

DISCRIMINATIVE GRANDPARENTAL SOLICITUDE AS REPRODUCTIVE STRATEGY

Harald A. Euler

Universität Gesamthochschule Kassel

Barbara Weitzel

Lohfelden, Germany

1,857 adults rated the grandparental solicitude they received in childhood. Through a simple model based on the evolutionary concepts of ontogenetically differentiated reproductive strategy and paternity confidence, an ordered discriminative pattern of grandparental caregiving was predicted and confirmed by solid main effects, based on 603 complete cases. The maternal grandmother was the most caring. Unlike prevalent gender stereotypes, she was followed by the maternal grandfather, the paternal grandmother, and the paternal grandfather. The preferential grandparental solicitude was not influenced by residential distance, grandparent age, and availability of other grandparents. A predicted higher correlation for male than for female progenitors between solicitude and phenotypic resemblance could be confirmed.

KEY WORDS: Grandparental solicitude; Grandparental caregiving; Kin recognition; Reproductive strategy; Paternity confidence; Phenotypic resemblance; Trivers-Willard hypothesis.

Despite the gradual disappearance of the three-generation family and the disintegration of family structures in modern societies, the relationship between grandparents and grandchildren appears to retain its importance. This subject has been largely ignored in psychology textbooks, but the same can be said even of parental care, as Daly and Wilson (1988) have pointed out.

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Address all correspondence to Harald A. Euler, Fachbereich 03 Psychologie, Universität Gesamthochschule Kassel, 34109 Kassel, Germany. E-mail: euler@psychologie.uni-kassel.de

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In view of the media-promoted youth ideal one might assume that entrance into grandparenthood would mark a time of crisis. Instead, the opposite appears to be the case. The first grandchild is usually received with pride and joy, rather than a feeling of loss (Fischer 1983). Grandchildren still have a definite place in the life of many elderly people (Harris et al. 1975). Grandparental caregiving continues to constitute a considerable contribution to society. Have we not all met the older person doting on the grandchildren and proudly displaying photos?

Looking at the relationship from the grandchild's viewpoint, discrimination between grandparents seems to be the rule. People often feel close to one grandparent, usually to the maternal grandmother. Other grandparents remain more emotionally distant. How can this discrimination be explained? Early childhood experience may be a possible answer. The influential attachment theory of Bowlby (1969) states that persons become "mother figures" through love, or, put more scientifically, through unconditional, responsive, and available care. The question then arises whether grandparents themselves are discriminatory in their love for grandchildren. Bowlby does not elaborate this point; rather, following ethological tradition, he considers the inclination for care of offspring as a general primate endowment. Discriminative caregiving, in his theory, is not part of this endowment, but instead is due to particular circumstances (Porter and Laney 1980). A sick, psychotic, or drug-addicted mother may be unable to provide the necessary love or care. In like vein, one could argue, a grandparent might become the grandchild's favorite simply because he or she lived close by and was thus able to provide care. Bowlby subscribes here to what Tooby and Cosmides (1992) call the Standard Social Science Model. Nature, in this view, provides the general endowment. Individual variations in preferences, aptitudes, and attitudes, however, are due to cultural input.

The aim of this paper is to extend the evolutionary model to grandparental solicitude and to test the deduced predictions with data obtained retrospectively from adult grandchildren. Evolutionary approaches, especially parental investment theory (Trivers 1972, 1985), make discriminative parental solicitude their focal point (Daly and Wilson 1980) and thus complement attachment theory.

The ultimate goal of life, according to current evolutionary thinking, is not the survival of the individual or of the species, but the successful transport of genes into following generations (Dawkins 1976; Trivers 1972; Williams 1966; Wilson 1975). The individual shares his or her genes with relatives, depending on the degree of relatedness (Hamilton 1964). Individuals strive for reproductive success by reproductive effort. Reproductive success is measured relative to that of contemporaries and includes reproduction of consanguineal kin. Reproductive effort is comprehensive, because it is not restricted to procreation. It includes caregiv-

ing, which extends to grandchildren. In fact, the number of grandchildren is a better measure of reproductive success than the number of children.

To maximize their own reproductive success by increasing the number or "quality" (or both) of grandchildren, men and women alike support their children in their reproductive effort, mainly in mating and parenting. Mating and parenting are strategically differentiated between species, sexes, and reproductive stages within a lifetime (Alexander 1987; Daly and Wilson 1983). The reproductive strategies are conditional strategies which enable persons to adopt particular behavioral alternatives, depending on specific circumstances (Alexander 1990). Although these strategies are genetically based, they are not immutable or statically fixed (Belsky, Steinberg, and Draper 1991; Smith 1987). Becoming a grandparent marks a change in reproductive strategy because the reproductive situation has changed. The new reproductive task is to aid one's own child (the grandchild's parent) in his or her reproductive strategy. Because the maternal strategy differs from the paternal—the former being more restricted to child care (Daly and Wilson 1983), the latter having the option to gain additional descendants by mating with additional partners (Symons 1979)—the grandparental reproductive effort should vary according to lineage. Therefore, maternal grandparents are expected to care more for the grandchild than paternal grandparents.

Parental investment serves the father's own gene distribution only to the extent of probability of parenthood. Paternal investment varies with paternity confidence (Alexander 1979; Kurland 1979). Human males are selective in choosing infants toward whom they direct their paternal care, favoring infants who have a high probability of being their genetic offspring. Grandparents have a double chance of possible parental uncertainty. The most uncertain is the paternal grandfather. He can be certain neither of his nor of his son's paternity. The most certain is the maternal grandmother, being certain of her as well as of her daughter's maternity. In comparison, the paternal grandmother and the maternal grandfather have both a medium chance of uncertainty of grandparenthood.

If we combine the three factors of (1) ontogenetically differentiated reproductive strategy, (2) paternity uncertainty of the father, and (3) paternity uncertainty of the grandfather into a simple additive model with equal weight for each factor, we obtain an ordered prediction about discriminative grandparental solicitude, as shown in Table 1 in the "Results" section. The plus sign denotes comparatively more caregiving or solicitude, the minus sign comparatively less caregiving or solicitude. The most caring grandparent should be the maternal grandmother (MoMo, for mother of mother), followed by the maternal grandfather (FaMo), the paternal grandmother (MoFa), and the paternal grandfather (FaFa).

Investment in descendants is an abstract concept based on a variety of concrete and operationally definable behaviors, of which care is only one. Other possible behaviors are frequencies of contact, mourning upon a grandchild's death, expressing feelings of closeness, readiness to adopt, and willing property. Empirical findings about these behaviors support the hypothesis of discriminative grandparental solicitude. Grandmothers tend to perceive the children of their daughters to be closer to them than the children of their sons (Fischer 1983). Grandparents spend more time with the children of daughters than with those of sons, with MoMos investing twice as much as FaFas (Smith 1988). Littlefield and Rushton (1986) asked parents of a deceased child to rate the extent of grandparental mourning. The most grief was ascribed to the MoMo, followed by the FaMo, the MoFa, and the FaFa. In ethological reports, Daly and Wilson (1980) found that MoMos are the most frequent adopters among the Inuit and the East Pacific Rotumans. Berger and Schiefenhoewel (1994) documented 56 cases of kin adoption on the Trobriand Islands. In 25 cases the child was given to the MoMo, followed by the sister (7 cases), the mother's sister (5), and the father's brother (5). Only once was a child adopted by the paternal grandparents.

In another study, the recipients of parental and grandparental care were found to discriminate between their caregivers when asked about feelings of closeness to them. Male and female students alike felt closer to their mother than to their father and closer to their maternal than to their paternal grandmother (Russell and Wells 1987). Students perceived themselves emotionally closest to the MoMo, followed by the FaMo, the MoFa, and the FaFa (Eisenberg 1988; Hoffman 1978/79; Kennedy 1990; Matthews and Sprey 1985), and their interaction frequencies corresponded to that pattern (Eisenberg 1988; Hoffman 1978/79). The same rank order was found by Kahana and Kahana (1970) for children between four and twelve years when asked to name their favorite grandparent. Hartshorne and Manaster (1982) questioned college students about their contact in person, by telephone, or by letter with the four grandparents and obtained a somewhat different rank order, namely MoMo followed by MoFa, FaMo, and FaFa. Rossi and Rossi (1990) asked a large representative sample of adults about the importance of the four grandparents while they were growing up. The childhood salience of the grandparents was patterned clearly according to the known rank order. Most salient was the MoMo, least salient the FaFa, and the FaMo was markedly more salient than the MoFa.

Male reproduction generally has a higher variance than female reproduction, a phenomenon known as Bateman's principle (Bateman 1948). More men than women have a high number of direct descendants, and

more men than women remain childless. Male reproductive variance depends mainly on availability of resources. Men with plenty of socio-economic resources compete more successfully for women with high reproductive potential than men with fewer resources. Women gain access to male resources through their reproductive potential, which is mainly determined by age. Parental investment maximizes reproduction through a sex bias. According to the Trivers-Willard hypothesis, high-status families are expected to invest preferentially in male, low-status families in female descendants (Trivers and Willard 1973). This hypothesis has been supported by various data with respect to investment after birth (Hrdy 1987; Voland 1993). Sex-biased investment may be revealed through allocation of material resources, property inheritance, medical care, duration of breast feeding, preferential treatment, quantity of interaction, and other behaviors. Extending the principle to grandparental caregiving, it may be assumed that socioeconomic status determines differential grandparental solicitude depending on the sex of the grandchild.

Effective parental or grandparental investment in children or grandchildren requires an ability to recognize kin. Various mechanisms of kin recognition, such as spatial location, association/familiarity, and phenotype matching, have been detected in various species, with the latter two mechanisms pertaining to humans (Porter 1987). Porter assumes that, owing to paternity uncertainty, fathers rely more on child resemblance for their investment than mothers. Indeed, paternal resemblance of a baby is more often commented on, especially by the mother or her relatives, than maternal resemblance (Daly and Wilson 1982; Regalski and Gaulin 1993). This could be taken as a first indication of a relation between perceived similarity and willingness to invest care. If this relation does exist, it should also apply to grandparents. The more paternity uncertainty accrues to a grandparent, the more his or her caregiving should depend on the extent of grandchild resemblance. The FaFa should rely most upon resemblance for his allocation of child care, the MoMo the least.

Phenotypic resemblance matters for the grandparent as the giver of care, not the grandchild as the receiver. We assume, however, that kin resemblance is frequently commented on while the child grows up, and that the child's estimate of his or her resemblance to a particular grandparent is partially modeled by kin comments. To the extent that this assumption holds, our deduction of kin recognition theory should apply to the grandchild's estimate of grandparent-grandchild resemblance.

The present study investigates the following hypotheses by questioning adult grandchildren: (1) The four grandparents provide varying amounts of care for the grandchild; (2) maternal grandparents care more

than paternal grandparents; and (3) within each grandparent couple, grandmothers provide more care than grandfathers. These three hypotheses together predict a rank order of grandparental solicitude. The most care is provided by the MoMo, followed, in order, by the FaMo, the MoFa, and the FaFa.

Two additional hypotheses are deduced from the Trivers-Willard hypothesis and from kin recognition theory: (4) If the socioeconomic status of the parental family is high, grandparents provide more care for grandsons; if it is low, more care for granddaughters. (5) The correlation between grandparental solicitude and grandparent-grandchild resemblance increases over the rank order of grandparents specified by hypotheses 1 to 3.

METHOD

Participants

1,857 persons of both sexes (720 male, 1,125 female, 12 unspecified) of ages 16 to 80 years returned a questionnaire. The participants younger than 40 years were students in various undergraduate courses at the University of Kassel. Almost half of the students majored in education. The participants older than 40 years were recruited by the student participants who were given questionnaires to take home. The return rate was 98% from the students and 70% from the older participants. 78.8% of all respondents were younger than 30 years. Male participants had a median age of 23.7 years and a mean age of 29.3 years; female participants had a median age of 21.5 years and a mean age of 26.1 years.

The study as a whole is based on a sample of 1,857 respondents. For the main analysis, those 603 cases of respondents were selected whose four (putative) biological grandparents were all living until the participant reached the age of seven years. Step- and foster relations were not considered. Unless otherwise indicated, data presentation is restricted to these 603 complete cases. The frequencies of living grandparents differ because of later parenthood and earlier death of men as compared with women. Without the restriction to complete cases, these frequency differences could cause unrecognized selection effects. For various other analyses, subsamples were used as indicated under the "Results" section.

Questionnaire

The participants were questioned on a seven-point rating scale from 1 (not at all) to 7 (very much) as to how much each grandparent had cared

for them (German: *kümmern*)¹ up to the age of seven years. We chose to question adult grandchildren about the current perception of their received grandparental solicitude because existing equity norms are assumed to level grandparents' self-descriptive statements about given discriminative care. For example, Fischer (1983) reports that the majority of grandmothers who had multiple grandchildren refused to name favorite grandchildren. The inclination to deceive oneself and others about an existing impartiality is itself seen as an adaptation (Alexander 1987). Self-descriptive statements about received discriminative care, however, are presumably less influenced by equity norms. We therefore assume that ratings by adult grandchildren are a better indicator of discriminative grandparental solicitude received in childhood than ratings given by grandparents themselves.

The questionnaire asked in forced-choice form about the parental and grandparental life situation (e.g., whether grandparent was unknown, dead, divorced, separated) and about the adult child's resemblance in appearance and in behavior and personality (German: *Wesen*)² to the respective parent or grandparent. Subsamples were asked about residential distances in kilometers between themselves and each of the grandparents, and about the four different grandparental years of birth. The questionnaire for the older participants contained a question about the family's socioeconomic status during the participant's childhood according to the procedure of social self-rating by Kleining and Moore (1968). Nine boxes were shown with four or five professions listed, representing seven social classes. The participants were asked to write their father's profession into the box that fit best. Various studies show the paternal or husband's profession to be the best single indicator of the family's socioeconomic status in industrialized societies (Kleining and Moore 1968; Scheuch and Daheim 1970). Because the research of Kleining and Moore was carried out in the early sixties in Germany, the professions listed represent roughly the situation of our participants' own childhood.

RESULTS

Discriminative Grandparental Care

Means and standard deviations of received grandparental care for the 603 complete cases are shown in the first two data columns in Table 1. The results confirm hypotheses 1 to 3. Most caring was the MoMo, followed, in order, by the FaMo, the MoFa, and the FaFa.

The analysis of variance with the variables "sex of participant," "sex of

Table 1. Grandparental Solicitude: Predictions from Reproductive Strategy and Parental Certainty and Results ($N = 603$); Residential Distance to Grandparent in Logarithmic Kilometers ($N = 207$)

Grandparent	Reproductive Strategy	Parental Certainty	Solicitude		Residential Distance	
			Mean	SD	Mean	SD
Maternal grandmother	+	+/+	5.16	1.84	3.75	2.26
Maternal grandfather	+	-/+	4.52	1.98	3.74	2.28
Paternal grandmother	-	+/-	4.09	2.00	3.83	2.27
Paternal grandfather	-	-/-	3.70	2.02	3.85	2.32

+ more care; - less care

parent" (i.e., maternal vs. paternal grandparents), and "sex of grandparent" revealed highly significant main effects for the latter two variables (Table 2). Maternal grandparents provided more care than paternal grandparents, with grandmothers more than grandfathers in both lineages. The effects are considerable. Effect sizes, given as $\eta^2_{[alt]}$ (Tabachnik and Fidell 1989:55), are .11 for the lineage effect (sex of parent) and .17 for the effect of sex of grandparent. $\eta^2_{[alt]}$ denotes the variance attributable to the effect of interest divided by this variance plus error variance.

Of special theoretical interest is the comparison of the maternal grandfather with the paternal grandmother. If grandparental caregiving is determined by a social role and child care is traditionally ascribed to the female, grandmothers generally should provide more care for grandchildren than grandfathers. However, our 603 participants reported that their FaMos cared significantly more than MoFas ($t[602] = 3.79, p = .000$, effect size $d = .21$, after Cohen 1988). This difference is also significant for the older participants (40 years or more), with the magnitude of the difference being even more pronounced (4.47 vs. 3.45).

Sex of Grandchild

We found only a marginally significant and weak effect of sex of participant (Table 2). Granddaughters rated slightly more grandparental solicitude (mean = 4.45) than grandsons (mean = 4.23).

Residential Proximity

Residential distance between grandparent and grandchild could be a confounding variable for grandparental solicitude. Because the distances between the grandchild and the four grandparents or the two grandparent couples frequently differ, occasions and requests for grandparental caregiving arise more frequently for those grandparents living close by (Rossi and Rossi 1990:422).

A subsample of 208 participants was asked for the distances in kilometers (km) to their four grandparents. The data were logarithmically transformed to counter distortions by a few grandparents residing extremely far away. The logarithmic scale corresponds to the following distances: 0 = 0 km; 1 = .1 to .3 km; 2 = .4 to 1.0 km; 3 = 1.1 to 4.0 km; 4 = 4.1 to 16.0 km; 5 = 16.1 to 64.0 km; and so on.

As expected, distance between residences correlates negatively with solicitude. The correlation coefficients for the four grandparents are $r = -.29$ (MoMo), $r = -.34$ (FaMo), $r = -.40$ (MoFa), and $r = -.41$ (FaFa). However, the differences between these coefficients are not significant. The difference between the MoMo and the FaFa tends towards significance ($p < .10$). The power of the significance test is not indicated by its author (Steiger 1980); however, the numerical values of the coefficients do show the theoretically derived gradations. It looks as if care for the grandchild is an adaptation least facultative for the MoMo and most facultative for the FaFa.

The means of the residential distances, however, do not differ significantly between the four grandparents (Table 1), confirming earlier findings (Eisenberg 1988; Thomas 1989). An analysis of variance showed neither significant main effects nor interactions. Moreover, the small absolute differences between the four grandparents with respect to residential proximity do not correspond to the gradation from MoMo to FaFa. Thus, differential residential proximity does not account for the discriminative grandparental solicitude.

Grandparent Age

On the average, the four grandparents are of different age because men generally marry at a greater age than women. This age difference could be a confounding variable, because the youngest grandparent, the

Table 2. Analysis of Variance of Grandparental Solicitude Rating as a Function of Sex of Participant, Sex of Parent, and Sex of Grandparent. Effect size given as $\eta^2_{(alt)}$; $N = 603$; $df = 1/601$, for each comparison

Source of Variance	F	p	$\eta^2_{(alt)}$
Between Subjects			
Sex of participant	3.99	.046	.01
Between Subjects			
Sex of parent	74.68	.000	.11
Sex of grandparent	122.65	.000	.17
Sex of participant \times parent	1.97	.161	.00
Sex of participant \times grandparent	1.23	.267	.00
Sex of parent \times grandparent	8.58	.004	.01
Sex of participant \times parent \times grandparent	.01	.905	.00

MoMo, was the most caring while the oldest, the FaFa, was the least caring. A subsample of 297 participants was therefore asked for their grandparents' years of birth. When the participant was three years old, the mean ages of the four grandparents were 59.3 (MoMo), 61.6 (FaMo), 61.2 (MoFa), and 63.0 (FaFa) years, with a considerable standard deviation of about eight years for each grandparent. Age did not correlate with the solicitude ratings for any of the grandparents (MoMo: $r = -.10$, $p = .144$; FaMo: $r = -.10$, $p = .211$; MoFa: $r = -.03$; FaFa: $r = -.01$). The discriminative grandparental care cannot be explained by the relatively small age differences between the four grandparents.

Number of Living Grandparents

The solicitude data considered thus far are from those participants whose four grandparents were *all* living and known during childhood. We now ask whether the amount of grandparental care received differed for those grandchildren whose grandparents were not all known or living during childhood. Assuming that a grandchild requires a certain amount of grandparental care, it follows that a child with fewer living grandparents would require more from each grandparent than a child with more living grandparents. Likewise, from the grandparental viewpoint, the distribution of care could depend on one's knowledge of being the sole grandparent or of being one among several, the diffusion of grandparental responsibilities being presumably higher in the latter case. Whatever viewpoint is taken, if grandparental care depends on the number of still-living and known grandparents, the differences between grandparents should diminish as the number of grandparents decreases.

We investigated this hypothesis and found the following: When three groups (one, two, or three other grandparents alive and known) were compared within each grandparent type, no differences in solicitude appeared in the analysis of variance. Irrespective of the number of other grandparents available, the discriminative grandparental solicitude remains a robust phenomenon. (Participants with only one grandparent are not appropriate for inclusion here, because the lack of between-grandparent comparisons could result in a tendency toward moderate rating values.)

Widowed and Separated Grandparents

Grandparents frequently care for the grandchild as a couple. The intra-couple correlations of the solicitude ratings are therefore high ($r = .70$ maternally, $r = .74$ paternally); the four inter-couple correlations, as expected, are around zero. Are the high intra-couple correlations due to

Table 3. Grandparental Solicitude Ratings for Grandparents Living Together vs. Living Separately, and for Grandparents Whose Partner Is Still Alive (Non-Widowed) vs. Partner Deceased (Widowed)

Grandparent	Living with Spouse		Living Separately from Spouse		p	Non-Widowed		Widowed		p
	Mean	N	Mean	N		Mean	N	Mean	N	
Maternal grandmother	5.09	633	5.06	48	ns	5.01	962	5.10	602	ns
Maternal grandfather	4.51	551	2.06	34	.000	4.04	906	4.17	517	ns
Paternal grandmother	4.20	595	3.25	36	.005	4.45	585	4.41	571	ns
Paternal grandfather	3.80	470	1.77	30	.000	3.64	523	3.89	487	ns

an ultimate cause, namely common reproductive interest, or a proximate one, namely partnership? If the latter cause is the effective one, single grandparents should differ in caregiving from grandparents living in a partnership.

When widowed grandparents (spouse died before grandchild’s second birthday) were compared with non-widowed grandparents from the total data file, no significant differences appeared (Table 3). On the other hand, when separated grandparents were compared with grandparents living together, a clear pattern of solicitude differences appeared. The MoMo who lived separately from her husband obtained the same solicitude means as the MoMo who lived with her partner. Our participants reported that the separately living MoFa provided significantly less care than the MoFa living with her partner (3.25 vs. 4.20). Marital separation had drastic effects on the amount of a grandfather’s caregiving. Separated FaMos obtained merely meager solicitude values (2.06) compared to FaMos living with the partner (4.51). Separately living FaFas as a group obtained the lowest solicitude ratings encountered in our data (1.77), lower still than the already moderate ratings for the FaFas living in partnership (3.80).

As expected, the rated grandparental solicitude was independent of whether the grandparents of the other lineage were both alive or not. Similarly, the existence of the other same-sex grandparent did not influence caregiving.

Socioeconomic Status

The variable of socioeconomic status (self-rating via paternal profession) was dichotomized into the lower three and the higher four groups

of professions. An ANOVA ($N = 651$) with the independent variable of parental solicitude and the dependent variables of sex of participant, status, and sex of parent yielded an expected and strong main effect for sex of parent. Mothers provided more care than fathers (6.36 vs. 5.30, $F[1/647] = 24.79$, $p = .000$, $\eta^2_{[alt]} = .33$). The variable of status yielded a weak but significant main effect; high-status parents were rated less solicitous than low-status parents (5.70 vs. 5.96, $F[1/647] = 7.42$, $p = .007$, $\eta^2_{[alt]} = .01$), the effect being stronger for fathers than for mothers (interaction Sex of Parent \times Status: $F[1/647] = 3.93$, $p = .048$, $\eta^2_{[alt]} = .01$). The interaction Sex of Participant \times Status as an expression of the Trivers-Willard hypothesis, however, was not significant ($F < 1$), even though the absolute mean differences went in the expected direction.

Also, grandparental solicitude did not differentiate throughout in accordance with the Trivers-Willard hypothesis. In the ANOVA, the interaction Sex of Participant \times Status did not reach significance except for the maternal grandparents; that is, the interaction Sex of Participant \times Status \times Sex of Parent was significant ($F[1/443] = 4.44$, $p = .036$, $\eta^2_{[alt]} = .01$).

Solicitude and Resemblance

For both male and female participants, physical resemblance during childhood to the father was rated higher than to the mother (males: 4.43 vs. 3.93, $t[351] = 4.01$, $p = .000$, $d = .31$; females: 4.54 vs. 4.23, $t[536] = 2.50$, $p = .013$, $d = .18$). The same differences were obtained with respect to resemblance in behavior, although they did not reach statistical significance for males (males: 4.57 vs. 4.40, $t[349] = 1.55$, $p = .12$, $d = .10$; females: 4.74 vs. 4.39, $t[531] = 3.37$, $p = .001$, $d = .22$). Because a higher paternal than maternal resemblance is not genotypically founded, and because not all persons can be assumed to be the genetic offspring of their putative father (Baker and Bellis 1995), the data reflect a socially constructed resemblance for the purpose of asserting paternity. The inclination to perceive and assert paternal resemblance, reported by Daly and Wilson (1982) for newborn babies and by Regalski and Gaulin (1993) for infants under the age of six months, apparently is maintained during childhood.

A greater paternal resemblance, however, was not found with respect to grandparents. The participants neither rated resemblance to paternal grandparents higher than to maternal grandparents (appearance: 2.62 vs. 2.56, $t[593] < 1$; behavior: 2.95 vs. 3.20), nor did they rate resemblance to grandfathers higher than to grandmothers (maternal, appearance: 2.46 vs. 2.74; maternal, behavior: 2.61 vs. 2.64; paternal, appearance: 3.12 vs. 3.32; paternal, behavior: 3.04 vs. 2.92, $t[614] = 1.47$, $p = .071$, one-tailed, for last comparison).

A higher correlation between solicitude and resemblance was predicted for male than for female progenitors, since males rely more on resemblance as an indication of kinship. The correlations should be higher for fathers than for mothers, higher for grandfathers than for grandmothers within grandparent couples, and higher for paternal than for maternal grandparents. The data set allowed eleven comparisons. In eight of them the correlation coefficient was higher on the male side, with two of them being significant (after Steiger 1980). A one-tailed Wilcoxon test of the eleven comparisons was significant ($p < .025$). The prediction of a higher correlation between solicitude and resemblance for male than for female progenitors was confirmed in the aggregated comparison.

DISCUSSION

Sex-specific reproductive strategies and uncertainty of paternity determine not only parental but also grandparental caregiving, as assessed retrospectively by adult grandchildren. The sex-specific reproductive strategies are conditional strategies, depending on life stages. Attaining grandparental status marks the onset of a new life stage and a strategic shift toward child care. The new strategy, however, does not merely imply a revival of parental care behaviors. Instead, the new task is to support one's own child in his or her reproductive effort. Grandparental solicitude serves this support strategy.

Evolution is structuring not only the composition of an organism's adult form but the whole ontogeny as well. Each species has a typical life history as an adaptation to its niche (Alexander 1979; Smith 1987; Stearns 1976; Williams 1957). This life history can be viewed as a genetically organized set of general strategies and special behaviors to secure and promote survival, growth, and reproduction. Alexander (1987) divides the life history into somatic and reproductive effort. The somatic effort of the first part of life is directed towards building somatic and cognitive structures. Somatic effort increases residual reproductive value; reproductive effort reduces it. Reproductive effort employs the acquired resources for genetic reproduction and is divided into mating, parental, and extraparental nepotistic effort.

We view grandparental solicitude as a differentiated subset of parental effort and not merely an undifferentiated extension of parental effort. This viewpoint is illustrated by comparing the maternal grandfather with the paternal grandmother with respect to their caregiving. The paternal grandmother clearly provides less care for her son's children than the maternal grandfather for his daughter's children, although

prevalent gender stereotypes would predict the opposite. Depending on their child's sex, the typical, solicitous mother must have become a relatively remote grandmother, and the typical, remote father a relatively caring grandfather. The data confirm the hypothesis that grandparents increase their own reproductive success by supporting the sex-specific reproductive strategies of their children.

It may be assumed that the attitudes, emotions, motivations, and causal attributions of the four grandparents with respect to each grandchild also reflect evolutionary structures. Traditional social roles that specify child care as women's business offer no satisfying explanation, because they require ad hoc and unparsimonious amendments to explain discriminative grandparental caregiving. Although the gender-specific traditional social roles for providing child care presumably decreased within this century, the caregiving differences between maternal grandfather and paternal grandmother are even more pronounced for the older than for the younger participants.

Discriminative grandparental solicitude appears to be a rather solid and robust phenomenon. It proves to be statistically significant, covers a sizable share of variation in solicitude, and remains uninfluenced by several potentially care-relevant conditions. Neither residential proximity, nor grandparent age, nor availability of other grandparents or grandparent couples determines the caregiving differences between grandparents. Only a separation from the partner was found to be a determining variable for three of the four grandparents. The maternal grandmother provides care intensively, whether she lives with the maternal grandfather or not. The other three grandparents, most pronouncedly the paternal grandfather, tend to lose interest in the grandchild after separation from their partner. The engagement of grandfathers seems heavily influenced by their partnership. Both maternal and paternal grandfathers tend to go along with their spouse's wishes and desires for contact with the grandchildren. The maternal grandmother, however, holds a prominent position. Her engagement seems to be the least impaired by adverse circumstances, like marital discord in the intermediate generation (Rossi and Rossi 1990:355).

The role of an ontogenetically differentiated reproductive strategy and of paternity confidence for grandparental solicitude is presumably underestimated by the data presented here, for three reasons. First, we assume that children from complete families are overrepresented in our sample of students and their parents or acquaintances, and children of fathers who deserted the mother are underrepresented. The special life strategies that the children of single-parent households acquire during childhood (Belsky, Steinberg, and Draper 1991; Draper and Harpending 1988) are less likely to provide access to German higher education.

Second, the analysis of variance was based on the complete cases with all four grandparents known and living during childhood. Such a sample constitutes a further selection of children of fathers inclined toward family life and child care, because intact grandparenthood biases towards intact parenthood. Third, certainty of paternity is not only determined by one's sex and by the resemblance between progeny and self, but also by the subjectively evaluated risk of double-mating (insemination by rival). Baker and Bellis (1989) showed human sperm count to correlate negatively with the proportion of time spent together since previous copulation. If the wisdom of the body adjusts ejaculate content to the risk of double-mating, why should the mind know nothing and be easily cuckolded? A look at the standard deviations of caregiving in Table 1 does not necessarily support this notion, but neither does it contradict it. The standard deviations are numerically higher for grandfathers than for grandmothers, but not significantly. It might well be possible that a subjectively assessed risk of double-mating would explain a further proportion of variance in caregiving not partialled out in our analysis.

Granddaughters gave somewhat higher grandparental solicitude ratings than grandsons. We assume this to be a difference caused by the receivers of solicitude, not by the givers of solicitude. Rossi and Rossi (1990:278–279) found mothers to give higher intimacy ratings towards sons and daughters than fathers do, and daughters to give higher ratings towards both mothers and fathers than sons do, which indicates a tendency for women to avow greater intimacy in all their relations than men.

The interaction Sex of Parent \times Sex of Grandparent (Table 2) is due to the sex effect being more pronounced with the maternal than with the paternal grandparents. The solicitude investment of grandmothers is larger than their husband's investment during the grandchild's first years of life. For grandmothers more is at stake, making the maternal-paternal dimension more important than for their husbands. This interaction also points to the salient role of the mother-daughter bond as the connecting link in kin relations, as observed by many researchers (e.g., Fischer 1986; Matthews and Sprey 1984; Rossi and Rossi 1990; Thomas 1989; Townsend 1957; Willmott and Young 1960) and employed as a proximate explanation. We chose an ultimate explanation which makes visible not only the salience of the maternal grandmother, but also the variance in the four grandparent types as well.

Many researchers in the social sciences have investigated grandparent-grandchild relations without differentiation of the four grandparent types. Often grandparents are pooled altogether, or they are insufficiently differentiated into either grandmothers vs. grandfathers or

paternal vs. maternal grandparents. Studies of complete differentiation are rare, although those that exist provide meaningful results (e.g., Hartshorne and Manaster 1982; Hoffman 1978/79; Littlefield and Rush-ton 1986; Rossi and Rossi 1990; Thomas 1989). The grandparent's kin position relative to the grandchild is a critical variable, and the popular stereotype of the highly involved grandmother may relate mostly to the maternal grandmother and not to both grandmothers equally. To differentiate between grandfathers seems equally appropriate, especially with respect to later investment. When it comes to solicitude as expressed through advice, money, and inheritance, grandfathers tend to contribute more than grandmothers (Rossi and Rossi 1990).

The Trivers-Willard hypothesis was not supported by our data, neither for parents nor for grandparents. We recognize that the method we employed is not a good test of this thorny hypothesis. Socioeconomic status was measured with only a single indicator. Moreover, the sample was not differentiated according to societal segments. The Trivers-Willard effect, however, might reveal itself only within circumscribed segments of society, as, for example, among farmers, urban professionals, nobles, and business people. Pooling such segments could blur the effect.

We did find that high-status parents are rated less solicitous than low-status parents, the effect being stronger for fathers than for mothers. This finding is in accordance with Hewlett (1988), who reported that high-status Aka pygmy fathers invest less direct care into their infants, whereas low-status fathers compensate with more solicitude.

The asymmetry of reproductive conditions results in a caregiving asymmetry between the four grandparents, which is most conspicuous in the salient role of the maternal grandmother. She not only provides the most care of all grandparents for the grandchild, but also is most willing to adopt, is most often the focus of the grandchild's feelings of closeness, is most often named as the favorite grandparent, and mourns most intensively upon a grandchild's premature death. Her eminent inclination to care is seen in a variety of other solicitous behaviors. She will volunteer as babysitter, even if her back hurts; she is the one who calls and sends care or gift packages; she drops by and helps. She is the quiet but dependable reserve, especially for the child's mother.

Contrary to evolutionary predictions, our study showed a resemblance of grandchildren to the maternal grandmother to be rated higher than a resemblance to the maternal grandfather, both in appearance and in behavior. This finding could raise the argument that resemblance in behavior is a secondary consequence of caregiving. This assumption, however, is untenable for two reasons. First, both sons and daughters estimate resemblance to the father higher than to the mother, even

though fathers on average provide less care. Second, similarity in behavior to grandparents who had already passed away before a grandchild's birth does not differ from similarity to grandparents still living.

The correlation between grandparental solicitude and grandparent-grandchild resemblance could be confirmed in its postulated dependence on paternity uncertainty. Our evidence is not strong at this point, although the differences are significant at an aggregated level. The test of this prediction was a side product of our research, the main focus of which was discriminative caregiving and solicitude. The rating by adult grandchildren was considered a valid measure for our purposes but is probably not appropriate for a test of the relation between solicitude and resemblance. To test this relation, a questioning of grandparents is surely the better measure. After all, it is the grandparents who would want to recognize themselves in their grandchildren as an assurance of some kind of immortality.

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Harald A. Euler is professor of psychology at the Universität Gesamthochschule Kassel. As a Fulbright student he received his Ph.D. at Washington State University. His publications cover the psychology of learning, behavior modification, aggression, and emotion. In recent years his main research interest has been in evolutionary psychology.

Barbara Weitzel received her M.A. in ethnology and anthropology from the University of Göttingen and is currently employed as an election district assistant to a member of the Bundestag (Federal German Parliament).

NOTES

1. We asked the participants how much each grandparent had *gekümmert*. The German verb *kümmern* has a behavioral as well as a cognitive-emotional meaning: (1) to take care of, to look after, and (2) to be emotionally and/or cognitively concerned about. The word *kümmern* is a natural category of everyday language; its meaning is located somewhere between the English *care(giving)* and *solicitude*. We are therefore using both *care(giving)* and *solicitude* interchangeably, each time implying the whole range of the original German term *kümmern*.

2. The meaning of the German noun *Wesen* can only be circumscribed in English as behavior, nature, personality, character(istic), disposition, nature, manner, or demeanor.

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