

Lineage based differences in grandparental investment: Evidence from a large British cohort study.

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ABSTRACT

Evolutionary theory suggests that maternal grandparents will invest more in their grandchildren than paternal grandparents, due to the difference between the certainty of maternity and the uncertainty of paternity. Most tests of this prediction have tended to use retrospective ratings by grandchildren rather than examining grandparental behaviour. Using a large-scale dataset from the UK ($n > 7,000$), we show significant differences between maternal and paternal grandparents in terms of frequencies of contact with their newborn grandchildren, while controlling for a wide range of other variables. Maternal grandparents also provided a significantly wider range of financial benefits than paternal grandparents. Maternal grandparents were also more likely to provide essentials and gifts and extras for the baby. Multiple correspondence analysis showed that contact frequencies systematically related to other measures of grandparental investment, indicating that contact frequencies are a useful proxy measure to examine overall investment. Findings are discussed with reference to the paternity uncertainty hypothesis.

Keywords: grandparental solicitude – paternity uncertainty – investment – contact frequencies – kin selection theory - lineage

INTRODUCTION

Kinship has been claimed to be of relatively low importance for social interaction in modern societies (Beck, 1993; Beck & Beck-Gernsheim, 2002; Giddens, 1991). However, from an evolutionary perspective, we should expect biological relatedness to be an enduringly powerful determinant of social investments, even in modern societies (Hamilton, 1964). In support of this, in historical European populations, grandmothers have been found to provide significant benefits for their grandchildren (Lahdenperä et al., 2004; Ragsdale, 2004). Similar beneficial effects were found for contemporary populations in rural Ethiopia, Gambia and Tanzania (Gibson & Mace, 2005; Sear et al., 2000; Sear et al., 2002; Hawkes et al., 1997). It appears that for humans, grandmothers may have a strong impact on their grandchildren's fitness and hence their own inclusive fitness (Mace & Sear, 2005; Sear & Mace, 2008). These fitness benefits, in combination with other traits, could potentially explain the evolution of a long postmenopausal lifespan in women (for example: Hawkes et al., 1998; Shanley & Kirkwood, 2001; Shanley et al., 2007 but see Cant & Johnstone, 2008). Grandfathers, by contrast, appear to have little impact on the fitness of their grandchildren (for example: Blurton-Jones et al., 2005; Lahdenperä et al., 2007; Sear & Mace, 2008). There appears to have been little selection pressure for a post-reproductive life span in men.

From an evolutionary psychological perspective one would predict however that lineage as well as sex of the grandparent will influence the level of grandparental investment. All else being equal, maternal grandparents will invest more in their grandchildren than paternal grandparents, because maternal grandparents are related to their grandchildren by certain maternity rather than uncertain paternity. Consistent with predictions based on paternity uncertainty, differences in solicitude between maternal and paternal grandparents have been found in historical (Volland & Beise, 2002), ethnographic (Sear et al. 2000, 2002) and

industrial societies (Euler & Weitzel, 1996; Euler et al., 2001; Michalski & Shackelford, 2005; Pashos & McBurney, in press). These studies find that maternal grandmothers tend to invest most in their grandchildren, followed by maternal grandfathers, and paternal grandmothers, with paternal grandfathers investing least (Eisenberg, 1988; Hoffman, 1979-1980, Kahana & Kahana, 1970; Rossi & Rossi, 1990), even though paternity uncertainty in contemporary societies is assumed to be relatively low (see Anderson, 2006). Similar differences between matriline and patriline have also been documented for uncles and aunts (Gaulin et al., 1997; McBurney et al., 2002). In general, individuals thus appear to invest more in their matriline than in their patriline. We argue that such differential investment can be ultimately explained by evolved psychological mechanisms attuned to paternity uncertainty (see Euler & Weitzel, 1996). Yet, the degree to which these psychological mechanisms are expressed and lead to measurable differences in investment between the maternal and paternal lineage depends on local ecologies, such as the factual degree of paternity uncertainty in a given population for example (see McBurney et al., 2002).

Pashos (2000), however, found the reverse pattern for rural Greeks: paternal grandparents invested more than maternal grandparents in their grandchildren. Similar effects have been found for rural areas in the USA (King & Elder, 1995; King et al., 2003). A possible explanation for this effect is that in rural samples inheritance of land benefits males and females differently and that solicitude measures reflect attempts by males to acquire land from grandparents, rather than grandparental investment (Michalski & Shackelford, 2005).

Evolutionary studies of grandparental investment in modern societies have mainly focussed on retrospective ratings by grandchildren, rather than grandparental behaviour (Chrastil et al., 2006; Euler & Weitzel, 1996; Euler, Hoier & Rohde, 2001; Laham, Gonsalkorale & von Hippel, 2005; Pashos, 2000; Pashos & McBurney, in press; but see Michalski & Shackelford, 2005; Pollet et al., 2006, 2007). The main argument for using this

method has been that grandparents would give socially desirable answers and therefore would claim to treat all grandchildren equally (Euler & Weitzel, 1996; Hoffman, 1979-1980). However, research from a family studies perspective has found consistent differences in grandparent-grandchild contact frequencies by lineage (Uhlenberg & Hamill, 1998). This suggests that grandparental behaviour can be examined by investigating contact frequencies. Michalski & Shackelford (2005) have argued, however, that contact frequencies are a poor measure for investment, mainly because they do not take into account who initiates contact. Yet, social network research commonly uses contact frequency measures and these measures often relate to emotional and financial support (for example: Taylor, 1986; see House, Umberson & Landis, 1988 for review). It is thus reasonable to examine contact frequency data from a grandparent perspective for evidence of lineage-based differences, as we have shown in previous studies (Pollet et al., 2006; Pollet et al, 2007). Here, we analyse a large data set from the UK for lineage effects on contact frequency and grandparental investment. We will control for marital separation of the grandparents, age and educational attainment of the mother and father, age of the infant and marital status of the mother.

The chief prediction of interest is that, when other factors are controlled for, there will be consistent differences in contact frequency between maternal grandmothers and paternal grandmothers/grandfathers, and between maternal grandfathers and paternal grandfathers. However, paternity uncertainty does not necessarily lead to predict that maternal grandfathers will invest more than paternal grandmothers, as is commonly found. This finding has been attributed to co-residence of grandparents (see Gaulin et al., 1997; McBurney et al., 2002 but see Euler & Weitzel, 1996) or sex-specific investment in matriline (Euler & Weitzel, 1996; Euler & Michalski, 2007). Laham and colleagues (2005) explained higher investment by maternal grandfathers than paternal grandmothers in terms of the availability of more certain

‘outlets’. If alternative investment options (e.g. cousins via a sister) are available to paternal grandmothers, they should invest less in grandchildren than maternal grandfathers do.

Differences between maternal grandmothers and paternal grandmothers and between maternal grandfathers and paternal grandfathers would thus suggest that psychological mechanisms attuned to paternity uncertainty are operating. Differences between maternal grandfathers and paternal grandmothers can be explained by co-residence of grandparents, sex-specific investment strategies or available investment outlets. In summary, we predict differences in face-to-face contact and investment according to the paternity uncertainty hypothesis. Moreover, we aim to test whether or not contact frequencies positively relate to other measures of grandparental investment. If contact frequencies do relate to financial investment, then they can be used as a reliable proxy for financial investment. Our study sample is very large compared to previous tests on the paternity uncertainty hypothesis (e.g. Euler & Weitzel, 1996) and allows thorough investigation of these issues.

METHODS

Sample description and variables

The Millennium Cohort Study is a nationally representative study on pregnancy and child development (Plewis & Ketende, 2006; CLS, 2003). It contains data on 18,819 children born between 2000 and 2002 (Hansen, 2006). The response rate was 68% and the data we present below are from the first survey wave when the children were between nine and twelve months old. The sample is disproportionately stratified and ethnic minorities as well as respondents from deprived areas were overrepresented in this sample in comparison to the general population (see Hansen, 2006 for details). Cases where the respondents of the interviews

were not the parents of the cohort member were excluded. We only included cohort members for which all four grandparents were alive at the time of the survey and for which the contact frequency details were known. We excluded homosexual parent couples from the analyses and parent couples where the male partner did not reside in the same household as the mother. Exclusion of couples where the male partner did not reside with the mother rules out that the lack of investment by paternal grandparents is due to factual separation of the parents (see Johnson, 1988). We also only included grandparents who had never separated. This rules out any effects based on grandparental marital status (Baydar & Brooks-Gunn, 1998; Denham & Smith, 1989; King, 2003; Reitzes & Mutran, 2004). The final sample consisted of 7,469 individuals.

During the computer assisted personal interview, parents of the cohort member reported how often they saw their parents. The question in the interview was *'How often do you see your mother/father nowadays?'* (CLS, 2003). This item had nine response categories ('Every day', '3-6 times a week', 'once or twice a week', 'less often but at least once a month', 'once every few months', 'once a year', 'never' and 'parent lives with me'). There were only three respondents for which there were no data on these response variables (two for maternal grandmother and one for the maternal grandfather). These cases were excluded for analyses involving contact frequency. The category 'every day' was combined with 'parent lives with me'. Cases where the respondent answered 'the parent lives with me' were not common (less than 2.5% of the sample). The conclusions presented remain unaltered if these cases are excluded. We calculated difference scores for this contact frequency measure between the four grandparents. A large score thus indicates that there is a large difference between grandparents in contact frequency.

Respondents also reported whether the birth of their child changed how often their mother and father had contact with them (three categories: 'more often', 'about the same as before',

‘less often’). As for the contact frequency variable, we calculated difference scores between the four grandparent categories.

During the interview the respondent and her partner also provided information on whether their parents provided any financial benefits towards the child. If the respondent answered ‘yes’ to the question that their parents provided help, they were then asked: ‘in what ways do they help you?’ (CLS, 2003). The respondents’ answers were subsequently coded in six categories: essentials for the baby, household costs, gifts and extras for the baby, loans and help for child care and other financial help. The category ‘other financial help’ mainly consisted of buying or paying for large capital items (1); giving money or cash gifts (2); trust fund or savings account for the baby (3). Given that less than 0.5% of the sample listed that their parents provided ‘other financial help’, this category was discarded. The survey did not further differentiate whether their father or mother provided these benefits, so we cannot distinguish between maternal grandmothers and maternal grandfather or between paternal grandmothers and paternal grandfathers, only between the two lineages (maternal versus paternal grandparents). We constructed two types of measures. Firstly, we computed the sum of the different provided benefits. We refer to this measure as the diversity index. Subsequently, a difference score between maternal and paternal grandparents was calculated. A larger score indicates that the maternal grandparents offer financial benefits in a more diverse way than paternal grandparents. Secondly, we also calculated difference scores for each type of benefit according to lineage (essentials, household costs, gifts and extras for the baby, loans and help for child care). These scores can be -1 (*paternal grandparents provide this benefit but maternal grandparents did not*), 0 (*no difference between maternal and paternal grandparents*) or 1 (*maternal grandparents provide this benefit but paternal grandparents did not*).

As control variables, we included educational attainment of the respondent and her partner as well as their ages, the age of the infant (in months) and the marital status of the mother. These factors have been shown to influence the relations between grandparents and their grandchildren (Baydar & Brooks-Gunn, 1998; Denham & Smith, 1989; Johnson, 1988; Kivett, 1985). Unfortunately no data on urbanisation, distance between grandparent and parent, frequency of telephone contact between parent and grandparent, age and educational attainment of the grandparents or initiation of contact (Does the grandparent or the parent initiate contact?) are available. These useful controls are lacking (see Barranti, 1985; Baydar & Brooks-Gunn, 1998; Lawton et al., 1994; King & Elder, 1995; King, 2003; Michalski & Shackelford, 2005; Uhlenberg & Hamill, 1998). Nonetheless even without these controls these data can be used to test whether there are lineage based differences in grandparental contact and investment. Moreover, these data have some additional benefit over the previous set that we used (Pollet et al., 2006, 2007) as the grandchildren are all aged between nine and twelve months and age of the grandchild has been shown to influence grandparental investment (Kivett, 1985). In addition, these data allow investigating whether the birth of a grandchild leads to differential investment by the grandparent. Moreover, previous research did not distinguish between types of financial investment.

Statistical analyses

Difference scores (contact frequency, change in contact after birth, financial help) are tested against zero by use of t-tests. If difference scores are indeed significantly different from zero, then there are significant differences according grandparent type. Cohen's D was also calculated for this difference (Cohen, 1988).

In order to ensure that any significant differences found are not due to a spurious relationship with a third variable, we test for effects of control variables (age, marital status, educational attainment of the respondent, age of the infant in months, age, and educational attainment of the respondent's partner) on the difference scores using linear mixed models in SPSS 15.0. Linear mixed models take into account correlated effects between variables, as are found here (age of mother, age of father and educational attainment of mother and educational attainment of the father). We also tested models with random effects (slopes and intercepts) at household level. The final models were selected based on Akaike Information Criterion (AIC) and Schwarz's Bayesian Information Criterion (BIC) (see Kuha, 2004). In all cases, the final 'best fit' models did not contain a random slope or intercept and all models presented differed minimum two units in AIC and BIC from the second best models. The models had absolute parameter, likelihood and Hessian convergence (SPSS, 2005). The parameters in the final models were estimated by REML, as this method deals better with outliers than Maximum Likelihood (see Diggle, 1988). For the final models, we present a brief summary of F-tests. The F-tests are used to examine whether a variable significantly contributes to the model. The effects of control variables in these models are not discussed in detail here, since our only concern is whether there is a difference by lineage that persists when other variables are controlled for. Parameter estimates for these variables can be obtained from the authors. If the residuals from the linear mixed models with control variables included are larger than zero, then the control variables do not entirely explain the observed differences. These residuals are tested against 0 by use of the correspondent Wald Z test. It is important to bear in mind that residuals are absolute residuals.

Finally, we will test whether contact frequencies relate to investment by use of multiple correspondence analysis (MCA) for each lineage (Clausen, 1998). MCA is a categorical equivalent to factor analysis and allows testing whether variables can be clustered

together as an underlying dimension. We will report the explained inertia (MCA labels variance as inertia) by each dimension and the loadings (which MCA labels as discrimination) of each variable for each dimension. The models presented had absolute convergence and the dimensions were extracted by the ‘variable principal’ method. For the MCA analysis, we will only look into whether contact frequency relates to financial investment, and not whether or not change in contact relates to financial investment

RESULTS

INSERT TABLE 1 HERE

INSERT TABLE 2 HERE

INSERT TABLE 3 HERE

Tables 1 to 2 show the raw frequencies of the responses. Table 3 shows the descriptive statistics for the control variables. It is important to stress here that the marital status relates to the legal marital status, not the relationship status with the cohabiting partner. Thus, being divorced or legally divorced does not imply that the mother is divorced or separated from the cohabiting father of the cohort member, rather that she had a previous marriage.

Subsequently, we calculated difference scores for contact frequencies according to the four grandparent types

Contact frequencies

INSERT FIGURE 1 HERE

Figure 1 shows that there are significant differences between all contrasts between grandparents. There was a significant difference between maternal and paternal grandmothers in face-to-face contact with their grandchild (Mean difference: 0.455; $t(7467)=16.9$; $p<0.0001$; Cohen's $D=0.2$; Figure 1). Maternal grandfathers also had significantly more contact than paternal grandfathers (Mean difference: 0.106; $t(7467)= 3.34$; $p=0.0008$; Cohen's $D= 0.04$; Figure 1). Maternal grandmothers had significantly more contact than paternal grandfathers (Mean difference: 0.8; $t(7466)= 26.91$; $p<0.0001$; Cohen's $D= 0.31$; Figure 1). Maternal grandfathers, however, had significantly less contact than paternal grandmothers (Mean difference: -0.23; $t(7467)= -7.81$; $p<0.0001$; Cohen's $D= -0.09$; Figure 1). Within each lineage the effect of sex was also significant: Maternal grandmothers had significantly more contact than maternal grandfathers (Mean difference: 0.685; $t(7466)= 34.37$; $p<0.0001$; Cohen's $D= 0.4$; Figure 1) and paternal grandmothers had significantly more contact than paternal grandfathers (Mean difference: 0.336; $t(7468)= 19.04$; $p<0.0001$; Cohen's $D= 0.22$; Figure 1).

There are thus consistent differences in contact frequency according to lineage and sex of the grandparent. The largest differences are between maternal grandmothers and paternal grandfathers. Interestingly, paternal grandmothers had more frequent contact than maternal grandfathers. The effect of sex differences within the same lineage also appear to be larger than lineage differences within the same sex. Next, we analyzed all the comparisons between grandparent categories in more detail (Table 4).

INSERT TABLE 4 HERE

We will now briefly verbally describe the effects from Table 4 (parameter estimates not shown). In general, if the respondent was older then their father or mother would have

relatively more contact than the respondent's partner's. If the parent was more highly educated instead of less highly educated, then their parent would have relatively more contact than the parent of their partner. With rising educational attainment of the parent, the difference between their father and their mother also becomes smaller. If the mother was not married instead of married, then grandmothers would become relatively more involved. If the infant was older, by contrast, then the maternal grandmother tended to have relatively more contact with the grandchild than the paternal grandfather.

While across models, the control variables predict differences in contact frequency, in none of the models do the control variables fully explain the observed differences between grandparent types. The main conclusion from the analyses is that the observed differences from Figure 1 cannot be explained by the control variables (maternal educational attainment, paternal educational attainment, marital status of the mother and age of father, mother and the infant). There are thus significant differences between lineages in face-to-face contact frequency with the grandchild. Within each lineage, sex also influences face-to-face contact frequency with grandmothers having significantly more contact with their grandchildren than grandfathers.

Changes in contact frequency since birth grandchild.

INSERT FIGURE 2 HERE

Figure 2 shows differences between grandparents in contact after their grandchild is born. There are consistent differences according to lineage with maternal grandparents having relatively more contact than paternal grandparents after the child was born. Within each lineage, grandmothers were also likely to have more contact than grandfathers after the child was born. Unlike the results from Figure 1, maternal grandfathers have a greater increase in

contact after the birth of a grandchild than paternal grandmothers. Also, unlike for raw contact frequencies (Figure 1), the effects of lineage and sex appear to be of similar importance for changes in contact frequency following the birth of a grandchild. All differences shown in Figure 2 are significantly different from zero (all t-tests; $p < 0.0001$). The largest effect sizes were found for the comparisons between maternal grandmothers and paternal grandmothers, between maternal grandmothers and paternal grandfathers and between maternal grandmothers and maternal grandfathers (all Cohen's $D = 0.1$). There were also sizeable differences between maternal grandfathers and paternal grandfathers and between paternal grandmothers and paternal grandfathers (both Cohen's $D = 0.08$). The difference between maternal grandfathers and paternal grandmothers was small (Cohen's $D = 0.03$).

Next, we constructed linear mixed models as we did for contact frequency. These analyses are summarized in Table 5 and show that none of the control variables explained the observed differences from Figure 2. The direction of the effects for the control variables was the same as described for Table 4 (parameter estimates not shown). All residuals from the analyses were significantly different from zero in the Wald Z tests ($p < 0.0001$). As above, we can thus conclude that there are significant differences between maternal and paternal grandparents in contact frequency after birth. Also within each lineage, grandmothers tended to have a greater increase in contact after the birth of a grandchild than grandfathers.

INSERT TABLE 5 HERE

Financial investment

INSERT FIGURE 3 HERE

Figure 3 shows significant differences between maternal grandparents and paternal grandparents in the diversity of benefits provided, the provision of essentials and giving gifts and extras for the baby. Maternal grandparents provided a wider range of financial benefits than paternal grandparents (Mean difference= 0.06; $t(7468)= 4.27$; $p<0.0001$; Cohen's $D= 0.049$). Similarly, maternal grandparents were more inclined to provide essentials for the baby than paternal grandparents (Mean difference= 0.03; $t(7468)= 4.43$; $p<0.0001$; Cohen's $D= 0.05$) as well as gifts (Mean difference= 0.04; $t(7468)= 6.41$; $p<0.0001$; Cohen's $D= 0.07$). Lineage does not appear to influence the provision of money for household costs, lending money or providing money for child care (*respectively*: Mean difference= 0.001; $t(7468)= 0.21$; $p=0.832$; Mean difference= -0.005; $t(7468)= -1$; $p=0.32$; Mean difference= 0.1; $t(7468)= 0.1$; $p=0.92$).

The differences shown for maternal and paternal grandparents in the diversity of financial benefits they provide, the provision of essentials and whether or not they gave gifts and extras for the baby in Figure 3 cannot be attributed to the control variables (Table 6). Parameter estimates for the control variables can be obtained from the author.

INSERT TABLE 6 HERE

Relationship between contact frequencies and grandparental investment

Subsequently we performed multiple correspondence analysis (MCA) with the (raw) contact frequency measures (contact with mother and contact with father) and the (raw) financial investment measures.

Maternal contact with mother and father and financial investment in grandchildren

Help with childcare was excluded as it did not discriminate at all in any of the analyses (all loadings <0.05). MCA showed that three dimensions had an eigenvalue larger than 1. The third dimension was similar to the second dimension, loading predominantly on face-to-face contact with mother and face-to-face contact with father and smaller crossloadings. Given that this factor does not appear to be substantially different and reaches the eigenvalue larger than one by. So we extracted two dimensions. These two dimensions account for 63% of the inertia (Table 7). The first dimension loads on nearly all items, albeit weakly for gifts and extras (0.17). This first dimension explains most inertia and therefore we can conclude that contact frequencies can indeed be grouped together with various forms of ‘financial investment’. The second dimension uniquely and strongly loads on contact with mother and contact with father and can thus be labelled ‘contact frequency’ (both loadings 0.8). As with factor analysis, one can examine the relationships after transformation (rotation) according to the extracted dimension(s). Transformation according to the first dimension all variables correlate from weakly (0.06 to 0.1) to strongly (0.77) (Table 8).

INSERT TABLE 7 HERE

INSERT TABLE 8 HERE

Paternal contact with mother and father and financial investment in grandchildren

Help with childcare was excluded as it did not discriminate at all in any of the analyses (all loadings <0.05). Like the previous analysis, MCA showed that three dimensions fulfilled the eigenvalue above one criterion. Again, like the previous analysis, the third dimension was essentially the same as the second dimension, only loading weaker. It was thus excluded and the analysis was redone with two dimensions. These two dimensions account for 70% of the inertia (Table 9). The first dimension loads moderately (around 0.3) on nearly all items and

strongly on the diversity of financial help provided. The correlations after transformation according to the first dimension are presented in Table 10. After transformation all variables correlate weakly (0.07 to 0.1) to strongly (0.7). The second dimension, most strongly loads on the father's contact with his mother and father, the diversity of the financial benefits and gifts and extras. The first dimension explains most inertia and therefore we can conclude that contact frequencies can be grouped together with various forms of 'financial investment'. The second dimension reveals that contact with mother and father is linked with the diversity of benefits provided as well as giving gifts and extras. The dimensions are very similar to those found for maternal contact with parents and financial investment, although the second dimension for this analysis does not uniquely load on contact with mother and father.

INSERT TABLE 9 HERE

INSERT TABLE 10 HERE

Discussion

Our results show consistent differences in contact frequency by lineage. Moreover, within each lineage grandmothers had more frequent contact with their grandchild than grandfathers. Paternal grandmothers were also significantly more likely to have frequent contact than maternal grandfathers. This effect is unlike previous studies which have tended to find the reverse, namely that maternal grandfather's solicitude exceeds that of paternal grandmothers. It is unclear what could explain the difference between our study and other studies.

For all comparisons, the observed differences from Figure 1 could not be (entirely) explained by the proposed control variables. While there thus were significant differences according to lineage in contact frequency, the effect sizes as measured by Cohen's D indicate

that the influence of lineage is relatively weak. The sex differences within a lineage in contact frequencies also appear larger than lineage differences within a sex. Thus, while significant, the effect of lineage is generally not very strong, especially in comparison to the effect of sex.

Lineage also influenced change in contact with a parent following the birth of the grandchild. Maternal grandparents were relatively more inclined than paternal grandparents to have more frequent contact following the birth of a grandchild. Sex of the grandparent also influenced changes in contact frequency following a grandchild's birth: grandmothers were more inclined than grandfathers to see their child more frequently following the birth of their grandchild. For change in contact frequency with a parent following the birth the size of sex differences between grandparents (within lineage) was of similar to the size of differences between grandparents according to lineage (within the same sex). Unlike raw contact frequencies, maternal grandfathers were more inclined than paternal grandmother to have more frequent contact with their child, after the birth of their grandchild.

Maternal grandparents provided their children with a wider range of financial support than paternal grandparents. Maternal grandparents also differed significantly from paternal grandparents in the likelihood of providing essentials and gifts and extras. Maternal grandparents were not significantly more likely than paternal grandparents to provide financial help towards childcare, household costs or loans. From Table 2, it is however evident that these forms of financial help, especially money for child care and money for household costs, are less common than other forms of financial help such as providing gifts and extras for the baby.

From the Multiple Correspondence Analysis, it is clear that contact frequencies are indeed a useful proxy for financial investment. For both maternal and paternal grandparents, contact frequencies are positively related to measures of financial investment. For both analyses, maternal and paternal, there is an underlying distinct dimension to which both contact

frequencies with mother and father relate. This dimension can be labelled 'general investment'. This dimension was the first extracted dimension and explained the most variance, in both cases. Thus, rather than providing financial benefits forming an autonomous dimension, the provision of financial benefits appears to be consistently linked with frequent face-to-face contact. It must be noted, however, that these relationships between contact frequencies and this underlying dimension of investment are not very strong, only moderate (loadings of 0.25 to 0.36). As can be easily seen from Table 2, however, certain forms of financial investment, help with household costs for example, are not frequent at all. The relatively low occurrence of these forms of investment explains why the loadings as well as correlations after transformation can be low.

There are a number of limitations to the study. For example, the observed lineage differences in contact frequency could be explained in terms of distance: that is if maternal grandparents live closer to their grandchildren than paternal grandparents do. However, Pollet et al. (2007) showed that there was no significant difference in how far maternal grandparents and paternal grandparents lived from their grandchild in a Dutch sample. In addition, they found that maternal grandparents, especially the maternal grandmother, generally travelled further than paternal grandparents in order to see their grandchild. Another limitation is that there are no controls for grandparental age or educational attainment. However, our analysis did have proxies for these, as grandparental age and education should correlate with parental age and education and these were included as controls. Moreover, our study sample is very large and the differences in investment and contact frequency according to lineage appear to be a robust finding (most of the analyses $p < 0.0001$). These observed lineage differences in investment cannot be easily explained away (entirely) by an underlying third variable. A further limitation is that our dependent measures for financial investment are 'yes or no' measures: they do not give a quantifiable amount. In theory it is thus possible that while

overall maternal grandparents are more inclined to provide a wider range of financial benefits than paternal grandparents, the amount invested is still larger. Further research is necessary to determine whether this is the case or not. At face value, however, it appears to be the case that maternal grandparents invest significantly more, given that they help in more ways, than paternal grandparents.

Future research can establish whether these differences in grandparental investment by lineage actually have any measurable effect on grandchildren's health and development. Data from historical populations and traditional populations suggests that this is the case: maternal grandmothers appear to have a beneficial effect on child health status and mortality (for example: Sear et al., 2000; Sear et al., 2002; Voland & Beise, 2002). As the Millennium Cohort Study has a longitudinal design, we aim to investigate whether these lineage differences persist throughout the life course and have any measurable effect on the grandchild. Moreover, we aim to investigate whether there is a critical period in which these occur. We expect that help from maternal grandparents has a larger impact when earlier during the child's life. For now, we have established the more limited fact that maternal grandparents have more contact with their grandchildren as well as being more inclined to provide certain financial benefits for them than paternal grandparents, all else being equal.

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Contact frequency	MGM	MGF	PGM	PGF
Every day / Resident (1)	1916	1166	956	918
3-6 Times a week (2)	1550	1213	1080	954
Once or twice a week (3)	1684	1796	2453	2101
Less often but at least once a month (4)	827	1015	1263	1233
Once every few months (5)	833	1019	961	1006
Once a year (6)	140	253	231	313
Less than once a year (7)	338	401	336	430
Never (8)	179	605	189	514
Chang in contact frequency	MGM	MGF	PGM	PGF
More often	2220	1752	1710	1357
About the same as before	4451	4975	4880	5315
Less often	798	742	879	797

Table 1: Raw frequencies for contact frequency and change in contact frequency by grandparent category (MGM: Maternal Grandmother; MGF: Maternal Grandfather; PGM: Paternal Grandmother; PGF: Paternal Grandfather).

		Maternal	Paternal
Diversity of Benefits provided	0	1341	1537
	1	3768	3735
	2	1564	1438
	3	528	539
	4	249	194
	5	19	26
Essentials	No	5599	5803
	Yes	1870	1666
Household costs	No	6966	6972
	Yes	503	497
Gifts and extras for the baby	No	1743	2040
	Yes	5726	5429
Loans	No	6180	6140
	Yes	1289	1329
Money for childcare	No	7414	7415
	Yes	55	54

Table 2: Raw frequencies for financial benefits provided by lineage.

		Mother	Father
Educational attainment	Higher degree	298	410
	First degree	1160	1073
	Diplomas in higher education	763	662
	A / AS / S levels	807	592
	O level / GCSE grades A-C	2591	2425
	GCSE grades D-G	745	836
	Other academic qualifications (incl. overseas)	184	170
	None of these qualifications	916	1290
	Missing	5	11
Age	Mean	29.56	31.73
	Std.	5.29	5.45
Marital status mother	Legally separated	116	
	Married, 1st and only marriage	4829	
	Remarried, 2nd or later marriage	327	
	Single, never married	1973	
	Divorced	221	
	Widowed	3	
Age infant (months)	Mean	9.19	
	Std.	0.5	

Table 3: Descriptive statistics (frequencies or mean and standard deviation) for control variables.

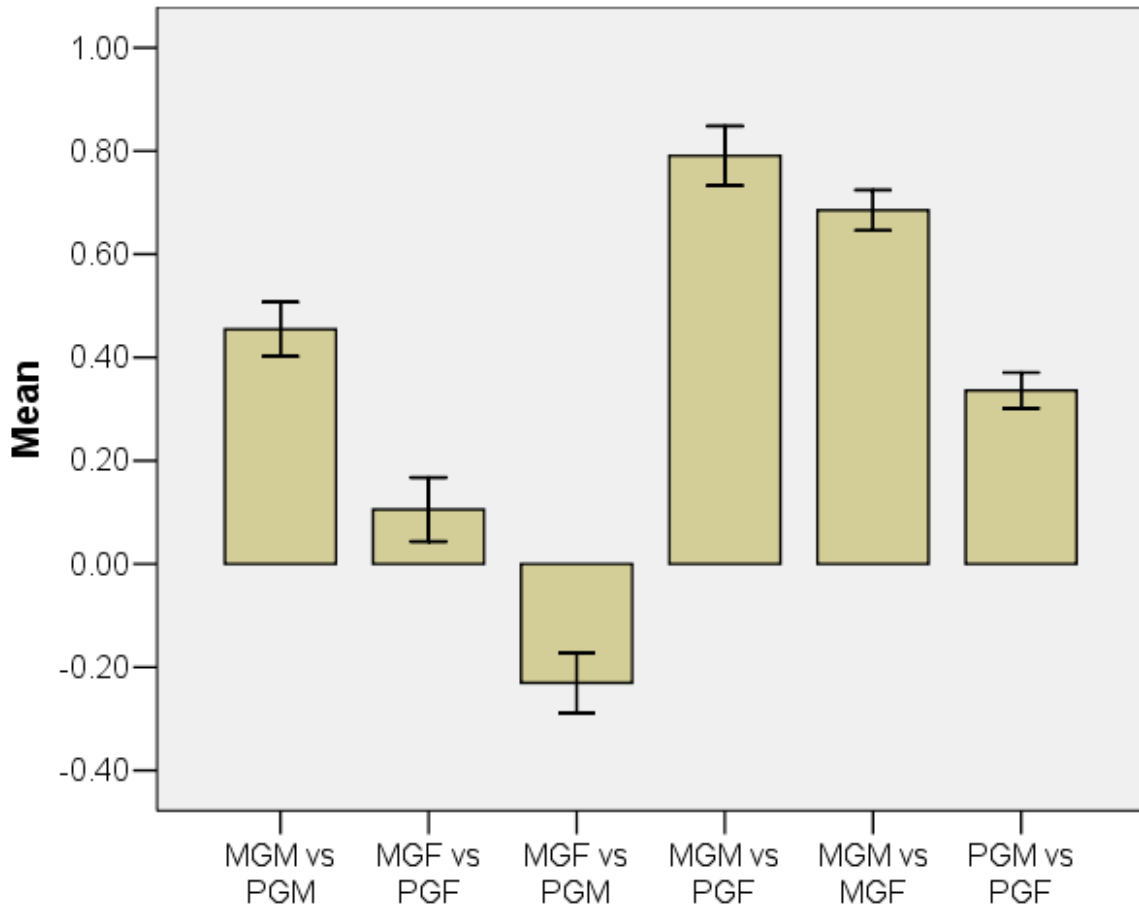


Figure 1: Mean difference (first minus second listed) in contact frequency. A score of 0 represents no difference between the first and second grandparent listed; A score of 1 would indicate a difference between the first and second grandparent listed by one category from Table 1. Bars represent 95% confidence intervals. MGM: Maternal Grandmother; PGM: Paternal Grandmother; MGF: Maternal Grandfather; PGF: Paternal Grandfather.

Contact frequency	MGM vs	MGF vs	MGM vs	MGF vs	MGM vs	PGM vs
	PGM	PGF	PGF	PGM	MGF	PGF
Maternal education	***	***	***	***	**	ns
Paternal education	***	***	***	***	**	***
Maternal age	*	***	ns	***	***	ns
Paternal age	ns	ns	ns	ns	ns	**
Maternal marital status	ns	ns	***	ns	ns	**
Age of the infant	ns	ns	ns	ns	*	ns
Estimated Residual (+/- std. error)	5.15 (+/-0.08)	7.17 (+/-0.11)	6.15 (+/-0.1)	6.18 (+/-0.1)	2.9 (+/-0.05)	2.29 (+/-0.04)

Table 4: Summary of linear mixed models for difference scores in contact frequency (first minus second listed) with closest fit; *: significant at $p < 0.05$; **: significant at $p < 0.01$. *: significant at $p < 0.001$ (F-tests). The last row gives the estimated residuals. All residuals were significantly different from 0 (All Wald Z test; $p < 0.0001$)**

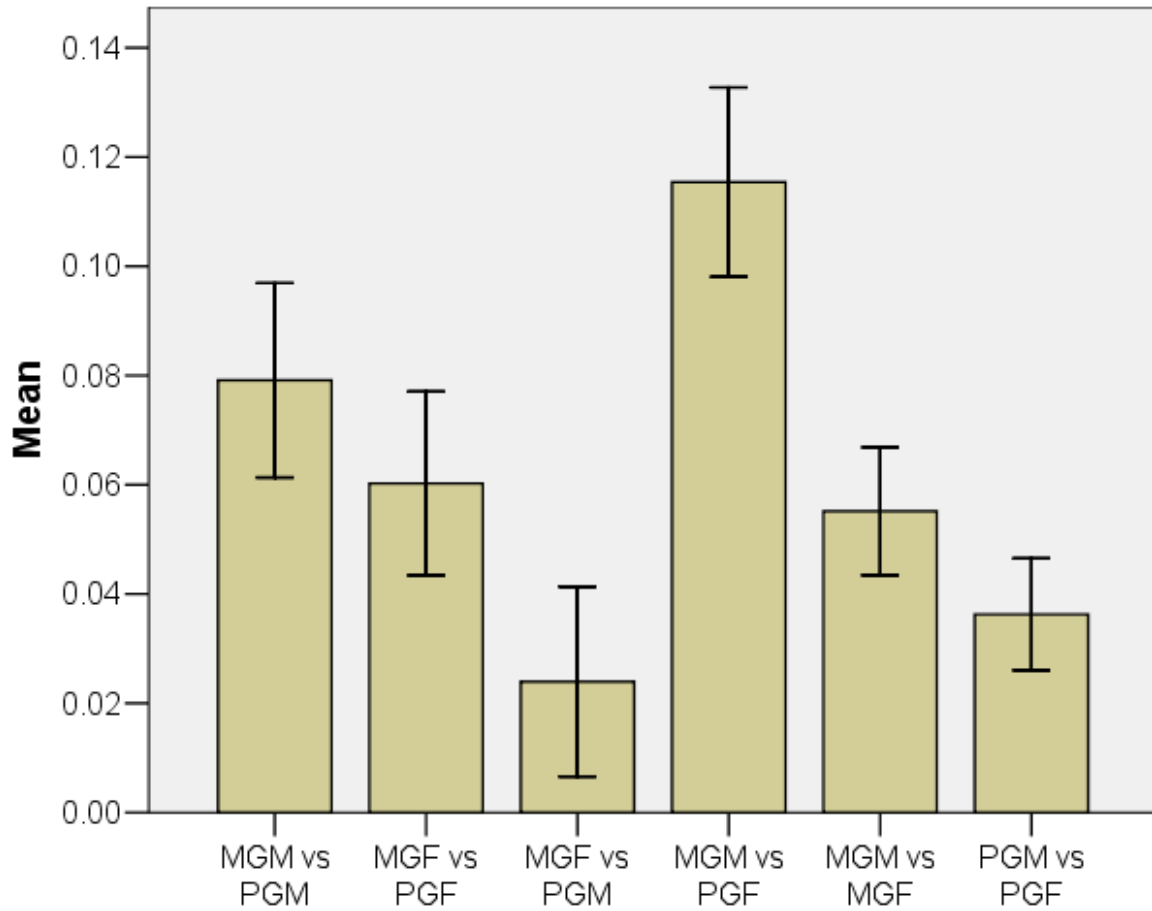


Figure 2: Mean difference (first minus second listed) in contact change after birth of the grandchild. A score of 0 represents no difference between the first and second grandparent listed. A score of 1 would indicate a difference between the first and second grandparent listed by one category from Table 1. Bars represent 95% confidence intervals. MGM: Maternal Grandmother; PGM: Paternal Grandmother; MGF: Maternal Grandfather; PGF: Paternal Grandfather.

Change in contact frequency	MGM vs PGM	MGF vs PGF	MGM vs PGF	MGF vs PGM	MGM vs MGF	PGM vs PGF
Maternal education	***	***	***	***	ns	***
Paternal education	ns	ns	ns	ns	ns	ns
Maternal age	*	ns	ns	ns	ns	ns
Paternal age	*	ns	ns	ns	ns	ns
Maternal marital status	ns	ns	ns	ns	ns	ns
Age of the infant	ns	ns	ns	ns	ns	ns
Estimated Residual (+/- std. error)	0.61 (+/-0.01)	0.55 (+/-0.01)	0.58 (+/-0.01)	0.58 (+/-0.01)	n/a	0.2 (+/-0.003)

Table 5: Summary of linear mixed models for difference scores in change of contact frequency (first minus second listed) with closest fit; *: significant at $p < 0.05$; **: significant at $p < 0.01$. *: significant at $p < 0.001$ (F-tests). The last row gives the estimated residuals. All residuals were significantly different from 0 (All Wald Z test; $p < 0.0001$)**

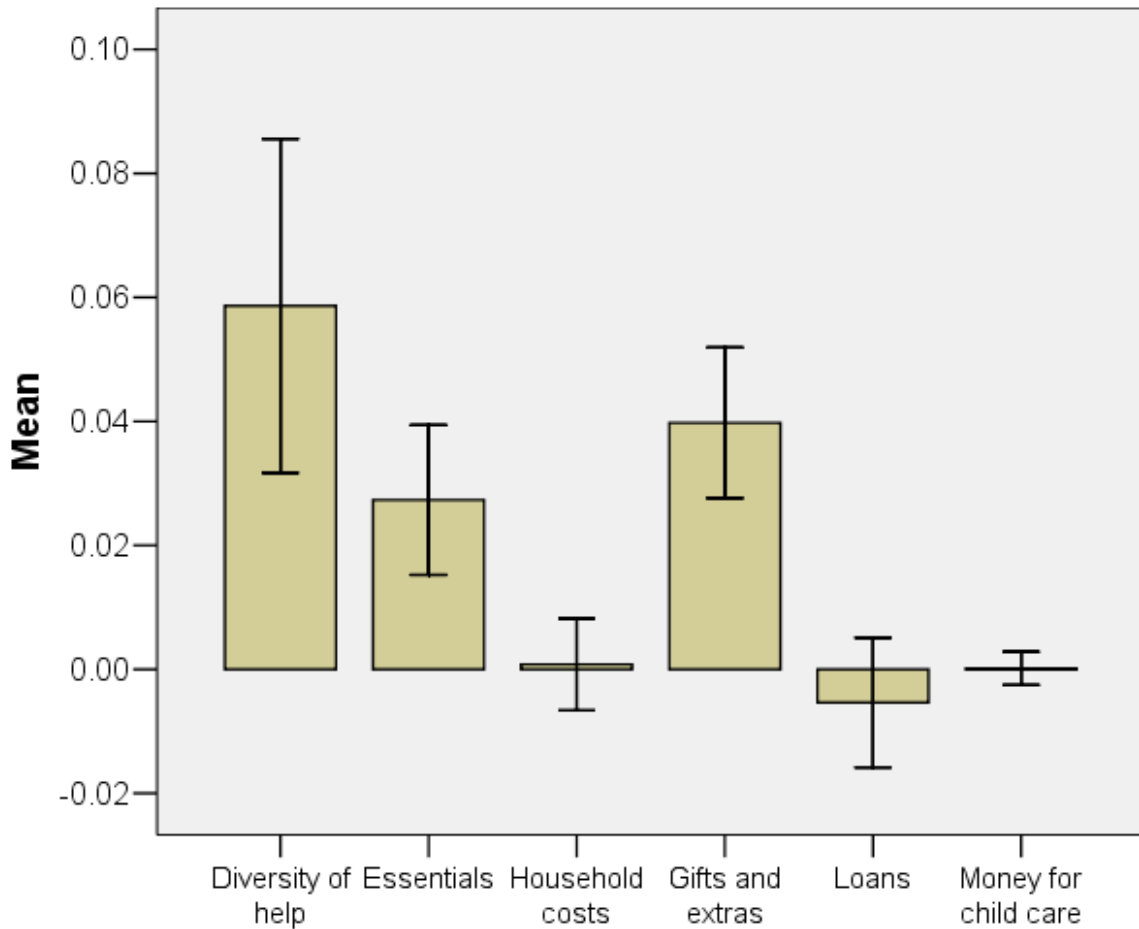


Figure 3: Difference between maternal and paternal grandparents in help. A score of 0 represents no difference between the maternal and paternal grandparents listed. Positive scores indicate that maternal grandparents invest more than paternal grandparents. A score of 1 would indicate a difference between the first and second grandparent listed by one category from Table 2. Bars represent 95% confidence intervals.

Investment	Diversity of help	Essentials	Gifts and extras
Maternal education	***	**	**
Paternal education	***	***	***
Maternal age	ns	*	ns
Paternal age	***	ns	*
Maternal marital status	*	ns	ns
Age of the infant	ns	ns	ns
Estimated Residual (+/- std. error)	1.4 (+/-0.02)	0.28 (+/-0.005)	0.29 (+/-0.005)

Table 6: Summary of linear mixed models for difference scores in investment (maternal grandparents minus paternal grandparents) with closest fit; *: significant at $p < 0.05$; **: significant at $p < 0.01$. *: significant at $p < 0.001$ (F-tests). The last row gives the estimated residuals. All residuals were significantly different from 0 (All Wald Z test; $p < 0.0001$)**

	Dimension	
	1	2
Contact with mother	0.31	0.83
Contact with father	0.25	0.83
Diversity	0.74	0.01
Essentials	0.54	0.01
Household costs	0.26	0.02
Gifts and extras	0.17	0.05
Loans	0.38	0.02
Eigenvalue	2.87	2.04
% of Inertia	37.99	25.24

Table 7: Loadings from multiple correspondence analysis on the maternal side.

	Diversity	Essentials	Household costs	Gifts and extras	Loans	Contact with mother	Contact with father
Diversity	1.00	0.77	0.37	0.31	0.56	0.21	0.16
Essentials	0.77	1.00	0.31	0.17	0.27	0.18	0.13
Household costs	0.37	0.31	1.00	0.06	0.31	0.10	0.07
Gifts and extras	0.31	0.17	0.06	1.00	0.07	0.23	0.16
Loans	0.56	0.27	0.31	0.07	1.00	0.17	0.12
Contact with mother	0.21	0.18	0.10	0.23	0.17	1.00	0.73
Contact with father	0.16	0.13	0.07	0.16	0.12	0.73	1.00

Table 8: Correlations after transformation according to the first dimension for the maternal side.

	Dimension	
	1	2
Contact with mother	0.36	0.53
Contact with father	0.30	0.50
Diversity	0.85	0.49
Essentials	0.46	0.03
Household costs	0.32	0.14
Gifts and extras	0.25	0.32
Loans	0.32	0.03
Eigenvalue	2.87	2.04
% of Inertia	41.05	29.12

Table 9: Loadings from multiple correspondence analysis on the paternal side.

	Diversity	Essentials	Household costs	Gifts and extras	Loans	Contact with mother	Contact with father
Diversity	1.00	0.70	0.54	0.58	0.61	0.30	0.24
Essentials	0.70	1.00	0.30	0.17	0.24	0.23	0.18
Household costs	0.54	0.30	1.00	0.07	0.23	0.18	0.16
Gifts and extras	0.58	0.17	0.07	1.00	0.08	0.20	0.15
Loans	0.61	0.24	0.23	0.08	1.00	0.16	0.12
Contact with mother	0.30	0.23	0.18	0.20	0.16	1.00	0.75
Contact with father	0.24	0.18	0.16	0.16	0.12	0.75	1.00

Table 10: Correlations after transformation according to the first dimension for the paternal side.