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Which grandparent is more intimate? The effects of the gender of grandchildren

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Abstract

Mothers have almost 100% certainty of their relationship with their offspring, but fathers face paternal uncertainty, which affects not only parental investment but also grandparents' investment in grandchildren. However, due to Chinese patriarchal culture and preference for sons, grandparents may give their grandchildren different investments by gender. To explore the psychological and behavioral mechanisms of grandparents' emotional investment in grandchildren from both cultural and evolutionary perspectives, this study collected data from 642 Chinese participants who had impressions of all four grandparents and measured their relationships with their grandparents and other demographic variables. After controlling for the number of grandchildren, participant's age, region, etc., a significant interaction between the grandchild's gender and grandparent categories was found. Simple effect analysis and post-hoc analysis showed significant differences in grandsons' intimacy with maternal grandmothers and grandfathers, but no other grandparents, while granddaughter's intimacy with maternal grandmothers was significantly higher and with paternal grandfathers significantly lower than with other grandparents, and there were no other significant differences. Those results support human psychology and behavior are jointly influenced by evolution and culture.

Keywords Paternal uncertainty · Intimacy between grandparents and grandchildren · Gender · Preference for sons

Introduction

Paternal Uncertainty and Parental Investment

In the process of human development, men and women face different adaptive challenges. Women need to choose a partner with healthy genes and a high economic status who can provide adequate material resources and protect them and their children during childbirth and rearing; this is supported both in Western culture (Buss, 1989; Greengross & Miller, 2011; Jonason et al., 2012; Le et al., 2005; Liu et al., 2011) and non-Western culture (Atari & Jamali, 2016; Kamble et al., 2014). For men, the wife's infidelity may cause the husband to raise an offspring who does not have his genes (Buss, 1996). In the United States, previous studies have found that 10%–15% of married women report having engaged in extramarital sex at some point during their marriages (Djamba & Kimuna, 2020; Wiederman, 1997), and that is about 13.4% in China (Hou & Pan, 2018). Therefore, fathers face paternal uncertainty (Buss, 1996; Trivers, 1972). Whereas, because of the inner fertilization, and care of their children, mothers are almost 100% assured of a blood relationship with their children (Gaulin & Schlegel, 1980).

The inclusive fitness theory supposes that, due to the selection pressure in human evolution, humans would give more care and investment to genetically more closely related individuals to promote the spread of their own genes (Hamilton, 1964). And some studies found that offspring with more parental resources could have an advantage in survival and reproduction (Gaulin & Schlegel, 1980; Sear & Mace, 2008). Therefore, parental investment theory posits that parents would inherently invest in their offspring to promote the spread of their own genes (Trivers, 1972).

Some studies found that non-biological parents, such as step-parents, still invested in their children (Prall & Scelza, 2020; Scelza et al., 2020). For example, Prall and Scelza

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(2020) found that social fathers know their children have no biological relationship with them in the Himba, however, they still take care of them. This behavior could be explained as reciprocal altruism. Moreover, social fathers rely on their non-biological children to support them when they grow old (Prall & Scelza, 2020). In fact, as reciprocity in humans has evolved from genetically related kin groups, it is likely to be stronger between close kin, especially for biological children who have a more certain blood relationship (Rotkirch et al., 2014; Trivers, 1971). A large body of evidence shows that the genetic relationship between kinship predicted reciprocity (Curry et al., 2013; Jeon & Buss, 2007; Rotkirch et al., 2014; Schriver et al., 2019).

Since the blood relationship between mother and child is virtually 100% certain, the mother's investment in the child is often "unconditional," while fathers are at risk of uncertainty; therefore, men's investment in offspring is "conditional." For example, studies have found that fathers' affections are often based on clues with which they adjust their investment, such as facial resemblance (Alvergne et al., 2009, 2010), body odor similarity (Bressan et al., 2009), and perceived infidelity (Apicella & Marlowe, 2004; Billingsley et al., 2018). Overall, mothers' investment in their children is significantly higher than that of fathers (Heijkoop et al., 2009; Huber, 2010; Yu et al., 2017a, 2017b; Yu et al., 2019a, 2019b).

Closeness of the Relationship between Grandparents and their Grandchildren

Paternal uncertainty not only affects fathers' parent–child investment but also grandparents' emotional and material investment in grandchildren. Due to paternal uncertainty, the blood relationship between grandparents and grandchildren is also different (DeKay, 1996; Euler & Weitzel, 1996; Michalski & Shackelford, 2005; Pashos, 2000). Specifically, the relationship between maternal grandparents and grandchildren is established through the mother of the child. Generally speaking, the blood relationship between the maternal grandmother and the child's mother is virtually 100% certain, and the blood relationship between the mother and the child is virtually 100% certain. Therefore, the blood relationship between the maternal grandmother and grandchildren is also virtually 100% certain. Similarly, for the maternal grandfather, although the blood relationship between the child's mother and the child is almost 100% certain, the blood relationship between the maternal grandfather and the child's mother cannot be certain. Therefore, the certainty of the blood relationship between the maternal grandfather and grandchildren is weaker than that of the blood relationship between maternal grandmother and grandchildren. As for paternal grandmothers, although the blood relationship between the paternal grandmother and the father of the child is virtually 100% certain, the blood relationship between the child and the father cannot be 100% certain. Therefore, from this perspective, the degree of determination of the blood relationship between the paternal grandmother and grandchild is comparable to that of the maternal grandfather. For the paternal grandfather, the blood relationship between the grandfather and the child's father is not certain, and the blood relationship between the father and the child also cannot be certain. Therefore, the certainty of the blood relationship between the paternal grandfather and the child is the lowest. In summary, the degree of determination of the blood relationship between grandparents and grandchildren in descending order is maternal grandmother > maternal grandfather = paternal grandmother > paternal grandfather.

Based on the inclusive fitness theory and parental investment theory, this difference in blood relationship uncertainty leads to differences in investments in their grandchildren. For example, previous studies found that maternal grandmothers invested the most, and paternal grandfathers the least in their grandchildren (DeKay, 1996; Euler & Weitzel, 1996; Michalski & Shackelford, 2005; Pashos, 2000). As for maternal grandfathers and paternal grandmothers, although the two blood relationship uncertainties are same, the paternal grandfather makes a greater investment in the grandchildren than the maternal grandmother (Eisenberg, 1988; Rossi & Rossi, 1990). In fact, Laham et al. (2005) proposed the preference investment hypothesis, which posits that since paternal grandmothers could be highly certain of their relationship with their daughter's child, they would invest more in their daughter's child than their son's child to promote the spread of their own genes. As for the maternal grandfather, he would not have a more certain blood relationship with his son's child than with his daughter's child; therefore, there would be no alternative investment object, leading to more investment from maternal grandfathers than paternal grandmothers. A study by Michalski and Shackelford (2005) in southeastern Florida supported this hypothesis. In sum, maternal grandmothers invest the most, followed by maternal grandfathers and paternal grandmothers, with paternal grandfathers investing the least (Eisenberg, 1988; Rossi & Rossi, 1990). This investment difference was reflected not only in material but also in emotional resources (Bishop et al., 2009; Euler & Weitzel, 1996). For example, Heijkoop (2010) found that both parents and children put the maternal grandmother first when evaluating the closeness of relationships with grandparents, followed by the maternal grandfather, then the paternal grandmother and the paternal grandfather. In addition, a retrospective study in United States, Netherlands, and Germany found similar results regarding the degree of care and concern of different grandparents for grandchildren

before the age of seven (Chrastil et al., 2006; Pashos, 2000).

Preference for Sons and Patrilineal Culture in China

Although many previous studies have supported the hypothesis of differences in grandparents' investment, most of these studies are in the context of Western cultures, such as United States (Chrastil et al., 2006; DeKay, 1996; Michalski & Shackelford, 2005), Germany (Euler & Weitzel, 1996; Pashos, 2000), and Greece (Pashos, 2000). However, unlike Western cultures, the idea of inheriting family genes from men rather than women has long been dominant in the Chinese culture (Chang et al., 2010). Therefore, the elder generation offers more resources, such as paying a bride price for their sons (Apostolou, 2007; Santos & Harrell, 2016) or providing male descendants a house for their marriage (Santos & Harrell, 2016), to promote the spread of their family genes; and women have not been expected to show any obligation and responsibility to take care of their parents (Peng, 2011), even though the law emphasizes and supports that men and women equal in China. Because of this patriarchal view, grandparents' investment in grandchildren may be moderated by the gender of their grandchildren. For example, Lin and Zhao (2015) found that in families whose first child was a boy, grandparents were significantly more likely to look after their grandchildren than in families whose first child was a girl.

Today's China is still a typical patriarchal society, which means that China still maintains a form of social organization in which the father or oldest male is the head of the family, and descent and relationship are determined through the male line (Santos & Harrell, 2016). Unlike in Western countries, people in China still live in multi-generational households, and most regions still follow the characteristics of couples living with the husband's relatives. Previous studies have found that in patrilineal cultures, paternal grandparents invest more than maternal grandparents (Kaptijn et al., 2013; King, 2003; Pashos, 2000). At the same time, because the wife lives with the husband's family, which could significantly reduce the possibility of the wife's sexual betrayal, this would increase paternal certainty and affect the level of investment by paternal grandparents in their grandchildren (Chang et al., 2010; Pashos, 2000).

Therefore, although under the inclusive fitness theory (Hamilton, 1964) and the preference investment hypothesis (Laham et al., 2005), the order of grandparents' investment in their grandchildren is expected to be: maternal grandmother > maternal grandfather > paternal grandmother > paternal grandfather; this ranking will be regulated by cultural factors. The idea that only men can inherit family genes is deeply ingrained in Chinese culture (Chang et al., 2010). As a result, this patriarchal ideology will affect the investment of grandparents differently than under a Western cultural background. Therefore, this study proposes that patriarchal culture affects the investment of paternal grandparents, which weakens the difference in investment between paternal grandparents and maternal grandparents. Meanwhile, due to the influence of patriarchal culture, the gender of the grandchild plays a moderating role in the intimate relationship. Specifically, when the offspring is a grandson, paternal grandparents regard him as a symbol of their own gene transmission and give him more emotional care, which further weakens the investment difference between paternal grandparents and maternal grandparents, whereas when the offspring is a granddaughter, paternal grandparents' investment in grandchildren should only be affected by the patriarchal cultural background. Therefore, the order of the close relationship between grandparents and grandchildren is expected to be maternal grandmother > maternal grandfather = paternal grandmother > paternal grandfather.

The Present Study

As suggested by previous studies (DeKay, 1996; Euler & Weitzel, 1996; Pashos, 2000), this study adopted the subjective reporting method of grandchildren to explore the close relationship between (four) grandparents and their grandchildren for two main reasons. On the one hand, if grandparents are directly asked about the closeness of their relationships with their grandchildren, they would be likely to state that there was no obvious difference because of the influence of social desirability bias (Laham et al., 2005). On the other hand, the degree to which people tend to like others is consistent with others' liking for them (Aronson & Linder, 1965; Backman, 1959; Condon & Crano, 1988; Kenny & Nasby, 1980). In addition, previous studies have demonstrated that grandparents may offer more help for the grandchildren who really need their support, such as younger grandchildren (Coall et al., 2018; Dench & Ogg, 2003) or grandchildren from a family with a lower socioeconomic position (Coall et al., 2014; Coall et al., 2018). Meanwhile, the number of grandchildren negatively correlates with the investment of their grandparents due to limited resources (Coall & Hertwig, 2010; Laham et al., 2005). Besides, divorced parents may lead to low grandparent-grandchild intimacy, particularly for paternal grandparents (Albertini & Tosi, 2018; Jappens & Van Bavel, 2016). As for region, compared with people from cities, people from rural areas have a better relationship with their paternal grandparents, especially for boys (Kaptijn et al., 2013; King, 2003; Pashos, 2000). Therefore, this study treated age, region, family structure, family economic status, and the number of grandchildren as control variables to eliminate their interference.

Method

Participants

A total of 1508 participants were recruited from Mainland China. Some participants had no impression of their grandparents and could not evaluate intimacy because their grandparents died before they were born or when they were very young. Therefore, this study only used the data in which the participants have impressions of all four grandparents and evaluate the intimacy between their grandparents and themselves. After excluding the data, a total of 642 valid sets of data regarding impressions of all four grandparents were collected from 257 men and 385 women. The average age of the participants was 19.49 (SD = 7.938).

Measures

Demographic Variables

We collected participants' demographic information, including gender, age, region, birth order, family economic status, family structure, number of siblings, number of paternal grandparents' grandchildren, and number of maternal grandparents' grandchildren. In this part, the participants were asked "where are you from" to measure their region, with the possible responses being "1″ for "a city" and "2″ for "a rural area," and "What type of family structure does your family belong to?" to measure the family structure, with the following three options: "two-parent family," "single-parent family," and "others." We used 1 to stand for double-parent family and 2 for else. This study adopted a self-made item, "What is your family's economic status?" to measure family economic status on a five-point scale, ranging from 1 (*lower class*) to 5 (*upper class*).

The Intimacy between Grandparents and Grandchildren

First, participants were asked to report whether they had an impression (or memory) of their grandparents. If they did not, they did not need to report the intimacy with their grandparents. For those that did, the participants were asked to report their closeness with their grandparents by answering four questions: "How is the relationship with your paternal grandfather?"; "How is the relationship with your paternal grandmother?"; "How is the relationship with your maternal grandfather?"; and "How is the relationship with your maternal grandmother?" on a 10-point scale, where 1 means *very distant* and 10 means *very close*.

Procedure

We recruited participants through the Qualtrics platform in Mainland China. After agreeing to participate in the survey, the participants first reported their own demographic variables; they were then asked for their impressions of their grandparents. When the participants had an impression of all their grandparents, they were further asked to assess their intimacy with their grandparents. Finally, the participants completed the questionnaire independently.

Data Analysis

SPSS 22.0 was used for data analysis. First, correlation analysis was used to describe the data overall. Second, repeated-measures analysis of variance was applied to explore differences in the degree of intimacy between grandchildren and different grandparents by grandchild's gender.

Results

Descriptive Analysis

As shown in Table 1, there was a significant negative correlation between the number of grandchildren and paternal grandparent–grandchild intimacy ($p < .001$), and the number of maternal grandparents' grandchildren had a significant negative correlation with maternal grandparent–grandchild intimacy ($p < .001$). In addition, there was a significant positive correlation between intimacy with the grandchild of grandparents and their partners, respectively ($ps < .001$).

The Relationship between Grandparent and Grandchild: The Moderating Effect of the grandchild's Gender

To explore the moderating effect of grandchild's gender on grandparent–grandchild intimacy, this study used the age of the participants, the region from which the participants came, the number of maternal grandparents' grandchildren, the number of paternal grandparents' grandchildren, family economic status, and family structure as control variables, with grandchild's gender as the between-subjects factor, grandparent type as the within-subjects factor, and intimacy as the dependent variable for repeated-measures analysis. As shown in Table 2, the number of paternal grandparents' grandchildren ($F(1, 638) = 9.62$, $p = .002$) and number of maternal grandparents' grandchildren ($F(1, 638) = 5.69$, $p = .017$) significantly affected grandparents' investment, while age ($F(1, 638) = 0.95$, $p = .33$), region ($F(1, 638) = 0.44$, $p = .51$), family structure ($F(1, 638) = 0.14$, $p = .70$), birth order ($F(1, 638) = 1.02$, $p = .31$), and family economic status ($F(1, 638) = 1.02$,

Table 1 Descriptive statistics and correlations among variables ($N = 642$)

	1	2	3	4	5	6	7	8	9
1. Age	–								
2. Number of grandchild (paternal)	.063	–							
3. Number of grandchild (maternal)	.040	.363**	–						
4. Birth order	.237**	.181**	.143**	–					
5. Social economic status	−.070	−.088**	−.140**	−.045	–				
6. Closeness (paternal grandfather)	.023	−.156***	−.085*	−.009	.016	–			
7. Closeness (paternal grandmother)	.015	−.161***	−.096*	.003	.006	.781***	–		
8. Closeness (maternal grandfather)	−.014	−.130***	−.169***	−.076	.074	.288***	.215***	–	
9. Closeness (maternal grandmother)	.026	−.106**	−.173***	−.079*	.066	.245***	.150***	.800***	–
M	19.49	6.455	6.650	1.37	2.91	7.411	7.640	7.6456	8.156
SD	7.938	4.485	4.327	.747	.545	2.489	2.192	2.20076	2.016

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

$p = .31$) did not reveal a significant effect on grandparents' investment. The gender of the grandchild had a significant effect on grandparent–grandchild intimacy (F (1, 638) = 47.65, $p < .001$). The intimacy between boys and their grandparents ($M = 8.27$, $SD = 0.10$) was significantly higher than that between girls and their grandparents ($M = 7.35$, $SD = 0.08$). The main effect of grandparent type was not significant, F (3,636) = 0.71, $p = .55$, while the interaction between grandparent type and grandchild's gender was significant, F (3,636) = 4.30, $p = .005$.

A simple effect test was conducted to further explore the differences in perceived intimacy with different grandparents. As shown in Fig. 1, both male and female grandchildren were associated with a significant intimacy difference among grandparents (male: F (3,254) = 5.62, $p = .001$; female: F (3,383) = 43.08, $p < .001$). A post-hoc test of the simple effect was conducted, showing that when the grandchild was male, the differences in intimacy with maternal grandfathers and grandmothers were significant ($p < .001$), while those with other grandparents were not ($p > .05$). When the grandchild was female, the intimacy with maternal grandmothers was significantly higher than with other grandparents ($ps < .001$), while that with paternal grandfathers was significantly lower ($ps < .01$); however, there was no significant difference between the degrees of intimacy with paternal grandmothers and maternal grandfathers ($p = .76$).

Discussion

This study found that the relationship between grandparents and grandsons was closer than that between grandparents and granddaughters in the Chinese cultural background, which is consistent with the findings of Lin and Zhao (2015). However, these gender differences have not been found in the context of Western culture (Laham et al., 2005), this discrepancy is mainly due to cultural differences. Unlike in Western cultures, Chinese women are excluded from their lineage and barred from inheriting property, although this violates China's current law; they are expected to support their husbands' families

Table 2 The moderating effect of grandchild gender on the intimate grandparent-grandchild relationship

	Sum of squares	*df*	*F*	*P*
Number of grandchildren (paternal)	102.00	1	9.62	.002
Number of grandchildren (maternal)	60.31	1	5.69	.017
Birth order	10.84	1	1.02	.31
Family structure	1.53	1	.14	.70
Family economic status	10.82	1	1.02	.31
Age	10.08	1	0.95	.33
Region	4.63	1	.44	.51
Grandchild gender	505.40	1	47.65	< .001
Grandparent type	6.53	3	.71	.55
Grandparent type × grandchild gender	39.71	3	4.30	.005

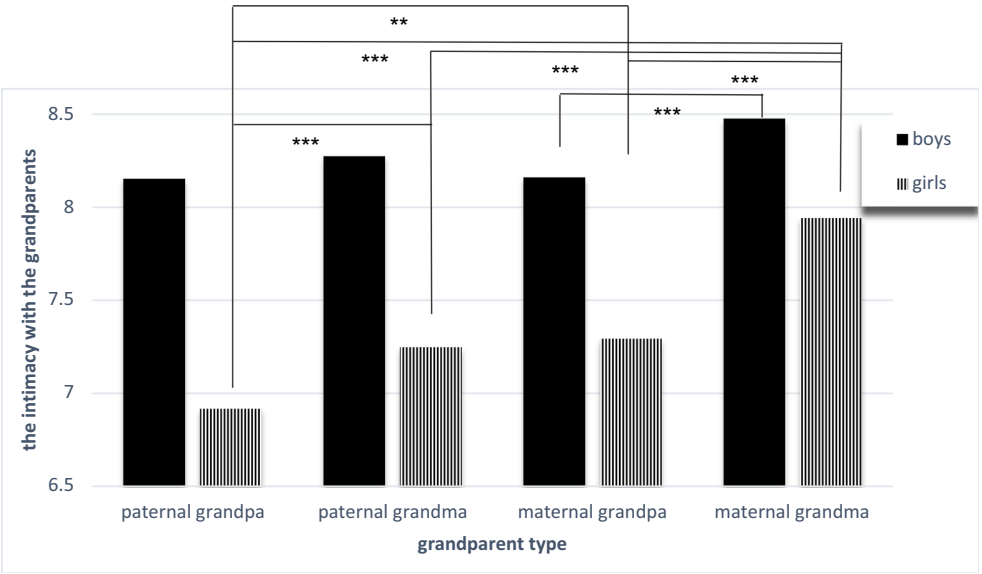

Fig. 1 Intimacy between grandparents and grandchildren: The moderating effect of grandchild's gender

by being dutiful wives and daughters-in-law (Santos & Harrell, 2016). Traditional Chinese culture emphasizes that only men can pass on family genes and refers to a family without a son as "finished" (Chang et al., 2010; Peng, 2011). More specifically, adult sons are culturally crucial for continuing the ancestral line and are expected to serve as care providers for their parents and patrilineal relatives in old age, while daughters are expected to support their husbands' families (Chang et al., 2010; Peng, 2011; Santos & Harrell, 2016). Therefore, grandparents generally believe that investing in male offspring is more beneficial (Kaptijn et al., 2013; Pashos, 2000).

This study found that for male participants, only maternal grandfather–grandchild intimacy and maternal grandmother–grandchild intimacy was significantly different, but there was no significant difference in the closeness of the relationships between other grandparents and grandchildren. This could be explained from two perspectives. On the one hand, in traditional Chinese culture, males rather than females inherit family genes (Chang et al., 2010; Li, 2012). When grandchildren are male, paternal grandparents consider them a continuation of the patrilineal family. Therefore, paternal grandparents invest more in male grandchildren, to some extent weakening the investment difference between paternal grandparents and maternal grandparents due to the evolutionary mechanism. Similarly, paternal grandfathers care more about the inheritance of patrilineal bloodlines than paternal grandmothers. Therefore, the investments of paternal grandfathers and paternal grandmothers are also influenced by the preference for male offspring, and as a result, the investment difference between the two is not significant. On the other hand, previous studies have also found that living with the fathers' family after marriage could increase the certainty of fathers' identity (Chang et al., 2010; Pashos, 2000). Considering these two reasons, it is clear that paternal grandparents have a stronger preference for grandsons and that living with the patrilineal family after marriage further reduces the risk of uncertainty of the father's identity. Therefore, the difference in investment between paternal grandparents and maternal grandparents in their grandson may be reduced to insignificance. However, maternal grandfathers and grandmothers are not affected in this way by patriarchal culture and male preferences; thus, the difference in investment was consistent with the effect of the certainty of their blood relationship via the evolutionary mechanism.

Since in the case of a granddaughter the preference for male descendants of paternal grandparents no longer applies, the difference in intimacy between paternal grandparents and maternal grandparents with their grandchildren is no longer moderated by the preference for male descendants. Therefore, consistent with the evolutionary mechanisms, maternal grandmothers invest the most in granddaughters and paternal grandfathers the least. However, unlike previous studies (Laham et al., 2005), the patriarchal social environment increases the certainty of the paternal grandmother's blood relationship with grandchildren, and this buffering effect regulates the preference investment of the maternal grandfather so that there is no longer a significant investment difference between paternal grandmothers and maternal grandfathers. Current research results showed that although evolutionary mechanisms play a vital role in people's adaptive behavior, the cultural environment also has an important impact on socialized behavior.

Consistent with the results of previous studies, this study found a significant negative correlation between the number of grandchildren and the intimacy of grandparents and their grandchildren (Laham et al., 2005). Due to the limited resources and energy of grandparents, increases in the number

of grandchildren would have a diffusion effect on the investment of grandparents (Coall et al., 2009; Danielsbacka & Tanskanen, 2012; Yu et al., 2017a, 2017b). Therefore, the number of grandparents' grandchildren is negatively correlated with the investment of their grandparents. However, inconsistent with previous studies (Albertini & Tosi, 2018; Coall et al., 2014; Dench & Ogg, 2003), this study showed that the effects of participants' age, family economic status, and family structure on the relationship between grandparents and grandchildren were not significant. This may be due to the homogeneity of the participants; in fact, most of our participants were college students, 91.6% came from intact families, and 76.9% had almost the same economic conditions.

It is worth noting that due to the possible generational effect of the patriarchal concept, there may be a certain difference in investment between grandparents and parents. This study found that when grandchildren are females, the difference in investment from grandparents to grandchildren follows the pattern of the evolutionary mechanism. Nevertheless, in previous studies, Yu and his colleagues found that facial similarity between father and daughter has no significant effect on the intimacy of the father–daughter relationship (Yu et al., 2017a, 2017b), nor does it have a significant effect on father's abuse (Yu et al., 2019a, 2019b). In fact, it was not proven that the father's investment in his daughter was incompatible with the evolutionary mechanism. Yu et al. (2017a, 2017b) found that there was no significant difference between father's investment in daughters and sons. However, grandparents' investment has a significant difference, perhaps due to the generational effects of the patriarchal concept. The social living environment of grandparents still shows a typical patriarchal cultural background, and the culture of living with the patrilineal line is extremely common. Correspondingly, the traditional concept of patrilineal inheritance and raising male offspring to provide for elderly parents was deeply rooted in the hearts of the grandparents (Chang et al., 2010; Li, 2012). Living with the patriline to a certain extent forms a family network with male blood as the main axis (Li, 2012). Men support their parents, while women must go to the men's families to support their husbands' parents (Li, 2012). There is no doubt that grandparents believe that the return on investment for male offspring is higher.

In addition, in the cultural background of a universal patrilineal society, the influence of the pressure of convergence has further led to the consolidation of patriarchal thought (Li, 2012). The social environment and the pressure of public opinion make people feel that raising a son to protect them when they are old is customary, thus strengthening the preference for male offspring (Luo, 2012). Nowadays, with development and modernization, this mindset is changing, and the characteristics of living with the patrilineal family are gradually being broken by urbanization. The improvement of the national pension system has also made parents no longer dependent on the support of male offspring (He, 2014; Luo, 2012). Because of the improvement in parents' own education level and the development of economic conditions, the concept of "raising a son to protect in old age" and patriarchal ideas are gradually disappearing (He, 2014), and the common currency of the idea that "both boys and girls are the same" has also weakened the pressure of public opinion. Therefore, for fathers, there is no significant difference in parent–child investment between sons and daughters. The reason that father–daughter intimacy and father–daughter behavior were not affected by father–daughter facial resemblance is more likely due to the particularity of emotional investment. Since women score higher in agreeability than men (Costa et al., 2001; Weisberg et al., 2011) and are better at dealing with interpersonal issues (Gabriel & Gardner, 1999), this personality trait may play a moderating role in the relationship between facial resemblance and father–daughter intimacy, resulting in insignificant results (Yu et al., 2019a, 2019b).

Nowadays, dual-earner families are increasingly common worldwide (Coall et al., 2014; Coall & Hertwig, 2010; Santos & Harrell, 2016). Consequently, grandparents play an indispensable role in the upbringing of grandchildren, especially in fast-developing China (Santos & Harrell, 2016). Therefore, our research focused on the intimate relationship between grandparents and their grandchildren. Meanwhile, unlike in Western cultures, the idea of preferring male offspring over female offspring has long been dominant in the Chinese culture. Therefore, the sex of grandchild modreted the intimacy of grandparent–grandchild, which supports and extends the theory of paternal uncertainty.

Although this study's hypothesis was supported, some limitations remain. First, the impact of patrilineal residence on the investment of paternal grandparents is significant. However, with the development and urbanization, the phenomenon of patrilineal living has gradually decreased in the cities. Therefore, in the current generational background, patrilineal residence can be studied separately as a moderating variable to further analyze the influence of cultural factors behind the evolutionary mechanism. Second, the participants in this study were mostly college students. The special generational effect of this group may thus affect the external validity of the study. In fact, due to China's rapid development since the 1980s, traditional concepts have undergone unprecedented changes. We need further research about whether grandparents of newborn babies still hold patriarchal notions. Finally, when studying the investment difference of grandparents, it is necessary to consider the special generational effect of the "only one child" policy, because, among grandparents of a certain age, it is very likely that all four grandparents will have only one grandchild. Under the influence of this background, further research is needed to distinguish whether the difference in investment between grandparents is due to changes in the concept of patriarchy or the limitation of the number of

grandchildren, which limits the objects in which grandparents can invest. Future research should pay more attention to the influence of cultural factors and the evolutionary mechanism.

Conclusion

In the context of Chinese culture, this study found that the gender of grandchildren moderated the intimacy between different grandparents and their grandchildren. For grandsons, only the maternal grandfather and maternal grandmother had significant differences in grandparent–grandchild intimacy; there were no significant differences for other grandparents. A granddaughter had the closest relationship with her maternal grandmother and the weakest relationship with her paternal grandfather. The closeness of the relationships between paternal grandmother and maternal grandfather were in between and showed no significant difference. The results thus show that grandparents' investment in grandchildren is influenced by both evolution (the certainty of blood relationship) and culture (patriarchal culture).

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Data Availability The data that support the findings of this study are available in https://osf.io/2rpa9/.

Declarations

Ethics The present study received approval from the psychological research ethics committee of the Faculty of Human-Environment Studies at Beijing Normal University (16JJD880007).

Conflict of Interest All authors declare that there no conflict of interest.

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