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Evolutionary Theory and Birth-Related Investments by Kin in Cross-Cultural Perspective[1]

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1. INTRODUCTION

The research reported in this paper uses evolutionary theory to examine birth-related investments made by kin. We begin with a selective overview of the theoretical literature related to inclusive fitness theory, paternal certainty, and sex-specific reproductive strategies. This overview leads us to make a number of specific predictions that are tested in two related cross-cultural studies. Both focus on investments kin make during pregnancy, child birth, and the post-natal period. The first study looks at investments made by kin living in three different kinds of societies: those with a) bilateral kinship and neolocal residence, b) patrilineal descent and patrilocal residence, and c) matrilineal descent and matrilocal residence. The second study examines birth-related investments by kin whose biological relationship to the mother and newborn is uncertain.

2. THEORETICAL BACKGROUND

2.1 Inclusive Fitness Theory

Inclusive fitness theory, developed by W. D. Hamilton (1964) and others (e.g., Williams 1966), was designed to explain altruistic behavior among kin. It predicts that individuals promote the transmission of copies of their genes to the next generation not only by investing in their children but also through acts that favor the survival and reproduction of other biologically related kin. This theory is supported by a considerable body of research including investigations of patterns of inheritance (Smith, Kish, and Crawford 1987), aid provided by kin in horticultural societies (Berte 1988; Hames 1987; Hawkes 1983), food sharing among foragers and food producers (Betzig 1988; Betzig and Turke 1986; Kaplan

and Hill 1985), everyday favors, and help provided during life-and-death emergencies (Burnstein, Crandall, and Kitayama 1994; Petrinovich, O'Neill, and Jorgensen 1993). Individuals are more likely to help relatives than non-relatives, and more likely to help closely related relatives than distantly related ones. Or to state it more succinctly, altruism is positively correlated with genetic relatedness.

2.2 Paternal Certainty

Genetic relatedness is not only a function of genealogical relationship, but also of paternal certainty (Buss 2004: 240). Paternal certainty refers to the probability that children and their putative fathers are genetically related.

> Before the days of embryo transplants (for 99.99 percent of human evolution!), women were unambiguously related to the children they bore. But a man is not so certainly and automatically related to his wife's children. If the wife's child is in fact his own, then the child will carry 50 percent of his genes—just as it does hers. But it may not be his child, and thus may carry none of his genes (Gaulin and McBurney 2001:347).

Cross-cultural researchers have related paternal certainty to a number of variables including type of marriage exchange, post-marital residence, descent, and inheritance (Flinn 1981; Gaulin and Schlegel 1980; Hartung 1985). Hartung (1985), for example, found that men tend to pass property to their wives' sons when a society's level of paternal certainty is high, and to their sisters' sons when paternal certainty is low.

In research undertaken in Europe and North America, paternal certainty has been shown to shape the investments of close relatives. Maternal grandmothers (MM's), for example, generally invest more resources in grandchildren than maternal grandfathers (MF's) and paternal grandmothers (FM's). Paternal grandfathers (FF's) tend to have the lowest level of investment of all (DeKay 1995 [cited in Buss 2004: 236-238]; Euler and Weitzel 1996; Euler, Hoier and Rohde 2001; Pashos 2000). DeKay explains this pattern of investment by pointing out that there are two opportunities to sever genetic kinship in the case of paternal grandfathers and their putative grandchildren. There is one opportunity to sever relatedness between grandchildren and their mother's father or father's mother. In contrast, it is certain that maternal grandmothers and their grandchildren are genetically related. Consistent with this research is the finding that paternal certainty shapes investments by aunts and uncles with maternal aunts and uncles investing more in their nieces and nephews than paternal aunts and uncles (Gaulin, McBurney, and Brakeman-Wartell 1997).

2.3 Sex-Specific Reproductive Strategies

Trivers (1972) developed a number of interesting predictions regarding parental investment and sexual selection. In the case of humans, he predicted that women will generally be more discriminating than men in regards to mating because they make larger investments in infant and child care. In contrast, men are more likely than women to compete with each other for

the opportunity to mate with members of the opposite sex. These reproductive strategies are rooted in differences in male and female reproductive physiology. As is well known, females produce fewer and larger gametes than males, carry and bear offspring after a nine-month period of gestation, and nurse infants.

Trivers' predictions have been supported. For example, Gaulin, McBurney, and Brakeman-Wartell (1997) found that aunts tend to invest more in nieces and nephews than do uncles. This sex effect is attributed to the tendency of men to invest surplus resources in mating with multiple partners. When the confounding influence of coresidence is controlled, grandmothers are found to invest more than grandfathers in their grandchildren (Euler and Weitzel 1996).

2.4 Descent and Post-Marital Residence

Anthropologists have long been interested in the study of kinship, especially the formation of social groups based on different descent and post-marital residence rules. The literature anthropologists have produced on these topics is quite large, and has been summarized elsewhere (e.g. Fox 1967; Keesing 1975; Pasternak, Ember, and Ember 1997; Stone 2000). Two general findings, however, are important in the context of our research: First, members of some societies tend to form independent nuclear family households after marriage while others form multi-generation, extended family households. The six most common post-marital residence rules are: patrilocal, matrilocal, ambilocal, avunculocal, natalocal, and neolocal residence. Second, many, but not all, societies form groups by using the principle of "descent from a common ancestor". Descent groups are formed using one of the following four descent rules: patrilineal, matrilineal, double, or cognatic descent. A bilateral kindred differs from a cognatic descent group but both are similar in that they are groups of kin who trace connections bilaterally (Fox 1967; Stone 2000). For the purpose of this paper, we group societies with bilateral kindreds and cognatic descent groups together, and refer to them collectively as "bilateral societies".

Descent and residence groups throughout the world have many important functions, and they are expected to be important in channeling birth-related investments made by kin. Some of their more important functions include the regulation of sex and marriage, the formation of military and trade alliances, the settlement of disputes, the recruitment of political and religious personnel, the allocation of land, the celebration of life cycle events such as marriage, and the performance of common but crucial tasks such as procuring food, and providing child- and healthcare.

The way descent and residence groups influence birth-related investments by kin can be conceptualized as follows: Imagine a society where paternity is always certain, and men and women invest in children equally. Suppose there are two sets of kin in this society whose coefficients of relatedness to the newborn are exactly the same. One set of kin (S_P) consists of a man, a son and daughter, and his son's four children. The other set of kin (S_M) is composed of a woman, a son and daughter, and her daughter's four children. If members of

this society have a patrilineal ideology, the level of altruism a member of S_P exhibits would be higher than the level exhibited by his or her counterpart in S_M even though their coefficient of relatedness is exactly the same.

3. STUDY 1: DESCENT, POST-MARITAL RESIDENCE, GENDER, AND THE LEVEL OF BIRTH-RELATED INVESTMENTS ACROSS CULTURES

3.1 Hypotheses

The goal of this section of the paper is to investigate birth-related investments by kin in light of the theoretical discussion above. We make the following predictions:

1. In general, we expect a gender effect in investment in all societies. Female kin should make larger investments than their comparable male kin counterparts. With respect to matrilateral relatives, for example, mother's mother should invest more than mother's father, and mother's sister should invest more than mother's brother.

2. In bilateral societies with neolocal residence, matrilateral relatives should invest more than their patrilateral kin counterparts. For example, mother's mother should invest more than father's mother, and mother's sister should invest more than father's sister. This prediction is based on the premise that matrilateral relatives are biologically related to mother and newborn with more certainty than are patrilateral relatives.

3. In societies with patrilineal descent and patrilocal residence, the investment pattern should be skewed in the direction of patrilateral relatives when compared to the pattern in bilateral, neolocal societies. Although paternal uncertainty has the effect of shifting investments onto matrilateral relatives, the strong expectation of altruism among members of patrilineal descent groups and patrilocal households should shift the investment load in the patrilateral direction. The precise amount of the investment "shift", however, is difficult to predict *a priori*.

4. In societies with matrilineal descent and matrilocal residence, investments by kin should be skewed in the direction of matrilateral relatives, and this shift should be more pronounced than in the case of bilateral, neolocal societies. It should be more pronounced because there is a strong expectation that members of matrilineal, matrilocal societies should behave altruistically toward each other, and because matrilateral kin are related to the newborn with more certainty than patrilateral kin.

3.2 Research Methods

3.2.1 The Probability Sample

These predictions are tested with data from the sixty-culture Probability Sample files (PSF) of the HRAF[2]. 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 comprised 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 were the most common post-marital residence rules found in our sample. These residence rules were followed by matrilocal (14.5%), avunculocal (3.6%), ambilocal (1.8%), and natalocal residence (1.8%).

3.2.2 Operationalizing the Level of Birth-Related Investment by Kin

A birth-related investment can be conceptually defined as any investment during the prenatal, delivery, and post-natal period that increases a mother's or her offspring's chances of survival and reproduction (cf. Clutton-Brock 1991; Trivers 1972: 139). Examples of birth-related investments include: 1) massaging the pregnant woman during the prenatal period; 2) providing physical support to the parturient during delivery (e.g., holding, supporting, balancing); 3) doing child care, cleaning, fetching water, cooking, gardening, or staying with a mother during the post-natal period.

Some investments are more important from an evolutionary perspective than others. Because of this, our coding scheme allowed for three different levels of importance of investment, ranging from 1 (least important) to 3 (most important). The following considerations guided our coding scheme for level of birth-related investments:

1. The greater the amount of time invested or the greater the amount of resources provided, the larger the investment.

2. Material investments in mother and newborn (e.g., the provisioning of physical assistance, medicines, food, and shelter) are more important to newborn and maternal survival than purely ritual investments (e.g., praying, divining the sex of the unborn child).

3. The provisioning of food to a mother during the pre- and post-natal periods, and investments that encourage nursing are especially important to mother and newborn survival (Trevathan 1987:177-182).

4. Doing some or all of the birth 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 post-natal periods, and how their level of importance was coded are found in Appendices 1a, 1b, and 1c. 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 excluded. In addition, we excluded investments designed to establish a child's personal or social identity, e.g., naming ceremonies, ceremonies that assign a newborn's descent group membership.

For each society in the sample, the birth-related investment of a particular relative was operationalized by multiplying the number of investments that relative made by the size of the investment. For example, if ethnographers indicate that father's mother makes two investments each during the prenatal, delivery, and post-natal periods and each was a level "3" investment, then father's mother's level of birth-related investment for that particular culture was "18", (2 x 3) + (2 x 3) + (2 x 3). When calculating the level of investment for a group of kin, such as the newborn's matrilateral relatives, the birth-related investments of the relatives are summed.

Birth customs, including the role kin play during the prenatal, delivery, and postnatal periods vary in a given culture over time. Thus, we stipulated a time focus for each culture: the most recent time period for which ethnographic information on birth-related investments was available. Another consideration in data collection and coding was related to the fact that some societies are relatively egalitarian while others are socially stratified. In the case of socially stratified societies, ethnographers generally provided the greatest amount of information on free people of lower socio-economic status. As such, our birth-related investment scores for stratified societies pertain to people of this status only.

3.3 Results of Study 1

Table 1A is a list of all of the newborn's relatives who ethnographers report as providing birth-related care in the sixty culture Probability Sample. Fifteen of the care providers are female while only seven are male, thus supporting our prediction regarding gender. Table 1B compares the mean levels of birth-related investments made by female and male consanguineal ("biological") relatives of the newborn for the fifty-two societies for which information was available. The mean for female relatives is much higher than that of male relatives.

Table 1A: List of Newborn's Matrilateral and Patrilateral Relatives Who Provide Birth-Related Care, Consanguineal Relatives Only

Newborn's Matrilateral Relatives	Newborn's Patrilateral Relatives
Newborn's Mother (M)	Newborn's Father (F)
Newborn's Brother, Sister (B, Z)	Newborn's Father's Brother (FB)
Newborn's Mother's Sister (MZ)	Newborn's Father's Sister (FZ)
Newborn's Mother's Brother (MB)	Newborn's Father's Sister's Daughter (FZD)
Newborn's Mother's Mother (MM)	Newborn's Father's Mother (FM)
Newborn's Mother's Mother's Sister (MMZ)	Newborn's Father's Mother's Sister (FMZ)
Newborn's Mother's Mother's Mother (MMM)	Newborn's Father's Mother's Brother (FMB)
Newborn's Mother's Father (MF)	Newborn's Father's Mother's Mother (FMM)
Newborn's Mother's Father's Mother (MFM)	Newborn's Father's Father (FF)
Newborn's Mother's Father's Sister (MFZ)	Newborn's Father's Father's Sister (FFZ)
Newborn's Mother's Father's Sister's Daughter (MFZD)	
Total: 15 Female, 7 Male	

Table 1B: Means and Standard Deviations of Birth-Related Investments by Sex of Newborn's Matrilateral and Patrilateral Relatives (N=52 Societies)

	Mean (SD)		Mean (SD)
All Female Consanguineal Relatives Except Mother	13.79 (12.00)	All Male Consanguineal Relatives Except Father	7.90 (9.00)

Tables 2A, 2B, and 2C display mean birth-related investment scores of the newborn's matrilateral and patrilateral relatives, and of individual grandparents, aunts, and uncles of the newborn. Table 2A displays the results for the seven societies in our sample with both bilateral kinship and neolocal residence. For the most part, the observed pattern of laterality and gender effects are in the predicted direction. Matrilateral relatives have a higher mean level of investment (5.6) than do patrilateral relatives (2.7). When the birth-related investments made by individual grandparents are examined, we see mother's mother (MM) and mother's father (MF) investing more than father's mother (FM) and father's father (FF), respectively, and grandmothers (MM and FM) investing more than grandfathers (MF and FF). For aunts and uncles we see a gender effect only, with aunts (MZ and FZ) investing more than uncles (MB and FB).

Table 2A: Means and Standard Deviations of Birth-Related Investment Scores by Newborn's Matrilateral and Patrilateral Relatives; <u>Bilateral</u> Societies with <u>Neolocal</u> Residence Only (N=7)

	Mean (SD)		Mean (SD)
All the Newborn's Matrilateral Relatives except Mother	5.6 (6.1)	All the Newborn's Patrilateral Relatives except Father	2.7 (6.0)
MM	2.9 (3.0)	FM	1.3 (2.4)
MF	0.4 1.1)	FF	0.0 (0.0)
MZ	1.4 (3.8)	FZ	1.4 (3.8)
MB	0.0 (0.0)	FB	0.0 (0.0)

Tables 2B and 2C show that a society's type of descent and post-marital residence strongly

influences the birth-related investments relatives make. Table 2B presents data on the sixteen societies that have both patrilineal descent and patrilocal residence. Here we see a pattern of birth-related investments skewed towards patrilateral relatives. The newborn's patrilateral relatives have a mean investment score (18.6) that is more than two times larger than that of the matrilateral relatives (8.4). In addition, we see a gender effect and very strong laterality effect among grandparents. However, there are mixed results among aunts and uncles.

Table 2B: Means and Standard Deviations of Birth-Related Investment Scores by Newborn's Matrilateral and Patrilateral Consanguineal Relatives; Societies With Patrilineal Descent and Patrilocal Residence Only (N=16)

	Mean (SD)		Mean (SD)
All the Newborn's Matrilateral Relatives except Mother	8.4 (13.7)	All the Newborn's Patrilateral Relatives except Father	18.6 (8.0)
MM	3.6 (4.8)	FM	9.7 (4.8)
MF	2.2 (3.7)	FF	8.3 (3.4)
MZ	0.2 (0.8)	FZ	0.4 (1.5)
MB	0.4 (1.0)	FB	0.0 (0.0)

Table 2C shows that the overall pattern of investment in matrilineal and matrilocal societies is as predicted. Matrilateral relatives of the newborn have a much higher mean level of investment (36.0) than do patrilateral relatives (3.8). In addition, mother's mother (12.0) and mother's father (10.2) invest much more than father's mother (3.2) and father's father (0.0), and matrilateral and patrilateral grandmothers invest more than matrilateral and patrilateral grandfathers, respectively. For aunts and uncles we see a gender effect in the predicted direction, and in the case of aunts, a laterality effect.

Table 2C: Means and Standard Deviations of Birth-Related Investment Scores by Newborn's Matrilateral and Patrilateral Relatives; Societies With Matrilineal Descent and Matrilocal Residence Only (N=5)

	Mean (SD)		Mean (SD)
All the Newborn's Matrilateral Relatives except Mother	36.0 (12.9)	All the Newborn's Patrilateral Relatives except Father	3.8 (5.5)
MM	12.0 (3.0)	FM	3.2 (5.2)
MF	10.2 (1.6)	FF	0.0 (0.0)
MZ	1.2 (1.6)	FZ	0.6 (1.3)
MB	0.0 (0.0)	FB	0.0 (0.0)

3.4 Summary and Implications of Study 1

The above findings can be summarized as follows: Tables 1 though 2C generally show gender effects in birth-related investment that are in the predicted direction with female relatives investing more than their comparable male kin counterparts. This effect can be attributed to differences in female and male reproductive strategies. In addition to a gender effect, Tables 2A, 2B, and 2C exhibit laterality effects. Table 2A exhibits a laterality effect

in the same direction and of the same magnitude as found in previous research conducted in European and North American societies characterized by bilateral kinship and neolocal residence. Table 2B shows patrilateral relatives making larger investments than matrilateral ones. Table 2C shows investments skewed in the opposite direction.

It would appear, based upon Tables 2A-2C, that a number of variables affect birth-related investments by kin in quite predictable ways. In order to appreciate how strongly paternal certainty is related to investments made by kin, we undertook a second, related study.

4. STUDY 2: PATERNAL CERTAINTY AND THE LEVEL OF BIRTH-RELATED INVESTMENTS BY BIOLOGICALLY UNCERTAIN KIN

4.1 Hypotheses

This section examines the hypothesis that a society's paternal certainty level is positively correlated with birth-related investments by kin whose biological relationship to mother and newborn is uncertain. We first discuss a measure of paternal certainty, and then a measure of what we call the relative level of investment.

4.2 Research Methods

4.2.1 Measuring Paternal Certainty

Previous cross-cultural research by Gaulin and Schlegel (1980), Flinn (1981), and others such as Broude and Greene (1976) and Frayser (1985) guided the development of our measure of paternal certainty. We assumed that a society's level of paternal certainty is inversely related to the frequency of premarital and extramarital relationships among its members, and positively related to how strongly members of a society deter these relationships.

Premarital sex is defined here as sexual intercourse of an unmarried person with an unmarried individual of the opposite sex. Extramarital sex is defined as sexual intercourse of a married man or married woman with an individual of the opposite sex, whether unmarried or married. In order to have a consistent basis for comparison, we stipulated the same time and class foci as our data on birth-related investments. We exclude from our analysis incest, prostitution, homosexuality, and sex among individuals from different societies, classes, and castes.

Our measure of paternal certainty is a composite index based on four items: the 1) frequency of premarital sex, and 2) extramarital sex, and the 3) deterrence levels of premarital sex, and 4) extramarital sex. The first two items range from most (1) to least (5) frequent; the last two items range from least (1) to most (5) deterrence. Paternal certainty level can vary between four and twenty; the higher the score the higher the paternal certainty level of a society. See the previous article in this issue for a more detailed description of the development of the paternal certainty measure. Appendix 2 reports the paternal certainty codes for the HRAF Probability Sample. [Editor's note: To obtain the paternal certainty scores reported in Appendix 1 of this paper, reverse the coding of the frequency of premarital sex and the frequency of extra-marital sex codes in the previous paper]

4.2.2 The Relative Level of Birth-Related Investments

Table 3 shows that we have divided a newborn's kin into six groups, reflecting different levels of certainty of biological relatedness. Group 1 consists of the newborn's mother, and Group 2, a newborn's mother's matrilateral kin, consists of the newborn's mother's mother, mother's mother's mother, and offspring of these individuals. Together, Groups 1 and 2 comprise kin whose genetic relatedness to the newborn is certain. Biologically 'uncertain' kin include the newborn's father, the father's matrilateral and patrilateral kin, and the mother's patrilateral kin. Their biological relatedness is uncertain because there are one or more opportunities to sever genetic relatedness between a newborn and these putative relatives.

For our current purposes, we now need to modify the measures of birth-related investment used in Study 1 in a way that will enable us to examine the birth-related investment of specific categories of patrilateral kin, while at the same time controlling for the overall level of birth-related investment characteristic of the society as a whole. It is desirable to control for this overall level of investment by kin because it is correlated with the level of investment of specific categories of kin, and it is only the latter, the practice of specific categories of kin, that is of interest. If we do not control for the correlated effect of the overall level of investment, any correlation between paternal certainty and the investment of specific categories of kin would be contaminated by the overall level.

One approach to control for the overall level of investment by kin would be to construct an overall measure of kin investment, and use this as a control variable when analyzing the relationship between paternal certainty and the level of investment of any particular kin category. In the current situation, with a small sample size, this is impractical. Instead, we have constructed what we call a measure of "relative investment" for different kin categories. "Relative investment" refers to the level of birth-related investment of a particular kin category 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 score of the mother's certain

kin from the investment score of each uncertain kin category. For example, the relative investment score for the newborn's father's patrilateral kin, RI_F, is:

$$RI_F = I_F - I_M$$

where I_M is the investment score of the mother's certain kin, and I_F is the investment score of the newborn's father's patrilateral kin. Thus, a society with a *higher* score for RI_F is one with relatively high levels of investment by fathers[3].

Table 3: Types of Biologically Certain and Uncertain Kin and their Coefficient of Relatedness to a Newborn

Relative	Symbol	Coefficient of Relatedness
Biologically Certain Relatives		
1. Newborn's Mother	M	0.500
2. Newborn's Mothers Matrilineal Kin		
Sibling	B, Z	0.500
Mother's Sister	MZ	0.250
Mother's Brother	MB	0.250
Mother's Mother	MM	0.250
Mother's Mother's Sister	MMZ	0.125
Mother's Mother's Mother	MMM	0.125
Biologically Uncertain Relatives		
1. Newborn's Father	F	0.500
2. Newborn's Father's Patrilateral Kin		
Father's Father	FF	0.250
Father's Father's Sister	FFZ	0.125
3. Newborn's Father's Matrilateral Kin		
Father's Mother	FM	0.250
Father's Brother	FB	0.250
Father's Sister	FZ	0.250
Father's Sister's Daughter	FZD	0.125
Father's Mother's Sister	FMZ	0.125
Father's Mother's Brother	FMB	0.125
Father's Mother's Mother	FMM	0.125
4. Newborn's Mother's Patrilateral Kin		
Mother's Father	MF	0.250
Mother's Father's Mother	MFM	0.125
Mother's Father's Sister	MFZ	0.125
Mother's Father's Sister's Daughter	MFZD	0.062

4.3 Results of Study 2

Table 4 shows Spearman's rho correlation coefficients of paternal certainty and the relative level of investment of the four different groups of uncertain kin from the time of conception to the end of the post-natal period. All of the correlations are positive and significant at the .05 level.

Table 4: Spearman's rho correlation coefficients of Paternal Certainty WITH

Combined Birth-Related Investments (Prenatal, Delivery, and Post-Natal) of Different Types of Kin (N = 51)

Variable	Spearman's rho
Newborn's Father	0.237 (p = 0.047)*
Newborn's Father's Patrilateral Kin	0.254 (p = 0.036)*
Newborn's Father's Matrilateral Kin	0.234 (p = 0.049)*
Newborn's Mother's Patrilateral Kin	0.272 (p = 0.027)*

* Indicates significance at $p < 0.05$

Table 5 shows correlation coefficients of paternal certainty with the relative investments of uncertain kin for the prenatal, delivery, and post-natal periods. Six of the eight pre- and post-natal coefficients are not significant. However, there are significant positive relationships between paternal certainty and the amount of investment provided by all four sets of "uncertain" kin during delivery.

Table 5: Spearman's rho correlation coefficients of Paternal Certainty WITH Prenatal, Delivery, and Post-Natal Investments of Kin (N = 51)

Type of Investment	Type of Care Provider	Spearman's rho
Prenatal	Newborn's Father	0.094 (p = 0.256)
	Newborn's Father's Patrilateral Kin	0.085 (p = 0.278)
	Newborn's Father's Matrilateral Kin	0.072 (p = 0.307)
	Newborn's Mother's Patrilateral Kin	-0.157 (p = 0.137)
Delivery	Newborn's Father	0.271 (p = 0.028)*
	Newborn's Father's Patrilateral Kin	0.336 (p = 0.008)**
	Newborn's Father's Matrilateral Kin	0.307 (p = 0.015)*
	Newborn's Mother's Patrilateral Kin	0.348 (p = 0.006)**
Postnatal	Newborn's Father	0.243 (p = 0.043)*
	Newborn's Father's Patrilateral Kin	0.174 (p = 0.111)
	Newborn's Father's Matrilateral Kin	0.156 (p = 0.138)
	Newborn's Mother's Patrilateral Kin	0.277 (p = 0.025)*

***** indicates significance at $p < 0.05$; ****** indicates $p < 0.01$

4.3 Discussion of Study 2

A society's paternal certainty level is positively correlated with the level of birth-related investments by the mother's and newborn's patrilateral kin. However, of the three periods of time--pregnancy, delivery, and the postpartum--the strongest correlations are for the period that begins with the onset of strong labor pains and concludes with the delivery of the child and placenta. This finding is consistent with the view that the delivery period is crucial from an evolutionary perspective. People who are relatively certain of their biological relatedness to the mother and newborn are likely to provide help at this time.

5. SUMMARY AND CONCLUSIONS

By way of summarizing the main points of this paper, we found that the kind of kin who make birth-related investments as well as their level of investment are predictable. Birth-related investments are primarily a function of an individual's: 1) sex-specific reproductive strategy, and 2) genetic relatedness to the mother and newborn. Female kin invest more than do male kin, and the more closely related kin are to mother and newborn, the greater their level of investment.

Genetic relatedness is a function of both genealogical relatedness and certainty of paternity. Uncertainty of paternity reduces the investment load of patrilateral relatives of the newborn and mother. Descent and post-marital residence rules can further modify birth-related investments by skewing the investment pattern towards either patrilateral or matrilateral kin. In spite of considerable cross-cultural variability, individuals making birth-related investments can be seen to be maximizing their fitness through acts that favor the survival and reproduction of biologically related kin.

6. REFERENCES

Berte, N.
1988 K'ekchi' horticultural labor exchange: Productive and reproductive implications. In, *Human Reproductive Behavior: A Darwinian Perspective* (L. Betzig, M. Borgerhoff Mulder, and P. Turke, eds.). Cambridge: Cambridge University Press. Pp. 83-96.

Betzig, L. L.
1988 Redistribution: Equity or exploitation. In, *Human Reproductive Behavior: A Darwinian Perspective* (L. Betzig, M. Borgerhoff Mulder, and P. Turke, eds.). Cambridge: Cambridge University Press. Pp. 49-63.

Betzig, L. L., and P. Turke
1986 Food sharing on Ifaluk. *Current Anthropology* 27:397-400.

Broude, G. J., and S. J. Greene
1976 Cross-cultural Codes on Twenty Sexual Attitudes and Practices. *Ethnology* 15:409-429.

Burnstein, E., Crandall, C., and S. Kitayama
1994 Some neo-Darwinian decision rules for altruism: Weighing cues for inclusive fitness as a function of the biological importance of the decision. *Journal of Personality and Social Psychology* 67:773-789.

Buss, David M.
2004 *Evolutionary Psychology: The New Science of the Mind*. 2nd edition. New York: Pearson Education, Inc.

Clutton-Brock, T. H.
1991 The evolution of parental care. Princeton: Princeton University Press.

Euler, H. A., and B. Weitzel
1996 Discriminative grandparental solicitude as reproductive strategy. *Human Nature* 7:39-59.
Euler, H. A., S. Hoier, and P. A. Rohde
2001 Relationship-specific closeness of intergenerational family ties. *Journal of Cross-Cultural Psychology* 32:147-149.
Flinn, Mark
1981 Uterine vs. agnatic kinship variability and associated cousin marriage preferences: An evolutionary biological analysis. In, *Natural Selection and Social Behavior: Recent Research and New Theory* (R.D. Alexander and D.W. Tinkle, eds.). New York: Chiron Press. Pp. 439-475.
Fox, Robin
1967 *Kinship and Marriage: An Anthropological Perspective*. Cambridge: Cambridge University Press.
Frayser, Suzanne G.
1985 *Varieties of Sexual Experience: An Anthropological Perspective on Human Sexuality*. New Haven, CT HRAF Press.
Gaulin, Steven J. C., and Donald H. McBurney
2001 *Psychology: An Evolutionary Perspective.* Upper Saddle River, NJ: Prentice Hall
Gaulin, Steven J. C., and Donald H. McBurney, and Stephanie L. Brakeman-Wartell
1997 Matrilateral biases in the investment of aunts and uncles: A consequence and measure of paternity uncertainty. Human Nature 8:139-151.
Gaulin, Steven J. C., and Alice Schlegel
1980 Paternal confidence and paternal investment: A cross-cultural test of a sociobiological hypothesis. *Ethology and Sociobiology* 1:301-309.
Hames, R.
1987 Garden labor exchange among the Ye'kwana. *Ethology and Sociobiology* 8:259-284.
Hamilton, W. D.
1964 The genetical evolution of social behaviour. Parts I and II. *Journal of Theoretical Biology* 7:1-52.
Hartung, John
1985 Matrilineal Inheritance: New Theory and Analysis. *The Behavioral and Brain Sciences* 8:661-688.
Hawkes, Kristen
1983 Kin selection and culture. *American Ethnologist* 10:346-363.
Huber, Brad R., Vendula Linhartova, and Dana Cope
2004 Measuring paternal certainty using cross-cultural data. *World Cultures* 15:xxx-xxx
Kaplan, H., and K. Hill
1985 Food sharing among Ache foragers: Test of explanatory hypotheses. *Current Anthropology* 26: 233-245.

Keesing, Roger M.
1975 *Kin Groups and Social Structure*. New York: Holt, Rinehart, and Winston.
Naroll, Raoul
1967 The proposed HRAF probability sample. *Behavior Science Notes* 2:70-80.
Pashos, Alexander
2000 Does paternal uncertainty explain discriminative grandparental solicitude? A cross-cultural study in Greece and Germany. *Evolution and Human Behavior* 21:97-109.
Pasternak, Burton, Carol R. Ember, and Melvin Ember
1997 *Sex, Gender, and Kinship: A Cross-Cultural Perspective*. Upper Saddle River, NJ: Prentice Hall.
Petrinovich, L., P. O'Neill, and M. Jorgensen
1993 An empirical study of moral intuitions: Toward an evolutionary ethics. *Journal of Personality and Social Psychology* 64:467-478.
Smith, M. S., B. J. Kish, and C. B. Crawford
1987 Inheritance of wealth as human kin investment. *Ethology and Sociobiology* 8:171-182.
Stone, Linda
2000 *Kinship and Gender: An Introduction*. 2nd edition). Boulder, CO: Westview Press.
Trevathan, Wenda R.
1987 *Human Birth: An Evolutionary Perspective*. New York: Aldine de Gruyter.
Trivers, R.
1972 Parental Investment and Sexual Selection. In, *Sexual Selection and the Descent of Man, 1871-1971* (B. Campbell, ed.). Chicago: Aldine-Atherton. Pp. 136-179.
Williams, G. C.
1966 *Adaptation and Natural Selection.* Princeton, NJ: Princeton University Press.

7. NOTES

1. This paper is based on a presentation at the Annual Meeting of the Human Behavior and Evolution Society, Berlin July 19, 2004.

2. http://ets.umdl.umich.edu/e/ehrafe/

3. We argue 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, since G subtracts out. Again using the example of the relative level of investment of fathers, we would have:

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

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.

8. APPENDIX 1: Levels of Kin Investment

8.1 During Prenatal Period

Level One
Accompanies Woman to Doctor
Bathes Pregnant Woman
Provides Small Amount of Food, Small Animal Sacrifice, Meal, Payment or Gift
Makes or Collects Rags to Clean Future Baby
Confirms Woman is Pregnant
Keeps Track of Birth Date
Prepares Baby's Clothes
Level Two
Massages Pregnant Woman
Satisfies Pregnant Woman's Food Cravings
Stays Close in Case Birth Assistance is Needed
Makes Cradle or Cradleboard
Offers Birth Advice
Provides Future Mother's or Baby's Clothing
Prepares Medicine One Time
Level Three
Performs External Version
Makes Birth Hut or "Fire Floor"
Sponsors Large Feast, Provides Large Amount of Food, Large Animal, or Large Payment
Does Child Care, Cleans, Fetches Water, Cooks, Gardens, Stays w/ Woman Two or More Days
Provides Woman with Living Quarters For Two or More Days
Marries Second Wife who does Chores or Attends Woman
Collects Large Amount of Firewood
Makes Medicine or Bathes Woman Two or More Times
Accompanies Woman to Doctor Several Times

8.2 During the Delivery Period

Level One
Prepares Birthing Bed or Area
Cuts Umbilical Cord
Makes Small or a Few Sacrifices
Helps with Cooking
Provides Small Gift or Amount of Food or Compensation
Keeps People From Entering Birth Room
Tightens Waistband, Wraps Parturient
Heats Water
Accompanies or Sends Parturient to Birth Place
Collects Small Amount of Firewood
Bathes Parturient
Screens Off Birth Area
Level Two
Watches over Newborn While Placenta is Born
Fetches or Notifies Midwife or Doctor
Determines Position of Fetus
Massages Parturient
Prepares Medicine to Facilitate Birth
Stays Close in Case Assistance is Needed
Warms Parturient or Baby
Beats Bamboo, Fires Gun, or Shakes Baby So Newborn Breathes
Level Three
During Delivery, Provides Physical Support to Parturient (Holds, Supports, Balances)
Serves in Capacity of Midwife During Birth and Delivery of Placenta
Provides Large Amount of Food
Makes Large or Numerous Sacrifices
Provides Large Gift or Amount Compensation
Provides Birth Place

8.3 During the Postnatal Period

Level One
Provides Small Gift, Animal, or Amount of Food
Fetches Some Fire Wood or Water
Builds Fire Place
Sponsors Small Meal
Disposes Afterbirth
Transports Parturient or Baby Home After Birth
Bathes or Cleans Parturient or Baby One Time
Tightens Waistband or Wraps Parturient
Level Two
Supplies Blankets and Cloths for Newborn
Makes Cradle or Cradleboard
"Closes" Hipbones and Pelvis
Stays With Mother One Day
Washes Soiled Clothing Once
Massages Parturient or Baby One Time
Performs Parturient's Chores Once or For One Day
Provides Home For One Day
Warms Parturient or Baby, Builds Warming Platform, or Keeps Fire Burning for One Day
Keeps People Away from Parturient or Baby
Prepares Medicine
Level Three
Provides Large Gift, Animal, or Food
Stays With or Provides Care to Mother or Newborn for Two or more Days
Washes Soiled Clothing Several Times
Fetches Large Amount of Fire Wood
Keeps Fire Burning for Two or more days
Massages or Bathes Parturient or Baby For Two or more days
Performs Parturient's Chores Two or more days
Cooks for Parturient Two or more days
Provides Home for Two or more days

9. APPENDIX 2: Paternal Certainty Scores

Culture	OWC Code	Time	Paternal Certainty Score
Akan	FE12	1900-1950	10
Ahmara	MP05	1950-1970	16
Andamans	AZ02	1880-1910	8
Aranda	OI08	1880-1930	6
Aymara	SF05	1937-1953	9
Azande	FO07	1909-1930	12
Bahia Brazil	SO11	1870-1945	12
Bemba	FQ05	1930-1990	14
Blackfoot	NF06	1830-1910	10
Bororo	SP08	1930-1960	8
Central Thai	AO07	1930-1980	11
Chukchee	RY02	1900-1921	6
Chuuk	OR19	1945-1956	9
Copper Inuit	ND08	1958-1983	5
Dogon	FA16	1931-1960	9
Eastern Toraja	OG11	1892-1932	9

Ganda	FK07	1910-1932	13
Garo	AR05	1953-1968	12
Guaraní	SM04	1946-1954	.
Hausa	MS12	1900-1972	11
Highland Scots	ES10	1953-1971	15
Hopi	NT09	1890-1945	9
Iban	OC06	1890-1960	14
Ifugao	OA19	1908-1940	11
Iroquois	NM09	1953-1960	10
Kanuri	MS14	1955-1966	14
Kapauku	OJ29	1948-1975	11
Khasi	ARO7	1900-1960	11
Klamath	NR10	1860-1900	15
Kogi	SC07	1914-1950	11
Korea	AA01	1945-1991	14
Kuna	SB05	1940-1980	12
Kurds	MA11	1880-1950	20
Lau Fijians	OQ06	1920-1934	8
Libyan Bedouin	MT09	1948-1980	16
Lozi	FQ09	1940-1965	12
Maasai	FL12	1894-1975	8
Mataco	SI07	1939-1985	11
Mbuti	FO04	1948-1958	10
Ojibwa	NG06	1932-1966	11
Ona	SH04	1910-1923	16
Pawnee	NQ18	1900-1920	16
Saami	EP04	1913-1959	11
Santal	AW42	1931-1942	11
Saramaka	SR15	1928-1980	11
Serbs	EF06	1920-1955	.
Shluh	MW11	Missing	.
Sinhalese	AX04	1954-1956	12
Somali	MO04	1919-1955	16
Taiwan Hokkien	AD05	1945-1973	13
Tarahumara	NU33	1930-1959	9
Tikopia	OT11	1928-1952	13
Tiv	FF57	1929-1953	11
Tlingit	NA12	1931-1954	15
Trobriands	OL06	1914-1981	9
Tukano	SQ19	1939-1973	10
Tzeltal	NV09	1950-1960	13
Wolof	MS30	1939-1975	15
Yakut	RV02	1876-1930	9
Yanoama	SQ18	1950-1987	8