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Evolutionary Theory, Kinship, and Childbirth in Cross-Cultural Perspective

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The authors combine evolutionary theory with the anthropological study of kinship to account for cross-cultural diversity in birth-related investments by kin. Four hypotheses are formulated using paternal certainty, gender, and kinship laterality as independent variables. They test these hypotheses with data from the 60-culture Probability Sample of the Human Relations Area Files (HRAF). Their hypotheses are generally confirmed. For example, grandmothers and aunts provide more direct birth care than grandfathers and uncles. However, they did have some unanticipated results. Fathers provide as much direct birth care as grandmothers and aunts. In addition, they found paternal certainty to be a better predictor of direct birth care than kinship laterality, and kinship laterality to be a better predictor of indirect care. They explain this difference by arguing that direct birth care is the most important kind of investment kin make to ensure the survival and reproduction of mothers and newborns.

Keywords: *descent; paternal certainty; parental investment; residence*

This cross-cultural research project has three objectives. First, we clarify the kinds and amount of help fathers and other close male kin provide during childbirth. Anthropologists, psychologists, physicians, and nurses have conducted cross-cultural research on childbirth for nearly 60 years (e.g., Cosminsky, 1976; Davis-Floyd & Sargent, 1997; Ford, 1945/1964; Jordan, 1993; Kay, 1982; MacCormack, 1994; Mead & Newton, 1967; Newton & Newton, 1972; Sargent, 2004; Trevathan, 1987). They generally characterize childbirth as a cooperative enterprise with care provided by a midwife and a handful of female kin (Jordan, 1993,

p. 60; Kay, 1982, p. 2; Kitzinger, 1997, p. 221; Newton & Newton, 1972, p. 162). Although scholars recognize that husbands and male kin often give economic help, “the practical, *direct* assistance comes from other women. In most cultures, daughters, sisters, mothers, mothers-in-law, co-wives, and other relatives and friends are regarded as the natural helpers of a woman during the childbearing process” (Mead & Newton, 1967, p. 192).

The second goal is to explore the relationship between human reproduction and social structure. We have many good accounts of childbirth in individual societies from around the world, and we know that the kinds and number of birth attendants vary. Nevertheless, we do not know of any comparative studies that systematically examine how descent and postmarital residence influence birth-related care. As with many other social domains, we argue that kinship is very important in explaining why the amount and type of investments kin make vary from culture to culture.

Third, we explore birth-related investments from a Darwinian perspective, especially how paternal certainty and sex-specific reproductive strategies shape investments by kin. From a Darwinian perspective, investments by kin around the time of birth are particularly important. “Individual and inclusive fitness and the survival of the species are directly dependent on the outcome of birth” (Trevathan, 1987, p. xi).

We begin our analysis by reviewing the theoretical and empirical research on paternal certainty, sex-specific reproductive strategies, descent, and postmarital residence. This leads us to develop and test specific hypotheses that relate the above variables to birth-related investments made by close kin. We conclude the article with a summary of our findings and a discussion of their implications.

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Theoretical Background

Paternal Certainty

*Paternal certainty*¹ refers to the probability that children and their putative fathers are genetically related. Richard D. Alexander (1974, p. 373) first predicted that paternal certainty could account for differences in kin investments in human societies. His prediction has subsequently been confirmed by a large number of empirical studies. For example, Hadza men are more nurturing, spend more time, play longer, and communicate more with biological children than with their stepchildren (Marlowe, 1999a, 1999b). Similarly, research undertaken in South Africa, Trinidad, and the United States found that genetic fathers and fathers with high paternity confidence generally provide more educational and financial support and spend more time with their children than do stepfathers and fathers with low paternity confidence (Anderson, Kaplan, Lam, & Lancaster, 1999; Anderson, Kaplan, & Lancaster, 1999, 2007; Flinn, 1988; Lancaster & Kaplan, 2000). Paternal certainty also shapes investments by aunts and uncles. Gaulin, McBurney, and Brakeman-Wartell (1997); Hoier, Euler, and Hänze (2001); and McBurney, Simon, Gaulin, and Geliebter (2002) found that mothers' sisters (MZs) and mothers' brothers (MBs) invest more in their nieces and nephews than do fathers' sisters (FZs) and fathers' brothers (FBs), whose genetic relatedness is less certain.

Data collected in Australia, Europe, and North America show how paternal certainty influences the investments of grandparents. In general, mothers' mothers (MMs) invest a greater amount of material resources, direct care, and time in grandchildren than mothers' fathers (MFs) and fathers' mothers (FMs) do. Fathers' fathers (FFs) tend to have the lowest level of investment of all (DeKay, cited in Buss, 2004, pp. 236-238; Euler, Hoier, & Rohde, 2001; Euler & Weitzel, 1996; Laham, Gonsalkorale, & von Hippel, 2005; Pashos, 2000). DeKay (cited in Buss, 2004) explained this pattern of investment by pointing out that there are two uncertain biological links in the case of FFs and their putative grandchildren. There is one doubtful link of relatedness between grandchildren and their MFs or FMs. In contrast, it is certain that a woman and her daughters' children are genetically related.

In a sample of 60 societies, Huber, Linhartova, Cope, and Lacy (2004, p. 71) found a positive relationship between paternal certainty and the level of investment in childbirth by a newborn's father (F), the father's patrilateral and matrilineal kin (e.g., FF, FM, FZs, FBs), and the newborn's

mother's patrilineal kin (e.g., MF). The higher a society's paternal certainty level, the more these "biologically uncertain" kin invest in childbirth, especially during the delivery and postnatal periods.

Sex-Specific Reproductive Strategies

Trivers (1972) predicted that women invest more in infant and child care than men and are more discriminating when selecting a mate because they have a lower potential rate of reproduction than men do. Men tend to maximize their Darwinian fitness by competing with each other for opportunities to mate, producing additional offspring as a result.²

Cross-cultural research on parental care (e.g., Hames, 1988; Katz & Konner, 1981) provides considerable evidence for these differences in male and female reproductive strategies. According to Hewlett (1991), "one consistent result from . . . cross-cultural studies [is] that fathers provide substantially less direct care to infants than mothers" (p. 2). By *direct care*, Hewlett referred to investments such as holding, feeding, grooming, cleaning, touching, and spending time with the infant. Even in the case of the Aka, a central African forest foraging group with possibly the world's highest level of paternal care, mothers provide more direct child care than fathers do (Hewlett, 1991, pp. 133-141).

As women grow older, their fertility decreases and the mortality risk associated with reproduction increases. Investing in their grandchildren, nieces, and nephews becomes the best way for older women to enhance their inclusive fitness (Hawkes, O'Connell, Blurton Jones, Alvarez, & Charnov, 1998; see also Hrdy, 1999). On the other hand, grandfathers and uncles can employ a different reproductive strategy. As men grow older, they can use their resources to gain extra mating opportunities, father children by other women, or invest in the children of their younger wives.

Evidence supporting this view comes from several quarters. Among the Hadza, for example, weaned children with grandmothers grew much faster than those without grandmothers. Older women were observed assisting child-bearing daughters and sister's daughters, a daughter's daughter, and sons' wives (Hawkes, O'Connell, & Blurton Jones, 1997, pp. 562-563). In rural Gambia, Sear, Steele, McGregor, and Mace (2002) found that children who have a living maternal grandmother had a higher probability of survival than those that do not. In addition, the presence of the FM increased her daughter-in-law's fertility (Sear, Mace, & McGregor, 2003). The authors attribute these enhanced growth, fertility, and survival rates to older female kin assisting mothers with child care, subsistence, and domestic duties. Similar findings

were reported by Volland and Beise (2002) for 18th- and 19th-century Germany and by Beise (2004) for 17th- and 18th-century Quebec, Canada.

In research undertaken in the United States, Gaulin et al. (1997) and McBurney et al. (2002) found that aunts show more concern for nieces and nephews than uncles do. Turning to grandparental investment, Euler and Weitzel (1996) reported that grandmothers provide more care to their grandchildren than grandfathers do if the confounding influence of coresidence is controlled.

Cross-cultural research undertaken by Huber et al. (2004, pp. 66-67) is consistent with the above investigations. When we compared investments by female consanguineal kin during the prenatal, delivery, and postnatal periods to those by male consanguineal kin, the female group collectively invests almost twice as much as the male group. The same pattern is found among individual male and female kin, with investments made by MM > MF, FM > FF, MZ > MB, and FZ > FB.

Kinship Laterality

Anthropologists have long recognized that members of descent and residence groups cooperate in domestic, economic, political, and religious tasks. They have also documented the tremendous amount of cross-cultural variability in kinship systems. The literature they have produced on these topics is quite large and has been summarized elsewhere (e.g., Fox, 1967; Keesing, 1975; Pasternak, Ember, & Ember, 1997; Stone, 2006). For our purposes, we note that anthropologists have identified six common postmarital residence rules (patrilocal, matrilocal, ambilocal, avunculocal, natalocal, and neolocal) and four principles used to trace descent from a common ancestor (patrilineal, matrilineal, double, and cognatic descent). Collectively these rules and principles account for much of the cross-cultural variability in residential groups, such as households and communities, and in descent groups, such as lineages and clans.

Residential and descent groups influence the type of kin that cooperate. In matrilineal, matrilocal societies, a woman, her sisters, and her mother often work closely together. Patrilineal, patrilocal societies facilitate close cooperation among a man, his brothers, and his father. In between these two kinds of societies are bilateral, neolocal societies. They tend to spread rights and obligations equally among patrilateral and matrilateral kin, and among male and female relatives.

Residential and descent groups also affect the level of kin cooperation (e.g., see Meehan, 2005). Cooperation among descent group members is

potentially high when they live close to one another. For example, cooperation among male and female matrilineal kin is generally higher when they reside in the same household (matrilineal, natalocal societies) than when matrilineal kin are dispersed into many different households (matrilineal, neolocal societies). For a similar perspective on descent and residence, see Fox (1967, pp. 97-121).

Study 1: Sex-Specific Reproductive Strategies and Birth-Related Care

Hypotheses

The cross-cultural research on birth that was discussed at the beginning of the article is the basis for our first hypothesis. We predict a sexual division of labor in birth care similar to that previously observed by scholars such as Mead and Newton (1967):

Hypothesis 1: Male kin will often provide substantial amounts of indirect care (e.g., food, shelter, fuel) but little direct care during birth (e.g., massaging a pregnant woman, delivering a child, cutting the umbilical cord).

We deduce our second hypothesis directly from evolutionary theory:

Hypothesis 2: Because males and females have different reproductive strategies, grandmothers will invest more in birth than grandfathers, and aunts will invest more than uncles.

Research Methods

The probability sample. We test these predictions with data from the 60-culture Probability Sample files (PSF) of the Human Relations Area Files (HRAF; see <http://ets.umdl.umich.edu/e/ehrafe/>). The Probability Sample is a cross-cultural sample designed to ensure representative coverage of traditional and peasant cultures of the world. The developers of the PSF randomly selected one well-described culture from each of 60 world regions (Lagacé, 1979; Naroll, 1967).

In this sample, patrilineal and bilateral societies each constitute 39.7% of the total followed by societies with matrilineal (19.0%) and double (1.7%) descent. Patrilocal (47.3%) and neolocal (30.9%) residence are the most common postmarital residence rules found in this sample. These

residence rules are followed in frequency by matrilocal (14.5%), avunculocal (3.6%), ambilocal (1.8%), and natalocal (1.8%) residence.

Operational definition of birth-related investments. Birth-related investments are defined as expenditures of effort or material resources during the prenatal, delivery, and postnatal periods that increase a mother's or her offspring's chances of survival and reproduction (cf. Clutton-Brock, 1991; Trivers, 1972, p. 139). Birth-related investments are of two basic types. We define *direct birth-related care* (DC) as active or passive support of a woman and her infant during the prenatal, delivery, and postnatal periods that requires only an expenditure of effort. Examples include massaging a pregnant woman, serving in the capacity of a midwife during the delivery, and bathing the newborn after the delivery. Indirect birth-related care (IC) comprises provisioning the mother or infant with food, shelter, clothing, or fuel; and compensating birth-care providers. Examples of IC include collecting firewood, making a gift to a midwife, providing a place to give birth, and supplying blankets and clothing for the newborn.

Some investments are more important than others in the sense of their increasing the likelihood of mother and infant survival and reproduction. Because of this our coding scheme allows for three different levels, ranging from 1 (*least important*) to 3 (*most important*). The following considerations informed our coding scheme for level of birth-related investments:

- The greater the amount of effort and time invested or the greater the amount of resources provided, the larger the investment.
- The provisioning of food to a mother during the pre- and postnatal periods, and investments that facilitate adequate lactation, are especially important to newborn survival and the mother's overall reproductive success (Ball & Panter-Brick, 2001, p. 255; Pike, 2001, pp. 49-51; Trevathan, 1987, pp. 177-182; Valeggia & Ellison, 2001, pp. 87-89).
- Doing some or all of the mother's regular chores is important because this frees her up to care for herself and her newborn.

Investments made during the prenatal, delivery, and postnatal periods, and how their level of importance was coded, are found in Tables 1, 2, and 3. We coded investments made during the course of "normal" pregnancies and births only. For example, investments due to prolonged labor, breech births, and the birth of twins were not coded. In addition, we excluded investments designed to establish a child's personal or social identity (e.g., ceremonies that assign an infant's name or descent group membership) and purely ritual investments (e.g., praying, divining the sex of the unborn child). To reduce random errors in statistical calculations (Ember & Ember,

Table 1
Level of Kin Investments During Prenatal Period:
Indirect Care (IC) or Direct Care (DC)

Level 1	Level 2	Level 3
IC	IC	IC
Provides small amount of food, small animal sacrifice, meal, payment, or gift	Satisfies pregnant woman's food cravings	Makes birth hut or "fire floor"
Collects cloth to clean future baby	Makes cradle or cradle-board	Sponsors large feast, provides large amount of food, large animal, or large payment
DC	DC	Provides woman with living quarters for 2 or more days
Keeps track of birth date	Prepares medicine one time	Collects large amount of firewood
Prepares baby's clothes	Offers birth advice	DC
Confirms woman is pregnant	Stays close in case birth assistance is needed	Does child care, cleans, fetches water, cooks, gardens, stays with woman 2 or more days
Accompanies woman to doctor	Massages pregnant woman	Prepares medicine two or more times
Bathes pregnant woman		Performs external version
		Bathes woman two or more times
		Accompanies woman to doctor several times

Table 2
Level of Kin Investments During Delivery Period:
Indirect Care (IC) or Direct Care (DC)

Level 1	Level 2	Level 3
IC	DC	IC
Provides small amount of firewood	Notifies midwife or doctor	Provides large amount of food
Makes small sacrifices	Prepares medicine to facilitate birth	Makes large or numerous sacrifices
Provides small gift or amount of food or compensation	Watches over newborn while placenta is born	Provides large gift or amount of compensation
DC	Determines position of fetus	Provides birth place
Helps with cooking	Massages parturient	DC
Screens off birth area	Stays close in case assistance is needed	
Keeps people from entering birth room	Warms parturient or baby	

(continued)

Table 2 (continued)

Level 1	Level 2	Level 3
Prepares birthing bed or area	Beats bamboo, fires gun, or shakes baby so newborn breathes	During delivery, provides physical support to parturient (holds, supports, balances)
Heats water		Serves in capacity of midwife during birth and delivery of placenta
Cuts umbilical cord		
Tightens waistband, wraps parturient		
Accompanies or sends parturient to birth place		
Bathes parturient		

Table 3
Level of Kin Investments During Postnatal Period:
Indirect Care (IC) or Direct Care (DC)

Level 1	Level 2	Level 3
IC	IC	IC
Provides small gift, animal, or amount of food	Supplies blankets and cloths for newborn	Provides large gift, animal, amount of food
Fetches some firewood or water	Provides cradle or cradle-board	Provides large amount of firewood
Provides fireplace	Provides home for 1 day	Provides home for 2 or more days
Provides small meal	Supplies wood for 2 day	DC
DC	Provides warming platform	Performs parturient's chores 2 or more days
Disposes afterbirth	DC	Cooks for parturient 2 or more days
Transports parturient or baby home after birth	Keeps people away from parturient or baby	Washes soiled clothing several times
Bathes or cleans parturient or baby one time	Prepares medicine	Provides personal care to mother or newborn for 2 or more days
Tightens waistband or wraps parturient	Washes soiled clothing once	Keeps fire burning for 2 or more days
	Performs chores once or for 1 day	Massages or bathes parturient or baby for 2 or more days
	Massages hips and abdomen	
	Provides personal care to mother 1 day	
	Massages parturient or baby one time	

2001, pp. 64-65), we stipulated a time focus for each culture—the most recent period for which ethnographic information on birth is available. For stratified societies, we calculated investment levels only for free people of lower socioeconomic status.

The level of birth-related investments were estimated for relatives whose biological links to the newborn are certain (MMs, MZs, and MBs) and for relatives whose biological relationship to the newborn is uncertain (Fs, FFs, FMs, FBs, FZs, and MFs). For each of these relatives, we estimated the level of birth-related investment by summing the number of investments weighted by their level of importance, $\sum I_w$, where I = an investment and W = its level of importance. For example, if ethnographers writing about "Society X" indicate that FMs make two investments each during the prenatal, delivery, and postnatal periods, and each is a level "3" investment, then FMs' level of birth-related investment is "18," $(2 \times 3) + (2 \times 3) + (2 \times 3)$.

Results of Study 1

Table 4 displays the means and standard deviations of the level of IC and DC investments by close male and female kin of the newborn. These data are useful in examining the first hypothesis, which predicts that male kin provide substantial amounts of IC but little DC during childbirth.

Looking first at IC, we see that the single largest individual provider of IC in this 60-culture sample is the F ($M = 8.6$, $SD = 4.9$). Fs are followed by all four grandparents (FMs, FFs, MMs, MFs) who contribute approximately one half ($M = 4.2$, $SD = 5.3$) to one third ($M = 3.0$, $SD = 4.3$) as much. Aunts and uncles (MBs, FBs, MZs, FZs) provide little or no IC in the birth of their nieces and nephews ($.4 \geq M \geq .0$). An ANOVA indicated that F's level of IC significantly differs from all the other individual kin categories; however MMs, FMs, MFs, and FFs do not significantly differ from each other. The difference between FMs ($M = 4.2$) and MFs ($M = 3.0$), for example, is not a statistically significant difference. Fs are the single most important provider of IC, and grandfathers invest as much IC as grandmothers do.

Turning to DC, maternal grandmothers (MMs) invest the most DC ($M = 2.2$, $SD = 2.5$). This significantly differs from grandfathers and uncles but not from paternal grandmothers, aunts, or fathers ($M = 1.7$, $SD = 2.0$). Fs provide as much DC during birth as do individual grandmothers and aunts.

We can provide some additional context that clarifies the role of Fs during childbirth. Fs provide DC during the delivery in 36.5% of the societies for which we have information ($N = 52$). In 86.5% of the societies in our sample, the F makes some kind of investment (IC or DC) during the delivery phase of childbirth. In 48 of 52 societies (92.3%), Fs provide some sort of investment during the prenatal, delivery, or postnatal periods. Thus, Fs invest in childbirth and make some sort of investment during the actual delivery of their

Table 4
Level of Indirect and Direct Care in Birth: Newborn's
Grandparents, Aunts, Uncles, and Father (*N* = 52 Societies)

	Level of Indirect Care	Level of Direct Care
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
Females		
Grandmothers as a group	7.3 (5.7)	3.3 (3.8)
MMs	3.2 (4.3)	2.2 (2.5)
FMs	4.2 (5.3)	1.2 (2.3)
Aunts as a group	.1 (.4)	2.0 (4.5)
MZs	.1 (.4)	1.1 (2.6)
FZs	.0 (.0)	.9 (2.7)
Males		
Grandfathers as a group	6.9 (5.5)	.2 (.6)
MFs	3.0 (4.3)	.2 (.6)
FFs	3.9 (5.0)	.0 (.0)
Uncles as a group	.6 (2.1)	.0 (.0)
MBs	.4 (1.7)	.0 (.0)
FBs	.2 (1.3)	.0 (.0)
Fathers	8.6 (4.9)	1.7 (2.0)
Grand means and standard deviations	2.6 (4.5)	.8 (1.8)

Note: MMs = mothers' mothers; FMs = fathers' mothers; MZs = mothers' sisters; FZs = fathers' sisters; MFs = mothers' fathers; FFs = fathers' fathers; MBs = mothers' brothers; FBs = fathers' brothers.

children in approximately 90% of the world's societies. In almost 4 of every 10 societies, Fs provide DC during their children's delivery.

Table 4 is also useful in examining the second hypothesis, which predicts grandmothers will invest more in birth than grandfathers, and aunts will invest more than uncles. We see that grandmothers as a group ($M = 7.3$, $SD = 5.7$) provide more IC than do grandfathers as a group ($M = 6.9$, $SD = 5.5$). However, uncles ($M = .6$, $SD = 2.1$) provide more IC than do aunts ($M = .1$, $SD = .4$). Turning to DC, grandmothers ($M = 3.3$, $SD = 3.8$) provide more DC than do grandfathers ($M = .2$, $SD = .6$), and aunts ($M = 2.0$, $SD = 4.5$) provide more DC than do uncles ($M = .0$, $SD = .0$).

ANOVA revealed that grandmothers differ significantly from grandfathers in the amount of DC they provide to mother and child, but not in the amount of IC. Grandfathers provide the same level of IC as do grandmothers. Aunts and uncles significantly differ in the amount of DC they provide but do not

differ significantly on the amount of IC. Aunts provide more DC than uncles; however, aunts and uncles provide the same relatively low level of IC investments.

Study 2: Paternal Certainty, Kinship Laterality, and Birth-Related Care

Hypotheses

Our third and fourth hypotheses examine the relationship among birth-related care and two independent variables, paternal certainty and kinship laterality:

Hypothesis 3: Direct and indirect care investments by Fs, FFs, FMs, FZs, FBs, and MFs—biologically uncertain kin—positively correlate with a society's paternal certainty level.

Hypothesis 4: Direct and indirect care investments by biologically uncertain kin will be largest in patrilineal societies—societies where patrilineal kin live in close proximity.

Research Methods

Operational definition of the relative level of birth-related investments. In some societies, the overall level of birth-related investment by relatives of the mother and infant is relatively low. A few kin make only a few modest investments during a woman's pregnancy, delivery, and postpartum period (e.g., Inuit, Tarahumara). In other societies, the opposite is true. Many kin make a relatively large number of quite substantial investments (e.g., Hausa, Kogi). The overall level of birth-related investment by kin is relatively high.

The overall level of investment by kin is correlated with the level of investment made by specific categories of kin. For example, when the overall investment level is high, the level of investment by Fs and MMs tends to be high. It is desirable to control for the overall level of investment when examining the relationship between the investment level of specific categories of kin and the independent variables, paternal certainty and kinship laterality. If we do not control for the effect of the overall level of investment, any correlation between our independent variables and the investment of specific categories of kin would be contaminated.

One way to try to control for the overall level of investment by kin is to construct an overall measure and use this as a control variable. In the current situation, with a small sample size, this is impractical. Instead, we have constructed what we call a measure of “relative investment.” *Relative investment* refers to the level of birth-related investment of a particular relative measured in such a way as to remove the overall level of investment. We have arrived at such a relative measure by subtracting the investment scores of biologically certain kin from the investment score of an uncertain relative. For example, the relative investment score for the newborn’s F, RI_F , is

$$RI_F = I_F - I_C,$$

where I_C is the investment score of the newborn’s certain kin, and I_F is the investment score of the newborn’s F. Thus, a society with a higher score for RI_F is the one with relatively high levels of investment by Fs.³

Operational definition of paternal certainty. As Gaulin et al. (1997) noted, measuring paternal certainty directly “is all but impossible in human populations” (p. 147). Researchers who have published the most reliable estimates of paternal certainty base them on blood group typing, Y chromosome genotyping, and other related methods.⁴ Paternal certainty levels vary from society to society. In small communities where residents closely monitor women’s behavior and strongly sanction adultery, and where husbands customarily time intercourse immediately before ovulation, the paternal certainty level is as high as 98.8% and 99.6%, the estimates for Sephardic and Ashkenazic Kohanim (Boster, Hudson, & Gaulin, 1999). When customs like these are absent, researchers report paternal certainty rates of 70% to 80%, for example, urban northwest and southeast English populations (McLaren, cited in Cohen, 1977; Philipp, 1973). In societies where contraceptives are not widely used, and parents permit adolescents to have as many lovers as they like (e.g., the Aranda), or where wife lending is customary (e.g., the traditional Inuit), paternal certainty rates must be much lower than 70%. See Kermyt Anderson’s (2006) article for an analysis of 67 studies reporting on paternity.

Previous cross-cultural research by Flinn (1981), Gaulin and Schlegel (1980), Schlegel and Barry (1991), and others such as Broude and Greene (1976) and Frayser (1985) guided the development of our measure of paternal certainty.⁵ Like previous researchers, we assume a society’s level of paternal certainty negatively correlates with the frequency of premarital and extramarital relationships among its members, and positively correlates with

how strongly members of a society punish individuals who engage in premarital and extramarital sex. *Premarital sex* is defined here as sexual intercourse of an unmarried person with an unmarried individual of the opposite sex. We define *extramarital sex* as sexual intercourse between a married man or woman and a married or unmarried individual of the opposite sex. We exclude from our analysis reports of incest, prostitution, homosexuality, and sex between individuals from different societies, classes, or castes. The time and social class foci used for investment-level calculations are the same for paternal certainty (and kinship laterality) calculations.

Our measure of paternal certainty is a composite index based on four items: the (a) frequency of premarital and (b) extramarital sex, and the (c) strength of the sanctions against premarital, and (d) extramarital sex. The first two items range from 1 (*most frequent*) to 5 (*least frequent*); the last two items range from 1 (*weakest*) to 5 (*strongest*) sanctions. Two individuals independently coded the four paternal certainty items for the 60 societies of the Probability Sample. Interrater reliability was high for the four items, with correlation coefficients (γ) ranging from .780 to .943. Rater discrepancies were resolved through discussion and resolution (cf. Ember & Ember, 2001, p. 133). For a more detailed account of the operationalization of this variable, see Huber, Linhartova, and Cope (2004).

Operational definition of kinship laterality. *Kinship laterality* refers to the extent to which members of a society rely on matrilineal, bilateral, or patrilineal kin groups. A society is assigned a kinship laterality score based on its rule of descent and its predominant type of postmarital residence. As you can see in the top-left side of Table 5, societies are coded "1 Very Strongly Matrilineal" if they have matrilineal descent and natalocal residence (middle row). Societies that combine matrilineal descent and natalocal residence localize male and female consanguineal kin in the same household (bottom row), thus facilitating mutual aid and cooperation among these matrilineal kin.

We assigned kinship laterality scores after examining ethnographic reports of a society's rule of descent and predominant form of postmarital residence. For descent, we assigned one of the following values to each society: patrilineal, matrilineal, double, bilateral,⁶ or missing. With respect to postmarital residence, we assigned one of the following values: patrilocal, matrilocal, ambilocal, avunculocal, natalocal, neolocal, variable, and missing. Ethnographers sometimes report two or more patterns of postmarital residence in a particular society, or the custom of bride service. In those cases, we identified the predominant residence pattern as the one followed

Table 5
The Kinship Laterality Scale

1	2	3	4	5	6	7
Very Strongly Matrilateral	Strongly Matrilateral	Moderately Matrilateral	Bilateral	Moderately Patrilateral	Strongly Patrilateral	Very Strongly Patrilateral
Matrilineal natalocal societies	Matrilineal matrilocal or matrilineal avunculocal societies	Matrilineal neolocal or bilateral matrilocal societies	(Bilateral or double descent) and (neolocal or ambilocal) societies	Patrilineal neolocal or bilateral patrilocal societies	Patrilineal patrilocal or patrilineal amitlocal ^a societies	Patrilineal societies with F-S-D residence groups ^b
Female and male matrilineal kin are localized	Female or male matrilineal kin are localized but not both	Presence of matrilineal descent groups or matrilocal households but not both	Bilateral kinship; kin are dispersed	Presence of patrilineal descent groups or patrilocal households but not both	Female or male patrilineal kin are localized but not both	Both female and male patrilineal kin are localized

Note: F-S-D = father-son-daughter.

a. Amitlocal residence would be the custom of couples residing with the wife's father's sister. This custom is not known in the ethnographic record.

b. We know of no societies where husbands customarily live with their unmarried children but apart from their wives.

by the majority of married couples, or if applicable, the one followed by the majority after the completion of bride service. If no residence pattern predominated, we coded that society's residence system as "variable."⁷ After coding descent and residence, we assigned each society a laterality score between 1 and 7. Societies ranged from being 1 (*very strongly matrilineal*) to 7 (*very strongly patrilineal*).

Results of Study 2

Tables 6, 7, and 8 display results of analyses bearing on our last two hypotheses, which predict that DC and IC investments by Fs, FFs, FMs, FZs, FBs, and MFs (biologically uncertain kin) will be: (a) positively correlated with a society's paternal certainty level and (b) highest in patrilineally organized societies. Table 6 shows intercorrelations of our two independent variables with the relative level of IC by the newborn's uncertain kin. Note first that the only correlations that are significant at the $p < .05$ level are found between laterality and IC investments by the F and the father's patrilineal kin. The strongest correlations are found between laterality and IC by both paternal grandparents, FFs ($r = .689, p < .001$) and FMs ($r = .686, p < .001$). Fs, FBs, and FMs and FFs tend to provide IC during childbirth when they reside with the newborn's mother or when they are members of the newborn's patrilineal descent group.

The pattern of results in Table 6 is quite different from the pattern found in Table 7. As predicted, the relative level of DC is positively correlated with kinship laterality and paternal certainty; however, the strongest correlations are found between paternal certainty and DC. The higher the society's paternal certainty level, the more likely the F, the FM and FZ, and the MF will provide DC at birth.

A question that arose at this point was "What kinds of direct care are uncertain kin providing in societies with high paternal certainty levels?" To address this question, we first identified societies with paternal certainty scores greater than or equal to the median score, 11. Then, we focused on the uncertain relatives who provided the largest amounts of DC (i.e., Fs, FMs, and FZs) and examined the kinds of DC they provide.

Table 8 shows that these three kin generally provide the kinds of DC that are very important to the survival and reproduction of the parturient and her newborn child: massage, birth advice, staying close to or physically supporting the parturient during birth, serving as a midwife, and providing postnatal care for 2 or more days. However, there were some

Table 6
Intercorrelations of Kinship Laterality and Paternal Certainty
With Relative Level of Indirect Care by Newborn's
Uncertain Kin—Spearman's *r*

Relative Level of Indirect Care by	Kinship Laterality	Paternal Certainty
F	.404**	.126
FF	.689***	.136
FM	.686***	.122
FB	.330**	.070
FZ	No indirect care provided	
MF	.117	-.018

Note: F = father; FF = fathers' father; FM = fathers' mother; FB = fathers' brothers; FZ = fathers' sisters; MF = mothers' father.

p* < .05. *p* < .01. ****p* < .005, one-tailed tests.

Table 7
Intercorrelations of Kinship Laterality and Paternal
Certainty With Relative Level of Direct Care by
Newborn's Uncertain Kin—Spearman's *r*

Relative Level of Direct Care by	Kinship Laterality	Paternal Certainty
F	.296*	.324**
FF	No direct care provided	
FM	.227	.297*
FB	No direct care provided	
FZ	.259*	.376***
MF	.250*	.356***

Note: F = father; FF = fathers' father; FM = fathers' mother; FB = fathers' brothers; FZ = fathers' sisters; MF = mothers' father.

p* < .05. *p* < .01. ****p* < .005, one-tailed tests.

differences in the scope of the DC these kin provide. When paternal certainty is high, paternal grandmothers (FMs) were observed to provide direct care to their daughters-in-law through all three stages of childbirth: the prenatal, delivery, and postnatal periods. FZs provide DC during the

Table 8
Kinds of Direct Care Fathers, Father's Mothers,
and Father's Sisters Provide in Societies With Paternal
Certainty (PC) Scores At or Above the Median (PC ≥ 11)

Father	
Labor and delivery	Stays in close proximity to his wife during delivery Physically supports his wife during delivery Serves in capacity of his spouse's midwife
Postnatal period	Transports his wife home after delivery Provides his wife with postnatal care for 2 or more days
Father's mother	
Prenatal period	Offers advice to her daughter-in-law about her upcoming birth
Labor and delivery	Accompanies her daughter-in-law to place of birth Stays close to her daughter-in-law during the delivery Physically supports her daughter-in-law during the delivery Serves in capacity of daughter-in-law's midwife
Postnatal period	Bathes her daughter-in-law and newborn grandchild
Father's sister	
Prenatal period	Massages her pregnant sister-in-law Offers advice to her sister-in-law about her upcoming birth
Labor and delivery	Accompanies her sister-in-law to place where birth will occur Stays in close proximity to her sister-in-law during delivery Cuts umbilical cord after the delivery Serves in capacity of her sister-in-law's midwife

prenatal period and the delivery. Fs provide DC during the delivery and postnatal period. Even though these three patrilineal relatives differ somewhat in the range of care they provide in high paternal certainty societies, they all provide DC during the delivery of the child. When paternity is more certain, they perform all the duties of a midwife or perform specific components of this role, that is, staying in close proximity to the parturient during the delivery, physically supporting her during the delivery, cutting the umbilical cord.

Discussion and Implications of Our Findings

Our research suggests that paternal certainty, kinship laterality, and sex-specific reproductive strategies explain a considerable amount of the cross-cultural variability found in birth-related investments. Of course, this set of independent variables is not exhaustive. Many additional factors probably

influence the investments kin make during the prenatal, delivery, and postnatal periods of childbirth. They include a relative's degree of genetic relatedness to the newborn; the likely duration of a couple's marriage or mating relationship; the extent to which the F and newborn child resemble each other; the tendency for daughters to reside closer to parents than sons in bilateral, neolocal societies; and the presence of sibling rivalry (M. Flinn, personal communication, September 13, 2005; A. Schlegel, personal communication, September 16, 2005). There may also be cultural imperatives or sanctions in some of the world's societies that regulate the kinds of people who may directly participate in childbirth. The conclusions reached by cross-cultural researchers are always limited by the variables they include in their analysis and the kinds of data available to them.

Despite these limitations, we do offer several tentative conclusions. Our research generally confirms our first two hypotheses. Aunts provide more IC and DC than do uncles, and grandmothers provide more DC than grandfathers. However, grandfathers were found to provide the same level of IC as grandmothers.

We expected and found Fs to provide significant amounts of IC. However, we did not anticipate Fs directly participating in birth at the same level as grandmothers and aunts. Fs provide DC during the delivery in approximately 1 of every 3 societies. This is surprising because cross-cultural researchers previously reported husbands, other male kin, and men in general to be excluded from directly participating in childbirth (Ford, 1945/1965, pp. 56-57; Mead & Newton, 1967, p. 193; Trevathan, 1987, pp. 113-114).

Previous cross-cultural researchers who looked at the role men play during birth employed samples that differed from ours. This may be one reason why there is a discrepancy between our findings and those obtained in the past. Another reason may be because previous cross-cultural researchers expected men's direct participation in birth to be insignificant, and this expectation biased their findings. Regardless of the cause, the first author found a similar discrepancy when undertaking a regional comparison of midwives in Mexico. Many scholars who have undertaken research in Mesoamerica give the impression that indigenous Mexican midwives are always women. However, in a sample of 41 indigenous Mexican groups, Huber and Sandstrom (2001, pp. 163-165) found evidence of male midwives in 20. Many researchers appear to underestimate the amount of DC men provide during the delivery of children.

With respect to paternal certainty and kinship laterality, our results generally support our third and fourth hypotheses. The higher the paternal certainty

level and the more a society relies on patrilineal groups, the larger the birth-related investments by biologically uncertain kin. However, both hypotheses require qualification. Paternal certainty is a better predictor than laterality of DC. In contrast, laterality is a better predictor of IC during birth. Why is DC correlated with paternal certainty whereas IC is not?

One way to address this question is to recall Table 8. It shows Fs, FMs, and FZs in high paternal certainty societies providing DC that is vital to the survival and reproduction of mothers and newborns. Fs, FMs, and FZs provide DC during birth when their genetic relatedness to the mother and newborn is certain because this benefits their individual and inclusive fitness. IC also benefits mothers and newborns; however, these investments are not as crucial as DC to mothers and newborns. Mothers and newborns rely on the relatives who live with them or who are in their same descent group to make these indirect, material-resource investments.

Notes

1. *Paternal certainty* is also referred to by other terms such as *paternal or paternity uncertainty*, *probability*, *confidence*, and *discrepancy*. Anderson (2006) made a useful distinction between “actual genetic paternity” and paternal confidence, “a man’s assessment of the likelihood that he is the father of a putative child” (p. 511).

2. In fact, paternal care is a mating strategy, at least in part (Marlowe, 1999a, 1999b).

3. In Huber et al. (2004), argued that:

defining a relative score in this way has the effect of removing from the relative investment scores for particular kin categories, such as RI_F , the effect of the overall level of investment characteristic of the society. Our argument runs as follows: Adopt a simple model in which the observed level of investment of any kin category, I_K , is the sum of the effects of the general level of investment characteristic of the society, denoted as G , and an effect that reflects the specific level of investment characteristic of that kin category, S_K :

$$I_K = G + S_K$$

Under this presumed model, if one subtracts the observed I_K values for any two kin categories, the difference is a relative measure that removes the effect of the general level of investment because G subtracts out. Again using the example of the relative level of investment of Fs, we have:

$$\begin{aligned} RI_F &= I_F - I_M \\ &= (G + S_F) - (G + S_M) \\ &= S_F - S_M \end{aligned}$$

Therefore, the relative investment scores for all uncertain kin categories here were constructed by subtracting the score for the mother’s certain kin from the observed investment score for the uncertain kin category. Note that the higher the relative investment

score, the less difference there is from the highly invested mothers' certain kin category, and therefore the larger the relative investment by the kin category in question is. (pp. 74-75)

4. They include Cerda-Flores, Barton, Marty-Gonzalez, Rivas, and Chakraborty (1999) for Nuevo León, Mexico; Neel and Weiss (1975) for the Yanomama of Brazil and Venezuela; Sasse, Müller, Chakraborty, and Ott (1994) for Switzerland; and Sykes and Irven (2000) for the United Kingdom.

5. Some scholars might argue that an operational definition of *paternal certainty* should take into account a society's divorce rate. The following sort of argument might be made: "While it is true that premarital and extra-marital rates are quite relevant to paternal certainty so is divorce. If divorce rates are high then a man knows that not all of his wife's children are his own." We chose not to incorporate "divorce rates" into our operational definition of *paternal certainty* for the following reason. A man is certain that a woman's children are not his biological offspring if he has not had sex with her. This is true regardless of her personal history of marriage and divorce, or the society's divorce rate. Because of this fact, a society's paternal certainty level can vary independently of its divorce rate.

6. For the purpose of this article, we classify societies with bilateral kindreds and cognatic descent groups together and refer to them collectively as *bilateral societies*.

7. For several more useful ways to code postmarital residence, see Marlowe (2004).

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