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Original Article

Differential Investment Behavior between Grandparents and Grandchildren: The Role of Paternity Uncertainty

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Abstract: Kin selection theory predicts that grandparents will differentially invest in their grandchildren as a function of paternity certainty. This study explored the hypothesis of "discriminative grandparental solicitude" (Euler and Weitzel, 1996; Smith, 1988) in a sample of college students. Students with four living grandparents were asked to indicate the frequency of various behaviors received from or directed to each grandparent. A significant linear trend on a majority of the measures supported this hypothesis. Reported contact and closeness were highest with the maternal grandmother (most genetically certain) and lowest with the paternal grandfather (least genetically certain); maternal grandfathers and paternal grandmothers were intermediate. The "preferential investment hypothesis" (Laham, Gonsalkorale, and von Hippel, 2005) predicts that the investment behavior of the maternal grandfather and the paternal grandmother should differ only when there are cousins through the father's sisters. Contrary to the predictions of this hypothesis, grandchildren did not rate the maternal grandfather consistently higher on any of the indices when more certain investment outlets were available to the paternal grandmother.

Keywords: discriminative grandparental solicitude, paternity uncertainty, preferential investment.

Introduction

In the human species parental certainty is asymmetrical. Human females can be completely certain that their children are their own even if they do not know the identity of the father. Because of concealed ovulation, internal fertilization, and risk of female infidelity, however, human males can never be completely certain of their paternity. Thus, the problem of paternity certainty is hypothesized to be an adaptive problem for human fathers. According to kin selection theory, psychological adaptations may have evolved to regulate investment in kin according to the degree of genetic certainty. These adaptations are hypothesized to produce a differential in male and female investment psychology. The logic of this psychology should extend to kin altruism of several types. Research on the differential investment patterns of aunts and uncles (Gaulin, McBurney, and Brakeman-Wartell, 1997); grandparents (Euler and Weitzel, 1996); and cousins (Jeon and Buss, 2007) has been consistent with this prediction. The purpose of the present investigation is to test predictions about grandparental solicitude using a sample of undergraduates who report four living grandparents.

For human grandparents parental uncertainty may be present in two generations of descendents. Grandfathers, for example, cannot be completely certain of the paternity of their sons or daughters and paternal grandparents cannot be completely certain that their son's children are really their grandchildren. Maternal grandmothers, in contrast, are completely certain that their daughters are really their own and that their daughter's children are really their grandchildren. Thus, for grandparents, genetic relatedness may vary from completely certain to doubly uncertain. Again, kin selection theory predicts that psychological adaptations may have evolved to regulate the investment in grandchildren as a function of genetic certainty. Smith (1988) predicted that investment should vary as a function of this certainty of relatedness: most for maternal grandmothers (MoMo; 0 uncertain links), least for paternal grandfathers (FaFa; 2 uncertain links), and intermediate levels for maternal grandfathers (MoFa; 1 uncertain link) and paternal grandmothers (FaMo; 1 uncertain link). Following Daly and Wilson's (1980) "discriminative parental solicitude," Euler and Weitzel (1996) termed this differential investment "discriminative grandparental solicitude."

When grandparents are directly questioned about the discriminative care directed to grandchildren their self-investment statements often suggest impartiality and equality of care (Fischer, 1983; Thomas, 1989). Grandparents may not be inclined to declare, or may not be aware of, differential favoritism (for exceptions to this tendency, see Michalski and Shackelford, 2005; Pollet, Nettle, and Nelissen, 2006). Self-descriptive statements about received solicitude, however, seem to be less influenced by such social desirability effects. Consequently, research has typically focused on the recipients of discriminative care--the grandchildren. Hoffman (1979-80) asked undergraduate females, with at least one living grandparent, to report on the frequency of contact with, and their perceived closeness to, each living grandparent. These grandchildren reported greater interactions with and being emotionally closer to their maternal grandparents (one shared uncertain link) than paternal grandparents (three possible uncertain links). Hartshorne and Manaster (1982) assessed the amount of contact between adult grandchildren and each living grandparent at three time periods: now, while in high school, and when home full time. Consistent with the uncertainty hypothesis, grandchildren had the most contact with MoMo (no uncertain links)

and the least contact with FaFa (2 possible uncertain links); contact with FaMo and MoFa was intermediate (1 uncertain link). Euler and Weitzel (1996) had German adults rate (on a seven-point scale) how much each biological grandparent had cared for them up until the age of seven. Once again, the grandparent with the greatest degree of genetic certainty (MoMo) invested the most, whereas the grandparent with the least degree of genetic certainty (FaFa) invested the least. Salmon (1999) asked Canadian undergraduates to report the frequencies of contact per annum (visits and phone calls) with their maternal and paternal grandparents. These grandchildren reported more frequent contact with maternal grandparents (one shared uncertain link) than paternal grandparents (three possible uncertain links). In a study by Pashos (2000), Greek and German adults estimated (on a seven-point scale) how much each grandparent had cared for them until the age of 7. Urban Greek and German ratings were generally consistent with the ordinal rankings found in prior studies. Finally, Laham, Gonsalkorale, and von Hippel (2005) replicated the differential grandparental investment effect in a sample of Australian psychology students. Respondents rated their emotional closeness to each of the biological grandparents they could remember on a 0-100 "feelings thermometer." As predicted, respondents reported greater emotional closeness to their MoMo, followed by the MoFa, then the FaMo, and finally the FaFa. While these studies are notable in their consistency in documenting the solicitude effect, they share the significant limitation that not all grandparents were living at the time of the self-report.

Recently, Laham, Gonsalkorale, and von Hippel (2005) have hypothesized that the two grandparent types with one uncertain link each will show an investment differential under certain circumstances. Specifically, MoFa will invest more in their grandchildren relative to FaMo because some FaMo will have genetically more certain outlets available to them. If cousins are available through the father's sisters, a FaMo will have investment outlets that are more certain than her investment outlet with her son. Consequently, she may invest in her daughter's children more heavily than her son's children. In contrast, a MoFa will not have a more certain outlet for his investment even if cousins are available through the mother's sisters. Thus, the "preferential investment hypothesis" predicts that the preference for the MoFa should be significant only when there are cousins through the father's sisters. In a test of this hypothesis, respondents were asked to report how many biological aunts and uncles they had on both sides of the family and how many biological children each of these relatives have. As predicted by the preferential investment hypothesis, MoFa were rated more highly than FaMo only when FaMo had grandchildren via their daughters.

The purpose of the present investigation was to test the hypotheses of discriminative grandparental solicitude and preferential investment using a sample of undergraduates who report four *living* grandparents. Extant tests of grandparental solicitude have relied either on retrospective reports of grandparental relationships from a given point in childhood or on reports of current relationships with at least one living grandparent. Reports of the former type return to a period in the respondent's life when all grandparents are more likely to be alive, and hence, differential solicitude can be assessed. This report strategy cannot assess current investment behavior or current emotional closeness and may suffer from retrospective distortion (e.g., second-hand descriptions of grandparents). Reports of the latter type allow the assessment of current investment behavior and emotional closeness but suffer from differential grandparent mortality, making assessment of differential solicitude

questionable. In one study, for example, approximately 60% of MoMo were still living at the time of assessment but only 30% of FaFa were still alive (Hoffman, 1979-1980). While some degree of differential investment should be evident despite differential mortality, an unconfounded test of this effect requires living grandparents in each category. To date, no study has tested the differential solicitude effect while insisting on four living grandparents. By restricting our sample to grandchildren with four living biological grandparents, we could assess differential investment and preferential investment by directly examining the two-way exchange of various investment behaviors between grandchild and grandparent type. In addition to a "feelings thermometer" rating, we asked respondents to indicate the number of telephone calls made, letters written, gifts given, etc. These behaviors should also reflect the closeness of the grandchild and grandparent dyad and may be less prone to response bias and/or retrospective distortion. We tested the following predictions: (a) reported investment behavior and rated closeness between grandchildren and grandparents will vary as a function of the number of uncertain links between grandparents and grandchildren and (b) the investment of MoFa will be greater than the investment of FaMo only when there are cousins through the father's sisters.

Materials and Methods

Respondents

One hundred and forty students (89 women and 51 men; mean age ± *SD* = 19.49 ± 1.15) from a Midwestern liberal arts college were approached opportunistically at their place of residence and asked to complete a series of questionnaires about their relatives. Only students who reported having four living biological grandparents were asked to complete the questionnaires. Upon completion of the questionnaires the students received a redeemable delicatessen coupon.

Procedure

The questionnaire packet consisted of a participant data sheet and four questionnaires. The data sheet required that respondents list the names of their grandparents by relationship (e.g., Paternal grandfather's name (your father's father): list name here) and their respective place of residence. The data sheet also required that respondents list paternal and maternal aunts and uncles and their respective number of biological children.

Following the completion of the data sheet, respondents were asked to complete a one page questionnaire about each of their four living grandparents. Each questionnaire consisted of 12 questions (see Table 1) pertaining to the grandparent listed at the top of the page. Eleven of the questions asked the respondent to report on the frequency of a behavior directed to a grandparent (over the last year) or the frequency of a behavior received from a grandparent (over the last year). One question asked the respondent to report their degree of emotional closeness (on a 0-100 scale) to the grandparent in question. The presentation of the grandparent questionnaires within a packet was counterbalanced.

Results

Transformation of raw scores

A preliminary screen of the distributions of the raw scores from each question revealed significant skew. Questions 1 through 11 were positively skewed and question 12 was negatively skewed. Following transformation procedures suggested by Tabachnick and Fidell (2001), raw scores were transformed to achieve closer approximations to normality. A value of 1 was added to each score on questions 1 through 11 to remove zero as a value. Questions 1 through 11 were then re-expressed using a logarithmic transformation. On question 12 each score was subtracted from a constant (largest possible value + 1) and then re-expressed using a logarithmic transformation. These transformations achieved closer approximations to normality.

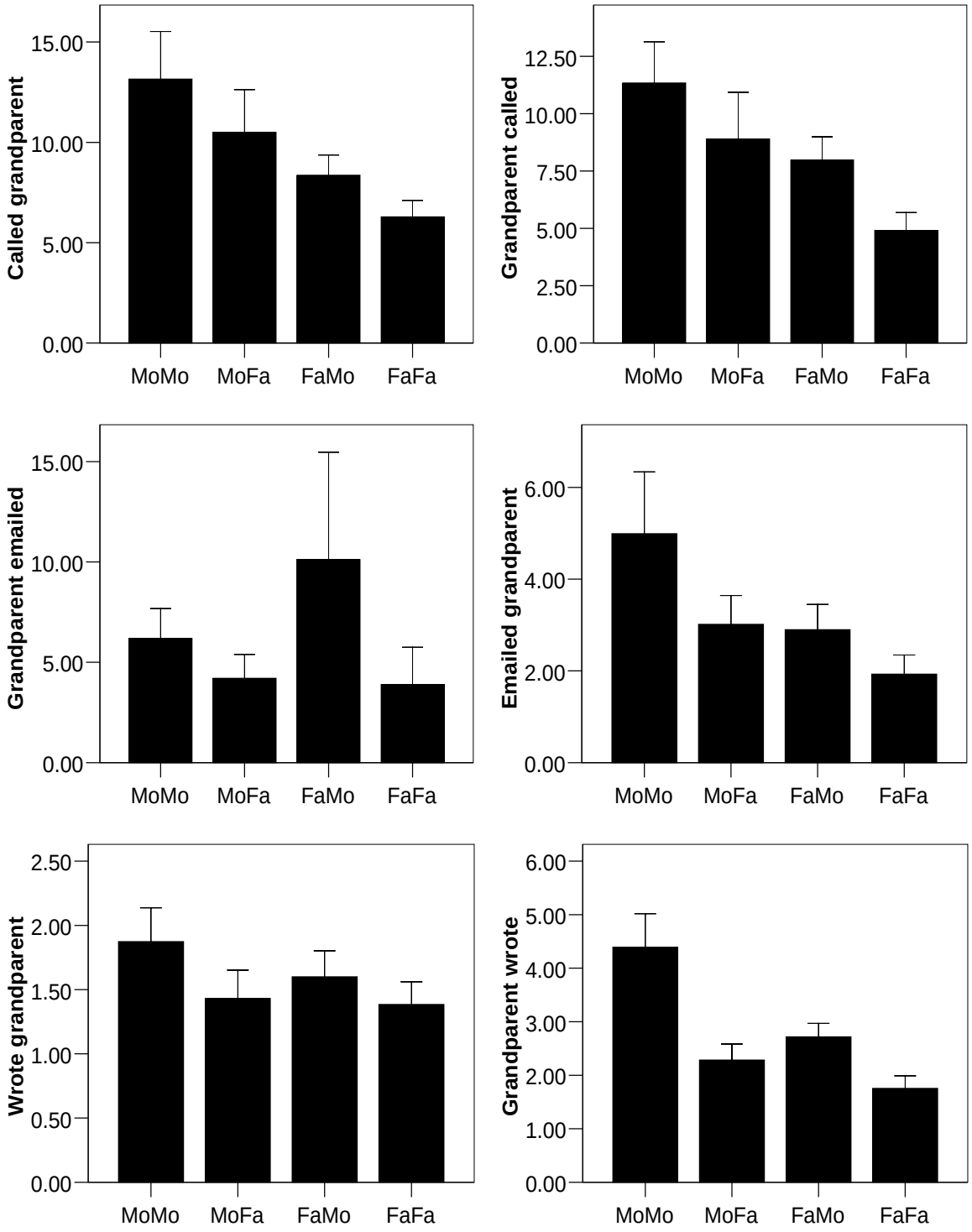
Differential solicitude by number of uncertain links

Means and standard errors for each grandparent by question (before transformation) are presented in Figure 1. A series of repeated-measures ANOVAs (on transformed scores) confirmed that investment behavior and rated closeness between grandchildren and grandparents varied as a function of the number of uncertain links (see Table 1 for transformed means and standard errors). There was a significant effect of grandparent type on all 12 questions. A significant linear trend was confirmed for 10 of these 12 measures. As predicted, grandchildren reported the greatest contact and the highest level of rated closeness with MoMo (0 uncertain links) and lowest level of contact and the lowest rated closeness with FaFa (2 uncertain links). As predicted, MoFa (1 uncertain link) and FaMo (1 uncertain link) were intermediate on all of the measures. Although MoFa were rated higher on some measures and FaMo on others, planned comparisons of adjacent group means showed that MoFa and FaMo were significantly different on only question 6 ($F(1,138) = 7.49$, $p < .01$). When the same analyses were performed on the data before transformation, there was a significant effect for grandparent type on only 9 of the 12 questions. The presence of a significant linear trend was confirmed for 8 of the 9 measures.

Distance between each grandparent and reporting grandchild

The residential distance between grandparent and grandchild has been considered a potential confounding variable by previous researchers (Euler and Wietzel, 1996; Pashos, 2000). For example, the distance between grandparent and grandchild might affect the frequency of visits to and from grandparents. To assess the influence of this potential confound, we calculated the distance in miles between the residential cities of the respondent and each of their four grandparents using the web-based Geobytes City Distance Tool. This tool calculates distance "as the crow flies" using the longitude and latitude of each city. The four distances were then entered as covariates into a series of one-way repeated-measures ANCOVAs (on transformed scores). Distance as a covariate was significant only on items 7 (visited grandparent), 8 (grandparent visited), and 11 (give a gift). Nevertheless, the covariate-adjusted means for these three items were virtually identical to the means reported in Table 1 above. Consequently, distance does not seem to affect the patterns of differential solicitude assessed in this study.

Figure 1. Means (+ *S.E.*) for each grandparent by question (before transformation).



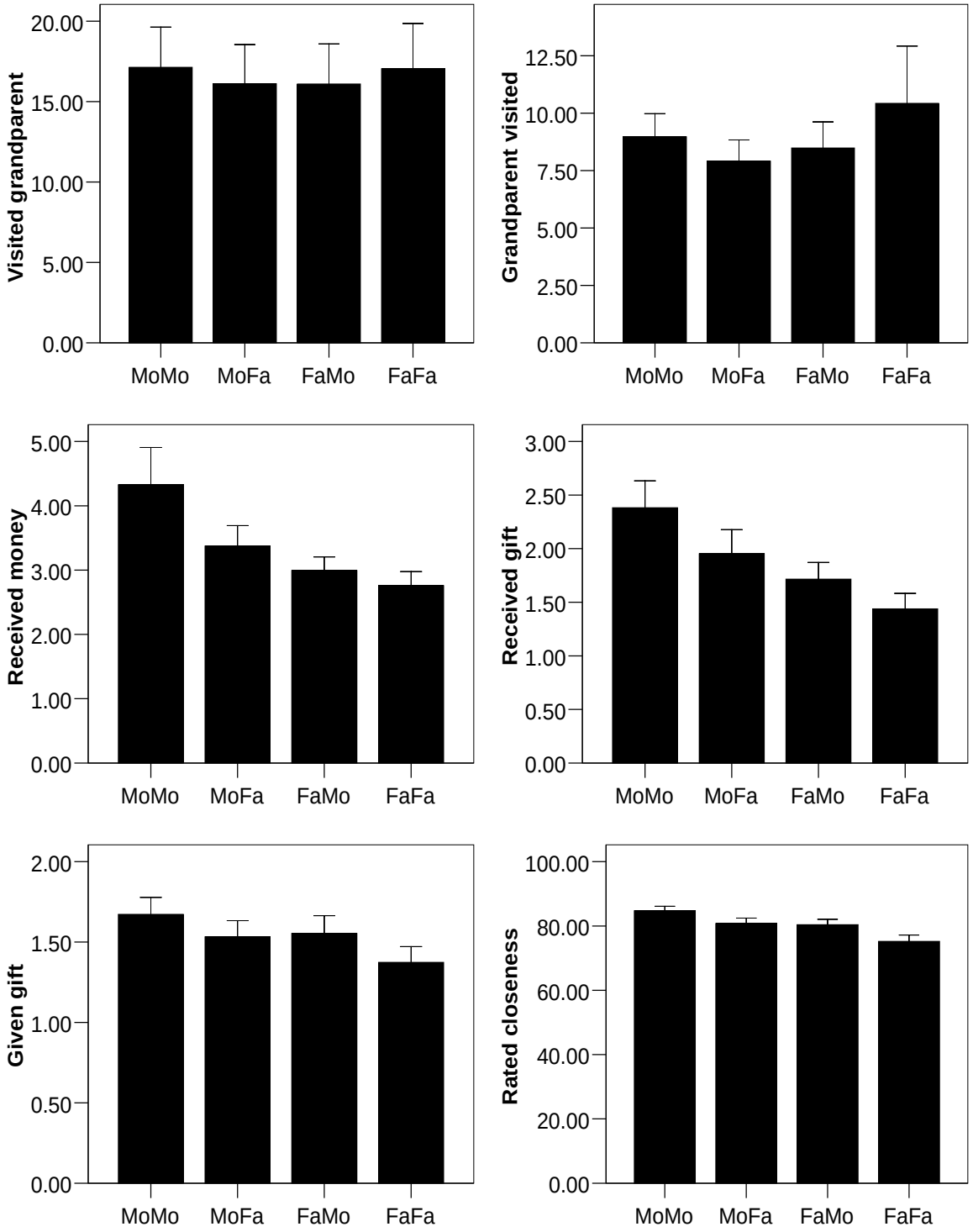

Visited grandparent
20.00
15.00
10.00
5.00
0.00
MoMo
MoFa
FaMo
FaFa
Grandparent visited
12.50
10.00
7.50
5.00
2.50
0.00
MoMo
MoFa
FaMo
FaFa
Received money
5.00
4.00
3.00
2.00
1.00
0.00
MoMo
MoFa
FaMo
FaFa
Received gift
3.00
2.50
2.00
1.50
1.00
0.50
0.00
MoMo
MoFa
FaMo
FaFa
Given gift
2.00
1.50
1.00
0.50
0.00
MoMo
MoFa
FaMo
FaFa
Rated closeness
100.00
80.00
60.00
40.00
20.00
0.00
MoMo
MoFa
FaMo
FaFa

Table 1. Transformed means (± S.E.) for each grandparent by question

Question	*MoMo*	*MoFa*	*FaMo*	*FaFa*	$F_{3,414}$	Linear $F_{1,138}$
1. Called gp	.81 (.04)	.70 (.04)	.72 (.04)	.61 (.04)	8.57 ***	11.90 **
2. Gp called	.78 (.04)	.59 (.05)	.67 (.04)	.50 (.04)	13.98 ***	18.31 ***
3. Gp emailed	.36 (.05)	.26 (.04)	.34 (.05)	.22 (.04)	3.37 *	3.48
4. Emailed gp	.34 (.04)	.28 (.04)	.30 (.04)	.21 (.03)	3.15 *	4.62 *
5. Wrote gp	.31 (.03)	.25 (.03)	.29 (.03)	.26 (.03)	3.53 *	1.71
6. Gp wrote	.52 (.03)	.35 (.03)	.44 (.03)	.29 (.03)	17.41 ***	19.18 ***
7. Visited gp	.97 (.04)	.95 (.04)	.88 (.05)	.87 (.05)	3.35 *	4.78 *
8. Gp visited	.77 (.04)	.72 (.04)	.70 (.04)	.65 (.05)	3.06 *	4.50 *
9. Rec. money	.59 (.03)	.55 (.02)	.53 (.02)	.49 (.02)	5.86 **	9.14 **
10. Rec. gift	.42 (.03)	.36 (.03)	.35 (.02)	.30 (.02)	7.86 ***	12.16 **
11. Give gift	.38 (.02)	.35 (.02)	.35 (.02)	.32 (.02)	5.41 **	10.07 **
12. Closeness †	.93 (.05)	1.04 (.05)	1.06 (.05)	1.17 (.05)	6.48 ***	10.48 **

* $p < .05$; ** $p < .01$; *** $p < .001$

† Smaller values indicate greater closeness

Preferential investment hypothesis

The preferential investment hypothesis predicts that the investment of MoFa should be greater than the investment of FaMo only when there are more certain genetic outlets for the FaMo--namely, cousins through the father's sisters. A series of 2 (MoFa vs. FaMo) by 2 (no cousins vs. cousins) repeated-measures ANOVAs was performed on each investment question. Transformed means and standard errors for MoFa and FaMo as a function of cousins by the father's sisters and interaction F statistics are presented in Table 2. The predicted interaction for question 1 (called grandparent) was significant. Contrary to predictions, however, simple effects analysis revealed that MoFa scores were not significantly higher than FaMo scores when FaMo have grandchildren via their daughters, $t_{102} = -1.60$, $p > .05$. The predicted interaction for question 2 (grandparent called) was significant. Contrary to predictions, simple effects analysis revealed that FaMo scores were significantly higher than MoFa scores when FaMo have grandchildren via their daughters, $t_{102} = -2.60$, $p < .05$. The predicted interaction for question 7 (visited grandparent) was significant. Simple effects analysis revealed that MoFa scores were not significantly different from FaMo scores when FaMo have grandchildren via their daughters, $t_{102} = .02$, $p > .05$. The predicted interaction for question 8 (grandparent visited) was significant. Once again, simple effects analysis revealed that MoFa scores were not significantly different from FaMo scores when FaMo have grandchildren via their daughters, $t_{102} = -1.48$, $p > .05$. The predicted interaction for question 10 (received gift) was significant.

Consistent with prior analyses, the simple effects analysis revealed that MoFa scores were not significantly different from FaMo scores when FaMo have grandchildren via their daughters, $t_{102} = -.84$, $p > .05$. Finally, the predicted interaction for question 12 (rated closeness) was significant. Contrary to predictions, simple effects analysis revealed that MoFa scores were not significantly different from FaMo scores when FaMo have grandchildren via their daughters, $t_{102} = .91$, $p > .05$. The predicted interactions for questions 3, 4, 5, 6, 9, and 11 were not significant. A parallel set of analyses was conducted on the data before transformation. Without the transformation, the predicted interactions for questions 3, 4, 7, 9, 10, 11, and 12 were not significant. On the questions yielding a significant interaction, simple effects analysis revealed that MoFa scores were not significantly higher than FaMo scores when FaMo have grandchildren via their daughters.

Table 2. Transformed means (± S.E.) for MoFa and FaMo as a function of cousins through the paternal aunt

	No Cousins		Cousins		Interaction
Question	*MoFa*	*FaMo*	*MoFa*	*FaMo*	$F_{1,137}$
1. Called gp	.78 (.09)	.62 (.08)	.67 (.05)	.76 (.05)	5.77 *
2. Gp called	.72 (.09)	.58 (.08)	.55 (.05)	.71 (.05)	6.56 *
3. Gp emailed	.38 (.09)	.36 (.09)	.22 (.05)	.33 (.05)	.89
4. Emailed gp	.46 (.07)	.40 (.07)	.22 (.04)	.26 (.04)	1.21
5. Wrote gp	.35 (.05)	.33 (.05)	.22 (.03)	.28 (.03)	3.16
6. Gp wrote	.45 (.06)	.47 (.06)	.32 (.04)	.43 (.03)	1.44
7. Visited gp	.90 (.08)	.67 (.09)	.96 (.05)	.96 (.05)	4.87 *
8. Gp visited	.81 (.07)	.52 (.08)	.69 (.04)	.76 (.05)	13.20 ***
9. Rec. money	.61 (.05)	.54 (.04)	.53 (.03)	.53 (.03)	.83
10. Rec. gift	.40 (.05)	.29 (.05)	.34 (.03)	.37 (.03)	5.73 *
11. Give gift	.38 (.04)	.35 (.04)	.34 (.02)	.36 (.02)	2.26
12. Closeness †	.92 (.10)	1.20 (.09)	1.08 (.06)	1.02 (.05)	6.58 *

* $p < .05$; ** $p < .01$; *** $p < .001$

† Smaller values indicate greater closeness

Discussion

The present study replicates and extends the work on discriminative grandparental solicitude by assessing multiple acts of investment behavior and emotional closeness with four living grandparents. By restricting our sample of grandchildren to those who report four living grandparents, we could ask respondents to report actual behaviors received from or directed to living grandparents. In addition to these direct behavioral measures, we also employed the single-item rating of emotional closeness used in prior investigations.

Consistent with the predictions of Smith (1988), there was a significant inverse linear trend between reported acts of solicitude and degree of parental uncertainty. Grandchildren reported the greatest contact and the highest level of rated closeness with MoMo (0 uncertain links) and lowest level of contact and the lowest rated closeness with FaFa (2 uncertain links). As expected, MoFa (1 uncertain link) and FaMo (1 uncertain link) were rated as intermediate and were not reliably different. Moreover, the discriminative solicitude effect was present on both behaviors received from grandparents and directed to grandparents. MoMo were more likely to write, give gifts, visit, send money, and call than FaFa. MoMo were also more likely to receive a gift, receive a call, and receive a visit than the FaFa. Our findings are consistent with prior investigations based on retrospective reports from childhood and contemporaneous reports of investment behavior with a *subset* of living grandparents. To our knowledge, this is the first study testing differential grandparental investment that has required all four grandparents to be alive at the time of the assessment.

Differential grandparental solicitude has also been studied by decomposing the four grandparent types into their two constituent components; namely, sex of grandparent and side of family. This approach to grandparental altruism treats sex of grandparent and side of family as independent effects and implies different underlying causal mechanisms for each effect. A number of researchers have approached differential grandparental investment from this perspective and reported both main effects and interactions (Hoffman, 1979-1980; Pashos, 2000; Salmon, 1999). While Pashos argues that cultural variables will affect sex of grandparent and side of family (as independent effects) differently, the presence of the reliable linear relationship between grandparent types requires that statements about main effects be carefully qualified. For example, as Euler and Weitzel (1996) correctly note, grandmotherly solicitude does not apply to both grandmothers equally but is more pronounced in the maternal grandmother. As our study confirms, the differentiation of all grandparent types yields the predicted linear function of solicitude on most of the variables we examined. Jeon and Buss (2007) have recently extended this same logic to the study of differential altruism among cousins.

We also tested the preferential investment hypothesis using multiple measures of investment and closeness with four living grandparents. Laham, Gonsalkorale, and von Hippel (2005) proposed that FaMo will invest less in their son's grandchildren when they also have grandchildren through their daughters. Under these circumstances, MoFa should make a greater investment in their grandchildren relative to FaMo. Contrary to the predictions of the preferential investment hypothesis, grandchildren did not rate the MoFa consistently higher on the direct behavioral indices or on closeness when more certain investment outlets were available to the FaMo. For grandparents who each have one uncertain link, the presence of more certain investment outlets does not seem to affect the calculus of their investment. While these findings call into question the preferential investment hypothesis, the findings are nevertheless consistent with the hypothesis of differential grandparental solicitude.

In the human species parental certainty is asymmetrical; consequently, both parental and grandparental solicitude should be discriminating. On both direct measures of investment and rated closeness with four *living* grandparents, we found that grandparental solicitude varied predictably as a function of parental certainty. Although we found no support for the preferential investment hypothesis when all four grandparents were alive,

other moderator variables have been identified (for a review of these moderator variables see Euler and Michalski, 2007) and should be tested using this design. Future studies should also replicate the solicitude effect in diverse cultures using different direct measures of investment appropriate to the particular culture. The actual investment behaviors received from or directed to grandparents will likely show great cross-cultural variability but should, nevertheless, reveal the calculus of differential investment. Finally, future studies should employ this design to document the differential investment effect with multiple siblings from the same family. Presumably, the age of the grandchild as well as their genetic certainty will affect grandparental investment. Although important questions remain, our findings add to a growing body of evidence demonstrating the robust nature of the differential grandparental solicitude effect.

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References

Daly, M., and Wilson, M. (1980). Discriminative parental solicitude: A biological perspective. *Journal of Marriage and the Family, 42*, 277-288.

Euler, H.A., and Weitzel, B. (1996). Discriminative grandparental solicitude as reproductive strategy. *Human Nature, 7*, 39-59.

Euler, H.A., and Michalski, R.L. (2007). Grandparental and extended kin relationships. In C.A. Salmon and T.K. Shackelford (Eds.), *Family relationships: An evolutionary perspective* (pp 230-255). New York, NY: Oxford University Press.

Fischer, L.R. (1983). Transition to grandmotherhood. *International Journal of Aging and Human Development, 16*, 67-78.

Gaulin, S.J.C., McBurney, D.H., and Brakeman-Wartell, S.L. (1997). Matrilateral biases in the investment of aunts and uncles: A consequence and measure of paternity uncertainty. *Human Nature, 8*, 139-151.

Geobytes City Distance Tool. http://www.geobytes.com/CityDistanceTool.htm.

Hartshorne, T.S., and Manaster, G.J. (1982). The relationship with grandparents: contact, importance, role conception. *International Journal of Aging and Human Development, 15*, 233-245.

Hoffman, E. (1979-1980). Young adults' relations with their grandparents: an exploratory study. *International Journal of Aging and Human Development, 10*, 299-310.

Jeon, J., and Buss, D.M. (2007). Altruism towards cousins. *Proceedings of the Royal Society of London, Biological Sciences, 274*, 1181-1187.

Laham, S.M., Gonsalkorale, K., and von Hippel, W. (2005). Darwinian grandparenting: Preferential investment in more certain kin. *Personality and Social Psychology Bulletin, 31,* 63-72.

Michalski, R.L., and Shackelford, T.K. (2005). Grandparental investment as a function of relational uncertainty and emotional closeness with parents. *Human Nature*, *16*, 292-304.

Pashos, A. (2000). Does paternity uncertainty explain discriminative grandparental solicitude? A cross-cultural study in Greece and Germany. *Evolution and Human Behavior*, *21*, 97-109.

Pollet, T.V., Nettle, D., and Nelissen, M. (2006). Contact frequencies between grandparents and grandchildren in a modern society: Estimates of the impact of paternity uncertainty. *Journal of Cultural and Evolutionary Psychology*, *4*, 203-213.

Salmon, C.A. (1999). On the impact of sex and birth order on contact with kin. *Human Nature*, *10*, 183-197.

Smith, M.S. (1988). Research in developmental sociobiology: parenting and family behavior. In K.B. MacDonald (Ed.), *Sociobiological perspectives on human development* (pp. 271-292). New York, NY: Springer.

Tabachnick, B.G., and Fidell, L.S. (2001). *Using multivariate statistics*. Boston: Allyn and Bacon.

Thomas, J.L. (1989). Gender and perceptions of grandparenthood. *International Journal of Aging and Human Development*, *29*, 269-282.