous publications) that the uniqueness of the data and its likely importance in understanding the origins of human infancy and infant care outweigh methodological limitations. Results from this dataset have been of value even to investigators with hypotheses far removed from the goals of the original study (Bakeman et al. 1990, 1997; Barr et al. 1987, 1991). In our discussion we try to address the limitations and take a cautious approach to interpreting our results.

The subjects comprised not a sample but in effect *the universe* of infants living in from 6 to 10 village-camps (this number varied with nomadic movements based on food and water availability) in an area about 10 miles long and 5 miles wide in northwestern Botswana, adjacent to the border of what is now Namibia. Numerous different kinds of studies were done on !Kung infants and young children, as described in the papers cited above. The data on infants analyzed here come from 15-min observation sessions marked in contiguous 5-s time blocks. Whenever possible, infants were observed for six 15-min sessions, for a total of 90 min at a specific age point. Randomization was impossible under the circumstances, but a serious effort was made to distribute the observations over the daylight hours and throughout the year. Usually (but no more than) two of the six 15-min sessions occurred on the same day, but the six at a given age point all occurred within one week. Criteria for onset of observation were that the infant was awake, not in the sling, not nursing, and within 10 feet of the mother. Although the last criterion could be seen to bias the data in favor of mother presence, spot observations had shown that mother and infant were rarely farther apart while in the village-camps (Konner 1976). (During the 10–15 h per week that mothers were outside the village-camp, gathering, infants under two were almost invariably with them and being carried in a leather sling at the mother's side. Our data do not apply to this situation, but non-quantitative observations suggest that response to crying was even more prompt, although mainly maternal.) Father availability was not a criterion for observation onset, nor was the presence of any other potential caregiver. The observations were recorded by hand in a shorthand and using a code developed for a study of mother-infant interaction among ten-month-old girls in Boston (Tulkin 1970, 1977; Tulkin and Kagan 1972), expanded to include a larger age range, using codes developed for other studies (Leiderman and Leiderman 1977; Leiderman, Tulkin, and Rosenfeld 1977), and then modified for the !Kung setting.

The resulting code consisted of more than 100 infant and caregiver behaviors, although in practice only a subset was used at any given age, and some were rare throughout the dataset. Since the original study was motivated more by ethological methods (Blurton Jones 1972) than by any particular psychological theory, an attempt was made to minimize inference by using a highly atomized behavior code, which could later be collapsed into psychologically interesting categories, as was done for the present study (see below). An electronic beeper marked 5-s blocks

through an earpiece, and an effort was made to preserve the order of events even within the 5-s blocks. Thus the data comprise an interval-based record of all behavior codes. In addition to the behavior codes, the individuals interacting with or caring for the infant during each block were identified (Mother, Father, Sister, Brother, Man, Woman, Boy, or Girl). Also identified was the individual who served as the primary caregiver during the block, defined as the person who appeared to have responsibility for the infant (e.g., the person the infant was being held by or was sitting on or beside). All observations were done by the second author, who had previously established the method's reliability with Steven Tulkin, the originator of the method, in Boston, admittedly but unavoidably a different setting. Reliabilities (agreements/[agreements+disagreements] in all coded variables) ranged from 0.85 to 0.92.

Subjects

The original dataset had 67 observations of 45 infants, 22 males and 23 females, ranging in age from 1 to 99 weeks ($M=38.4$). Because of the logistic considerations described above, not all infants could be observed more than once. For the purposes of the present study this original corpus of observations was reduced to include only complete sets of observations. A complete set is defined as including all 6 15-min (90 min total) observation sessions of one infant at an age point. This resulted in the elimination of one age point's observation for each of 8 infants (5 males, 3 females) ranging in age from 2 to 88 weeks ($M=19.5$). Because of the present study's focus on caregivers' responses to infant distress, the dataset was further reduced to include only those complete sets of observations in which an infant was found to cry at least once during the 90 min, eliminating another 20 observation sets of 18 infants (7 males, 11 females) ranging in age from 2 to 86 weeks ($M=37.1$). Note that 20 of 59 90-min observation sets contained no record of infant crying. The ratio of criers to non-criers among the infants was consistent across age, but boys were more likely to be represented among the criers than were girls, constituting 62% of the final sample.

The present analysis is based on the remaining 39 observation sets of 29 infants (18 males, 11 females) ranging in age from 1 to 99 weeks ($M=42.8$), for a total of 58.5 h of observations. In this reduced dataset 20 infants were observed once, 8 were observed twice, and 1 was observed three times (Table 1). The inclusion of observations of individuals at more than one age point does raise a question about the assumption of independence. However, given the special importance and relative rarity of hunter-gatherer infancy data and the reduced number of infants observed to cry even once, we believe that this decision is justified. Results will be interpreted with the limits on independence taken into account.

The observations are divided into age groups: Group 1 (1–12 weeks, $M=7$; 9 observations), Group 2 (13–24 weeks, $M=19$; 6 observations), Group 3 (25–54 weeks, $M=45$; 10 observations), and Group 4 (55–99 weeks, $M=75$; 14 observations). Only three infants are represented more than once (twice each) in the same age group.

Table 1 Full observation sets for each infant by age group

Infant #	Gender	Age Group 1	Age Group 2	Age Group 3	Age Group 4
1	male	1	1		
2	male			2	
3	male		1		
4	male	1			
5	female	1	1		
6	female	1	1		
7	male	2			
8	female	1			
9	male	1			
10	male	1	1		
11	male			1	
12	male		1		
13	male			2	1
14	female			1	1
15	male			1	
16	female			1	1
17	female			1	
18	male				1
19	male			1	
20	male				1
21	male				1
22	female				1
23	male				1
24	male				1
25	male				1
26	female				1
27	female				1
28	female				1
29	female				1

Present Procedure

The original, atomized behavior codes were reanalyzed to address the research questions of the present study. In the first step of reanalysis of the reduced data archive described above, the original data record was marked for each code indicating a cry. Crying was defined in the original data collection as rhythmic, ongoing, whining vocalization associated with cry face. In contrast to Barr et al. (1991), only crying, not fretting or fussing (non-rhythmic, transient), was included in the present analyses because of our interest in response to this type of infant distress. Cry bout length was defined using contiguous 5-s intervals during which crying was noted. Thus, if crying was observed for only one 5-s interval, the cry bout was 5 s in

length; if for three 5-s intervals successively, the cry bout was considered 15 s in length. A bout of any length (in multiples of 5 s) represents the duration of crying bounded by intervals without crying,

In the second step of reanalysis of the data archive, all of the behaviors that were directed toward the infant by the mother and by any others present (e.g., fathers, siblings, children, and other adults) were marked if they occurred during a cry bout or during the 15 s following the cry bout. These behaviors were tabulated by responder and summed for each observation set. No judgment was required in either step in the present procedure and thus no reliability measures were made. In both steps, behaviors from the original dataset were marked, organized, and summed according to the criteria described above.

All of the behaviors noted in the data archive as directed toward the infant during or following a cry bout were organized here into four major categories (Comforting, Distracting, Nursing, Controlling) constructed post hoc for the present analysis. We defined Comforting as stimulation by sound or touch that appears designed to soothe excitation. Original behavior codes such as Sing or Rock were included in this category. “Distracting” is stimulation via the introduction of a new focus of attention that appears designed to redirect excitation. Behavior codes such as Give Food and Entertain were included in this category. Nursing was defined as feeding the infant at the breast, and Controlling was defined as verbal or nonverbal commands that appear designed to restrict infant behavior. The behaviors observed in response to crying and the organizing categories to which they are assigned are outlined in Table 2.

Results

The results presented below include a description of the amount of infant crying (in seconds) observed in the four age groups and a comparison between age groups. We also describe and compare crying by age groups in terms of the length of crying bouts. We then review the frequency and rate of types of responses to crying and follow that with an analysis of which persons responded to the infant's distress. Finally we explore the situations in which the mother was the only responder to crying.

Infant Crying

Because of differences from previously published databases in the definitions, subject groupings, and observations discarded, !Kung infant crying is described in two ways in this analysis. First, the mean number of seconds of crying per 90 min of observation was calculated for each of the four age groups and compared via a one-way ANOVA. Results indicate a shallow U-shaped function with respect to age, $F_{3,38}=3.02$, $p=0.000$, $h^2=0.59$. (Note that this curve covers a period much longer than that in Barr's “normal crying curve”; the period of interest in relation to that phenomenon is largely subsumed in our Age Group 1.) Post-hoc tests (Tukey's HSD) indicated that infants in Age Group 1 were observed to cry significantly more

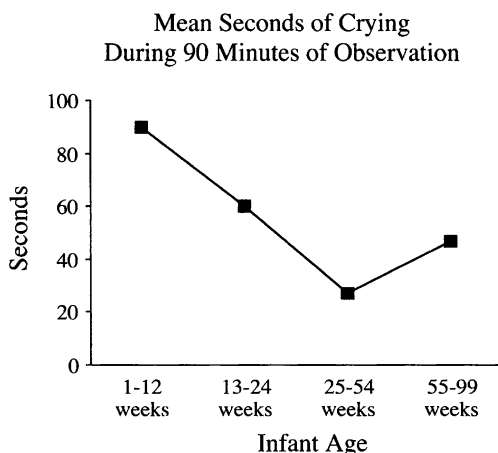
Table 2 Behaviors by mothers and others directed to crying infants

Category	Operational Definition	Original Code
I. Comforting	Stimulation via sound or touch that appears designed to soothe excitation	
A. Oral		Vocalize Sing Chant Imitate Vocally
B. Tactile		Rock Adjust Nurture Nuzzle Touch Stimulation
II. Distracting	Stimulation via the introduction of a new focus of attention that appears designed to redirect excitation	Give food Give object Entertain Encourage
III. Nursing	Feeding the infant at the breast	Insert nipple
IV. Controlling	Verbal or nonverbal commands that appear designed to restrict infant behavior	Direct Verbally prohibit Physically prohibit Verbally punish

than infants in Age Group 3 ($p=0.029$). These findings are illustrated in Fig. 1. Second, crying was studied with bouts as the units of analysis, classified by length. A short bout was defined as ≤ 10 s, a medium bout as 15–25 s, and a long bout as ≥ 30 s. For the entire sample of observations used here (all ages combined), in 90 min of observation, short bouts ($M=3.44$, $SD=3.70$) were more than 3 times more frequent than medium bouts ($M=0.90$, $SD=0.97$) and more than 12 times more frequent than long bouts ($M=0.26$, $SD=0.55$). A MANOVA was calculated to reveal any differences among the age groups in the number of short, medium, and long bouts. Differences were observed for the frequency of long bouts only, $F_{3,38}=8.38$, $p=0.000$, $h^2=0.42$. Post-hoc examination (Tukey's HSD) revealed the youngest infants (Age Group 1) had more long bouts of crying than the infants in Age Group 2 ($p=0.017$), Age Group 3 ($p=0.000$), and Age Group 4 ($p=0.001$). These results are illustrated in Fig. 2.

This description of infant crying is slightly different from previous published accounts based on this dataset (e.g., Barr et al. 1991) because only crying (and not crying and fretting) was examined here. However, the picture of infant crying among the !Kung presented here is comparable to earlier analyses of the dataset in terms of the low overall amount of crying (at its peak in Age Group 1, one minute of crying

Fig. 1 Mean seconds of crying by infants over 90 min of observation

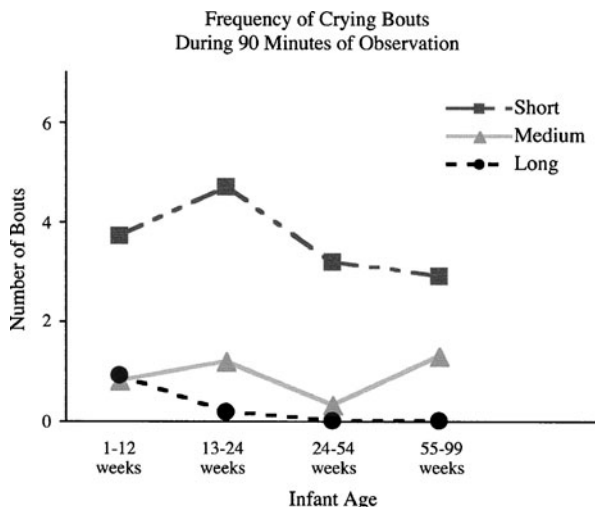


per hour of observation) and the predominance of short bouts. Unlike in previous analyses, we went on to determine (a) the nature of the responses made to crying and (b) the identity of the person or people responding.

Responses to Crying

One way to understand caregiver responsiveness is to examine the *frequency* of different *types* of responses to crying over the 90 min of observation. Looking across the age groups and all responders, Comforting responses occur most frequently ($M=10.67$, $SD=12.10$) and are five times as likely as Distracting ($M=2.08$, $SD=2.96$) or Nursing ($M=2.05$, $SD=4.20$). Controlling responses are rare ($M=0.41$, $SD=0.82$). The mean number of total responses to crying over the 90 min is 10.05 ($SD=13.74$). When the total number of responses is divided by the total seconds of crying, the mean is 0.33 ($SD=0.21$), or a rate of 1 response for every 3 s of crying.

Fig. 2 Frequency of crying bouts of different lengths over 90 min of observation



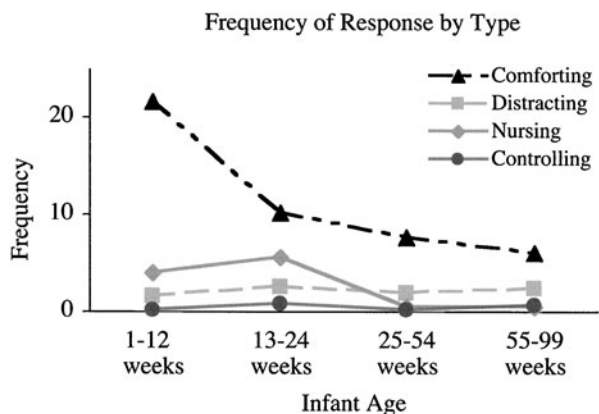
A second approach is to calculate the general *rate* of response (any response to crying by anyone available) by making the crying bout the unit of analysis. This provides a close examination of timely responses, although at the cost of over-representing in the summary statistic caregivers of infants who cried more at the time of observation. A total of 177 cry bouts were observed in the present study. Of these, 22 (12%) resolved without a response; these were short bouts ($M=8.63$ s, $SD=5.16$) produced by 10 males (ranging in age from 11 to 76 weeks, $M=40.5$) and 5 females (ranging in age from 48 to 99 weeks, $M=78.6$). Each of the remaining 155 bouts prompted at least one response from someone in the infant's environment; this indicates a bout-by-bout response level of 88%. These bouts were somewhat longer ($M=12.32$, $SD=18.53$). The entire sample of infants, described above, contributed to these 155 bouts.

To investigate differences among the four age groups on response *frequency*, a MANOVA on the frequency of responses in the four categories defined above (Comforting, Distracting, Nursing, Controlling) revealed significant age group differences in Comforting, $F_{3,38}=4.26$, $p=0.011$, $h^2=0.27$, and in Nursing, $F_{3,38}=3.86$, $p=0.017$, $h^2=0.25$. Tukey HSD tests indicated that significantly more Comforting responses are provided to crying infants in Age Group 1 than in Age Group 3 ($p=0.036$) and Age Group 4 ($p=0.009$). As already noted, infants in Age Group 1 have longer cry bouts than all others, and this difference in Comforting frequency may be a function of that phenomenon. There are also significantly more Nursing responses for Age Group 2 than for Age Group 4 ($p=0.049$). These findings are illustrated in Fig. 3. Over the age ranges examined, the degree to which responders use Comforting and Nursing as responses to crying decreases over time, while Distracting and Controlling responses are used more consistently over time.

The Social Context of Responsiveness

The responses to crying made by the mother and by all others (considered together) in the infant's environment were compared. Using a doubly multivariate repeated measures model, Comforting, Distracting, Nursing, and Controlling responses by mother versus all others were compared generally and across the age groups for the 90-min observation sets. There were significant within-subjects effects of Caregiver

Fig. 3 Frequency of response types over 90 min of observation



(Mother vs. Others) for Comforting ($F_{1,35}=6.47$, $p=0.016$, $h^2=0.16$) and Nursing ($F_{1,35}=16.74$, $p=0.000$, $h^2=0.32$). These main effects were clarified by interaction effects of Caregiver \times Age Group for both Comforting ($F_{3,35}=3.17$, $p=0.036$, $h^2=0.21$) and Nursing ($F_{3,35}=3.86$, $p=0.017$, $h^2=0.25$). With regard to the Caregiver \times Age Group interaction effect on Comforting, inspection of the means makes it clear that mothers produce more comforting responses than all others combined ($M=7.05$, $SD=10.56$ and $M=3.61$, $SD=4.18$, respectively). The MANOVA results reported above indicate that these Comforting responses occur more often with Age Group 1 infants than with infants in Age Groups 3 or 4. The Caregiver \times Age Group interaction effect on Nursing represents more Nursing responses by mother at the youngest ages. The mother was the only person ever observed to nurse an infant, and the MANOVA analyses reported above indicate that Nursing is used as a response to crying significantly more often with Age Group 2 than with Age Group 4 (Fig. 4). According to this analysis there was no difference between mother and all others in Distracting and Controlling responses to crying across infancy.

We also compared mothers and others using the cry bout as the unit of analysis. This examination was done separately for short, medium, and long bouts. Figure 5 illustrates the findings. For short bouts, the mother was the only responder to 47% of the bouts, one or more caregivers excluding the mother responded to 28% of the bouts, and the mother plus one or more other caregivers responded together to 11%. For the remaining 14% no response was observed. The pattern was similar for the medium bouts. However, there were no long crying bouts to which the mother did not respond. Half of the long bouts received a response from mother alone; the other half received a response from both mother and one or more other caregivers. Looking across all bouts combined, mothers alone responded to 46% of bouts (bout length of $M=10.73$ s, $SD=9.85$), others without mother to 28% ($M=8.98$ s, $SD=6.45$), and mother with others to 14% ($M=24.58$ s, $SD=41.02$). No response was given to 12% ($M=8.64$ s, $SD=5.16$).

Fig. 4 Frequency of Comforting responses by mother versus all others (and compared with mother Nursing) over 90 min of observation

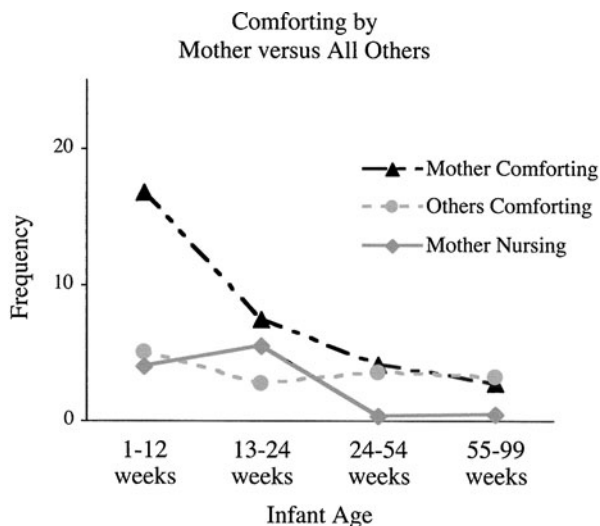
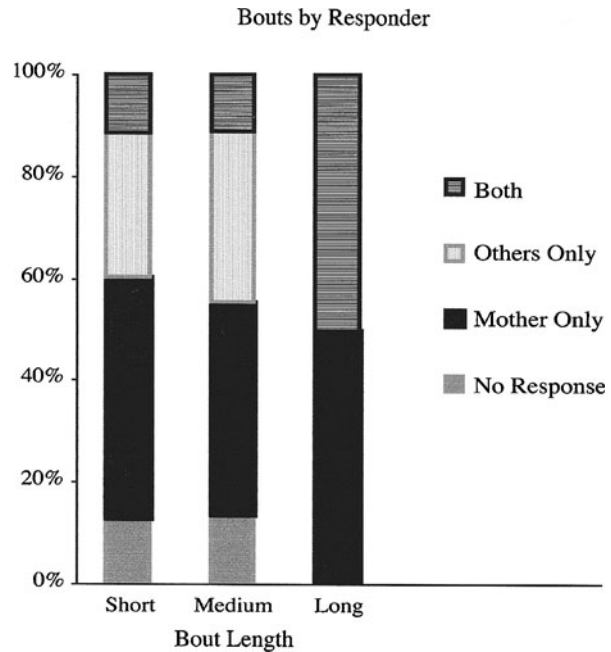


Fig. 5 Percentage of short, medium and long bouts receiving no response, or responded to by either mothers only, others only, or both



Nonmaternal responders to infant crying were mostly adult women, sisters, and other girls (producing 67% of all responses by others) and fathers (producing 17%). Brothers and other boys (7%) and men and unidentified other adults (9%) were less frequently observed to respond.

As expected from previous analyses, these results reveal a general rate of responsiveness that, whether measured in frequency per second of crying or in percentage of bouts receiving responses, indicates sensitive and timely provision of care. However, they also show that caregivers other than the mother respond to the crying *without* the mother for 28% of the bouts, and that they join the mother in providing care for 14%. Although the mother provides significantly more Comforting and Nursing responses than all others combined, she is the exclusive responder to a crying baby less than half (46%) of the time.

Context of Mother as Solo Responder

Of the 39 observations included in the present dataset there were eight (20.5%) in which the mother was the only person to respond to crying. There were six (15%) in which only caregivers other than the mother responded to crying, and 24 (61.5%) in which both the mother and another responded. Only one observation (3% of total observations) included crying by an infant and no response. (This infant was a male 65 weeks of age who was observed to cry for 15 s at the end of the observation session. It is possible that someone responded to him shortly thereafter. This was the only time he was observed to cry during the 90-min observation period.)

To look further into the social context and support of mothers caring for !Kung infants, a close examination of those observations during which the mother was the only responder may be helpful. Of the eight observations in which a mother was the

solo responder, in only one was the mother recorded as being the only person present with the infant. This mother-infant dyad was alone for only two of the six 15-min sessions; during the other four sessions, others were present with the mother, but the baby did not cry. In the other seven observations in which a mother was a solo responder, the data record indicates that she was never alone with a crying baby. In fact, in six of the seven observations, persons other than the mother are coded as the infant's primary caregiver at times during the 90-min observation. Thus, of 58.5 h of observation of infants who cried at least once, there were only two 15-min periods in which a mother was completely alone with her baby. Table 3 presents these data.

Discussion

The results of the present analysis of this dataset (previously studied with different definitions and subject grouping) confirm that !Kung babies cry, at *most*, for about one minute per hour, mainly in bouts of 10 s or less. Of 59 90-min observation sets considered, 20 had no crying at all. Roughly 6% of crying bouts observed were 30 s or longer; roughly 20%, of medium length; and the remaining, short. Long bouts were almost all in the first half-year, primarily the first quarter.

The overall response by the !Kung caregiving environment is consistent and prompt. Eighty-eight percent of all cry bouts receive a response, and almost all the others resolve within 10 s. Responses to crying occur at the rate of one response for every 3 s of crying, and the most typical response is oral or tactile comforting. Thus, the caregiving environment of !Kung infants is sensitive and indulgent.

Our analysis goes substantially beyond previously published results on the !Kung (and, to our knowledge, other hunter-gatherer groups) in being the first to separate responses to crying, measuring the participation by mother and others in the practice of responsive infant care, and analyzing how they respond. !Kung mothers provide significantly more frequent comforting responses than do all the others in the infant's environment combined. Furthermore, mothers are the only ones observed to nurse

Table 3 Non-mothers active in observations in which only the mother responded to crying

Infant age in weeks	Infant gender	Primary caregiver at the time of crying	Other active caregivers
5	Female	Mother	Father, Sister ^a , Girl ^a , Woman 1 ^a , Woman 2 ^a
6	Male	Mother	Sister, Brother, Woman ^b
16	Female	Mother	none
20	Male	Mother	Boy, Sister 1, Sister 2
38	Female	Mother	Father ^a , Father ^b , Sister ^a
41	Male	Mother	Woman ^a
48	Female	Girl 2, Sister 1	Mother ^a , Girl 1
76	Male	Mother	Brother ^a , Sister ^a , Father ^a

^a served as primary caregiver at some time during the observation

^b served as secondary caregiver at some time during the observation

infants, and nursing is used to respond to infant distress, especially at the younger ages. Finally, the mother always responds to long crying bouts (≥ 30 s), and for half of these she is the sole responder.

However, and equally important, the !Kung mother is almost never alone with a crying baby. On her own, she accounts for only about half of the bout-based responsiveness rate: 46% of bouts are responded to by mother alone, while 88% of the total receive some response. Thus, for nearly half the bouts, other caregivers either are the sole responders or join the mother in responding. Even when others do not respond to the cry bout, they are nearly always present and offering some type of care to the baby, sometimes as the primary attendant, at some point during a typical 90-min observation set.

These data reveal at least two important findings. First, the mother is by far the most frequent individual responder to crying. This can be interpreted to confirm that the mother is the central and primary care provider to an infant in distress. Second, and equally important, the high rate of sensitive and indulgent care also appears to be a community project, since others in the infant's environment make major contributions to the degree, timeliness, and consistency of the response. These findings are consistent with recent theorizing about the importance for human societies of nonmaternal support for infant and child care (*allocare*) and of cooperative breeding.

However, this should not be taken to suggest that *allocare* in any and all forms is “natural,” reflecting the original human condition. The nonmaternal caregivers under study here always knew the mother well and usually were kin of the baby. Therefore, these findings do not have direct bearing on controversies over contemporary childcare arrangements, except to suggest that exclusive maternal care was probably not part of the original human condition and that sensitive maternal care may be dependent on the availability of *allocare*.

These data also contribute to a growing literature on the social context of infant crying in Western and other cultural contexts (Axia and Bonichini 1998; Barr et al. 1991; Bond et al. 2001; Gray et al. 2000; K. Lee 2000; McGlaughlin and Grayson 2001). This ancient, fundamental, and universal infant behavior reflects varying degrees of distress in infants, so responses contributing to the resolution of that distress should be very salient for the infant, whether in terms of the promptness of the response, its specific nature, or the people who perform it. There are many other ways of looking at infant care and infant social experience, but normal crying and responses to crying appear to deserve more attention than we have given them so far. There is much that we do not know. We can say, for example, that caregiver sensitivity is associated with later secure attachment (Bakermans-Kranenburg et al. 2003), but we have little idea whether or how much responsiveness to crying may contribute to sensitivity, which includes a number of other variables, nor do we understand how nonmaternal responsiveness may contribute to later attachment to the mother or other caregivers.

The present study of !Kung response to crying used several approaches to analyzing responsiveness that are productive and that go beyond previous publications. First, it was useful to categorize responses as Comforting, Distracting, and Controlling, with Nursing as a separate single variable. This revealed interesting age by category interactions, such as the greater amount of comforting in the first

few months. Second, different insights come from using both time in seconds and crying bouts as units in separate analyses. Third, responsiveness should be considered separately for different categories of individuals, and particular attention should be paid to overlapping responses, when more than one caregiver intervenes in a given crying bout. Finally, in line with recent thinking in evolutionary anthropology, the findings suggest a need for more attention to caregivers other than the mother in both Western and other cultures, and to the possibility of simultaneous, mutually supportive responding. We tend to think of multiple caregiving in Western middle-class culture in terms of childcare that relieves mothers who are alone with their infants much of the time. But in many non-Western cultures the mother-infant dyad is usually embedded in a context of shared caregiving.

In hunter-gatherers other than the !Kung, responsiveness to crying is also very high (Fouts et al. 2004; Lozoff and Brittenham 1979), and at least two direct comparisons between hunter-gatherers and neighboring farmers show that the farmers are markedly less responsive. Aka infants at 3–4 mos cried or fussed significantly less than infants of neighboring Ngandu farmers (percentage of time, less than half; frequency, slightly more than half), and the absence of any response to fussing or crying (by any caregiver) was three times as common among the farmers (Hewlett et al. 1998, 2000). A Euro-American sample fell between the foragers and farmers on these measures. Similarly, when Bofi foragers and farmers were compared on measures of infant distress, the farmers' infants were found to have more "excessive and unusual crying" (Fouts et al. 2004). Other careful studies of infants among agricultural peoples find levels of crying higher and response to crying lower than is generally reported for hunter-gatherers (reviewed in Hewlett et al. 2000).

Despite early reports (Bell and Ainsworth 1972), it is not easy to show that responsiveness to crying decreases later crying (St James-Roberts et al. 1998), and the reverse may be the case (Etzel and Gewirtz 1967; Van IJzendoorn and Hubbard 2000). However, the !Kung do show both low crying levels and high responsiveness levels. While this was not an experimental study, it is difficult to see how a simple reinforcement model of crying could be valid for this culture given the very high level of response to crying during the first 12 weeks and the low level of crying thereafter.

More directly, perhaps, our findings also address the controversy over the central role of the mother in hunter-gatherer infancy, a question raised in part by differences between the !Kung and the Efe. The !Kung have always been described as having extremely indulgent infant care, with a very central role for the mother but with support from others. This new analysis of one important caregiving behavior, response to infant crying, supports all three of these claims about the !Kung—indulgent care, maternal centrality, and multiple caregiving. All three are robust effects that are not likely to be very sensitive to the potential methodological limitations of these data.

It is interesting to revisit the Efe data in the light of this new analysis of !Kung caregiving. Since there is concern about maternal primacy in infant attachment, it seems useful to distinguish between collective nonmaternal care (performed by several caregivers for one infant), which is high in the !Kung but even higher in the

Efe, and care for one infant by any single individual other than the mother. Among the Efe, as among the !Kung, the mother is the overwhelmingly important individual caregiver, and she has no individual rivals for the infant's attachment propensity. This is most true at 8 months, an important age for attachment formation (see Konner 2005 for discussion). This does not of course mean that the infant cannot form other attachments; all normal infants can and do (Howes 1999). However, these data support the concept of maternal primacy—the extent to which the mother's contact with and care for the infant predominate over those of any other individual caregiver (Konner 2005). By this definition, maternal primacy applies to the Efe as well as the !Kung. It also clearly applies to the Aka, despite their exceptionally high level of paternal care (Hewlett 1989).

However, Efe and !Kung differ markedly in collective or aggregate nonmaternal care. Even if Efe infants do not spend a great deal of time with any individual other than the mother, they have more exposure to allocare overall, especially in the mother's absence, than the !Kung do, and they have more experience with maternal separation. A slightly different issue is the density of social contact these infants experience: “Efe infants and toddlers are almost never alone in the sense of being out of sight or hearing of other people” (Tronick et al. 1992:574). This is also true of the !Kung, although the Efe exceed them in the amount of allocare (Konner 2005).

An important point arising from the present analysis is that very high levels of maternal contact and responsiveness need not exclude others. In fact, the reverse appears to be true for the !Kung, among whom very high levels of nonmaternal care cooccur with maternal care. It is likely that the presence of actual or potential nonmaternal caregivers, or even of social companions for the mother, helps to make the exceptional responsiveness of !Kung mothers possible, as suggested more than three decades ago (Konner 1976).

Our understanding of hunter-gatherer infancy and childhood has become broader and more nuanced in recent years (Hewlett and Lamb 2005). The Efe studies contribute greatly to our picture of hunter-gatherer infant care (Ivey 2000; Tronick et al. 1992) and markedly broaden our perspective on what infancy may have been like during part of our evolution. This is also true of recent studies of the Aka, who have exceptionally close fathers (Hewlett 1991; Hewlett et al. 1998) and other important alloparents (Meehan 2005); the Ache, who hardly ever set their infants or toddlers down on the dangerous forest floor (Hill and Hurtado 1996; Kaplan and Dove 1987); the Bofi, who have indulgent mothers and serious weaning conflict (Fouts and Lamb 2005); and the Hadza, who have somewhat less indulgent mothers and wean by age two (Blurton Jones 1990, 1993).

Thus we now know that Bowlby's reference to infancy in the human environment of evolutionary adaptedness (Bowlby 1970–1980) is in a sense misleading; there was no one EEA, but rather a spectrum of EEAs. Thus far, for all these cultures, and in many others described in the anthropological literature (Konner 1981; Lozoff and Brittenham 1978), maternal primacy is a valid description of caregiving in infancy, but it always exists in a dense social context (Konner 2005). Nonmaternal care varies in hunter-gatherers, but it is almost always prominent, even among the !Kung. It may not take a village to soothe a crying baby, but it often involves more than a mother alone, a fact that is taking on growing importance in our understanding of human evolution.

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