Kin Relationships and the Caregiving Biases of Grandparents, Aunts and Uncles:

A Two-Generational Questionnaire Study

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Abstract

Paternity certainty and matrilineal family ties have been used to explain the asymmetric caregiving of grandparents and aunts and uncles. The proximate mechanisms underlying biased kin investment, however, remain unclear. A central question of the presented study was whether the parent-kin relationship is an important link in the kin caregiving. In a bi-generational questionnaire study, we asked subjects to estimate the intensity of their relationships to parents, grandparents, aunts and uncles (emotional closeness, investment received in childhood). In addition, the subjects' parents rated their emotional closeness to their parents and siblings. We found that the parent-kin relationship was closely linked to the relatives' childcare and could partly explain asymmetric caregiving. Maternal aunts played a special role as caregivers. Especially the mother's younger or lastborn sister cared intensively for nieces and nephews, regardless of her closeness to the subjects' mother.

Introduction

Prolonged childhood, long lifetime and the need for intensive child-care are characteristics of humans that make the caregiving by relatives of major importance. However, the investment of relatives in children differs. Asymmetric caregiving structures among grandparents have been well known since the '70s (e.g., Eisenberg, 1988; Euler and Weitzel 1996; Hartshorne and Manaster 1982; Hoffman 1979/80; Littlefield and Rushton 1986). On average, the maternal grandmother cares most for grandchildren, followed by the maternal grandfather and the paternal grandmother, while the paternal grandfather cares the least for grandchildren. Asymmetric kin investment has also been found in the caregiving of aunts and uncles (Gaulin, McBurney and Brakeman-Wartell 1997; Hoier, Euler and Hänze 2001; McBurney, Simon, Gaulin and Geliebter 2002). As among the grandparents, the maternal aunt is the most caring of all aunts and uncles, followed by the paternal aunt, the maternal uncle, and the paternal uncle, who is the least caring. In a very recent study, similar asymmetries were also reported for the relationships within cousins (Jeon and Buss, 2007).

Biased kin caregiving has been demonstrated in studies using ratings of caregiving received in childhood, emotional closeness to kin or contact frequencies (Eisenberg, 1988; Euler and Weitzel 1996; Gaulin et al. 1997; Hoffman 1979/80). When kin investment was measured through grandparents (Michalski and Shackelford 2005; Thomas 1989), the results did not yield the same pronounced biases as in studies where the receivers of caregiving were surveyed. Measuring estimations made by the kin caregivers themselves might be however less consistent, because these results evidently vary depending on which items and method are used, e.g. lineage-based comparisons (Pollet, Nettle and Nelissen 2006). Another factor that might influence the results on kin caregiving are alternative investment options (Laham, Gonsalkorale and von Hippel 2005), but these have minor effects and cannot account for the kin asymmetries in all. Marital status again has a significant influence on grandfathers' grandchild-care. However, this does not explain the investment asymmetries (Euler and Weitzel 1996). Furthermore, there is also no correlation of grandparent age with caregiving intensity (Euler and Weitzel 1996, Pashos 2000). Confounding variables cannot explain the differential kin caregiving.

The first evolutionary explanation proposed for the asymmetric kin caregiving pattern of grandparents was based on the paternity certainty hypothesis in connection with kin selection (Hartung 1985; Russell and Wells 1987; Smith 1988). Because of paternal uncertainty in the male family lineage, women have the highest genetic relatedness to their daughters' children, whereas men's relatedness to their son's children is, on average, the lowest. However, recent studies have found several discrepancies in the initial paternity certainty interpretation. Euler and Weitzel (1996), in their German study, found that the maternal grandfather cared significantly more than the paternal grandmother, although the two should not differ according to the paternity certainty hypothesis. Furthermore, aunts care on average more than uncles for nieces and nephews, even though they have no higher certainty of relatedness. In current interpretations, the paternity certainty hypothesis is therefore combined with other evolutionary theories, such as sex-specific reproductive strategies (Euler and Weitzel 1996; Gaulin et al. 1997). Furthermore, two separate kin investment biases are often differentiated: the sex effect, the higher caregiving of females as compared with men; and the laterality effect, the higher caregiving of maternal relatives as compared to paternal relatives (McBurney et al. 2002; Pashos 2000).

Recent studies have however also shown some problems with the paternity certainty explanation as a proximate interpretation. In rural Greece, a society with more patrilateral cultural traditions, paternal grandparents cared more for grandchildren than maternal grandparents (Pashos 2000). This result cannot be explained solely by the paternity certainty theory. Even if a high paternal certainty is assumed in rural patrilocal areas, the laterality in grandparental caregiving should disappear. From this, it follows that differential grandparent investment is not necessarily a direct reflection of grandparental certainty. Moreover, among orthodox Jews, who are assumed to have high paternity certainty, about the same asymmetric caregiving pattern of aunt and uncles was found as in a Pittsburgh comparison sample (McBurney et al. 2002). However, according to the paternity certainty hypothesis, with high paternal confidence in a society, the caregiving biases should be diminished or disappear. McBurney et al. (2002) therefore concluded that kin investment biases may rather reflect paternity certainty in the environment of evolutionary adaptedness (EEA) than current paternal confidence.

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For the sex and laterality differences in grandparental kin caregiving, there are different possible explanations matching the empirical state of research. Throughout life history, two psychological mechanisms of kin investment could exist. Parents should invest in both sons and daughters, under good conditions with an expected tendency to prefer sons somewhat more than daughters (Gaulin and Robbins 1991; Hartung 1979; Trivers and Willard 1973). However, grandparents should invest more in their daughter's children, due to the potentially higher certainty of relatedness, so the matrilaterality bias would be explained by paternity certainty theory. However, the sex effect in grandparents, i.e. the higher caregiving of grandmothers compared to grandfathers, could be explained by the different mating efforts of the sexes. Males, in contrast to females, tend to choose a quantity mating strategy. Therefore, the caregiving of women compared to men is generally higher. This would also explain the sex difference in the aunts' and uncles' investment, because both have the same certainty of relatedness to their nieces and nephews. Hence, the explanation for the laterality in kin caregiving is parenting effort and for the sex difference it is mating effort. A patrilateral bias, such as found in rural Greece (Pashos 2000), may only superimpose itself on the paternity certainty effect. When the mother lives very closely with her husband's family in the same house, paternity certainty is relatively assured. Investment in a son's children, especially grandsons, may become more advantageous than investment in a daughter's children who live in a foreign family.

There are however also other evolutionary interpretations, which do not take the paternity certainty hypothesis into account. Pashos (2000) interpreted the caregiving biases as resulting from stronger matrilineal family ties. According to this proximate view, the fact that women have closer family contacts than men (Rossi and Rossi 1990; Salmon 1999; Troll, Miller and Atchley 1979) leads to matrilineal family bonds that exceed those in the paternal lineage. These close matrilineal family relationships may also influence the caregiving of maternal relatives, and hence explain the asymmetric kin investment. Matrilaterality, the investment in daughters' or sisters' children, could hence be a reflection of the closer family contacts of women as compared to men. Patrilateral investment, however, is culturally characterized by a strong involvement with the paternal family, reflecting a kin strategy of

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investing patrilineally in sons and heirs. The higher caregiving of females compared to males could proximately be explained by the special role of mothers in childcare, due to the close physical contact of the mother to her offspring and the different mating efforts of the sexes.

Another theory, which could also be applied to asymmetric kin care in a somewhat different way, is Hrdy's concept of allo-mothering (Hrdy 1999, 2005). According to this view, humans in the ancestral environment were cooperative breeders. This means that as well as the mother there are helpers, called allo-mothers, who care intensively for the helpless and demanding human babies. It is thus to be expected that especially certain very close family members of the mother, e.g., the mother's mother or also the mother's older teenage daughters (Sear, Steele, McGregor and Mace 2002), take the role as allo-mothers.

In theories of the evolution of grandparenthood, the different ancestral roles of the four grandparents are not very clear. Hawkes' version of the grandmother hypothesis (Hawkes, O'Connell, Blurton Jones, Alvarez and Charnov 1998) mainly focused on the maternal grandmothers as intensive caregivers. Other researchers, in contrast, have also stressed the importance of males as kin investors, e.g., for the provision of food (Kaplan, Hill, Lancaster and Hurtado 2000). Many studies using anthropological data (Leonetti, Nath, Hemam and Neill 2005), medical data (Sear, Mace and McGregor 2000; Sear, Steele, Mace and McGregor 2002) and historical data (Jamison 2002; Ragsdale 2004; Voland and Beise 2002) found positive effects on health and survival rates of grandchildren only when the maternal grandmother was present. In some studies, the paternal grandmother was found to exert even a negative influence (Voland and Beise 2005). Paternal grandmothers however might have a positive influence on their daughter-in-law's fertility (Leonetti et al. 2005; Sear, Mace and McGregor 2003). The question of the evolutionary origin and formation of grandparenthood is closely connected with the question of the causes of kin caregiving biases in grandparents and other close family members.

Kin caregiving asymmetries have been found in many empirical studies around the world. In addition, there are numerous family studies in social sciences dealing with proximate factors for kin caregiving and social support (Lawton, Silverstein and Bengtson 1994; Marks and McLanahan 1993; Rossi and Rossi 1990). However, from an evolutionary point of view the proximate causes of biased kin

investment are still unclear. The aim of the present study was to analyze proximate mechanisms of kin caregiving within the family, to provide a better basis for interpreting the kin investment asymmetries along with the different evolutionary theories. A main question is whether the parents of the recipients of the care play an important role as connecting links to the caregivers, and therefore affect the grandparent and the aunt and uncle caregiving. In recent research, some results have suggested that the relationship between parents and grandparents, especially between mother and maternal grandmother, may have a significant influence on grandchild-care, emotional closeness to grandchildren or contact frequencies to grandchildren (Michalski and Shackelford 2005; Pashos 2000; Steinbach and Henke 1998; Uhlenberg and Hammill 1998). The effect of the family members' relationships on biased kin caregiving has not, however, been systematically analyzed yet. Moreover, grandchild-care and parent-grandparent relationships have also not hitherto been measured independently of each other.

Method

Questionnaire and Measurement

We created a two-generational questionnaire, in which participants were asked about the caregiving they received from parents, grandparents, aunts and uncles. The parents of the participants were asked in a separate anonymous questionnaire to estimate their relationship to their own parents (i.e., the subjects' grandparents) and to their own siblings (i.e., the subjects' aunt and uncles). We differentiated blood-related subjects from adoptive children as well as full relatives from half-, step- and adoptive relatives. We chose the following measurements, given on a 7-point-scale:

a) Investment:

"Caregiving/Donations: When you were a child, how much did your relative invest in you, that is how much resources [gifts, money, as well as time, help/protection etc.] did you receive, compared to the overall resources the caregiver was able to give?"

b) Emotional Closeness:

"Emotional Closeness: How close do/did you feel emotionally to your following relatives?"

c) Physical and Psychological Resemblance

"Resemblance: How much do you resemble (physically and psychologically) your relative? (If your relative was already deceased, but you think you know your resemblance to him/her, please give an estimate.)"

Most former questionnaire studies used either the item *caregiving/investment* or the item *emotional closeness*. The kin caregiving asymmetries were found for both items, and therefore both items are assumed to be close by related to each other. However, the relationship between the two variables is still unclear. Resemblance is another variable that might have influence on kin caregiving, although an asymmetric distribution similar to the investment and emotional closeness biases is not to be expected (see Euler and Weitzel 1996).

In addition, we asked about the residential distance to the relatives during childhood, using a 9-point scale. Former studies have shown that the spatial distance of grandparents to grandchildren influences grandparental caregiving, but does not affect the caregiving biases (Euler and Weitzel 1996, Pashos 2000). The question we chose for this item was, how much time, door-to-door, did they need to visit each other by the usual means of transportation (by foot, bus, railway, car, airplane), from 1) *in the same house,* 2) *5 minutes or less,…* to 9) *more than 1 day (24 hours)*. The scale values were designed to be logarithmically spaced. Furthermore, on the parent questionnaire we measured birth order and sex-specific birth order (firstborn, middle-born, lastborn) as well as the age difference between the parents and their siblings in years (including whether these were older or younger siblings).

Because of the complexity of the statistical analysis of family member data, the collection of full aunt and uncle data is somewhat problematical. In contrast to grandparents, where every subject has exactly four relatives, the number of aunt and uncles varies. Therefore, in all former aunt and uncle studies the subjects rated only the oldest of each of the maternal and paternal aunts and uncles. For an exact analysis of aunt and uncle caregiving in connection with family relationships however, a full collection of all aunt and uncle data is desirable. Thus, we constructed a questionnaire that aimed to collect all existing aunt and uncle data as completely as possible for a statistical analysis. The maximum number of maternal

and paternal aunts and uncles that could be given in each of these four categories was six. Subjects were asked to start with the oldest and go down to the youngest. If more than six aunt or uncle scales were needed in one category, subjects had to include, instead of the sixth oldest, the youngest relative.

Sample and Data Collection

A total of 189 subjects (50 male, 137 female, 1 sex unspecified, 1 missing = only parent questionnaires) at the university of Pittsburgh participated in the bi-generational questionnaire study. The data were mainly collected in Psychology courses. Other data were collected opportunistically in the department of Psychology or in adult education courses. The rate of return was 73%. Of the parents' questionnaires, 166 fathers' questionnaires were returned and 166 mothers' questionnaires. In all, 164 questionnaire sets had complete parent pairs. The average age of the subjects was 20,0 years (SD = 4,3 years).

The participants received five sets of questionnaires, one for grandparents, each one for maternal and for paternal aunts and uncles, and each one set of questionnaires for the father (colored blue) and the mother (pink) of the subjects. The aunts and uncles questionnaires contained a colored helping sheet (blue for paternal/father, pink for maternal/mother) with free fields that fitted exactly to the questionnaire's scales. Here, the subjects wrote the first names of their aunts and uncles (1st aunt, 2nd aunt, 3rd aunt etc.), in order to avoid identification mistakes. After the subjects completed their questionnaires, they took the colored helping sheets and stapled them (fitting to the scales) to the parent questionnaires, blue to blue and pink to pink. The subjects then put the parent questionnaires in separate envelopes together with return envelopes, after they had written the addresses of their father and their mother on each. When the parents had finished their questionnaires, the helping sheets were not needed anymore and were to be taken away to ensure the families' anonymity.

Statistical Analysis

For the present analysis, we only used data on full blood-related relatives, because the number of non-blood-relatives (half related, step related or adoptive related) was small. For the analysis of aunts and uncles the following categories were devised:

a) First-mentioned aunt or uncle, i.e. the relative eldest according to the method of Gaulin et al. (1997). The subjects in the present study had to list their aunts and uncles, beginning with the eldest.

b) Mean value of each of all maternal and paternal aunts or uncles, i.e. the average rating for maternal aunts, maternal uncles, paternal aunts and for paternal uncles.

c) The firstborn and the lastborn aunt or uncle, and the average rating of all middle-born aunts and uncles.

d) Mean value of all aunts or uncles older or younger than the parent

In order to analyze the influence of the parent-kin relationship, residential distance and resemblance on the caregiving asymmetries of grandparents, aunts and uncles, variables with the difference values of two relatives were created. These difference variables were calculated as follows, for laterality: maternal grandmother minus paternal grandmother or maternal grandfather minus paternal grandfather, and for the sex difference: maternal grandmother minus maternal grandfather or paternal grandmother minus paternal grandfather. Thus, a positive value stands for a matrilateral bias or a preference of a female, and the higher the value the stronger that bias. The difference variables were used as dependent variables (investment or closeness) and as independent variables (parent-kin relationship, residential distance, resemblance) in linear regression analyses. For the analyses of aunts and uncles, the first-mentioned aunts or uncles were used.

For a control, we made additional statistical analyses, which are not presented in this paper, using configurational frequency analysis (Lienert 1969; von Eye 1990), a multidimensional chi-square analysis, and logistic regression analysis. In the configurational frequency analysis, 3-by-3 cross table comparisons were conducted (e.g., investment of grandmother compared to grandfather: higher, equal, lower; emotional closeness of parent to grandmother compared to grandfather: higher, equal, lower). For the logistic regression analysis, variables were dichotomized (e.g., matrilaterality in investment: yes / no).

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The configurational frequency and the logistic regression analyses yielded about the same results as the linear regression analyses presented in this paper.

Results

Asymmetries in Grandparents

Among grandparents, the expected asymmetries were found for investment and for emotional closeness (see table 1). Compared to the German data by Euler and Weitzel (1996) and Pashos (2000), the average ratings for the grandparental investment were relatively high. However, the item in the present study was somewhat different and included the phrase "[investment] …compared to the overall resources the caregiver was able to give." The subjects rated the grandmothers' investment significantly higher than the grandfathers' investment (for maternal grandparents: $t = 2.11$, $p = .037$, $N = 124$; for paternal grandparents: $t = 2.26$, $p = .026$, $N = 109$) and felt closer to their grandmothers than to their grandfathers (for maternal grandparents: $t = 2.67$, $p = .009$, $N = 123$; for paternal grandparents: $t = 3.80$, $p = .000$, $N = 109$). Maternal grandparents invested significantly more than paternal grandparents (for grandmothers: $t = 3.89$, $p = .000$, $N = 140$; for grandfathers: $t = 3.01$, $p = .003$, $N = 87$) and maternal grandparents were perceived as closer than paternal grandparents (for grandmothers: $t = 3.69$, $p = .000$, $N = 139$; for grandfathers: $t = 4.58$, $p = .000$, $N = 87$). Furthermore, the maternal grandfather invested significantly more than the paternal grandmother ($t = 2.08$, $p = .040$, $N = 125$) and was perceived by the subjects as closer ($t = 2.42$, $p = .017$, $N = 124$).

<Insert table 1 here>

For the item "physical and psychological resemblance with the four grandparents", no asymmetries were found, as was expected. However, male subjects perceived more resemblance to their fathers than to their mothers ($t = -2.34$, $p = .023$, $N = 50$), and to their grandfathers than to their grandmothers (for paternal grandparents: $t = -4.30$, $p = .000$, $N = 31$, for maternal grandparents: $t = -3.88$,

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p = .000, N = 37). Female subjects perceived more resemblance to their mothers than to their fathers (t = 2.71, p = .008, N = 137), and to their grandmothers than to their grandfathers (for paternal grandparents: t = 2.30, p = .024, N = 86, for maternal grandparents: t = 4.48, p = .000, N = 98). As was the case with the grandparents, male subjects perceived also more resemblance to uncles than to aunts (maternal: t = -1.96, p = .061, N = 26. paternal: t = -5.55, p = .000, N = 33) and female subjects perceived more resemblance to aunts than to uncles (maternal: t = 5.62, p = .000, N = 77. paternal: t = 4.71, p = .000, N = 64). Regarding the subjects' parents, a sex difference was also found in emotional closeness and investment. The respondents rated the mother's investment more highly than the father's (t = 6.39, p = .000, N = 188) and estimated their emotional closeness to their mother as being greater than their emotional closeness to their father (t = 6.74, p = .000, N = 188).

Asymmetries in Aunts & Uncles

For the analysis of aunts and uncles, it must first be clarified whether the oldest aunts and uncles in each category (method Gaulin et al .1997) are representative for all aunts and uncles. The first-mentioned aunts and uncles in the present study are normally the oldest, because the subjects were requested to start the list with the oldest aunt or uncle. The investment mean values for the first-mentioned aunts and uncles were as follows: mat. aunt 4.57 (n = 134), mat. uncles 3.53 (141), pat. aunt 3.59 (127), pat. uncle 3.43 (128). The mean values of the other aunts and uncles (2nd to 6th) were: mat. aunt 4.32 (80), mat. uncles 3.43 (66), pat. aunt 3.51 (75), pat. uncle 3.31 (72). The t-tests yielded no significant investment differences between the first-mentioned and the other aunts and uncles. The same was true for closeness and resemblance. Thus, the relative oldest or first-mentioned oldest maternal and paternal aunt and uncle is representative for all other aunts and uncles.

For aunts and uncles, the asymmetric kin investment was found in the predicted order. However, the maternal aunt was rated much higher than the three other aunts and uncles, who again were very close to each other (see table 2). Hence, the t-test yielded only clearly significant differences in the comparisons with the maternal aunt (t-tests, first-mentioned aunts & uncles. Investment: pat. aunt - pat. uncle t = 1.26,

p = .212, N = 96; mat. aunt - mat. uncle, t = 5.85, p = .000, N = 101; mat. aunt - pat. aunt t = 4.60,

p = .000, N = 90; mat. uncle - pat. uncle t = -.50, p = .615, N = 99. Emotional closeness: pat. aunt - pat.

uncle t = .39, p = .695, N = 97; mat. aunt - mat. uncle, t = 5.60, p = .000, N = 101; mat. aunt - pat. aunt

t = 5.95, p = .000, N = 91; mat. uncle - pat. uncle t = -.45, p = .656, N = 101.).

<Insert table 2 here>

Comparison of Investment and Emotional Closeness

For grandparents, there was a high correlation between investment and emotional closeness (r = .70 to .79,

p < .001) and a moderate correlation of both with resemblance (Inv. & Res.: r = .30 to .41; Clos. & Res..:

r = .36 to .43, p <= .001). When the three measurements were compared among parents, the correlations

were much lower (Inv. & Clos.: mother r = .34, father r = .54; Inv. & Res.: mother r = .16, father r = .16;

Clos. & Res.: mother r = .20, father r = .18). As with the grandparents, for aunt and uncles a high

correlation of investment and emotional closeness existed (r = .73 to .81) and lower correlations of

investment and emotional closeness with resemblance (r = .25 to .54).

Parent-Kin Relationship, Residential Distance and Resemblance

One of the main questions of the present study is whether the parents' relationship to the subjects'

grandparents, aunts and uncles is important for the emotional closeness and the investment of these

relatives in the children. Our first analysis examines whether the relationship between parents and

grandparents influences the relationship of the grandchildren to the grandparents. In fact, significant

positive correlations existed between the subjects' emotional closeness to their grandparents and the

parents' emotional closeness to the grandparents, i.e. their own parents. This correlation was higher

among maternal grandparents (maternal grandmother r = .49, N = 138; maternal grandfather r = .49,

N = 119; paternal grandmother r = .32, N = 144; paternal grandfather r = .36, N = 99; always p < .001).

Moreover, there were positive correlations between the subjects' rating of received grandparental

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investment and the parents' emotional closeness to the grandparents, especially for the maternal grandmother (maternal grandmother r = .45, N = 137; maternal grandfather r = .29, N = 118; paternal grandmother r = .32, N = 143; paternal grandfather r = .36, N = 99; always p < .01). Significant positive correlations were also found between the subject's emotional closeness to aunts and uncles and the emotional closeness of the parents to their siblings. (first-mentioned aunts & uncles: maternal aunt r = .56, N = 117; maternal uncle r = .42, N = 126; paternal aunt r = .49, N = 112; paternal uncle r = .33, N = 110; always p <.001). The aunts' and uncles' investment in their nieces and nephews was related to the emotional closeness of the subjects' parents to the aunts and uncles (first-mentioned aunts & uncles: maternal aunt r = .45, N = 117; maternal uncle r = .31, N = 126; paternal aunt r = .43, N = 112; paternal uncle r = .32, N = 110; always p <.01).

The next question to be examined is the extent of the influence of the parent-relative relationship on the care of grandparents for grandchildren and of aunts and uncles for nieces and nephews. Using linear regression analysis, we analyzed the influence of the emotional closeness between the parent and the care-providing relative together with the influence of the residential distance between the subject and the relative on the investment of the relatives for grandchildren, aunts and uncles. The emotional closeness of the subjects' parents to the grandparents greatly influenced the grandchild investment of the grandparents, especially among the maternal grandmother (see table 3). The influence of residential difference on grandparental investment, however, was comparatively much smaller. For aunts and uncles the results were similar. There was a high influence of the emotional closeness of the parent to their siblings on the investment of these aunts and uncles in nieces and nephews. Especially for the aunts' kin investment, the parent-sister closeness played a major role. The influence of residential distance, however, was much smaller, predominantly even not significant (First-mentioned aunts & uncles. Maternal aunt: closeness mother-mat.aunt, beta = .44, p = .000; res. distance, beta = -.12, p = .157; N = 117, R^2 = .22. Maternal uncle: closeness mother-mat.uncle, beta = .31, p = .000; res. distance, beta = -.09, p = .305; N = 126, R^2 = .10. Paternal aunt: closeness father-pat.aunt, beta = .42, p = .000; res. distance, beta = -.07,

$p = .423$; $N = 112$, $R^2 = .19$. Paternal uncle: closeness father-pat.uncle, beta = .29, $p = .002$; res. distance, beta = -.20, $p = .033$; $N = 110$, $R^2 = .14$).

<Insert table 3 here>

A key question of the present study is whether the high influence of the parent-kin relationship on kin investment could also explain asymmetries in the caregiving of grandparents, aunts and uncles. Although in grandparents, both parents were emotionally closer to the grandmother than to the grandfather (father: $t = 2.6$, $p = .010$; mother: $t = 2.8$, $p = .006$), the mother's relationship to her parents was not significantly closer than the father's relationship to his parents. However, in the descriptive statistics there was a tendency in the expected direction predicted by the closer matrilineal family ties (mother-mat.GM 5.75 (N=162), mother-mat.GF 5.36 (154), father-pat.GM 5.67 (162), father-pat.GF 5.27 (156)). In aunts and uncles, the mother-sister (i.e. maternal aunt) relationship was emotionally closer than the other parent-sibling relationships (mother-mat.aunt 5.49 (118), father-pat.aunt 4.71 (112), mother-mat.uncle 4.74 (128), father-pat.uncle 4.90 (111)). Another factor that could influence the kin investment is residential distance. In the present study the maternal grandparents lived closer to the subjects than did the paternal grandparents (Residential Distance: mat. GM, 4.30 (N=154); mat. GF 4.47 (135); pat. GM 4.9 (166); pat. GF 4.83 (118)).

In order to analyze the influence of parent-grandparent relationship and residential distance on the kin asymmetries, we used difference variables for the laterality in grandmothers and in grandfathers and the sex difference in maternal and in paternal grandparents. In addition, we created difference variables for parent-grandparent closeness, residential distance and resemblance in the different grandparent-grandparent comparisons. In linear regression analyses we examined the influence of these variables on the laterality and sex difference in investment and in emotional closeness (table 4). The change in R-square was analyzed stepwise starting with the difference in parent-grandparent closeness, followed by the residential distance difference, and finally by the resemblance difference.

The various regression analyses listed in table 4 show that the difference in parent-grandparent closeness between two grandparents clearly influenced the differences between these two grandparents in grandchild-investment and emotional closeness. Particularly the investment difference between the grandfathers was explained by the difference in parent-grandparent closeness. The differences in residential distance further explained an additional part of the total variance. This was especially true for the investment difference of the two grandmothers. Here, this effect was higher than that of parent-grandparent closeness. However, the difference between the two maternal grandparents was hardly explained by the residential distance difference. The difference in resemblance to the grandchild also had an additional effect on the laterality of the grandparental investment and closeness, when concerning parent-grandparent closeness and residential distance as constants. However, the influence on the sex differences of maternal and paternal grandparents was tiny or not significant. In all, the three independent variables explained a higher amount of the total variance of the grandparent laterality than of the grandparent sex difference. Especially the investment difference between the two maternal grandparents was explained only to a relatively small extent by the differences in parent-grandparent closeness, residential distance and resemblance (R-square = .16).

Because the maternal grandparents lived closer than the paternal and residential distance had an additional influence on the kin investment laterality, an extra comparison of grandparents with the same residential distance is recommended. However, even when their residential distance was identical, the maternal grandmother invested more in the grandchild than the paternal grandmother (MeanDiff = .40, t = 2.1, p = .046, N = 45). The same was true for the grandfathers (MeanDiff = .56, t = 2.7, p = .012, N = 32).

The results of the linear regression analyses for the laterality and sex difference between aunts and uncles were more consistent than those for grandparents (table 5). The difference in parent-sibling closeness had the highest influences on the differences in investment and closeness of aunts and uncles. The influence of the difference of residential distance was the smallest. The difference in the resemblance

of aunts and uncles to the respondent, however, had a higher effect than residential distance and was the second highest influence on the investment and closeness asymmetries.

<Insert table 4 here>

<Insert table 5 here>

Differences in Aunts and Uncles by Age and Birth Order

A further question in the present study is whether there are differences among the aunts and uncles in age or birth order which could have influence on the caregiving asymmetries. Aunts and uncles who were close in age to the subjects' parents may be very close family members, and hence invest more in nieces and nephews. However, aunts' and uncles' emotional closeness and investment did not correlate with the age difference between parent and sibling (r from -.14 to .08, for first-mentioned aunts & uncles). There were also no significant correlations between aunt and uncle caregiving and age difference to the parent, when younger or older parents' siblings were distinguished. Furthermore, no differences were found in aunt and uncle investment between older and younger siblings of the parent. However, there was a significant result that younger maternal aunts were emotionally closer to nieces and nephews than were older maternal aunts (t-test for the mean value of all older and all younger maternal aunts. MeanDiff = -.74, t = -2.14, p = .041, N = 30).

The analysis of birth order also yielded significant results only for the maternal aunts. Predominantly, no significant differences in aunt and uncle investment and emotional closeness existed regarding the aunts' and uncles' birth order. The subsample size for this analysis, however, was very small. Nevertheless, even though, among maternal aunts significant differences were found for emotional closeness. Lastborn maternal aunts were, on average, emotionally closer to the subjects than firstborn maternal aunts (MeanDiff = 1.07, t = 2.54, p = .023, N = 15). Also, lastborn maternal aunts were emotionally closer to the subjects than the mean of all middle-born maternal aunts (MeanDiff = .99, t = 2.31, p = .041, N = 25). Finally, in all, lastborn maternal aunts also were significantly emotionally

closer to the subjects than the mean of all other not-lastborn maternal aunts (MeanDiff = .77, t = 2.58, p = .015, N = 33). Because the subsample size was relatively small, a view at the descriptive statistics is recommended. Table 6 shows indeed that for maternal aunts great differences between firstborn and lastborn sisters of the mother existed. For the other aunts and uncles, there were not such great differences. For the sex-specific birth order, i.e. the female firstborn/lastborn or male firstborn/lastborn siblings of the parent, no significant results were found.

<Insert table 6 here>

It could be assumed that the significant results for younger or last-born maternal aunts might be owing to chance, because of the small subsample size. However, further analyses revealed another effect for the maternal aunts. As in the analysis of first-mentioned aunts and uncles (see above), for firstborn maternal aunts there was a highly significant positive correlation between both the maternal aunt's investment and emotional closeness to the subject and the emotional closeness of the subject's mother to her sister, i.e. the maternal aunt (emotional closeness r = .54, N = 65; investment r = .43, N = 65; both p <.001). This correlation was the highest among aunts and uncles. However, for lastborn maternal aunts this correlation disappeared (emotional closeness r = .25, N = 44; investment r = .14, N = 44; both n.s.). Using regression analysis there was also no significant influence of the emotional closeness between the mother and the lastborn maternal aunt on the maternal aunt's investment and emotional closeness to the niece or nephew. Lastborn maternal aunts cared for their nieces and nephews independently of their relationship to their older sister, i.e. the mother of the children. Another descriptive result was that younger maternal aunts lived farther away from niece or nephews than older maternal aunts, although even though their investment and emotional closeness was higher (Mean values. Younger mat. aunts: 5.56, N = 66. Older mat. aunts: 5.18, N = 81).

Discussion

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In the present study, as expected, sex and laterality biases were found for investment and emotional closeness, and no asymmetries were found for resemblance among grandparents. The relatively high average rating for the grandparental investment could due to the item's wording "[investment] …compared to the overall resources the caregiver was able to give." The standard deviations of the ratings were somewhat lower than in the comparable studies (Euler and Wetzel 1996; Pashos 2000), so the items were apparently at least as clear.

An unanticipated result of the present study was the kin investment and emotional closeness of aunts and uncles. Compared to the results for grandparents, the sex and laterality biases were only roughly indicated in the descriptive statistics. The maternal aunt was by far the highest rated of all aunts and uncles, especially among the parents' younger or lastborn siblings. Indeed, also in former studies on aunt and uncle kin caregiving (Gaulin et al. 1997; Hoier, Euler and Hänze 2001; McBurney et al. 2002), the sex and laterality biases were not as clear as might have been expected, because the distances between the maternal aunt rating and the other aunt and uncle ratings were somewhat too high. In the present study however, these discrepancies were even higher, so that mostly only the maternal aunts were significantly different from the other aunts and uncles.

On the other hand, the present results showed that the method of measuring only the relative oldest maternal and paternal aunts and uncles (Gaulin et al. 1997) is a valid procedure for investigating aunt and uncle caregiving. In the present study, there were in general no significant differences in investment, closeness and resemblance between first-mentioned, i.e. relative oldest, aunts and uncles and the mean value of the other aunts and uncles.

This study showed that in grandparents as well as in aunts and uncles a high correlation of investment and emotional closeness and a moderate correlation of both with resemblance existed. A very high correlation of investment and emotional closeness was expected, because of the similar results regarding the kin asymmetries. The present study yielded a relatively high correlation of investment and emotional closeness (r = .7 to .8) for grandparents, aunts and uncles. In the ratings for parents, however, the correlations were not very high (r=.34 & r=.54). Thus, both items do not measure exactly the same,

although they broadly overlap each other. The moderate correlations of emotional closeness and resemblance were slightly higher than those of investment and resemblance.

The main hypothesis we tested was whether the parents' relationship to the relatives had an influence on the kin caregiving of these relatives. The results showed that the closeness of the subjects' parents to the grandparents (their parents) and to the aunts and uncles (the parents' siblings) considerably influenced the kin investment and the emotional closeness of these relatives. The effect of the parent-kin relationship was especially high among maternal grandmothers and maternal aunts. In comparison to the parent-kin closeness, the effect of residential distance on investment and emotional closeness of grandparents, aunts and uncles was much smaller.

Parent-kin closeness, residential distance and resemblance also had an influence on the asymmetries in kin investment and emotional closeness. The difference in parent-kin closeness almost always had the greatest effect on investment or closeness biases between two relatives. Only for the difference in investment between the maternal and the paternal grandmother, the effect of different residential distance was slightly higher. For the asymmetries among grandparents, however, residential distance for the most part played only the second most important role. The third factor, physical and psychological resemblance to the grandchild, had only little influence on the grandparental asymmetries, and mainly only influenced the laterality in investment and closeness. Among aunts and uncles however, resemblance to a niece or nephew played the second most important role in both the laterality and sex difference. The effect of residential difference was only very slight and the additional explaining part of the total variance was often not even significant. In all, the results for the aunts and uncles were more consistent than those for the grandparents.

Another important result was that lastborn and younger sisters of the mother were, as maternal aunts, significantly closer to their nieces and nephews than firstborn and older sisters of the mother, and also cared on average more for them. Because the sub-samples were relatively small, it is not clear whether only the lastborn or whether all younger sisters of the mother show this higher caregiving and were closer to nieces and nephews. Another result was that lastborn maternal aunts were unaffected by

their emotional closeness to the mother (their older sister) in their caregiving and closeness to nieces and nephews. This is an interesting result, because for maternal aunts the correlation of the mother-sister relationship and the maternal aunt's caregiving and closeness to nieces and nephews was normally the highest. Furthermore, the mother's younger sisters' higher caregiving appears not to be confounded by residential distance, because in the present study they lived on average farther away from their nieces or nephews than did the mothers' older sisters.

Theoretical Interpretations

The results of the present study provide various points of reference for a theoretical discussion, which however do not exclusively argue in favor of only one of the existing theoretical interpretations. The comparatively great influence of parent-kin closeness on kin caregiving supports the theory of the stronger matrilineal family ties. Parent-kin relationships were found to play a decisive role in the emotional closeness to grandparents, aunts and uncles and their investment in grandchildren, nieces and nephews. This corresponds with the theory that the closer family ties of women compared to men lead to a matrilateral bias in kin caregiving. The emotional closeness of men to their parents however was only slightly less intense than that of women. Nevertheless, women have more frequent contact with their parents (cf. Salmon 1999). This means that the closer relationships of women to their family must be further investigated to reveal the cause of these closer female family bonds. It may be that the different mating efforts of the sexes cause the greater distance of men as compared to women towards their families. Females are more dependent on the mutual exchange of help with their parents than men. For the men, their parents' help is less important.

An argument against the parent-kin relationship as the crucial factor for kin caregiving could be that the parent-kin relationship and the kin investment are not independent of each other. The interest of kin in the caregiving for related children might also influence the contact of these relatives to the children's parents and therefore their relationship. Hence, kin caregiving might not only be influenced by parent-kin relationship, but also vice versa kin investment interests could also have a bearing on the kin

relationships. However, the interest of the kin caregiver of having contact with the child's parent in order to get the contact to the child, might indeed have an influence on the contact frequency to the parent of the child, but does not necessarily affect the parent's feeling of closeness to that relative. Kin caregiving is usually taking place inside the family. When sons are less connected to their parents' family than daughters, the sons' children belong less to the family-core than the daughters' children. Sons leave the family because of their interest to start their own family. By contrast, daughters keep connected to the family more than sons do. In patrilateral cultures, such as earlier traditional (mainland) Greece, these roles are interchanged, because of the patrilocal cultural system. The daughters' children are less familiar to the grandparents than the sons'. Still a daughter feels close to her parents, but her children do not. They live in another family. Grandsons especially feel remote to their maternal grandparents (Pashos 2000). Thus very probably family structure normally comes first, and then the kin caregiving.

Because several studies have not been able to find an influence of the actual paternity certainty on kin investment asymmetries in Western societies (e.g., McBurney et al. 2002), paternity certainty probably does not explain kin caregiving biases as a proximate cause. However, there are some indications that paternal kin recognition or imprinting by means of body odor or pheromones might take place after the birth of a child (Ligabue-Stricker and Cattani 2006). Even though actual paternity certainty could influence kin investment proximately to a certain degree, this cannot explain the caregiving biases measured by questionnaire studies. These asymmetries are greater than the presumed paternity uncertainty in the Western world, which is very probably in fact less than a mere 1 to 3 percent (Anderson 2005; Euler 2004). The paternity certainty explanation therefore has to take into account other proximate mechanisms in order to explain asymmetric kin investment. If paternal uncertainty in past societies reduced the caregiving of paternal relatives because of the risk of misinvestment, a working kin recognition mechanism should exist. This mechanism could be social closeness (Bekoff 1981; Korchmaros and Kenny 2001; Lorenz, 1935, 1937). Genetically-related family members live and grow up very close to each other. In our evolutionary history, adoptions of non-blood related children were usually an exception. Thus, social closeness of family members usually goes hand in hand with genetic relatedness. On a proximate

level, social closeness could therefore be an argument for both the theory of matrilineal family ties and the paternity certainty hypothesis.

In the present results, the special role of the maternal aunts as kin caregivers could be well interpreted in the light of the allo-mothering hypothesis. Allo-mothers are necessary helpers of the mother in her successful rearing of offspring. The sisters of the mother could act as helping allo-mothers, such as the mother's mother or older daughters. Other possible allo-mothers such as males and paternal family members are normally of minor importance. For grandparents, the unique role of the maternal females is not that clear. Empirical studies of kin investment based on current data in the Western world (Euler and Weitzel 1996; Hoffman 1979/80; Pashos 2000; Steinbach and Henke 1998) including the present study, show indeed the relatively highest level of caregiving by maternal grandmothers. However, the other three grandparents also take an important role as kin caregivers. Accordingly, a gradual differentiation of kin investment by sex and laterality appears to correspond here best with the empirical data. By contrast, studies using historical or anthropological kin data find support for the view of the maternal grandmother as the only important kin investor (cf. Mace and Sear 2005).

The higher caregiving of lastborn or younger maternal aunts in the present results appears to correspond very well with evolutionary biology. The mother's younger sister's high level of caregiving for nieces and nephews could reflect the biological interest of young females in learning mothering behavior. Younger sisters who often do not have their own children when their older sisters' children are born apparently take advantage of their altruistic kin caregiving for their own child-care. Especially in mammals, caregiving and nurturing behavior must be learned by observation and by helping others in child-care. Moreover, with good care in childhood, close social contacts and own kin caregiving, primate young and young adults learn social competence which has also an advantage for their reproductive success (cf. Suomi 2003 for rhesus monkeys).

Another theoretical interpretation for sibling differences in kin care exists is the helpers at the nest theory (Emlen 1995). Staying in the family and helping family members with child-care could be less costly than realizing one's own reproductive success. Accordingly, elder daughters and relatives

should care more for their siblings. In the present study however the younger maternal aunts provided more care for their nieces and nephews. This argues in favor of the interpretation of the learning of maternal caregiving behavior. On the other hand, one important proximate factor for the caregiving of maternal aunts could be the presence of one's own children. Compared to older sisters, the younger sisters of the mother are less likely to have their own children, hence their higher caregiving interest. According to the helpers-at-the-nest explanation, this would mean that when older sisters already have their own children, they do not primarily have to care for the younger sisters' children. Nevertheless, the argument of the younger sisters' childlessness supports the "learning mothering behavior" interpretation, rather than contradicting it. The practicing of mothering behavior among young girls can be observed in modern as well as in traditional societies, and matches the present study's data and its evolutionary interpretation very well.

However, the presence or absence of one's own children must not necessarily be the crucial factor for the caregiving differences in maternal nieces and nephews. One might assume, since older sisters already cared for their younger siblings, they do not need to learn mothering behavior through their nieces and nephews anymore (M. Butovskaya, personal communication, July 2007). Younger sisters generally lack this experience in child-care, and therefore have this particular interest in caregiving for their older sisters' offspring. This would also agree with the result that the mother's older sisters' caregiving remains still very high, although they already might have their own children. The impact of the presence of own children or alternative investment options on the maternal aunts' kin caregiving should be further investigated in future studies.

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Tables

Table 1

Mean values in investment and emotional closeness for parents and grandparents.

	Relationship to Parents & Grandparents					
	Investment			Emotional Closeness		
	Mean	SD	N	Mean	SD	N
Mother	6.77	(.59)	188	6.44	(.94)	188
Father	6.29	(1.17)	188	5.74	(1.43)	188
Maternal Grandmother	5.34	(1.56)	155	5.19	(1.67)	154
Maternal Grandfather	4.94	(1.69)	137	4.84	(1.70)	136
Paternal Grandmother	4.68	(1.77)	166	4.48	(1.81)	166
Paternal Grandfather	4.46	(1.81)	116	4.06	(1.92)	116

Table 2

Mean investment and mean emotional closeness of all aunts and uncles.

| | Relationship to Aunts/Uncles | | | | | |
| | Investment | | | Emotional Closeness | | |
Mean Value of All	Mean	SD	N	Mean	SD	N
Maternal Aunts	4.51	(1.50)	135	4.74	(1.65)	135
Paternal Aunts	3.61	(1.65)	133	3.65	(1.80)	134
Maternal Uncles	3.53	(1.57)	142	3.46	(1.67)	142
Paternal Uncles	3.33	(1.47)	130	3.47	(1.52)	132

Table 3

Regression analyses. Influence of parent-grandparent closeness and residential distance on the investment of the four grandparents.

| | Emotional Closeness | | | |
Investment	Parent-Grandparent	Residential Distance	N	R²
Mat. Grandmother	beta =.43, P =.000	beta = -.22, P =.005	135	.26
Mat. Grandfather	beta =.30, P =.001	beta = -.08, P =.360	115	.10
Pat. Grandmother	beta =.34, P =.000	beta = -.28, P =.000	141	.19
Pat. Grandfather	beta =.31, P =.002	beta = -.21, P =.033	97	.16

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Table 4

Regression analyses for grandparents. Influence of the differences in parent-grandparent closeness, in residential distance and in resemblance on the laterality or sex difference in investment and emotional closeness of grandmothers and grandfather. Changes in R-square stepwise.

Laterality	Difference in:				
	Closen.Parent-GP	Residential Dist.	Resemblance	N	R²
Inv. Grandmothers	β = .31, P =.000	β = -.37, P =.000	β = .23, P =.005		
Changes in R²	(1) R² =.15***	(2) R² =.16***	(3) R² =.05**	118	.35
Clo. Grandmothers	β = .30, P =.000	β = -.30, P =.000	β = .36, P =.000		
Changes in R²	(1) R² =.16***	(2) R² =.11***	(3) R² =.12***	119	.39
Inv. Grandfathers	β = .46, P =.000	β = -.24, P =.016	β = .30, P =.003		
Changes in R²	(1) R² =.25***	(2) R² =.10**	(3) R² =.08**	70	.43
Clo. Grandfathers	β = .38, P =.000	β = -.22, P =.034	β = .31, P =.004		
Changes in R²	(1) R² =.18***	(2) R² =.09**	(3) R² =.09**	70	.36

Sex Difference	Difference in:				
	Closen.Parent-GP	Residential Dist.	Resemblance	N	R²
Inv. Maternal GPs	β = .27, P =.008	β = -.07, P =.468	β = .21, P =.034		
Changes in R²	(1) R² =.11**	(2) R² =.01 ns	(3) R² =.04*	103	.16
Clo. Maternal GPs	β = .40, P =.000	β = -.18, P =.053	β = .18, P =.041		
Changes in R²	(1) R² =.24***	(2) R² =.05*	(3) R² =.03*	104	.32
Inv. Paternal GPs	β = .39, P =.000	β = -.28, P =.004	β = .05, P =.611		
Changes in R²	(1) R² =.17***	(2) R² =.08**	(3) R² =.00 ns	90	.25
Clo. Paternal GPs	β = .33, P =.001	β = -.33, P =.001	β = .12, P =.226		
Changes in R²	(1) R² =.14***	(2) R² =.11**	(3) R² =.01 ns	90	.26

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* P <.05   ** P <.01   *** P <.001

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Table 5

Regression analyses for first-mentioned aunts and uncles. Influence of the differences in parent-sibling closeness, in residential distance and in resemblance on the laterality or sex difference in investment and emotional closeness of aunts and uncles. Changes in R-square stepwise.

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Laterality          Difference in:

                    Close.Parent-Sibl. Residential Dist.  Resemblance       N    R²
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Inv. Aunts           β = .34, P =.001  β = -.23, P =.019  β = .30, P =.003

Changes in R²       (1) R² =.19***     (2) R² =.07**      (3) R² =.09**     77   .34

Clo. Aunts           β = .43, P =.000  β = -.23, P =.016  β = .29, P =.003

Changes in R²       (1) R² =.26***     (2) R² =.07**      (3) R² =.08**     77   .41

Inv. Uncles          β = .49, P =.000  β = -.21, P =.020  β = .30, P =.001

Changes in R²       (1) R² =.23***     (2) R² =.04*       (3) R² =.09**     84   .36

Clo. Uncles          β = .41, P =.000  β = -.19, P =.041  β = .36, P =.000

Changes in R²       (1) R² =.16***     (2) R² =.03 ns     (3) R² =.13***    84   .36
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Sex Difference      Difference in:

                    Close.Parent-Sibl. Residential Dist.  Resemblance       N    R²
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Inv. Maternal A/U    β = .36, P =.000  β = -.10, P =.282  β = .24, P =.014

Changes in R²       (1) R² =.15***     (2) R² =.01 ns     (3) R² =.06*      89   .22

Clo. Maternal A/U    β = .46, P =.000  β = -.13, P =.142  β = .37, P =.000

Changes in R²       (1) R² =.24***     (2) R² =.02 ns     (3) R² =.14***    89   .39

Inv. Paternal A/U    β = .35, P =.000  β = -.21, P =.018  β = .41, P =.000

Changes in R²       (1) R² =.29***     (2) R² =.04*       (3) R² =.15***    81   .47

Clo. Paternal A/U    β = .48, P =.000  β = -.12, P =.172  β = .31, P =.001

Changes in R²       (1) R² =.38***     (2) R² =.01 ns     (3) R² =.09**     81   .48
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* P <.05   ** P <.01   *** P <.001
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Table 6

Mean investment and mean emotional closeness of all firstborn and lastborn aunts and uncles.

	Investment Aunts/Uncles						Closeness Aunts/Uncles					
	Firstborn			Lastborn			Firstborn			Lastborn		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Maternal Aunts	**4.25**	(1.81)	65	**4.73**	(1.50)	45	**4.28**	(1.91)	65	**5.09**	(1.58)	44
Paternal Aunts	3.57	(1.93)	53	3.49	(1.73)	45	3.40	(1.96)	53	3.49	(2.08)	45
Maternal Uncles	3.52	(1.73)	54	3.63	(1.76)	54	3.26	(1.68)	54	3.60	(2.06)	53
Paternal Uncles	3.27	(1.53)	45	3.26	(1.50)	62	3.11	(1.79)	45	3.58	(1.64)	62