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Dead or alive: The interplay of grandparental investment according to the survival status of other grandparent types

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Abstract

BACKGROUND

According to the kin selection theory, grandparental investment has its evolutionary roots in the individuals' aim to maximise their inclusive fitness. Owing to an increasing overlap between successive generations in modern affluent populations, the importance of grandparental investment remains high. Despite the growing literature on this topic, there is limited knowledge regarding how the survival status of different grandparent types influences each other's investment in grandchildren.

OBJECTIVE

The present study examined how the survival status of grandparents influenced grandparental investment among other grandparent types using a wide range of grandparental investment variables divided into two latent constructs measuring relationship quality between grandparents and grandchildren and grandparental involvement in grandchildren.

METHODS

We used Bayesian structural equation modeling with multiple-indicator latent variables and the Involved Grandparenting and Child Well-Being Survey, providing nationally representative data of British and Welsh adolescents aged 11–16-years.

RESULTS

Maternal grandmothers' investment was most strongly influenced by whether other grandparents were dead or alive. Living maternal grandfathers and paternal grandmothers had an almost identical positive influence on the investment of maternal grandmothers in their grandchildren. Weaker

evidence suggested that living maternal grandmothers decreased the investment of paternal grandmothers and grandfathers.

CONCLUSIONS

These findings suggest the opposite influences of the survival status of paternal and maternal grandmothers on their investment. The results are discussed with reference to kin competition and incidental exposure.

CONTRIBUTION

The current study represents the first attempt to test whether the survival status of other grandparents is associated with focal grandparents' investment within and between lineages.

Keywords: Adolescent grandchildren, grandparental investment, structural equation modeling, survival status

Introduction

Based on kin selection theory, grandparents can increase their inclusive fitness by investing in grandchildren with whom they share, on average, 25% of the same genes (Hamilton 1964). Grandparental investment can be defined as actions of grandparents that can improve the fitness of grandchildren at the expense of any opportunity cost for grandparents themselves. Compared to parental investment, the costs of grandparental investment tend to be lower, particularly for those older adults who are post-reproductive, but the potential benefits of grandparental investment in terms of inclusive fitness are high (Euler 2011; Trivers 1972). In contemporary societies, grandparental investment is typically indicated via factors assumed to improve the well-being of grandchildren, including contact frequency, emotional closeness, financial support, and care.

Due to increased life expectancy, it is currently common for adolescent children to have two, three, or even four grandparents alive and only very few have none (Danielsbacka and Tanskanen 2012). A handful of studies so far investigate whether the death of one grandparent has any effect on other grandparents' levels of investment. Some studies indicate that there tends to be a decrease in grandfathers' investments in their grandchildren when their spouses (in the case of this research, grandmothers) are deceased (Westphal et al. 2015; Uhlenberg and Hammill 1998), although other studies find that this effect is either very small or negligible (Danielsbacka and Tanskanen 2012; Monserud 2008). According to these prior studies, the death of grandfathers tends to have no impact on the investment of grandmothers. These prior findings thus indicate that when grandmothers are investing in their grandchildren, their spouses (i.e., grandfathers) will be "incidentally exposed" to the grandchildren as well (Euler 2011).

Perhaps the most important limitation of these prior studies is that they investigate the influence of grandparental survival status only within a lineage and ignore the fact that the investment of maternal grandparents may influence paternal grandparents and vice versa. More accurately, because all dyadic relationships between grandchildren and grandparents tend to be linked to one another (King and Elder 1995), the survival status of a focal grandparent could have an impact on the investment of other grandparents as well. Within a lineage, the presence of a spouse can be assumed to boost the investment of the focal grandparent, and this is demonstrated in some prior studies (Westphal et al. 2015; Uhlenberg and Hammill 1998). However, this may not be the case if one considers the effect between lineages. When grandparents from both lineages are alive, there could be competition over access to grandchildren’s lives between maternal and paternal grandparents (Euler 2011). This competition may lead to two opposite outcomes. First, when grandparents from other lineages are alive, there may not be room for the investment of the focal grandparents. Prior studies indicate, in particular, that the investment of maternal grandparents in grandchildren tends to diminish the investment of paternal grandparents (Danielsbacka et al. 2011; Laham et al. 2005). Second, an alternative option is that kin competition will present itself in the way that the presence of other grandparent types will “cheer” the investment of the focal grandparent and thus lead to an accumulation of grandparental investment.

The present study explores how the survival status of grandparents influences grandparental investment among other grandparent types. We used a wide range of grandparental investment variables divided into two latent constructs measuring relationship quality between grandparents and grandchildren and grandparental involvement in grandchildren. To the best of our knowledge, no prior study has tested whether the survival status of other grandparents is associated with focal grandparents’ investment both within and between lineages. The present analyses are based on nationally representative data from the UK, where adolescent grandchildren provide information on grandparental investment.

Materials and methods

Data

We used the Involved Grandparenting and Child Well-Being 2007 survey, recruited by GfK National Opinion Polls, which is a nationally representative sample of British and Welsh adolescents aged 11-16 (see also Attar-Schwartz et al. 2009; Danielsbacka and Tanskanen 2012; Griggs et al. 2010; Tan et al. 2010; Tanskanen et al. 2011). From the 103 randomly selected schools, in which the classes were randomly chosen, 70 schools returned the questionnaires (response rate: 68%). Respondents completed the questionnaire in a school classroom, and the original sample included 1566 adolescents (Attar-Schwartz et al. 2009). When filling in the questionnaire on grandparental investment, respondents were asked to answer questions for only those grandparents who were still alive. Hence, only those respondents who had at least one living grandparent (n = 1,488) were considered in the analyses. We also excluded those children from the analyses (n = 58) who were co-residing with their grandparents; in such cases, the co-residing grandparents tend to be forced to invest more heavily in grandchildren where it might not necessarily be the case otherwise. That is, the maximum total number of children included in the analyses was 1,430. Among these children, 83.7%, 68.8%, 73.2%, and 57.1% had a living maternal grandmother, maternal grandfather, paternal grandmother, and paternal grandfather, respectively. The descriptive statistics of the sample have been reported elsewhere (Danielsbacka and Tanskanen 2012; Tanskanen et al. 2011).

To measure grandparental investment in grandchildren, we used two latent constructs, one describing the grandparent's closeness or relationship quality with the grandchild (i.e., the "relationship" factor) and the second describing the grandparent's involvement with the grandchild (i.e., the "involvement" factor) (Elder and Conger 2000). The "relationship" factor was measured by five questions addressed to grandchildren on whether "they could depend on their grandparents," "they felt appreciated, loved, or cared for," "the grandparent helped them in significant ways" (used as a marker indicator), "they are happy with their relationship with the grandparent," and "they were close compared to other grandchildren to grandparents," measured on a 4-point Likert-type scale ranging from 1 = not at all to 4 = a lot. The "involvement" factor was measured by six questions about grandchildren on whether "their grandparents had looked after them," "participated in their social interest and school-related activities," "had been a mentor/advisor for future plans and problems," "offer good advice," "provided financial assistance" (used as a marker indicator), and finally, they were asked "how often do you see them." These questions were measured on a 3-point Likert-type scale ranging from 1 = never to 3 = usually, whereas the question "how often do you seem them" was measured on a 4-point scale like the questions regarding the "relationship" factor.

Statistical analysis

We used structural equation modeling (SEM) with multiple-indicator latent variables (Kline 2016) to examine how the survival of other living grandparents influenced subjects' investment, measured as the latent variables "relationship" and "involvement", of a focal grandparent on their grandchild. That is, for all grandparents, we constructed two latent variables to describe their investment in their grandchild, and how these latent variables were influenced by whether each of the other grandparent types was dead or alive. All indicators of latent variables were treated as ordinal, using a probit link function. Therefore, the loadings can be interpreted as the extent to which a one-unit increase in the latent variable score changes the predicted probit index in standard deviation units. In SEM with categorical latent variable indicators (nominal or ordinal) it is assumed that the categories of observed ordinal variables are determined by the thresholds (the number of categories in the observed variable minus one) in the underlying normally distributed latent variable (Kline 2016). These latent variables then become the indicators of the main latent variable (here, "relationship" and "involvement"), which are, in turn, associated with the ordinal observed variables by the respective threshold structure (Kline 2016). The model fitted included living distance between grandparents and the grandchild (in the same town, not in the same town but within 10 miles, further away in the UK, or overseas (= a reference category)), the number of other grandchildren (single grandchild (a reference category), one to two grandchildren, more than three grandchildren, two to four grandchildren, more than four grandchildren, and more than six grandchildren), and grandchild's age and ethnicity (white (= a reference category), black or Afro-Caribbean, Asian, and mixed parentage) to account for variance in variables measuring grandparental investment. Please note that these variables were not considered as statistical confounders, as we do not expect them to be causally linked to the survival status of a given grandparent. Instead, they were considered as competing treatments, aiming to reduce error variance in response variables (Figure 1). Grandchild age was grand mean-centred. Finally, we allowed for covariances among the errors (i.e., unexplained parts of the variation) of all the latent variables in order to account for unmeasured factors influencing grandparental investment.

In order to make appropriate comparisons of grandparental investment among different grandparent types, we must first establish the measurement invariance of our latent constructs to ensure that they measure the same constructs in all grandparent types (Vandenberg and Lance 2000). In other words, we need to establish scalar invariance (i.e., invariance in factor thresholds and loadings) between different grandparental types (Guenole and Brown 2014). In our analyses below, we relied on partial measurement invariance as one of the indicators (out of a total of 11 indicators) showed metric non-invariance (please see supplementary materials). That is, in our main model, the factor loading of this one indicator was freely estimated among grandparental types, whereas the loading of all other indicators was constrained to be equal among grandparental types.

Owing to the high dimensionality of the model (i.e., eight latent variables) precluding maximum likelihood estimation, we applied Bayesian inference using the Gibbs sampler for the Markov Chain Monte Carlo (MCMC) algorithm to draw posterior distribution to our model parameters. The median of posterior distribution was used as a point estimate and the highest posterior density (HPD) was used for (credibility) interval estimation. Missing data was assumed to be missing at random (MAR); that is, full information was used for parameter estimation. Non-informative normally distributed priors were used for structural regression coefficients (hyperparameters for prior mean and variances = $N(0, 100^2)$), factor loadings ($N(0, 5)$), thresholds ($N(0, 3)$), and non-informative inverse Wishart priors for error variances ($IW(1, 9)$), and covariances ($IW(0, 9)$) of latent variables as well as for error covariances for ordinal indicators ($IW(0, 3)$).

Three chains with a total of 400,000 iterations were run, thinned by every 50th iteration due to some strong autocorrelation among threshold parameters, with a burn-in of 4,000 iterations. The convergence of MCMC chains was determined using a potential scale reduction factor that compared the estimated between-chains and within-chains variances for each parameter (Gelman and Rubin 1992). In general, values below 1.2 and 1.1 are considered to indicate good convergence of the chains. The potential scale reduction factor for our model was 1.011 after the iterations, suggesting appropriate convergence (convergence was also verified by doubling the number of iterations). We also inspected the individual trace plots of individual parameters as well as their autocorrelation plots, confirming convergence. Mplus 8.4 (Muthén and Muthén 2018) was used for all data analyses.

Results

Our results showed that maternal grandmothers' investment in grandchildren was influenced by whether other grandparents were dead or alive (Table 1; for complete model results, please see supplementary material Table S2). With respect to both of our measures of investment, "relationship" and "involvement," having a living spouse (i.e., maternal grandfather) and a living paternal grandmother increased maternal grandmothers' investment (Table 1). In terms of marginal effects, a grandchild's conditional probability of scoring "never" and "often" for the maternal grandmother related question anchoring the construct "relationship" when the maternal grandfather was dead were 21.5% and 1.9%, respectively (Table 2). The corresponding probabilities were 14.4% and 3.6% for grandchildren whose maternal grandfathers were alive (Table 2). For the construct "involvement," a grandchild's conditional probability of scoring "never" and "usually" for the question setting scale for the construct were 10.3% and 35.2%, respectively, when the maternal grandmother was a widow (Table 2). The grandchildren with both living maternal grandparents had the corresponding probabilities of 7.0% and 43.1% for the construct "involvement" (Table 2).

Paternal grandmothers' survival status was also related to maternal grandmothers' investment (Table 1; Table S2). When the paternal grandmother was deceased, a grandchild's conditional probability of scoring "never" and "often" for the marker question of the construct "relationship" was 21.5% and 1.9%, respectively. The corresponding probabilities were 14.3% and 3.6% for grandchildren whose paternal grandmother was alive (Table 2). Therefore, the survival status of both the maternal grandfather and paternal grandmother had almost an identical influence on the maternal grandmother's "relationship" with their grandchildren. In the case of the construct "involvement," a grandchild's conditional probability of scoring "never" and "usually" for the marker question when lacking a living paternal grandmother was 10.3% and 35.2%, respectively. The grandchildren having a living paternal grandmother had the corresponding probabilities of 7.6% and 41.5%, respectively (Table 2).

It should be noted that our results also showed a nearly non-zero negative association between the survival status of maternal grandmothers and the investment of paternal grandmothers (Table 1; Table S2). The proportion of the posterior distributions having positive parameter values for the constructs "relationship" and "investment" were 6.6% and 3.5%, respectively (Table 1). This suggests that living maternal grandmothers decreased the investment of paternal grandmothers. Interpreted as marginal effects, a grandchild's conditional probability of scoring "never" and "often" for the paternal grandmother related question anchoring the construct "relationship" when the maternal grandmother was dead were 27.3% and 1.5%, respectively (Table 2). The corresponding probabilities were 34.2% and 0.9% for grandchildren whose maternal grandmother was also alive (Table 2). For the construct "involvement," a grandchild's conditional probability of scoring "never" and "usually" for the question setting scale for the construct were 19.1% and 21.8%, respectively, when the maternal grandmother was dead (Table 2). The grandchildren having both living grandmothers had corresponding probabilities of 24.6% and 16.8% for the construct "involvement" (Table 2).

Likewise, there was nearly a non-zero negative association between the survival status of the maternal grandmother and the level of the construct "involvement" of the paternal grandfather, the proportion of positive posterior parameter values being 7.2% (Table 1; Table S2). The grandchild's conditional probabilities of scoring "never" and "usually" for the question setting scale for the construct "involvement" were 13.3% and 29.8%, respectively, when the maternal grandmother was dead (Table 2). The corresponding probabilities for paternal grandfather "involvement" given a living grandmother were 17.5% and 24.0%, respectively (Table 2).

After taking the survival status of other grandparents and competing treatments into account, we observed non-zero positive covariances among almost all pairs of latent variables presenting grandparental investment (Table S2). From Table 3, it can be seen that the highest correlations (ranging from 0.854 to 0.894) are between the latent investment variables "relationship" and "involvement" within a grandparent. Furthermore, high correlations were observed within a lineage (i.e., within maternal and paternal grandparents). Such correlations seemed somewhat higher among paternal grandparents (ranging from 0.755 to 0.873) compared to maternal grandparents (ranging from 0.560 to 0.688) (Table 3).

Discussion

The present study investigated the interplay of grandparental investment according to the survival status of other grandparent types. We found that maternal grandmothers' investment in their grandchildren was influenced by the survival status of maternal grandfathers and paternal grandmothers such that living maternal grandfathers and paternal grandmothers increased the investment of maternal grandmothers. Moreover, some evidence was found that living maternal grandmothers decreased the investment of paternal grandmothers and the involvement of paternal grandfathers. In other cases, the survival status of other grandparent types was not associated with increased or decreased investment on the part of the focal grandparent.

The living maternal grandfathers may boost the investment of maternal grandmothers simply because maternal grandfathers' presence indicates that there are more resources in the household, and maternal grandmothers are able to use these extra resources for the advantage of grandchildren. In general, prior studies have indicated that women are more likely to invest extra resources to benefit their families than men (Coall and Hertwig 2010). In turn, the findings related to survival status and investment of maternal and paternal grandmothers show that kin competition may present itself in different ways according to grandmaternal lineage. According to the present findings, maternal grandmothers, who typically invest the most of all grandparent types in their grandchildren, tend to respond to the presence of paternal grandmothers by increasing their investment even further. In contrast, living maternal grandmothers tend to diminish the investment of paternal grandmothers and grandfathers, perhaps because the dominant role of maternal grandmothers leaves only limited space for paternal grandmothers and grandfathers to invest. These findings indicate that it is important to consider grandparental survival status not only within but also between lineage.

The data used in the present study has several strengths. According to the data, the adolescents were the respondents providing information on grandparental investment and background variables related to themselves, their family, and grandparents. Grandparents may not be the ideal source of information because, as the norm in Western societies is to treat all children equally, they may try to present their investment as equal in all grandchildren (Coall and Hertwig 2010; Tanskanen and Danielsbacka 2019). Parents, in turn, may think of grandparents as couples, meaning they may not accurately report the amount of grandparental investment within lineages. Finally, if one is interested in the investment of all four grandparent types, it would be very complicated to ask either grandparents or parents about the grandparental investment according to all the different grandparent-grandchild dyads. Because of these limitations related to surveying parents and grandparents, children could be the most reliable source of information on biased grandparental investment.

Perhaps the most important data limitations of this research are related to the fact that adolescent children may not be aware of all their grandparents' backgrounds or even their parents' background factors that may have confounded the associations studied here. By allowing for error covariances (i.e., unexplained aspects of the variation) among latent variables measuring grandparental investment, our estimates account for unmeasured factors influencing these grandparental investments. Finally, our survey was based on a cross-sectional design, and longitudinal data could be used to study how the death of one grandparent tends to influence the investment of other grandparent types.

From a methodological perspective, our results (if replicated in forthcoming studies) may have implications when one aims at regressing, for instance, grandchild outcomes on the investment of different grandparents using simple multiple regression modelling and how the results of such analyses should be interpreted. For example, if the presence of a paternal grandmother is causally related to the increased investment of the corresponding maternal grandmother, estimating a traditional regression model where the investment of both maternal and paternal grandmothers on grandchild outcomes is simultaneously considered would bias downward the causal estimate of the paternal grandmother as this estimate would be a direct effect of the paternal grandmother's effect, not its total effect, as is the case with respect to the maternal grandmother's effect (Pearl 2009). In other words, controlling for mediators changes the causal interpretation of regression estimates. If such effects exist, researchers should apply methods that can accommodate both direct and indirect effects, such as structural equation modelling.

To the best of our knowledge, the present study is the first to investigate whether the survival status of a particular grandparent influences the investment of other grandparent types within and between lineage. Our findings are based on data from adolescent grandchildren, and future studies are needed to replicate these findings and detect whether the same effect exists if one investigates grandparental investment in younger grandchildren. Moreover, the present study used data from contemporary Britain, but the results could be different in other societies, and ideally one should conduct a multinational study. Finally, longitudinal studies are needed to show whether and how other grandparent types will respond to the death of a particular grandparent. To conclude, the present findings highlight the complex interplay of grandparental investment behaviour and how it is related to the survival status of other grandparents within and between lineages.

Availability of data

Data is available via UK Data Archive (www.data-archive.ac.uk/).

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Conflicts of interests

The authors declare no conflict or competing interests.

Preregistration of study

The current study was not preregistered.

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Table 1. Structural (probit) regression coefficients of a Bayesian structural equation model on how the survival status of maternal grandmothers (MGM) and grandfathers (MGF) as well as paternal grandmothers (PGM) and grandfathers (PGF) influenced each other's investments, measured as the constructs "relationship" and "involvement", on grandchildren. For our full results, please see the supplementary material Table S2. 95% C.I. denotes a 95% credibility interval of the posterior median for the coefficients. For a positive posterior median, one-tailed p-values give the proportion of posterior distribution that is below zero, and for a negative posterior median the proportion of posterior distribution that is above zero is given.

	Median	95% C.I.	One-tailed p-value
Maternal grandmother			
Relationship			
MGF	0.273	0.085, 0.472	0.002
PGM	0.277	0.032, 0.518	0.012
PGF	0.098	-0.097, 0.286	0.163
Involvement			
MGF	0.206	0.088, 0.329	0.001
PGM	0.165	0.009, 0.319	0.019
PGF	0.049	-0.077, 0.165	0.212
Maternal grandfather			
Relationship			
MGM	0.085	-0.221, 0.376	0.289
PGM	-0.071	-0.357, 0.209	0.303
PGF	0.031	-0.192, 0.254	0.392
Involvement			

MGM	0.089	-0.133, 0.310	0.213
PGM	-0.068	-0.276, 0.140	0.261
PGF	-0.040	-0.203, 0.123	0.315
Paternal grandmother			
Relationship			
MGM	-0.212	-0.493, 0.075	0.066
MGF	0.036	-0.193, 0.263	0.378
PGF	0.100	-0.125, 0.322	0.189
Involvement			
MGM	-0.185	-0.388, 0.016	0.035
MGF	-0.031	-0.189, 0.134	0.357
PGF	0.045	-0.108, 0.206	0.289
Paternal grandfather			
Relationship			
MGM	-0.133	-0.435, 0.178	0.193
MGF	-0.106	-0.355, 0.140	0.205
PGM	0.203	-0.146, 0.550	0.125
Involvement			
MGM	-0.176	-0.405, 0.066	0.072
MGF	-0.123	-0.306, 0.071	0.110
PGM	0.095	-0.168, 0.357	0.236

Table 2. Predicted probabilities (i.e., marginal effects) of scoring different response categories for the questions “How often does your mum’s mum help you in important ways by giving you advice or helping solve problems you have?” and “Do they give you money or help in any other way?,” which were used as marker indicators for the latent “relationship” and “involvement” variables, respectively, in relation to the survival status of different grandparental types. Please note that only non-zero effects of grandparental survival status are shown here.

		Probability		Probability	
	Score	MGF dead	MGF alive	PGM dead	PGM alive
Relationship_MGM					
	"Never"	0.2729	0.1902	0.2729	0.1892
	"Rarely"	0.4568	0.4425	0.4568	0.4420
	"Sometimes"	0.2553	0.3385	0.2553	0.3397
	"Often"	0.0150	0.0288	0.0150	0.0291
Involvement_MGM					
	"Never"	0.1913	0.1403	0.1913	0.1496
	"Occasionally"	0.5907	0.5764	0.5907	0.5808
	"Usually"	0.2180	0.2833	0.2180	0.2696

Table 3. Pairwise correlation matrix of latent variables representing grandparental investment in grandchildren. Cells filled in with dark and light grey denote within-grandparent and within-lineage correlations of the investment variables, respectively. Moreover, “Rel” denotes the latent variable “Relationship” and “Inv” denotes “Involvement.” The suffixes _MGM, _MGF, _PGM and _PGF denote maternal grandmother, maternal grandfather, paternal grandmother, and paternal grandfather, respectively.

	Rel_MGM	Inv_MGM	Rel_MGF	Inv_MGF	Rel_PGM	Inv_PGM	Rel_PGF	Inv_PGF
Rel_MGM	1							
Inv_MGM	0.854	1						
Rel_MGF	0.688	0.589	1					
Inv_MGF	0.560	0.681	0.881	1				
Rel_PGM	0.165	0.109	0.225	0.156	1			
Inv_PGM	0.109	0.249	0.210	0.325	0.879	1		
Rel_PGF	0.170	0.100	0.161	0.088	0.872	0.755	1	
Inv_PGF	0.096	0.212	0.161	0.260	0.795	0.873	0.894	1