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The allocation of parental care among the Ye'kwana

Introduction

It is well known that human children require more care or parental investment than any other primate species (Lancaster and Lancaster 1983). While this dimension of human behavior is well documented in the psychological literature for Euroamerican populations (Babchuck *et al.* 1985), it has received scant, quantitative attention by anthropologists working among tribal populations (for exceptions see Whiting and Whiting 1975, Katz and Konner 1981, Hurtado *et al.* 1985, Hewlett, this volume (Chapter 16), Turke, this volume (Chapter 10)). The role of alloparental care (care of non-offspring children) has received even less quantitative attention by

social scientists (for a review see Weisner and Gallimore 1977) although it has been a growing theoretical concern of evolutionary biologists (Skutch 1961, Brown 1978, Reidman 1982, Emlen 1984). The primary goal of this chapter is to describe the allocation of direct care to infants by sub-adults and adults among the Ye'kwana and to show that the degree to which an individual engages in caregiving correlates with options an individual has for enhancing his or her inclusive fitness.

By direct care I simply mean different forms of physical contact between a caregiver and care-

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receiver which enhances or maintains the well-being of the latter and the inclusive fitness of the former. Behaviors such as nursing, grooming, holding, and feeding are examples of direct care. Other forms of care, which one could label indirect care, include securing food, providing shelter, inculcating social and technical skills, and assistance in mate acquisition (Chagnon 1979). Although indirect care is just as important to an offspring's long-term reproductive success as direct care, it is much more difficult to measure. Furthermore, parents devote more time and energy to direct care when their offspring are infants and pre-adolescents than when they are juveniles and adults, and this investment is more aimed at offspring survival than offspring reproduction.

From an evolutionary perspective the allocation of care to children is viewed as a means for the caregiver to enhance his or her inclusive fitness by increasing a child's chances of survival and reproduction (Hamilton 1964, Trivers 1972). As a result, the probability of a caregiver investing greater or lesser amounts of care in a child should be determined by two major factors: (1) the degree of relatedness between the caregiver and child, and; (2) the ratio of the cost of care to a caregiver's fitness compared to the benefit of care to the receiver's fitness.

In most environments those caregivers most closely related to a child ego have the most to benefit by providing care and the most to lose in inclusive fitness terms by not providing care to a child ego. This is because close kin share a large fraction of their genes by common descent, and the likelihood of those genes spreading through the population will depend on the efforts they expend in promoting the survival and reproduction of closely related individuals. This does not mean that close kin will render care in direct linear proportion to their degree of relatedness (Altmann 1979), but simply that close kin will be expected to render more care than distant kin or non-kin. However, the probability of close kin, even those of the same degree of relatedness to a particular ego, rendering aid will be conditioned by the costs and benefits of care, a subject to which I now turn.

A caregiver's sex and age are the most important factors that determine the costs and benefits of childcare. Other factors such as caretaking ability and wide differences in infant needs for

care affect an individual's allocation of care but they will not be considered here. The way in which sex affects costs and benefits has to do with male-female differences in the costs of reproduction (Trivers 1972). Essentially, human females, because of the biology of mammalian reproduction (Daly and Wilson 1983), usually invest more in reproduction than males. As a result their potential rate of reproduction is less which means that the cost of losing an infant or producing an infant less fit than average through inadequate care is greater compared to a male's cost. Although the cost of losing an offspring or rearing a less fit offspring will negatively affect a male's fitness a male can more easily absorb such a loss by allocating time to activities that lead to the acquisition of other mates or mating opportunities. As a result of the higher costs of reproduction for females, females are expected to invest more in infant care than males. Extant cross-cultural data on time allocation to infant care from a wide range of tribal and Euroamerican populations (Katz and Konner 1981, Babchuck *et al.* 1985) overwhelmingly indicate that mothers allocate more time to direct investment in offspring than do fathers. Nevertheless, fathers do invest in offspring and two of the questions I wish to deal with in this chapter are how much time is a father willing to invest in his offspring and does the father invest differently in offspring than a mother?

The mating system of a population will partially determine whether males will attempt to enhance their fitness by acquiring more mates (or mating opportunities) or by investing in offspring. In societies where polygyny is permitted males will be more motivated to expend effort in gaining additional mates; in societies where monogamy is ecologically or socially imposed (Alexander *et al.* 1979) males will be more motivated to invest in offspring. The Ye'kwana represent a transitional population since polygyny is traditionally permitted but today socially imposed monogamy is spreading through the population. In monogamous Euroamerican populations even when women are employed outside the home males do not compensate by increasing direct investment in offspring (Babchuck *et al.* 1985). As I will later show, relatively high female work-loads among monogamously married Ye'kwana women, high levels of direct

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care required by infants and low paternal participation in this activity would seem to limit female reproduction and hence male fitness. Among the Ye'kwana, seemingly, it would be in a male's inclusive fitness interest to either increase his work-load by assuming feminine tasks or to increase his effort in direct childcare.

However, even in the most rigidly monogamous societies male investment may not be equal to female investment in offspring for three reasons: (1) low confidence of paternity (Alexander 1974); (2) differences in the duration of male and female reproductive careers; and (3) the utility of extra-marital liaisons as an additional avenue for reproductive success – a phenomenon common in Amazonia (Carneiro 1958, Siskind 1973, Symons 1979, and Gregor 1985). For example, if a husband believes one or more of his wife's offspring are not also his he may instead devote his energy to courtship with the aim of impregnating and/or marrying another woman. A strong correlate of paternity certainty is the frequency of divorce (Flinn 1981). When a man marries a divorced woman with children from her previous marriage he knows with certainty that some of his wife's offspring are not his. As a result, a male may not be expected to invest in all his wife's offspring whereas the wife will. Even if paternity certainty is high, extra-marital liaisons can still have a high pay-off if the benefits to courtship are greater than the benefits to investment in offspring. Finally, a male may wish to invest in courtship as his wife's reproductive value declines as she approaches menopause, and ultimately he may abandon her by marrying another, younger woman.

Alternatively, one may wish to consider that low paternal investment may be a maladaptive result of phylogenetic inertia: men are less competent or temperamentally disinclined caretakers because of our long history as a slightly polygynous species. I think this explanation unlikely because it appears that males vary widely in the amount of parental investment they allocate (Katz and Konner 1981) which suggests that their behavior may be responsive to the above outlined environmental variables. A possible explanation not addressable by the data presented here is that male investment is made in indirect forms such as attaining high social status, in assisting offspring (especially sons) in obtaining high-quality mates, or in providing

protection to the entire family via rare but important risk-taking activities.

An individual's age (as it correlates with reproductive ability) is the second factor that determines the costs and benefits of childcare. Pre-reproductive and post-reproductive individuals who lack young offspring of their own are more likely to engage in alloparental behavior than reproductive individuals who are actively caring for their own offspring. For these individuals the cost of alloparenting is low since it does not detract from their ability to care for their own offspring (but cf Turke, this volume (Chapter 10)): they either have none or they have older offspring who are in less need of care than younger kin. In addition, the very young and the old are less able to engage in alternative fitness enhancing activities, such as economically productive labor, that require a great deal of strength, skill, or endurance. As a result, childcare is an attractive alternative: it is not physically taxing and can be competently performed even by the very young (Weisner and Gallimore 1977, Borgerhoff Mulder and Milton 1985; Turke, this volume (Chapter 10)).

Variation in parental and alloparental behavior as it is determined by sex and relatedness will allow us to determine if individuals are pursuing their inclusive fitness interests in childcare. The variable of age (i.e. reproductive status) will not be strongly analyzed because the data set is not sufficiently large to simultaneously control for sex and relatedness effects.

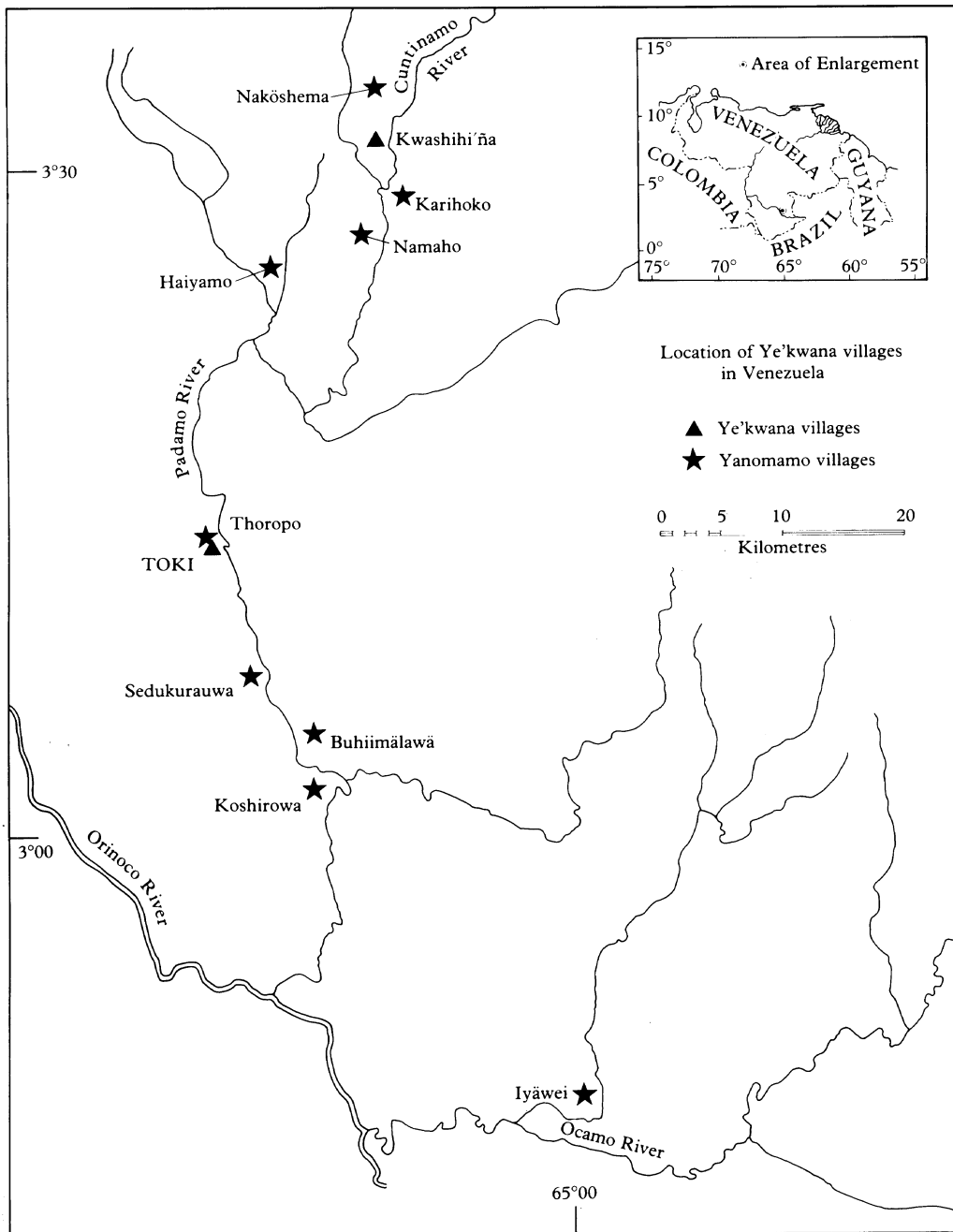
Methods

Research for this chapter took place during 1975–1976 in the Ye'kwana village of Toki located on a tributary to the upper Orinoco river in the federal territory of Amazonas, Venezuela (see Figures 14.1). The 88 full-time residents of Toki are largely isolated from the mainstream of Venezuelan national society. Contact with non-Ye'kwana *criollos* (i.e. Spanish-speaking peasants) is largely made by men through their sale and trade of basketry and crops in the regional capital of Puerto Ayacucho, four to five days distant by canoe. The Ye'kwana engage in cash-cropping in order to secure steel goods, gasoline, outboard motors, shotguns, and ammunition but not food. Additional impact has been made by evangelical missionaries with the most impor-

tant change in traditional culture being the disappearance of shamans and religious practices and the decline of polygyny. The initial goal of the project was to collect time-allocation data

on all members of the village of Toki, with a strong focus on economic behavior and its relation to ecological variables. As a result, codes for child behavior and care of children were not

Figure 14.1 Location of Toki, field site for this study.



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as finely resolved as would be for a study that intensively focused on parental investment.

Data on childcare and child behavior were collected using instantaneous scan sampling (Altmann 1974). Each observation represents a behavioral state as opposed to the observation of a behavioral event with a definite beginning and end (Altmann 1974: 231–2). Scan sampling is methodologically suited to give a measure of the percent of time individuals spend in various activities. Sampling occurred from 0700 hours to 1959 hours yielding a 780-minute day. Percent time in various activities are multiplied by 780 to give a measure of minutes per day (m/d) spent in various activities. It is important to note that childcare does occur at night (see Konner 1977 for information on night-time care among the !Kung). The significance of unrecorded night-time care will be discussed later in relation to underestimates of total care, especially for mothers. The procedures I used in sampling behavior have been described extensively elsewhere (e.g. Hames 1979a, 1979b, unpublished) and the reader is referred to those works for details and to Borgerhoff Mulder and Caro (1985) for broader discussion of sampling in tribal populations.

At this point it is only necessary to describe the constellation of behaviors classified by each code to allow the reader to assess the validity of the data. Instances of childcare were divided into the following categories: nursing, grooming, washing, general care, feeding, and carrying (or holding). The meaning of each is based on standard definitions but general care and carrying require comment. General care is an omnibus category that encompasses all behaviors that the others do not. It refers to such behaviors as calming, caressing, cuddling, distracting from environmental hazards, and the like. Carrying (or holding) means holding or carrying a child (usually on the hip) while moving or standing or sitting. The child is usually supported in a sling during this behavior. It is classified as a kind of care because its net effect is to protect the child from environmental hazards and allow it easy access to the breast. This is done at an energetic cost to the carrier and diminishes the efficiency at which work can be performed.

Most of the care behaviors are symmetrical interactions. That is, if a child is coded as 'being washed' then the woman doing the nursing is

coded as 'washing infant'. In many instances, however, childcare was asymmetrical: a caregiver was engaged in another activity while simultaneously caring for a child. For example, caretakers frequently engage in food preparation while holding a child in a sling or nursing a child. In such cases the offspring was coded as being carried while the mother was coded as preparing food. As a result, in some of the tables on time allocation care received by offspring is much greater than the amount of care given by mothers and other caretakers.

The behavioral data I present on childcare represents an underestimate of total childcare since all behavioral observations occurred within the village during daylight hours. If an individual was absent from the village (e.g. hunting, fishing, gathering, or gardening) while I was conducting a scan I asked the nearest available family member where that individual was and what he or she was doing. During the pilot phase of this research I questioned individuals who were absent from the village during scan samples after they had returned to the village and I was able to determine that informant information on absent individuals was 94% accurate (on a sample of 48 visits to and interviews of absent individuals). The reliability of informant-generated observations was continually checked throughout research by evening visits to households to weigh resources acquired in hunting, gathering, fishing, and gardening activities. While informant-generated behavioral observations were adequate for economic activities it gives one no clear idea of whether or not an infant was being cared for while it was with its caretaker. While this is a hinderance in obtaining absolute figures on time allocation to infant care, it is not a problem in measuring differences in the amount of care allocated by caregivers if one assumes that all children were equally subject to the same bias.

It should be apparent that the above categories do not exhaust direct forms of childcare. Activities such as play, story-telling, teaching, and active and passive forms of monitoring (e.g. keeping an eye on an infant as it crawls about the floor to insure that it does not wander into the hearth) all qualify as important forms of care. A full analysis of childcare would require an analysis of patterns of social interaction and proximity which are partially completed and will be

Table 14.1 *Infant time allocation in minutes/day*

Child ID No.	Carry	Care	Nurse	Eat	Sleep	Play	Soc. Int.
0-6 months old							
1	130	111	167	0	161	6	6
2	215	158	23	0	237	45	11
3	258	174	50	3	76	25	0
4	186	160	56	0	104	72	3
5	169	200	32	32	190	11	11
Mean	192	161	65	7	153	32	4
Mean total care	418						
7-12 months old							
6	149	86	17	8	75	25	3
7	135	172	44	5	84	42	0
Mean	147	129	30	7	79	33	1
Mean total care	305						
13-26 months old							
8	74	104	31	37	31	43	6
9	170	140	35	3	75	41	3
10	23	32	18	59	82	146	14
11	42	70	5	62	31	130	13
12	28	91	0	44	51	121	12
13	25	102	10	35	55	141	22
Mean	60	90	17	40	52	104	12
Mean total care	167						
27-40 months old							
14	0	0	0	84	69	126	42
15	9	46	3	98	58	160	25
16	3	54	0	54	67	206	41
Mean	4	33	1	79	65	164	36
Mean total care	38						

presented in a companion piece to this chapter. Nevertheless, inspection of the preliminary results of these other forms of care indicates that the age/sex dimensions of care follow the same patterns as presented below.

For this analysis of childcare all village children less than 41 months of age (16 children: 9 boys and 7 girls) were selected as recipients of caregiving behavior (Table 14.1). The cutoff of 40 months was chosen empirically: children beyond 40 months receive very little direct care. All children in the sample co-resided with both biological parents throughout the study.

Results

As described above, deductions from inclusive fitness theory suggest that relatedness, sex, and age should determine the amount of care individuals allocate to childcare. The goal of this section is to present data that evaluate this hypothesis. I will begin with a discussion of the amount of care given to infants. The purpose

of presenting this data is to demonstrate that childcare is a time-consuming task which limits a caretaker's ability to engage in alternative activities (Denham 1974, Draper 1976, Hurtado *et al.* 1985). I will then turn to a description of the allocation of care by individuals according to their age, sex, and degree of relatedness to the children for whom they provided care. Finally, I will deal with the problem of low direct parental investment by fathers by hypothesizing that they may provide indirect investment in offspring.

Childcare requirements

Table 14.1 documents the time allocation of selected activities for 16 infants and children from birth to 40 months of age. The subtotal 'total care' indicates the sum of 'care', 'carrying', and 'nursing', direct forms of parental investment. Children are rank-ordered by age within the broader age categories. The obvious trend is that care diminishes with age and this trend

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Table 14.2 *Proportion of time spent inside and outside the village by children less than 41 months. (Figures in parentheses indicate number of observations.)*

Age	Outside (%)	Inside (%)
0-6 months	12.9 (111)	84.8 (734)
7-12 months	24.0 (82)	75.5 (254)
13-26 months	20.6 (318)	79.3 (1219)
27-40 months	9.2 (55)	90.7 (594)

is statistically significant if age is regressed on care (Pearson $r = 0.81$, $p < 0.01$, one-tailed). But perhaps more striking is the fact that infants less than 7 months of age receive 6.96 hours of direct care per day with care diminishing sharply to 2.77 hours and 0.44 hours by the second and third years, respectively. In the first two cohorts carrying/holding rank as the highest allocation to care and its rapid diminishment thereafter coincides with a child's development of walking. It is also significant that near the mid-point of the third year nursing has all but ceased and the time allocated to eating solid foods is at its highest level.

Care outside the village

Care that a child received while outside the village is not represented in Table 14.1. While I had a clear idea of what the mother was doing in a garden (e.g. pulling weeds) I had no idea of what the child was doing. Even though there is no way of knowing what a child was doing it would be useful to determine how frequently children were outside of the village when their caretakers were engaged in economic tasks. This measure is interesting because it gives one an idea of the constraints that children place on caregivers in locations up to 6 kilometers away (i.e. forest, garden, or river) from the village where high-quality care or monitoring is necessary because of the elevated risk of environmental trauma. Table 14.2 shows the amount of time infants less than 41 months of age spend outside the village. I interpret the trends as indicating that the youngest children (0 to 6 months) are too delicate to travel outside the village and spend protracted periods of time in their mothers' slings while they labor. During the second half of the first year they are hardier and time outside the village doubles. In the second

year they are hardier than before but they are old enough to be left in the care of someone at home. This diminution of travel with mother in the third year corresponds with a radical lowering of general care as seen in Table 14.1. At this time a child is all but weaned and does not require the immediate attention of 'on demand' nursing.

Tables 14.1 and 14.2 show that young children and especially infants (children less than 1 year old) require a huge investment in time. Indeed, care given to infants is more than 90% of a mother's total labor time (see Table 14.6). If a mother were the sole caretaker of an infant and had to do her normal amount of labor she would have to put in more than a 14-hour day. In addition, as Table 14.2 suggests, she would accomplish this labor less efficiently by having to simultaneously tend to a child while she labors outside the village.

Who cares for children?

Any assistance a mother could get in childcare or labor is likely to be fitness enhancing by (1) reducing birth intervals; (2) increasing the quantity and/or quality of care (decreasing a child's probability of death) or; (3) increasing the food supply to her household to allow a mother to enhance the nutritional status of household members. Turke demonstrates this for the Ifaluk (this volume (Chapter 10)). Below I identify the kinship, age, and sex attributes of individuals who care for infants. The care a Ye'kwana child receives can be divided into two forms: passive and active. Passive care (see 'carry' Table 14.1 and 'carrying/holding' Table 14.3) occurs when the caretaker is actively engaged in some activity while he or she is in direct contact with a child. Active care occurs when the caretaker is solely providing some sort of direct care to a child.

Carrying (or holding) is a passive form of childcare; that is, by definition, a caretaker is engaged in some other activity while he or she is carrying the child. Indeed, if I determined that a caretaker had picked up a child to hold or carry it, for example, in order to calm the child then I scored the behavior as general childcare and not carrying/holding. Table 14.3 describes what the child-carrier/holder was doing when he or she was carrying a child and the

Table 14.3 *Percent time allocated to child carrying/holding by context and carrier^a*

Carrier	Context						Total
	Leisure ^b	Idle	Walk	Eat	Misc. labor ^c	Food preparation	
Mother	37.2 (105)	8.8 (25)	11.0 (31)	8.5 (24)	9.6 (27)	2.5 (7)	77.6 (219)
Sister	3.9 (11)	2.1 (6)	1.7 (5)	<1 (1)	<1 (1)	<1 (1)	8.9 (25)
Female cousin	3.5 (10)	0 (0)	<1 (1)	<1 (1)	0 (0)	0 (0)	4.3 (12)
Grandmother	1.8 (5)	0 (0)	1.1 (3)	<1 (1)	<1 (1)	<1 (1)	3.5 (10)
Aunt	1.4 (4)	0 (0)	1.1 (3)	0 (0)	0 (0)	0 (0)	2.4 (7)
Father	<1 (1)	<1 (2)	<2 (1)	0 (0)	0 (0)	0 (0)	1.4 (4)
Brother	<1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.7 (2)
Male cousin	<1 (2)	<1 (0)	<1 (0)	<0 (0)	<0 (0)	<0 (0)	0.7 (2)
Unrelated	<1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.4 (1)
Grandfather	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total	50.0 (141)	11.7 (33)	15.6 (44)	9.6 (27)	10.3 (29)	3.2 (9)	100 (282)

^aFigures in parentheses indicate number of observations

^bThis activity is primarily conversation and other forms of social interaction

^cThis activity is primarily household maintenance and manufacturing

identity of the caregiver. Not surprisingly, 87% of the time a child was carried or held the carrier was not engaged in work. 'Leisure' activities (generally social interaction such as conversation) account for the majority of non-work activities with the balance more or less evenly divided between idleness, food consumption, and walking about the village. However, it should be noted that the amount of time children are carried in a work context is certainly higher than the 14% figure in Table 14.3 would indicate since these figures only measure carrying that occurred within the village and not forest and garden where much of one's time is spent in labor. By focusing on caretaking by individuals other than mothers one gets a quick introduction to the role of alloparenting. One finds that if carrying in non-work versus work contexts are compared among all caregivers, mothers' proportional allocation to carrying increases while all other caregivers except for grandmothers decrease. While it is difficult to apply any statistical test to analyze this trend, it does indicate that alloparents are less willing than a mother to carry a child while they are laboring.

The results of Table 14.3 clearly show that mothers, in doing 78% of the child carrying/holding, monopolize this dimension of care. Another dimension of childcare, general childcare, is displayed in Table 14.4. The interesting result is that this trend is nearly reversed: mothers allocate but 24% of the total general care received by infants. Although the mothers' total is the highest, sisters and grandmothers are very close seconds and thirds. If carrying/holding are added to the figures on general care it turns out that mothers allocate just under half of all non-nursing care to their children (see bottom Table 14.4). This indicates that individuals other than mothers are absolutely salient to infants as sources of care.

Alloparenting, or the allocation of care to offspring other than one's own, is most likely to be a strategy of enhancing one's inclusive fitness. The benefits that accrue, which have been described above, include increasing a mother's rate of reproduction, reducing child mortality by providing more care, and allowing a mother to labor more effectively so as to enhance the nutritional and material well-being of her offspring.

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Table 14.4 *Frequency of general caretaking by age class of child and identity of caretaker*

Child ID No.	Caretaker										Total
	Mother	Sister	Grand-mother	Aunt	Female cousin	Male cousin	Brother	Father	Grand-father	<0.125	
0-6 months old											
1	5	6	0	0	0	0	0	0	0	0	11
2	2	9	1	0	0	1	1	0	0	0	14
3	12	0	4	23	0	6	0	2	0	0	47
4	6	21	0	0	1	5	0	0	0	0	33
5	6	0	0	0	1	0	0	1	0	0	8
Mean	12.8	7.2	1.0	4.6	0.4	2.4	0.2	0.6	0	0	22.6
7-12 months old											
6	6	0	0	0	0	0	0	3	0	6	15
7	15	0	23	0	9	4	0	0	1	1	53
Mean	10.5	0	11.5	0	4.5	2	0	1.5	0.5	3.5	34
13-26 months old											
8	7	6	0	1	0	0	0	1	0	0	15
9	6	0	1	7	13	3	6	1	0	0	37
10	0	2	1	0	0	0	0	0	0	0	3
11	5	7	0	2	0	0	0	1	0	1	16
12	5	0	25	1	1	1	0	2	0	0	35
13	5	20	2	0	0	0	1	0	0	0	28
Mean	4.6	5.8	4.8	1.8	2.3	0.7	1.2	0.8	0	0	22.2
27-40 months old											
14	0	0	0	0	0	0	0	0	0	0	0
15	1	1	1	0	3	2	0	1	1	0	10
16	2	5	1	0	0	0	2	1	0	3	14
Mean	1.0	2.0	0.7	0	1.0	0.7	0.7	0.7	0.3	1.0	8
Total	83	79	60	34	28	22	10	13	2	11	342
Percent	24	23	17.5	10	8.2	6	2.9	3.8	<1	3.2	
Total of carry and care											
	302	104	70	41	40	24	12	17	2	12	624
Percent	49	16.7	11.2	6.6	6.4	3.8	1.9	2.7	<1	1.9	

It should be noted that the first benefit affects the mother's fitness while the others affect the fitness of children and/or mothers. In the analysis below I assume that the main affect of alloparenting is to enhance the child's fitness. I further assume that caregivers other than parents provide care of nearly equal quality as parents. While I have no quantitative data that play on this question my year-long observations of interaction between non-parental caretakers and children lead me to believe this to be true. In fact it is my impression that young female sisters and cousins are more likely to interact intensively with children through play, conversation, and feeding than do mothers, which parallels the careful quantitative findings of Borgerhoff Mulder and Milton (1985). (Kim Hill, pers. comm., finds just the opposite to be true for the Ache.) The only occasion I found non-parental

caretakers to be less competent than mothers was when girls between the ages of 4 and 7 clumsily attempted to heft a child on their hips and walk. It is also possible that young caretakers were gaining practice for future childcare, but I think this is largely a side-effect.

The simple prediction that follows is that the amount of care allocated to infants and children will be positively correlated to the degree of relatedness between the child and caretaker. To test this proposition accurately the tabular data on 'carrying/holding' and 'general care' must be normalized. Because each individual (unless two or more individuals are siblings) has a unique number of sisters, aunts, grandmothers, etc., variation in investment by different kin types may largely reflect the numbers of these kin. To control for this effect I have divided the raw scores in Tables 14.3 and 14.4 by the number

Table 14.5 *Childcare allocation by age–sex classification in minutes per day*

Sex	Age						
	4–6	7–11	12–16	17–23	24–37	38–50	50+
Female	24.1 <i>n</i> = 6	34.0 <i>n</i> = 6	20.4 <i>n</i> = 5	51.6 <i>n</i> = 7	48.6 <i>n</i> = 3	50.2 <i>n</i> = 6	96.0 <i>n</i> = 1
Male	2.8 <i>n</i> = 4	5.7 <i>n</i> = 7	1.5 <i>n</i> = 4	5.9 <i>n</i> = 7	4.0 <i>n</i> = 5	5.7 <i>n</i> = 3	5.0 <i>n</i> = 1

of kin of each type possessed by each individual. The correlation between normalized care and all nine degrees of relatedness is positive and significant ($r = 0.59$, $p < 0.05$, one-tailed). If males are removed from the sample (since their caretaking roles are insignificant) and only females are retained, the correlation is more powerful and significant ($r = 0.865$, $p < 0.025$, one-tailed).

Age and sex dimensions of care

Another way of observing the distribution of childcare is to cross-tabulate it with the age–sex class of a potential care giver. Table 14.5 shows this relationship and corresponds closely to the conclusions drawn from Table 4.14. But some new trends emerge. As expected, females allocate more time to care than males in all age-matched cohorts. While, as expected, there is variation among females corresponding to the onset of adulthood, no such differences are found among males. Male caretaking is rather constant and low throughout the male life cycle. This suggests that males and females are differentially reared in regards to their future roles as parents and alloparents.

Care and labor among husbands and wives

It has been established that females regardless of age allocate more time to direct childcare than do males. A reasonable explanation for this difference is that males have less time for direct childcare because they allocate more time to economic activities and that these labor activities are actually a form of indirect care since they are mainly designed to provide food and shelter for spouse and child. If both male and female allocation to combined labor and childcare were equal then one could assume that parental investment was equal for the sexes. For each married couple in the sample Table 14.6 compares (under

the ‘Wife’ and ‘Husband’ columns) the allocation of labor, nursing (note this column does not exist for ‘Husbands’), care, and the total of labor, nursing and childcare. Under the ‘Wife–Husband’ column it measures the difference between spouses in care (including nursing), labor, and the total of care and labor. A negative value in any of the ‘Wife–Husband’ columns indicates that a husband allocates more time to the activity than his wife and a positive value indicates the opposite. In 11 of the 13 comparisons wives allocate more time to labor and childcare (‘Total’ column) than do husbands, the average difference is 51.5 minutes/day, and this difference is statistically significant (t -test, $p = 0.006$ two-tailed). In 9 of 13 cases wives allocate more time to labor than husbands and the average difference is only 11.8 minutes/day and non-significant (t -test, $p = 0.541$, two-tailed). In 11 of 13 cases wives allocate more non-nursing care than husbands and the difference is highly significant (t -test, $p = 0.004$, two-tailed).

Given my assumptions, the data in Table 14.6 force us to reject the hypothesis that husbands compensate for lower direct investment by allocating more time to one form of indirect investment (i.e. labor). There is no statistically significant difference in labor time of husbands and wives but wives allocate significantly more time to childcare and combined labor and childcare than do husbands. However, it is clear with the addition of indirect care (labor) to husbands’ direct care that husbands, contrary to the impressions in Table 14.3 and 4.4, allocate more time to care than all other of a child’s relatives. Since the scan sample data does not measure all forms of investment it is possible that males (and females as well) allocate more time to parental investment. I will pursue this idea below.

Discussion

Throughout this paper the major point of departure has been on infants and their caretakers. But for purposes of discussion I want to shift focus to mothers and infants. This is because mothers are the primary caretakers of infants, and mothers, but not infants, are more able to manipulate others to provide care. I have shown that the childcare requirements of infants and very young children are perhaps beyond the

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Table 14.6 *Husband-wife comparison in allocation to labor and childcare*

Couple	Wife				Husband			Wife-Husband		
	Labor	Nurse	Care	Total	Labor	Care	Total	Care	Labor	Total
1	431	37.5	34.8	503	390	16.6	407	55.7	41	93
2	368	32.5	75.8	476	376	4.8	380	103.5	-8	100
3	538	0	0	538	470	0	470	0	68	68
4	442	0	30.8	473	466	0	466	30.8	-24	11
5	534	0	15.8	550	448	4.7	453	11.1	86	97
6	434	35.0	23.3	493	499	0	499	58.3	-65	-6
7	450	22.1	4.4	477	382	0	382	26.5	68	95
8	474	31.8	36.4	542	460	7.7	468	60.5	14	74
9 ^a	488	9.2	25.3	522	479	2.4	482	32.1	9	40
10 ^a	319	55	27.5	403	479	2.4	482	80.1	-160	-74
11	461	13.7	10.2	485	431	15.9	446	7.6	30	38
12	502	20.6	16.0	539	476	11.3	491	25.3	28	46
13	539	5.6	17.3	561	473	5.2	479	17.7	66	88
Mean	460	20.2	24.4	505	448	5.5	454.2	39.1	11.8	51.5

^aPolygynous marriage

work capacity of a mother if she is simultaneously expected to do a normal amount of economic labor. For example, if a mother were the sole caretaker of her infant she would have to put in a 14.5-hour day of labor and childcare. While it is conceivable a mother could work this hard, doing so would leave her little time for the care of older but still dependent offspring and the quality of infant care would undoubtedly diminish. This last point is important when one realizes that infant mortality in tribal populations ranges from 15 to 35% (Babchuck *et al.* 1985, Chag-non, Dow, and Cheverud, unpublished data): this suggests that a diminution in the quality or quantity of infant care would be maladaptive. To overcome this problem a mother has two alternatives: she may ask for assistance in caretaking and/or work less (i.e. ask for assistance in labor).

The data from Tables 14.3 and 14.4 indicated that infants receive care from individuals in proportion to their coefficient of relationship to the infant: close kin provide more care than distant kin or unrelated individuals. While this kin biasing in alloparenting suggests nepotistic behavior it is not clear whether reciprocity is or is not mixed with nepotism and why males compared to females of equal relatedness to infants caretake less.

To understand whether reciprocity and/or nepotism is involved in childcare one must realize that either relationship can occur over the short-term or long-term. Over the short-term it

appears that mothers with highly dependent children work less and stay at home more (see below) in order to provide intensive care for their offspring. While doing so they may also babysit the older dependent children of actively working mothers who must leave the village to garden, fish, or gather. When infants mature to ages 2 to 3, mothers may leave them in the care of formerly active workers who are now caring for recently born, highly dependent children. The data in Table 14.2 suggest that something like this is occurring but identification of caretakers is required along with evidence of role reversals through time.

The issue becomes more complex when one considers the possibility that women with dependent children are economically assisted (reciprocated) by the women for whom they babysit. Data from Table 14.6 suggests that this may be occurring. If time spent nursing is regressed on labor time the correlation is negative and highly significant (Pearson $r = -0.81$, $p < 0.001$). This means that women with highly dependent offspring (indexed by time spent nursing) work less than women with more independent children (see Hurtado *et al.* (1985) for similar findings). Interestingly, husband and wife labor time is uncorrelated (Pearson $r = 0.276$, $p = 0.491$). This means that a husband is not making up the difference in his wife's lowered labor allocation when she is caring for a highly dependent child. A family's food requirements should increase with each additional member, so who

is making up the difference of increased productive needs and lower labor time?

The answer to that question seems to be a woman's kin. Unpublished statistical data on reciprocal garden labor exchange reveals that close kin exchanged labor more frequently than distant kin and that households tolerated greater imbalances in exchange (i.e. the difference between labor given and labor received from other households) with close kin compared to distant kin. Since women do 80% of all garden labor it is possible that women with highly dependent offspring are gaining assistance in garden labor, a woman's main economic task, from her female kin. One would predict, therefore, that households with negative exchange balances (those who received more labor than they gave) would have greater numbers of highly dependent offspring than households with positive exchange balances (those who gave more than they received). Furthermore, the very existence of garden labor exchange among women may be an adaptation to childcare constraints and not, as I have previously proposed, an adaptation to hedge against garden failure (Hames 1983: 400).

Among Ye'kwana women there appears to be a long-term and a short-term pattern of reciprocal childcare. Over the short-term, women with highly dependent infants gain assistance from women without dependent infants. Later those who were assisted will reciprocate as their children become more independent. This pattern can be a result of simple reciprocal altruism or reciprocal altruism mixed with nepotism. A long-term pattern primarily occurs between mothers and daughters and is based on nepotism. When daughters are pre-pubertal they assist their mothers and when mothers are no longer able to bear children they assist their childbearing daughters. The correlation between relatedness and alloparenting supports either pattern. Whether nepotism, reciprocal altruism, or a mixture of the two will be employed will most importantly depend on the number of kinswomen a woman has in the village: when a woman has many kinswomen in the village she will more likely depend on nepotism since it is in her kin's inclusive fitness interest to assist, but when a woman has few or no kin she may have to rely on reciprocal arrangements. Resolution of these issues will require analysis of old as well as recently collected data on Yānomanö

(see Chagnon this volume (Chapter 1)) and Ye'kwana alloparenting. The resolution promises to be complex since it apparently involves assistance in childcare and gardening through a combination of reciprocity and nepotism.

There exist two empirical studies on the allocation of childcare by kinship status that may be usefully compared to the Ye'kwana data, although neither focus intensively on the issue. Goodman *et al.* (1985: 136: Table V) report for Agta hunter-gatherers the following rank-ordering of time allocation to childcare: mother, sister, grandmother, father, grandfather and female cousin (tie), brother, aunt, and male cousin. With the exception of father (ranked 4th among the Agta compared to 7th among the Ye'kwana) and aunt (ranked 7th for the Agta compared to 4th for the Ye'kwana) these results correspond closely to those of the Ye'kwana (Table 14.4). Denham's (1974: 264) Alyawara hunter-gatherer data on child carrying by kinship relationship also correspond closely to the carrying data on the Ye'kwana (Table 14.3). All three studies show that care is more frequently done by close kin than distant kin.

Sex was found to be an important determinant of care. Table 14.5 showed that females engaged more frequently in care than males while Table 14.6 showed that husbands cared less for infants than mothers despite the fact that they are equally related to their infant offspring. In fact, as Table 14.4 indicates, in all cases when a male and female ego are equally related to an infant ego (grandmother versus grandfather, female cousin versus male cousin, brother versus sister, etc.) females invest more. These results are identical to the findings of Goodman *et al.* (1985) on the Agta.

To determine whether wives really invested more in offspring than husbands I hypothesized that husbands, as well as wives, provide indirect investment in offspring through household labor. Although females labor more than males the difference is not statistically significant but when labor, nursing, and care are combined as total measures of investment it was found that wives invest significantly more in offspring than husbands. There are two possible ways to resolve this question of low male investment in offspring. First, the behavioral categories of direct and indirect care fail to capture the full range of parental investment in offspring. It is possible

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that husbands spend significant amounts of time in education, proximity maintenance to allow passive monitoring of young (Draper 1976), game-playing, and other forms of social interaction that enhance offspring survival and reproduction. Many of these potential forms of investment were recorded and will be reserved for a publication on Ye'kwana socialization. Also, it has been suggested to me that males may invest in their offspring by engaging in risk-taking activities such as defense against predators and enemies. However, warfare with the Yano-mamö ceased in the early 1950s (Hames 1983) and predation of offspring is more likely to be deterred by mothers than fathers since mothers are more frequently in proximity to offspring.

The second way to resolve the question of paternal (relative to maternal) parental investment is to conclude that males can make better use of their time by competing for positions of high prestige and status which will allow them to gain other mates or mating opportunities. Recent research by Kaplan and Hill (1985, this volume (Chapters 17 and 18)) indicate that Ache males who gain high status through their extraordinary economic (in this case, hunting) productivity have higher reproductive success than low status, less productive males. This is especially significant when one realizes that the Ache are monogamous and more than 90% of what a man produces is consumed by individuals outside his own family. In addition, there is a growing literature that shows a correlation between male wealth and reproductive success (Irons 1979, Turke and Betzig 1985, Betzig 1986, this volume (Chapter 2)). Therefore, a father may be allocating effort to status-enhancing activities which lead to increased mating opportunities and which have a higher pay-off than parental investment. Conversely, it is possible that high status can be traded by a father to assist his son or daughter in finding a high quality mate at an early age. If this were the case then status-seeking behavior could be seen as a form of paternal investment. Unfortunately, I do not possess data to evaluate either of these hypotheses.

I think it is clear that females or wives invest more than males or husbands in *direct* childcare and that alloparental care is, in part, determined by relatedness. However, a number of points require further clarification through research. On the issue of male-female differences in paren-

tal or alloparental childcare it is not clear to what degree there are sexual differences in *indirect* parental investment and hence total parental investment. Research should be initiated to explore those things that parents may do to enhance the fitness of their offspring outside the basics of providing food and physical care. Although alloparental care is determined by relatedness it may be blended with reciprocity (i.e. biasing exchange relationship toward kin) and mixed with exchanges of childcare for economic assistance. Finally, the local conditions (e.g. post-marital residence rules) which determine the distribution of kin and non-kin in a village setting must be understood before straightforward predictions can be made about the allocation of alloparenting.

Summary

1. Due to the nature of the Amazonia neotropical forest environment and the Ye'kwana's economic adaptations to it, infant care requirements are difficult to meet if a mother must simultaneously perform necessary subsistence tasks. Any assistance she gains in childcare or labor should positively affect infant survivorship and/or her fertility.
2. Mothers rely on close kin to assist them in childcare and garden labor. The allocation of alloparental care correlates with closeness in genetic kinship.
3. Although fathers are just as closely related to their children as mothers, fathers allocate less time to all forms of direct care measured compared to mothers. It appears that males may be following a reproductive strategy which places more emphasis on increasing mating opportunities than on parental investment in offspring; or that male care is more frequently indirect.

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