

Willingness to Invest in Children: Psychological Kinship Estimates and Emotional Closeness

Evolutionary Psychology
April-June 2017: 1–10
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DOI: 10.1177/1474704917705730
journals.sagepub.com/home/evp



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Abstract

In general, adults invest more in related children compared to unrelated children. To test whether this pattern reflects variations in psychological kinship estimates (i.e., putative relatedness weighted by certainty in relatedness), willingness to invest in children belonging to different categories (direct offspring, nieces/nephews, stepchildren, and friends' children) was measured in a population-based sample of 1,012 adults. Respondents reported more willingness to invest in their own biological children, than in other related children (nieces and nephews), or in stepchildren and friends' children. Compared to putative relatedness, respondents' psychological kinship estimates better predicted the willingness to invest. This association was partially mediated by emotional closeness. Additionally, the age of a child and the number of children in the care of the respondent were negatively associated with willingness to invest. The association between psychological kinship estimates and willingness to invest supports evolutionary predictions. Investment in stepchildren was, however, higher than expected.

Keywords

family, family relations, kinship, stepfamilies, childcare, parental investment

Date received: January 2, 2017; Accepted: March 24, 2017

Several studies investigating altruism and prosocial behaviors have shown that people are most willing to invest time and resources in individuals that they are closely related to (such as children, siblings, and parents) and that the willingness decreases as distance in biological relatedness increases (e.g., Burnstein, Crandall, & Kitayama, 1994; Rachlin & Jones, 2008; Stewart-Williams, 2007, 2008). For example, studies have found that people report being more willing to help close relatives (compared to distant relatives and acquaintances) both with everyday challenges and in life-threatening situations (Burnstein et al., 1994; Korchmaros & Kenny, 2006). People are also willing to incur higher costs in the form of physical pain if this benefits close relatives compared to more distant relatives (Madsen et al., 2007). These patterns of favoring close relatives over distant relatives are found especially when the cost of the investment is high to the actor (Stewart-Williams, 2007, 2008).

The variation in altruistic investment in family members has been explained as stemming from variations in emotional closeness (Korchmaros & Kenny, 2001, 2006), such that humans are more inclined to invest in individuals they feel

emotionally close to. At the same time, emotional closeness is often higher in biological relationships than in sociolegal relationships (Korchmaros & Kenny, 2001, 2006; Neyer & Lang, 2003), and emotional closeness covaries with factors such as proximity and similarity—cues that indicate true biological relationship (Byrne, 1961; Korchmaros & Kenny, 2006). The degree to which investment in children is affected by biological relatedness or by other social factors is debated (Korchmaros & Kenny, 2006; Roberts & Dunbar, 2011; Stewart-Williams, 2007).

In the current study, we focused on adults' self-reported willingness to invest in both biologically related and unrelated children. With respect to these relationships, we also measured the degree and type of putative biological relatedness

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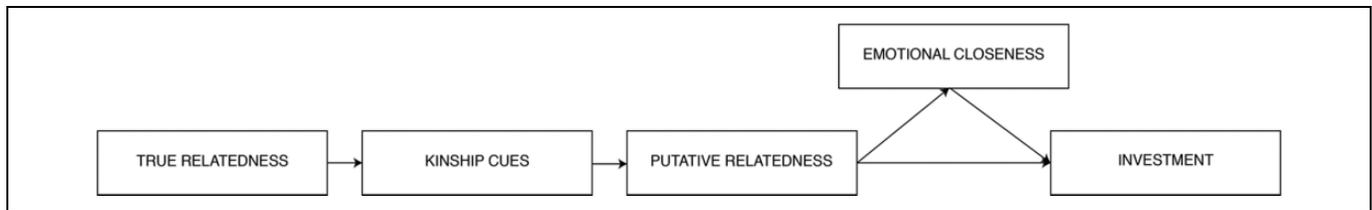


Figure 1. The hypothesized relationship between true relatedness, kinship cues, putative relatedness, emotional closeness, and investment. Each arrow denotes a positive association.

(i.e., self-reported relatedness without corroborating information about true relatedness), the certainty of relatedness (i.e., self-reported certainty that putative relatedness actually reflects true relatedness), and emotional closeness.

Investment in Related Children

Within an evolutionary framework, inclusive fitness theory (Hamilton, 1964) defines the conditions under which “altruistic investment” can evolve under natural selection. Inclusive fitness theory explains how alleles underlying helping one’s kin are naturally selected, even when the investment is costly to the actor (i.e., decreases one’s direct fitness). Alleles associated with increased investment in relatives are likely to be present in our close biological kin as well, and therefore, when humans invest in biological relatives, this investment increases the likelihood of this particular allele to be propagated to future generations. For example, investments in the well-being of direct offspring and nieces/nephews—with whom we share 50% and 25% of our genetic material, respectively—can be evolutionary advantageous to the allele even though investment comes at a cost to the actor (i.e., the investing individual). The condition is that the benefit to the recipient of the act is higher than the cost to the actor, after accounting for the degree of relatedness between the two. This means that in order for the disposition to evolve, the benefit to a biological child must be at least twice as high as the cost is to the parent. In the case of a niece or a nephew, the benefit must be at least four times as high. In other words, the cost of the investment, the benefit to the recipient, and the degree of relatedness describe the level over which a particular form of investment will be biologically advantageous (Hamilton, 1964). This theoretical model has later been applied to the human family and corroborated by vast amounts of anthropological data (e.g., Daly & Wilson, 1988; Hughes, 1988). Self-report data (e.g., Antfolk, Lieberman, & Santtila, 2012; Lieberman, Tooby, & Cosmides, 2007) also suggest that rather than following degrees of true relatedness, human kin selection follows psychological kinship estimates and the cues affecting them.

Within the same theoretical framework, parental investment has been defined by Trivers (1972) to include all resources that benefits a child while decreasing the parent’s possibilities to produce and invest in other (earlier, current, or future) offspring. As such, the definition covers a wide variety of phenomena, ranging from the provision of metabolic resources associated with gestation to more overt, observable behaviors,

such as providing the child with shelter and food (Trivers, 1972). Some acts such as donating an organ to save someone’s life are, evolutionarily speaking, very costly. Such costly acts can be considered a particular form of investment. From an evolutionary perspective, costly investment is biologically advantageous only when the benefits to the recipient are high and the recipient is a close relative.

Psychological Kinship Estimates

As indicated, true biological relatedness cannot be perceived directly. In differentiating between relatives and nonrelatives, humans rely on so-called kinship cues such as proximity (e.g., cohabitation; Antfolk, Karlsson, Bäckström, & Santtila, 2012; Westermarck, 1891) and similarity (e.g., facial resemblance; e.g., Alvergne, Faurie, & Raymond, 2009, 2010; Krupp, DeBruine, & Jones, 2011). Apart from the mother–child relationship, in which mothers can be certain a child they gave birth to is their biological child, all other relationships contain varying degrees of certainty. The certainty in relatedness is very high for all links between a mother and her child—and higher than the comparable link between a father and his child. Nevertheless, the link between two full siblings depends on both their maternal and the paternal relatedness (e.g., Haig, 2009). Although mothers can be sure of their relatedness to their child, children report less than perfect certainty regarding their putative father *and* their putative mother (e.g., Antfolk, Lindqvist, Albrecht, & Santtila, 2014). As a consequence, certainty in relatedness to a nephew or niece born by one’s sister might be affected by the certainty in relatedness to the sister.

A positive association between certainty in relatedness and investment has been demonstrated by some previous research investigating fathers and their children. Asking fathers how certain they were in the biological relatedness to their child, Fox and Bruce (2001) found this certainty to be positively associated with fathers’ affective involvement in their children. Furthermore, certainty in relatedness has been shown to be positively associated with the time fathers devote to activities with their child (Anderson, Kaplan, & Lancaster, 2007). Also, the perceived fidelity of the mother has been found to be associated with the amount of time and attention fathers report spending on their child, presumably mediated by the certainty in the relatedness to the child (Apicella & Marlowe, 2004).

The evolutionary model (Figure 1) assumes that kinship cues are valid indicators of true relatedness. Putative relatedness follows from the available kinship cues. Putative

relatedness has an effect on investment. This effect may, partly or fully, be mediated through emotional closeness. Moreover, putative relatedness can also be regulated by certainty in relatedness (not visualized in the model).

Investment in Unrelated Children

Alongside investment in biologically related children, investment in unrelated children, such as stepchildren, is also prevalent. Comparing stepchildren to biological children, research has shown that parents spend more time with and give more financial support to biological children (Anderson, Kaplan, Lam, & Lancaster, 1999; Henretta, Van Voorhis, & Soldo, 2014; Kalil, Ryan, & Chor, 2014; Zvoch, 1999) and that stepchildren are at a higher risk of maltreatment, such as physical abuse (Daly & Wilson, 1985, 1996) and sexual abuse (Sariola & Uutela, 1996).

Adults can also invest in other unrelated children, such as the children of friends. Because resources are unevenly distributed across individuals, situations, and time, a difficult situation (e.g., failing to provide for a child) can be resolved by receiving help from a friend who has an abundance of the resource needed. Later on, when the situation has changed, the friend's altruistic deed can be reciprocated. In this way, both actor and friend can provide for their children. This theory of reciprocal altruism (Trivers, 1971) can explain why adults also invest in children outside their own family. Especially under conditions where interactions endure over longer periods of time, it can be advantageous to provide investment (e.g., Axelrod, 2006). Naturally, the same type of reciprocity can also take place between biological relatives. In fact, the facilitating aspect of long-lasting interactions is often in place in biological dyads. However, differently from investment in unrelated individuals, investment in biological relatives can also be evolutionarily beneficial even when not reciprocated. Hence, the willingness to provide costly investment in a friend's child or a stepchild, with whom the actor has no biological relation, is likely lower than it is to related children.

Number of Children and Their Ages

Another aspect that needs to be considered is age. Younger adults tend to have younger children, and young children need more parental investment to survive and reach nutritional independence and to increase their reproductive value (e.g., Fischer, 1930; Haig, 2009). Because young children also tend to have young parents, parental investment is expected to be negatively associated with both parental age and child's age.

Parental age is also related to the number of children: Young parents are less likely to have many children. Because most resources are limited and because of this, the number of offspring will also affect the amount of investment that can be directed to a particular child. An adult cannot invest more than the available resources, and in the case where an adult cares for more than one child, the willingness to invest in one child depends on the willingness to invest in another child (Becker

& Tomes, 1976). This trade-off between the willingness to invest in a particular child and the number of children in an adult's care has, for example, been evidenced by adults being less willing to pay for schooling for children in large families (Cáceres-Delpiano, 2006). This suggests that the number of children in an adult's care should be negatively associated with the willingness to invest in a particular child.

The Current Study

In the present study, we aimed to extend the current understanding of how psychological kinship estimates (i.e., putative relatedness weighted by certainty of relatedness) and emotional closeness are associated with the willingness to investment in children. We also extended on earlier studies by examining members outside the core family. Because we included adult-niece/nephew dyads, we were able to measure certainty of relatedness also in women. The main objective of the present study was to investigate to what degree the respondents' self-reported hypothetical investment in different adult-child relationship types (i.e., toward one's own biological children, sisters' and brothers' children, stepchildren, and friends' children) relates to relatedness beyond emotional closeness.

With regard to earlier findings and the framework of evolutionary theory, the following predictions regarding investment were made:

Hypothesis 1: Psychological kinship estimates are positively associated with willingness to invest in children.

Hypothesis 2: The association between psychological kinship estimates and willingness to invest in children is mediated by emotional closeness.

We also explored the associations between respondent's age, gender, relationship status and number of children, child's age and gender, and the respondent's willingness to invest.

Method

Respondents

For the present study, responses from 1,012 respondents (627 females, 385 males) between the age of 20–50, $M_{\text{female}} = 37.16$, $SD = 7.06$ and $M_{\text{male}} = 39.43$, $SD = 6.09$, $t(902.64) = 5.42$, $p < .001$, were obtained from the population-based Finn-Kin study (Albrecht et al., 2014). Respondents had answered questions regarding their willingness to invest in children belonging to the following categories: their own biological child, their sister's and/or brother's child, their stepchild, and a friend's child. Only children who were 18 years old or younger were included in the present study. Because all respondents provided responses regarding several of their actual relationships, our final data set consisted of a sample of 2,246 responses (1,369 from females and 877 from males). Out of these responses, 862 responses concerned a biological child, 253 responses a sister's child, 246 responses a brother's

child, 42 responses a stepchild, and 843 responses a friend's child.

The Finn–Kin study was given ethical permission in by the Institutional Review Board of the Department of Psychology and Logopedics at Åbo Akademi University.

Measures

Willingness to invest. For each child, respondents were asked to answer the three following questions: (1) “How willing would you be to donate your kidney to [name] if she/he would need it?” (2) “Imagine [name] being sentenced to jail for 12 months, how willing would you be to serve the sentence instead of [name]?” and (3) “How willing would you be to give half of one month's salary to [name]?” The response scale ranged from 0 (*not at all*) to 100 (*very*) for Questions 1 and 3. For Question 2, the anchors were 0 (*no time*) and 100 (*the whole sentence*). To calculate a composite score for each dyad, the scores on these three variables were averaged. The scale's internal consistency (3 items; $\alpha = .78$) was sufficient.

Psychological kinship estimates. The measure of psychological kinship estimates consisted of the putative relatedness between the adult and the child (one's own child = .50, brother's child = .25, sister's child = .25, and stepchild and friend's child = .00) multiplied by the certainty of relatedness for each dyad. The certainty of relatedness to one's own children and brothers' and sisters' children was assessed by asking respondents to answer the question “How sure are you that [name] is related to you?” using a scale from 0 (*not at all*) to 100 (*completely certain*). Women were not asked this question with respect to their biological child, because childbirth provides women with full certainty. Women were therefore only asked about their certainty of relatedness to a brother's child and a sister's child. For direct offspring, the mean certainty of relatedness (including only male respondents) was 98.43 ($SD = 8.53$). For sisters' and brothers' children, the mean certainty of relatedness was 96.04 ($SD = 14.72$) for sister's child and 93.22 ($SD = 16.38$) for brother's child. To get a psychological kinship estimate value between 0 and 1, such that it could be compared to the coefficient of relatedness (r), certainty of relatedness was first divided by 100. For the children who were not biologically related to the adult, the certainty of relatedness was set as 0, meaning that all stepchildren and friends' children had a psychological kinship estimate of 0 (putative relatedness = 0 multiplied by certainty of relatedness = 0).

Emotional closeness. Emotional closeness was measured by asking respondents to answer the question “How emotionally close are you and [name]?” on a scale from 0 (*not at all*) to 100 (*completely*).

For all measures mentioned above, respondents provided information using a slider scale. In addition to the aforementioned measures, respondents gave information on their own age, gender, and relationship status (single, in relationship and living apart, in relationship and living together, or married); the

age and gender of each child; the number of years the respondent had coresided with each child; as well as the total number of children in his or her care.

Procedure

The data used in the current study were collected from the Finn–Kin study (Albrecht et al., 2014). For this study, letters with information about the study and a link to the online survey were sent to addresses obtained from the Central Population Registry in Finland containing information regarding all individuals currently residing in Finland; the addresses were selected randomly from the registry. Four thousand men and 4,000 women were invited to participate, and out of these 8,000 individuals, 25.2% responded, and of these, 84.5% completed the survey. This provided a sample of 1,399 respondents. Some of these respondents did, however, not provide information regarding some or all of the variables of interest, and therefore the sample included in the present study consisted of 1,012 respondents. When respondents were compared with the general population on important descriptive variables, Albrecht and her coauthors (2014) found the sample to be representative of the whole population.

As part of the survey, respondents were asked questions regarding actual children belonging to five categories: one's own biological child, a stepchild, a brother's child, a sister's child, and a friend's child. In the case respondents reported having more than one actual relationship with a child within any of the categories, only the oldest child within a category was chosen for subsequent questioning. If no target individual existed in a category (e.g., the respondent had no stepchildren children), respondents were not presented with any questions regarding these categories. To facilitate responding, the names of the selected children were obtained (but were not for reasons of confidentiality included in the data file) and displayed as a part of the subsequent questions. This was done in order to decrease the cognitive burden of responding (Albrecht et al., 2014).

Statistical Analyses

Analyses were conducted using linear mixed-effects modeling (LME) with the *lmer* function in the *lme4* package in R (Bates, Maechler, Bolker, & Walker, 2015; R Core Team, 2015). LME was used in order to take into account the dependency between responses within individuals (one individual provided response regarding several of their adult–child relationships). In all LME analyses, respondent was set as a random factor.

First, preliminary analyses investigated whether child gender (female vs. male), child age, respondent age, respondent relationship status (single vs. in relationship but living apart vs. in relationship but living together vs. married), and the number of children in the care of the respondent were associated with willingness to invest. Each variable was included in separate preliminary analyses as fixed factors with willingness to invest (composite score) as outcome variable. Additionally, as the age of the respondent and the age of the child are likely to be

Table 1. Descriptive Information by Child Gender.

Variable	Female (n = 890)			Male (n = 1356)		
	Range	M	SD	Range	M	SD
Child age	0–18	9.07	5.14	0–18	8.39	5.28
Kidney investment	0–100	68.46	33.37	0–100	72.75	32.37
Salary investment	0–100	31.01	34.54	0–100	32.99	35.03
Jail investment	0–100	27.76	36.65	0–100	22.48	33.51
Willingness to invest: Composite score	0–100	42.41	29.48	0–100	42.74	27.90
Biological child	0–100	67.28	22.66	0–100	66.37	21.99
Sister's child	0–90	30.55	21.43	0–100	38.42	20.25
Brother's child	0–87	31.25	20.90	0–100	37.81	20.39
Stepchild	6–79	38.29	20.30	0–98	38.24	25.20
Friend's child	0–100	22.61	20.11	0–91	22.54	17.71
Emotional closeness	0–100	51.16	33.23	0–100	53.66	34.32
Biological child	0–100	80.62	17.24	0–100	85.26	15.15
Sister's child	0–100	45.87	22.99	0–100	52.35	25.14
Brother's child	0–92	38.16	25.80	0–97	44.26	26.09
Stepchild	0–83	44.00	28.68	2–90	39.08	27.12
Friend's child	0–100	25.11	25.24	0–100	26.43	25.84
Psychological kinship estimates	0.00–0.05	0.24	0.22	0.00–0.50	0.24	0.22

Note. M = mean; SD = standard deviation.

associated with one another, we conducted an analysis with both child age and respondent age included as fixed factors in the same model. We also investigated the relationship between coresidence duration and investment in stepchildren.

Second, we investigated the difference in the amount of investment between the adult–child relationships. This LME analysis included willingness to invest (composite score) as outcome variable and adult–child relationship (biological child, sister's child, brother's child, stepchild, and friend's child), as a fixed factor, and was followed up with pairwise comparisons.

Third, to test whether putative relatedness or psychological kinship estimates (i.e., putative relatedness weighted by certainty in relatedness) explained more variance in willingness to invest, two LME analyses with willingness to invest as outcome variable were run, one with putative relatedness as a fixed factor and another one with psychological kinship estimates as a fixed factor. These models were then compared using an analysis of variance of the two models to examine whether one explained significantly more variance than the other.

Fourth, to test for the mediating effects of emotional closeness on the relationship between psychological kinship estimates and willingness to invest, the analyses were conducted stepwise in accordance with a procedure suggested by Baron and Kenny (1986). The stepwise analyses were conducted separately for male and female respondents. To enable comparison of the regression coefficients, all continuous variables were standardized by transforming the values into *z*-scores before the stepwise analyses were conducted. Then, the zero-order effect between all three variables of interest was assessed (Step 1–3). After this, an analysis including both psychological kinship estimates and emotional closeness as predictors and

willingness to invest as the outcome variable was conducted (Step 4). If the zero-order standardized β between the predictor (psychological kinship estimates) and the outcome variable (investment) decreases, but remains significant, after inclusion of the mediating variable (emotional closeness), partial mediation is supported. If there no longer is a significant association between the predictor and the outcome variable after including the mediating variable, full mediation is supported. The difference between the zero-order association and the association when the mediating variable is included in the model represents the indirect effect of the predictor variable on the outcome variable via the mediating variable. To test the significance of the indirect effect, the Sobel (1982) test was performed by using the *mediation.test* function in the R package (version 5.1.6) (Wang, 2015) in R. The Sobel test examines whether the decrease in the effect of the predictor when the mediating variable is introduced in the model is significant. In all analyses, a *p*-value < .05 (two-tailed) was considered significant.

Results

Preliminary Analysis

Descriptive information regarding the variables child age, willingness to invest, emotional closeness, and psychological kinship estimates is shown in Table 1. For the following analyses, adjusted means and standard errors are reported. In the preliminary analyses, no difference between willingness to invest in female ($M = 42.41$, $SE = 0.96$) and male ($M = 42.74$, $SE = 0.78$) children was found, $b = 0.33$, $SE = 1.23$, $t = 0.26$, $p = .789$. Neither was there a difference in willingness to invest between male ($M = 42.30$, $SE = 0.96$) and female ($M = 42.80$, $SE = 0.77$) respondents, $b = -0.50$, $SE = 1.23$, $t = 0.41$,

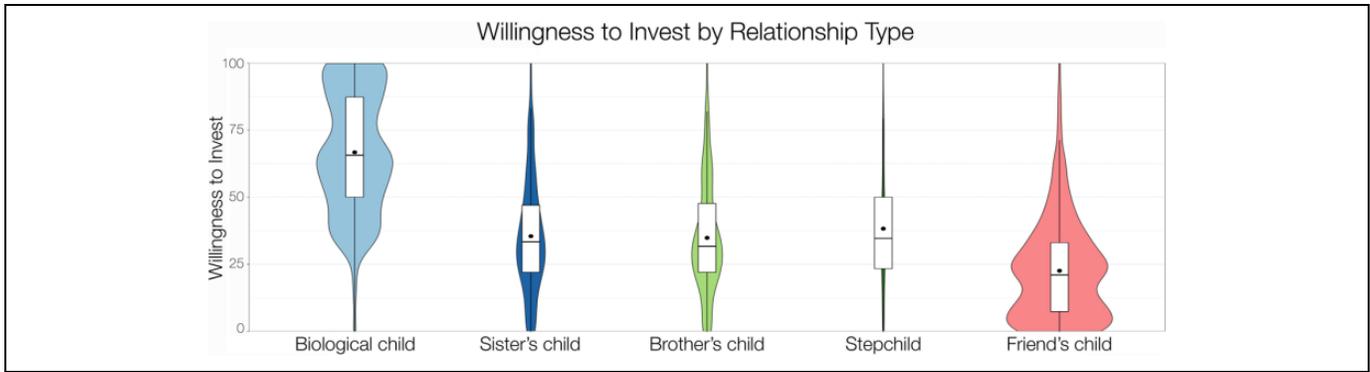


Figure 2. Violin plot for adjusted means for adults' willingness to invest in children belonging to the categories biological child, sister's child, brother's child, stepchild, and friend's child. Higher values indicate more willingness to invest. The violin shape gives the frequencies of responses by each category, with broader frames indicating more responses.

$p = .686$. Furthermore, no effect of the marital status of the respondent was found, $F = 0.10$, $p = .957$.

Regarding the child's age, we found a significant negative association between child age and the willingness to invest, $b = -0.38$, $SE = 0.11$, $t = 3.34$, $p < .001$. Similarly, a significant negative association was found between the age of the respondent and willingness to invest, $b = -0.21$, $SE = 0.09$, $t = 2.22$, $p = .026$. However, the significant effect of the respondent's age disappeared when both child and adult age were included in the same model. In this model, only child age significantly predicted willingness to invest, $b = -0.38$, $SE = 0.11$, $t = 3.34$, $p < .001$. The duration of coresidence between a stepparent and stepchild can be assumed to be weakly correlated with the child's age. For this reason, we conducted an analysis including both child's age and coresidence duration. This analysis was limited to observations regarding stepchildren. We found no association between coresidence and investment when controlling for child's age, $b = -0.01$, $SE = 1.03$, $t = 0.01$, $p = .995$. Child's age was on the other hand significantly associated with investment also in stepchildren, $b = -2.08$, $SE = 1.01$, $t = 2.06$, $p = .046$. Regarding the number of children that a respondent had in his or her care, we found a significant negative association with willingness to invest, $b = -1.55$, $SE = 3.57$, $t = 0.41$, $p < .001$. We decided to retain child's age and the number of children a respondent had in his or her care as control variables in subsequent mediation analyses.

Further, an LME analysis with follow-up pairwise comparisons revealed that adults were significantly more willing to invest in biological children ($M = 66.97$, $SE = 0.69$) than in sisters' children ($M = 36.84$, $SE = 1.17$), brothers' children ($M = 35.51$, $SE = 1.19$), stepchildren ($M = 36.89$, $SE = 2.79$), or friends' children ($M = 22.64$, $SE = 0.70$, $p < .001$; Figure 2). Furthermore, adults were significantly less willing to invest in friend's children compared to all other children ($p < .001$). There was no significant difference in willingness to invest between sisters' children, brothers' children, and stepchildren. We also conducted an analysis to test the interaction between respondent gender and relationship type. The interaction term was significant ($F = 4.61$, $p < .001$). For a sister's child, women reported slightly more willingness to invest ($M = 39.62$, $SE =$

1.47) than men did ($M = 32.12$, $SE = 1.93$), $t[2,133.66] = 3.09$, $p = .002$. The same pattern was seen for a brother's child. Women reported more willingness to invest ($M = 38.21$, $SE = 1.59$) than men ($M = 32.29$, $SE = 1.78$), $t(2,133.66) = 2.48$, $p = .013$. For biological child, stepchild and friend's child, there were no differences between men and women (all $p > .05$).

The comparison between the two models including willingness to invest as the outcome variable, and putative relatedness and psychological kinship estimates, respectively, as fixed factor showed that psychological kinship certainty ($R^2 = .47$, Akaike information criterion [AIC] = 19.73) explained more variance in willingness to invest than putative relatedness ($R^2 = .46$, AIC = 19.80), $\chi^2 = 78.73$, $p < .001$.

The results from the stepwise LME analyses can be seen in Table 2. As child age and number of children under the care of the respondent were both associated with willingness to invest, we included these variables in all models. For both male and female respondents, the zero-order relationships between all variables of main interest (psychological kinship estimates, emotional closeness, and willingness to invest) were significant ($p < .001$; Step 1–3) and positive. In the analyses including both psychological kinship estimates and emotional closeness as predictors and willingness to invest as outcome variable (Step 4), both variables significantly predicted the willingness to invest ($p < .001$). The relationships between psychological kinship estimates and willingness to invest were weaker ($b_{\text{male}} = 0.40$, $b_{\text{female}} = 0.45$) than in the zero-order analyses ($b_{\text{male}} = 0.71$, $b_{\text{female}} = 0.67$), but remained significant ($p < .001$), suggesting that emotional closeness partially mediates the relationship between psychological kinship estimates and willingness to invest. The Sobel (1982) test showed that the indirect effect was significant for both male, $Z = 12.04$, $p < .001$, and female, $Z = 11.39$, $p < .001$, respondents.

Discussion

In the current study, we aimed to investigate how putative psychological kinship estimates and emotional closeness are associated with parental investment. To do this, we measured the willingness to invest in children belonging to different

Table 2. Results From the Stepwise Linear Mixed Effects Analyses Separately for Responses From Male and Female Respondents.

Fixed Factor	Step 1: Investment			Step 2: Investment			Step 3: Emotional Closeness			Step 4: Investment		
	<i>b</i>	SE	<i>t</i>	<i>b</i>	SE	<i>t</i>	<i>b</i>	SE	<i>t</i>	<i>b</i>	SE	<i>t</i>
Male												
Intercept	0.02	0.03	0.61	0.05	0.03	1.52	−0.04	0.03	1.49	0.03	0.03	1.17
Child age	−0.02	0.03	0.91	0.02	0.03	0.79	−0.08	0.02	3.16**	0.01	0.02	0.22
Number of children	−0.03	0.03	1.04	0.01	0.03	0.44	−0.07	0.03	2.63**	−0.00	0.03	0.16
PKE	0.71	0.02	33.94***				0.73	0.02	34.64***	0.40	0.03	12.76***
Emotional closeness				0.76	0.02	32.30***				0.42	0.03	12.54***
Log likelihood		−959.6			−959.4			−876.0			−887.4	
AIC		1,931.2			1,930.7			1,764.0			1,788.8	
BIC		1,959.9			1,959.4			1,792.7			1,822.2	
Female												
Intercept	0.01	0.02	0.44	−0.01	0.02	0.38	0.03	0.02	1.35	0.00	0.02	0.15
Child age	−0.04	0.02	2.24*	0.01	0.02	0.69	−0.09	0.02	4.70***	−0.02	0.02	0.98
Number of children	−0.04	0.03	1.54	−0.02	0.03	0.71	−0.05	0.02	2.32*	−0.03	0.02	1.10
PKE	0.67	0.01	47.23***				0.76	0.02	46.75***	0.45	0.02	19.26***
Emotional closeness				0.68	0.02	39.57***				0.29	0.03	11.52***
Log likelihood		−1,357.4			−1,450.5			−1,340.6			−1,294.1	
AIC		2,726.8			2,912.9			2,693.2			2,602.3	
BIC		2,758.1			2,944.3			2,724.5			2,638.8	

Note. The estimate represents the *b* value from the mixed-effects modeling analyses with the standardized (*z*-scored) variables; AIC = Akaike information criterion; BIC = Bayesian information criterion; investment = willingness to invest; PKE = psychological kinship estimates; number of children = the number of children in the care of the respondent; SE = standard error.

p* < .05. *p* < .01. ****p* < .001.

categories (direct offspring, nieces/nephews, stepchildren, and friends' children) in a population-based sample of Finnish adults.

Psychological Kinship Estimates and Emotional Closeness

In accordance with predictions derived from inclusive fitness theory, stating that when investing, close relatives are preferred over more distant relatives, which, in turn, are preferred over unrelated individuals (e.g., Burnstein et al., 1994; Rachlin & Jones, 2008; Stewart-Williams, 2007, 2008), respondents reported significantly more willingness to invest in their own biological children than in other related children (nieces and nephews), stepchildren, and friends' children. As expected, the willingness to invest in friend's children was low.

An essential finding of the study is that the willingness to invest is more strongly associated with respondents' psychological kinship estimates regarding a child than it is associated with the putative relatedness to this child. The higher the kinship estimate, the more willing adults were to make costly investments to their biological relatives. This finding is in accordance with previous research suggesting that certainty in relatedness has a positive effect on kin directed behavior, increasing, for example, altruistic dispositions (Alvergne et al. 2009; Anderson et al., 2007; Apicella & Marlowe, 2004; Webster, 2003).

Additionally, we tested whether the association between psychological kinship estimates and the willingness to invest is mediated by emotional closeness as hypothesized by Korchmaros and Kenny (2001). Due to adult-niece/nephew dyads

being included in the analysis, we were able to also measure psychological kinship certainty not only in men but also in women. The results were similar for both men and women. We found evidence of partial mediation, but contrary to earlier findings (Korchmaros & Kenny, 2006), we also found that part of the association between psychological kinship estimates and the willingness to invest was independent of emotional closeness, which is in line with some previous findings (Burton-Chellew & Dunbar, 2011; Danielsbacka, Tanskanen, Rotkirch, 2015). Interestingly, after the inclusion of psychological kinship estimates, child age and number of children were associated with emotional closeness but not with investment. This further suggests that emotional closeness and investment may partly be independent of one another.

We also found an interaction between respondents' gender and the type of relationship, such that, compared to men, women were more willing to invest in nieces and nephews. In line with earlier research (e.g., Hrdy, 2007), these results suggest a sex difference in kin-directed alloparenting, such that women investment more effort in the caretaking of their sibling's children.

Age and Number of Children

We also found that both age of a child and the age of the parent were negatively associated with willingness to invest. This corroborates the evolutionary assumption that parental care is mostly required at younger age, and therefore the requirement

for investment decreases with child's age; consequently, investment in older children decreases the amount of resources that could be directed toward younger offspring (e.g., Clutton-Brock, 1991). This also pertains to age-related variation in reproductive value. An individual's reproductive value increases from birth to be maximized at the age of peak fertility, after which it declines toward 0 at different rates for men and women (e.g., Fischer 1930; Hughes, 1983). A young child therefore increases its reproductive value, while its parent's reproductive value tends to decrease year by year. Because reproductive potential is dependent on nutrition and care, parents nevertheless benefit from investing in their young, ensuring they reach nutritional independence and sexual maturity.

When including emotional closeness in the analysis, we no longer found an association between the child's age and the willingness to invest. It is important to here consider the type of investment measured in the current study: the items (donating a kidney, serving a prison sentence) might not measure the type of investment that most strongly is related to a child's age-related dependency on parental care.

In line with earlier research (Becker and Tomes, 1976; Cáceres-Delpiano, 2006), we also found that the number of children in the care of an adult was negatively associated with investment. This association was no longer significant after including child's age, emotional closeness, and/or psychological kinship cues.

Investment in Stepchildren

Interestingly, stepchildren received as much investment as nieces/nephews and more investment than friends' children. Investment in stepchildren can be understood as the indirect effect of mating efforts (Anderson et al., 1999; Bjorklund & Shackelford, 1999; Trivers, 1972). As children need continuous care in order to survive and thrive, parents are likely to choose a new partner displaying traits of parental care (Anderson et al., 1999; Trivers, 1972), and investment in stepchildren can thus be a way of gaining access to the child's parent (Anderson et al., 1999). Although most stepparents invest in their stepchildren, this investment is generally smaller than that of biological parents (Tifferet, Jorev, & Nasanovitz, 2010; Zvoch, 1999).

For stepchildren, we also investigated the effect of coresidence and investment. We found no indication that coresidence duration was associated with investment.

Study Limitations

Some limitations to the current study need to be considered. The sample of responses regarding stepchildren was small ($n = 42, 4.2\%$). While this reflects the proportion of Finnish families that contain at least one stepchild under the age of 18 (3.4%; Statistics Finland, 2016), the small sample size means that estimates can be unreliable. The small sample size also increases the possibility of failing to detect a true association between the duration of coresidence and investment for stepchildren.

It should also be noted that the present study measured the adults' self-reported willingness to invest in children. This willingness was measured as responses to hypothetical and very costly forms of investment. Because of this, the results of the present study should be generalized to real investment with caution.

Because we did not have measures more directly measuring reciprocity included in the current study, it is difficult to rule out that the observed patterns are due to reciprocal altruism. As the potential cost of the measured investment was very high, it is, however, likely that reciprocity played a relatively small role in the current study. This is because as investment costs increase, genetic relatives become preferred over others (e.g., Stewart-Willians, 2007).

It has been shown that men who currently live together with the mother of a biological child invest more in that child compared to men who do not live together with the mother (Anderson et al., 1999). In the current study, our measure of relationship status did not capture whether respondents lived together with the other parent of a biological child or not. Because of this, the absence of association between relationship status and investment should be interpreted with caution.

Conclusions

With these limitations in mind, the results in the study partly provide empirical support for the evolutionary predictions regarding adults' investment in children, that is, an adult's willingness to invest in a child is dependent on psychological estimates of the biological relatedness between the adult and the child. The only exception from this was stepchildren who received more investment than predicted from inclusive fitness theory alone.

Children with access to parents who estimate their kinship to be high are thus expected to receive more investment than other children. It is, however, important to remember that stepchildren generally have access to at least one biological parent, and thereby it is likely to assume that, in most cases, they also receive high levels of investment. From an evolutionary standpoint, investing in stepchildren is costly. From this perspective, it is interesting to note that the observed willingness to invest in stepchildren was considerable.

The study also implies that an important factor mediating adult's will to invest in child is emotional closeness. In sum, psychological kinship estimates and emotional closeness are important factors to consider for understanding adult-child relationships, but these do not fully explain variations in the willingness to invest in children.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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