Personality and Individual Differences 58 (2014) 95–100

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Associations between family size and offspring education depend on aspects of parental personality

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ARTICLE INFO

Article history:
Received 16 June 2013
Received in revised form 3 October 2013
Accepted 13 October 2013
Available online 13 November 2013

Keywords:
Personality
Parental investment
Quantity–quality
Trade-off
Education

ABSTRACT

Personality traits have been associated with fertility rates, but little is known how parental personality is associated with trade-offs between family size and offspring outcomes. Using the Wisconsin Longitudinal Study ($n = 5422$ parents with 17,253 adult biological offspring), we examined whether parental personality traits assessed with the Five Factor Model (extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience) modified associations between family size (measured as offspring number and birth order) and offspring education. Compared to low parental neuroticism, high parental neuroticism was associated with stronger trade-off between number of offspring and offspring educational achievement. High parental openness to experience, in turn, was associated with higher educational achievement of early-born offspring but not of later-born offspring. These personality-dependent differences in trade-offs between family size and offspring outcomes may help to explain why some personality dimensions are associated with low fertility rates.

1. Introduction

Personality differences are correlated with reproductive success in humans (Alvergne, Jokela, & Lummaa, 2010; Berg, Rotkirch, Väisänen, & Jokela, 2013; Hutteman, Bleidorn, Penke, & Denissen, 2013; Jokela & Keltikangas-Järvinen, 2009; Jokela, Kivimaki, Elovainio, & Keltikangas-Jarvinen, 2009) as well as in a variety of non-human animals, including baboons (Seyfarth, Silk, & Cheney, 2012), sheep (Réale, Martin, Coltman, Poissant, & Festa-Bianchet, 2009), and common lizards (Cote, Dreiss, & Clobert, 2008), among others (Biro & Stamps, 2008; Smith & Blumstein, 2008). For example, sociable and extraverted people are more likely to have children than non-sociable and introverted people (Jokela, Alvergne, Pollet, & Lummaa, 2011; Jokela, Hintsa, Hintsanen, & Keltikangas-Järvinen, 2010). Of the other higher-order Five Factor Model personality traits, low neuroticism and low openness to experience have been associated with higher offspring number in both sexes, while high agreeableness and low conscientiousness have been associated with higher fertility rates especially in women (Jokela, 2012; Jokela et al., 2011). These associations have also been shown using partly the same data as used in the present study (Jokela, 2012; Jokela et al., 2011).

In species with parental care, parents face a trade-off between the number of offspring and the amount of resources available for each offspring (Lack, 1947). Given that human offspring are extremely dependent on parental care and parental investment in the offspring's development (Kramer, 2010), many behavioral ecologists have argued that trade-offs between offspring quantity and "quality" may be relevant in understanding human fertility patterns (Borgerhoff and Mulder, 1998, 2000; Kaplan, 1996; Lawson & Mace, 2009, 2010, 2011). Parental investment of individuals with good resources is less affected by trade-offs between quantity and quality of offspring, so they can afford to have many offspring without the quality of offspring substantially decreasing. For parents with limited resources, it may be more optimal to constrain the number of offspring in order to maximize the success of each individual offspring. The benefits of such constrained reproduction have been demonstrated in some pre-industrial human populations (Gillespie, Russell, & Lummaa, 2008; Meij et al., 2009; Strassmann & Gillespie, 2002). Economists have argued for similar trade-offs between family size and parental investment (Becker, 1981; Van Bavel, 2006). Supporting these arguments, large

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0191-8869/$ - see front matter © 2013 Published by Elsevier Ltd.
http://dx.doi.org/10.1016/j.paid.2013.10.009

family size in contemporary humans has been shown to correlate with poorer cognitive development (Downey, 2001) and lower educational achievement (Jaeger, 2008) of offspring, among other adverse outcomes. This may reflect the dilution of limited parental resources (Downey, 2001) as well as the risks of sibling competition (Lawson & Mace, 2008).

If parental personality traits determine, in part, how much offspring success decreases with increasing offspring quantity, this could indicate that lower fertility rates associated with certain personality traits reflect an adaptive strategy against decreasing offspring quality. In other words, some personality traits may reflect parental psychological and social resources that influence offspring outcomes, and different individuals have such personality-dependent resources in different degrees. It is also possible that parents with high resources avoid having many offspring in order to transmit their high resources to few offspring undivided rather than having to distribute smaller resources to multiple offspring.

In the present study, we examined whether the trade-offs between family size and offspring educational achievement are dependent on parental personality traits. We hypothesized that personality traits associated with lower reproductive rates are also associated with stronger trade-offs between offspring quantity and quality, thereby favoring lower fertility rates with these traits. We therefore hypothesized that a large family size combined with parent's high neuroticism, high openness to experience, or low extraversion would have negative consequences for offspring educational achievement. We hypothesized a similar trade-off for women's low agreeableness and high conscientiousness, as these traits have been associated with lower fertility rates particularly in women (Jokela, 2012; Jokela et al., 2011). This was examined by testing for the interaction effects between parental personality traits and family size in predicting offspring education, which estimates whether the strength of offspring quantity–quality trade-off is dependent on parental personality.

2. Materials and methods

2.1. Participants

Participants were 5422 men (n = 2471) and women (n = 2951) from the Wisconsin Longitudinal Study (http://www.ssc.wisc.edu/wlsresearch/), a study that has followed a random sample of 10,317 individuals born between 1937 and 1940 and who graduated from Wisconsin high schools in 1957 (Wollmering, 2007). After the 1957 baseline, survey data have collected from the participants or their parents in 1964, 1975, 1993/4, and 2003/5. The WLS sample is broadly representative of white, non-Hispanic American men and women who have completed at least a high school education (among Americans aged 50–54 in 1990 and 1991, approximately 66% were non-Hispanic white persons who completed at least 12 years of schooling). It is estimated that about 75% of Wisconsin youth graduated from high school in the late 1950s – everyone in the primary WLS sample graduated from high school. The present study used data from the 1993/4 and 2003/5 follow-up. Data were collected first via a telephone interview after which a questionnaire was mailed to the participants. Informed consent was obtained at the beginning of the telephone interview. All instruments and operations were approved by the Institutional Review Board of the University of Wisconsin-Madison. In the 1993/4 follow-up, personality data were available for 6763 participants. Of these participants, 5422 reported having at least one biological child aged 18 years or older for whom data on education were available, and these individuals were included in the present study. Data on offspring's own children (i.e., grandchildren) were not available.

2.2. Measures

Parental personality data were collected via mail questionnaire including a 29-item Big Five Inventory (BFI) assessment in the 1993/4 follow-up (John, Donahue, & Kentle, 1991; John, Naumann, & Soto, 2008). Participants were asked whether they agreed or disagreed that certain personality descriptions fitted themselves, rated on a six-point scale (1 = disagree strongly, 6 = agree strongly). The internal consistency estimates (Cronbach's alpha) were 0.76 for *extraversion* (5 items including: talkative, reserved, full of energy, tends to be quiet, generates a lot of enthusiasm), 0.78 *neuroticism* (6 items including: can be tense, is emotionally stable, not easily upset, worries a lot, remains calm in tense situations, gets nervous easily), 0.69 for *agreeableness* (6 items including: tends to find fault with others, is sometimes rude to others, is generally trusting, can be cold and aloof, is considerate to almost everyone, likes to cooperate with others), 0.64 for *conscientiousness* (6 items including: does a thorough job, is a reliable worker, tends to be disorganized, is lazy at times, does things efficiently, is easily distracted), and 0.61 for *openness to experience* (6 items including: prefers the conventional and traditional, prefers work that is routine and simple, values artistic and aesthetic experiences, has an active imagination, wants things to be simple and clear-cut, is sophisticated in art, music, or literature). The original BFI and its shortened versions have been shown to have good psychometric properties, such as test–retest correlations and correlations with other inventories of the Five Factor Model (John et al., 1991, 2008; Rammstedt & John, 2007; Soto & John, 2009). All personality traits were used as standardized variables in the analyses (mean = 0, standard deviation = 1).

Family size was conceptualized as (a) number of children in the family and (b) birth order of the offspring. Birth order of offspring was included to measure the effects of the number of older siblings in the family. While family size is the same for all children in the same family, birth order varies between siblings. Birth order effects can therefore be examined by comparing siblings within the same family. Such within-family comparisons are not confounded by family-level variables, such as parental socioeconomic status, because these family-level variables are common to all siblings in the same family.

Offspring education was determined from the family roster filled by the parents in both the 1993/4 and 2003/5 follow-up phases. The participants reported some details of their children, including children's birth year and educational achievement measured as the years of schooling with a range of 0 to 20 (0 = none, 12 = high school graduate, 20 = post-doctorate education). While all offspring were included in the calculation of family size irrespective of their age, offspring education was assessed only among the participants' biological children who were at least 18 years of age (n = 17,253 offspring).

Parental socioeconomic status (SES) was measured with a composite score of *education* (highest educational qualifications reported by the participants on a 20-point scale indicating years of schooling; 12 = high school graduate, 20 = post-doctorate education), *financial assets* (total net worth of the participant and his/her spouse) and *occupational status* (measured on the 1970 Duncan Socioeconomic Index scale) reported by the participants in the 1992/3 follow-up. The three variables were first standardized (mean = 0, standard deviation = 1) and a composite SES scale was then created as the mean of the three standardized values.

2.3. Statistical analysis

Random-intercept multilevel linear regression was used to examine whether parental personality traits predicted offspring education (i.e., main effects), and whether the associations

between family size and offspring outcomes depend on parents' personality traits (i.e., interaction effects). In the multilevel dataset, each offspring was a separate observation nested under a parent, with the multilevel regression model taking into account the non-independence of the observations, assuming errors distributed following a normal distribution. Offspring number and birth order were tested in separate models. Given that birth order varies across children from the same family, we examined both total and within-family associations of birth order. The latter removes the influence of between-families differences by comparing siblings from the same family with respect to their birth order (also known as fixed-effect regression). All models were adjusted for parental age, sex, and education, and for offspring age and sex. Statistical analysis was carried out with STATA 12.0 software.

3. Results

Participants' mean age was 63.0 (SD = 3.7), had 13.6 years of education (SD = 2.3), 54.4% were female, and had 3.2 (SD = 1.5) offspring on average. The offsprings' mean age was 36.3 (SD = 5.8) and mean years of education was 14.3 (SD = 2.3). Offspring number and birth order were related to lower education of offspring (Fig. 1). The birth order effect was also observed in a within-family sibling comparison, indicating that later-born siblings achieved lower education than their earlier-born siblings (Fig. 1). Statistically significant interaction effects with offspring sex ($p < .001$) indicated that birth order was more strongly related to offspring education in male offspring (B for linear trend = −0.16, SE = 0.02, $p < .001$) than in female offspring ($B = -0.10$, SE = 0.02, $p < .001$). Independently of parental socioeconomic status, which was adjusted for in all the models, parents with high extraversion ($B = 0.05$, SE = 0.02, $p < 0.05$) and high openness to experience ($B = 0.14$, SE = 0.02, $p < .001$) had offspring with higher education, whereas there was no association between offspring education and parental neuroticism ($B = 0.03$, SE = 0.02), agreeableness ($B = -0.02$, SE = 0.02) or conscientiousness ($B = -0.01$, SE = 0.02). There were no offspring sex differences between parent's personality and offspring outcomes (all p-values >.16).

For offspring number, there was a significant interaction effect with parental neuroticism when predicting educational level of offspring ($p = .001$) but not with other parental personality traits ($p > .31$). For offspring birth order, there was a significant interaction with parental openness to experience ($p = .01$). There were no other significant interactions with personality traits (all $p > .19$). The interaction effect between offspring number and parental neuroticism is shown in detail in Table 1, and the interaction between offspring birth order and parental openness to experience is shown in Table 2. The categorically coded interaction effects followed fairly linear patterns in both interactions, so linear interaction effects were used to illustrate these patterns by calculating the model-predicted values of offspring education for low (1 SD below the mean), average (mean) and high (1 SD above the mean) levels of parental personality traits (Fig. 2). Offspring number was associated with lower offspring education more strongly in those with high ($B = -0.23$, SE = 0.02, $p < .001$) compared to low ($B = -0.12$, SE = 0.02, $p < .001$) parental neuroticism. Interpreting the interaction the other way around, high neuroticism was associated with higher education of offspring in individuals with few children ($B = 0.15$, SE = 0.04, $p = .001$ for one-child families) but this association first disappeared and then turned negative with increasing family size ($B = -0.12$, SE = 0.05, $p = .13$ for families with 6 or more children). In terms of effect magnitudes on the Cohen's d scale, the difference between high and low parental neuroticism was $d = 0.15 \times 2/2.3 = 0.13$ for 1-child families but $d = -0.12 \times 2/2.3 = -0.10$ for families with 6 or more children.

A similar pattern was observed for offspring birth order and parental openness to experience (Fig. 2). Offspring birth order was more strongly related to low offspring education in parents with high openness to experience ($B = -0.15$, SE = 0.02, $p < .001$) compared to those parents with low openness to experience ($B = -0.09$, SE = 0.02, $p < .001$). Correspondingly, high parental openness to experience predicted higher education in offspring born early ($B = 0.15$, SE = 0.03, $p < .001$ for first-borns), but this association disappeared with advancing birth order ($B = 0.00$, SE = 0.05, $p = .98$ for offspring born 6th or later). In terms of Cohen's d, the difference between high and low parental openness to experience was $d = 0.15 \times 2/2.3 = 0.13$ for firstborns but $d = 0.00 \times 2/2.3 = 0.00$ for offspring born 6th or later. This interaction effect was similar and slightly stronger when birth order was modeled only as a within-family effect instead of a combination of within- and between-family effects (Table 2; not illustrated in Fig. 2). The interaction between parental personality and family size might produce spurious results if the association between offspring quantity and quality was non-linear. To test this, we re-fitted the above models by adding the squared effect of family size in the models. All the results remained essentially the same (data not shown), suggesting no confounding caused by non-linear effects.

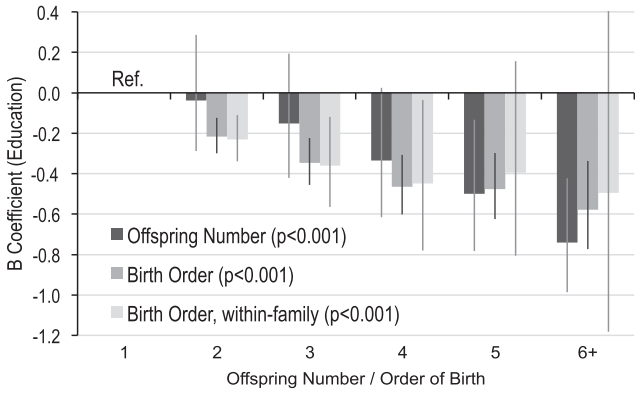

Fig. 1. Associations of offspring educational level with the number and birth order of offspring (one-child family or first-borns as the reference category). The bars illustrate regression coefficients from three separate models for each outcome with offspring number (dark bars), the total effect of birth order (dark gray bars), and the within-family effect of birth order (light gray bars) as the predictor variable. Error bars are 95% confidence intervals of the regression coefficients. p-Values reported for the variables are p-values for testing a linear trend.

Table 1
Interaction effects between neuroticism and offspring number in predicting offspring education.

	Main effects	Interaction effect
Neuroticism	0.23* (0.11)	–
Number of offspring		
1	(Ref.)	(Ref.)
2	−0.05 (0.12)	−0.17 (0.12)
3	−0.16 (0.12)	−0.17 (0.11)
4	−0.33** (0.12)	−0.24* (0.12)
5	−0.50*** (0.13)	−0.27* (0.12)
6+	−0.75*** (0.13)	−0.37** (0.13)
p For linear trend	<.001	.001

Note: values are regression coefficients (and their standard errors) of the main effects of neuroticism and number of offspring (left column), and their interaction effect (right column). Ref. = reference category.
Variables included in the model: number of offspring, neuroticism and the 4 other personality traits, interaction effect between neuroticism and number of offspring, parental age, sex, and socioeconomic status, and offspring sex and age. See Fig. 2 for illustration of the interaction effect.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 2
Interaction effects between openness to experience and offspring birth order in predicting offspring education.

	Model 1: total regression		Model 2: within-family regression	
	Main effects	Interaction effect	Main effects	Interaction effect
Openness to experience	0.16*** (0.03)	–	–	–
Birth order of offspring				
1st	(Ref.)	(Ref.)	(Ref.)	(Ref.)
2nd	−0.22*** (0.03)	−0.04 (0.03)	−0.23*** (0.04)	−0.06 (0.04)
3rd	−0.35*** (0.04)	−0.06 (0.04)	−0.37*** (0.06)	−0.09* (0.04)
4th	−0.47*** (0.05)	−0.12* (0.05)	−0.47*** (0.08)	−0.17** (0.06)
5th	−0.48*** (0.08)	−0.08 (0.07)	−0.42*** (0.11)	−0.10 (0.08)
6th or later	−0.59*** (0.09)	−0.13 (0.09)	−0.52*** (0.14)	−0.14 (0.10)
p For linear trend	<.001	.008	<.001	.002

Note: values are regression coefficients (and their standard errors) of the main effects of birth order of offspring and openness to experience, and their interaction effect. Model 2 is fitted with the fixed-effect estimator assessing within-family effects of birth order. Ref. = reference category.
Variables included in the model: birth order of offspring, openness to experience and the 4 other personality traits, interaction effect between openness to experience and birth order of offspring, parental age, sex, and socioeconomic status, and offspring sex and age. See Fig. 2 for illustration of the interaction effect.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

4. Discussion

Large family size predicted lower educational achievement of offspring, particularly in families with parents scoring high in neuroticism. In addition, the positive association between parental openness to experience and offspring education attenuated with advancing offspring birth order. These results suggest that parents with high neuroticism and high openness to experience have "more to lose" in terms of offspring quality with increasing offspring quantity than parents with low neuroticism and low openness to experience. These interactions were independent of parental SES. Considering parental investment, the optimal number of offspring may vary as a function of parental personality characteristics.

4.1. Plausible mechanisms

Parental neuroticism was positively associated with offspring educational achievement when family size was small (i.e., less than 3 children) but this association reversed to a negative association when family size was large (i.e., more than 5 children). The positive association observed in small families may be explained by neurotic parents' higher level of competitiveness and concern for the success of their offspring (Nettle, 2006), which leads them to invest more in their offspring. Moreover, individuals with high neuroticism tend to have fewer children (Jokela, 2010; Jokela et al., 2011) and to become even more stressed with increasing family size compared to their less neurotic counterparts (Hutteman et al., in press; Jokela et al., 2009), suggesting that parents with high neuroticism may not be well adapted to cope with large families. This may explain why the negative association between family size and offspring education is amplified by parents' high neuroticism, and why the association between parents' neuroticism and offspring education turns negative as family size increases.

Later birth order was associated with lower educational achievement of offspring particularly among parents with high openness to experience, implying a more marked trade-off associated with this personality trait. Thus, high parental openness to experience conferred an educational advantage to early-born offspring but this advantage attenuated with offspring birth order. This pattern is in agreement with the resource dilution hypothesis of parental investment (Downey, 2001), which suggests that late-born siblings do not benefit from the same limited parental resources as the early-born offspring. This dilution effect appeared to be specific to individual offspring born rather than an effect affecting all the offspring in the family, as the interaction effect was not observed with offspring number.

4.2. Evolutionary considerations

Our results may have implications for evolutionary personality psychology. From an evolutionary point of view, trade-offs between offspring number and parental investment may be important in understanding the persistence of heritable variation in personality traits that correlate negatively with offspring number (Penke, Denissen, & Miller, 2007). Under some conditions large family size combined with certain personality traits may have led to sub-optimal offspring success via reduced parental investment and offspring quality. In a sample of preindustrial Senegalese women, high neuroticism was associated with higher number of offspring but poorer health condition of these offspring (Alvergne

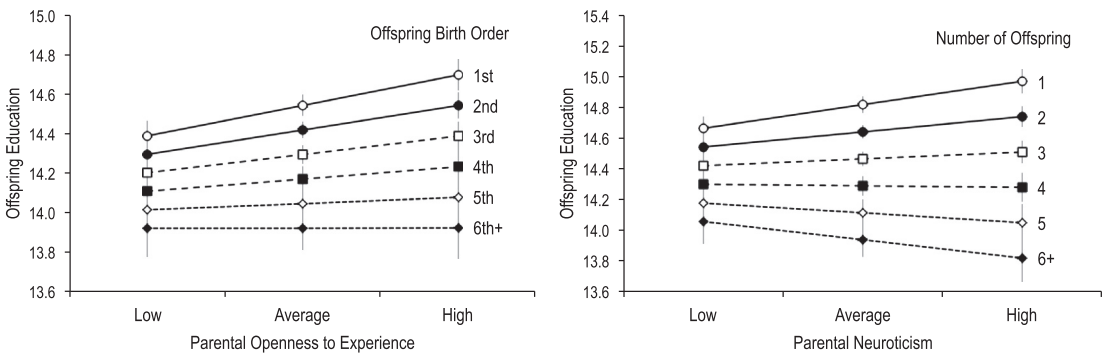

Fig. 2. Model-predicted offspring educational level by parental neuroticism and offspring number (left-hand panel), and by parental openness to experience and offspring birth order (right-hand panel), showing that the trade-offs between family size and offspring education become steeper with increasing parental neuroticism and openness to experience. Predicted offspring education is calculated for levels of low (1 SD below the mean), average (mean) and high (1 SD above the mean) parental personality. Error bars are 95% confidence intervals. See Tables 1 and 2 for details.

et al., 2010). Thus, high neuroticism may have reproductive benefits unless there are limits to resources that constrain parental investment.

Given that we used offspring education as a proxy for offspring quality and parental investment, the present associations may not generalize directly to evolutionarily relevant outcomes, as higher parental investment in modern humans does not necessarily lead to higher reproductive success. For instance, higher offspring education may decrease rather than increase reproductive success, particularly in female offspring (Skirbekk, 2008). However, the more general hypothesis that personality modifies parental investment and quantity–quality trade-offs should merit further investigation also in other species besides humans (Kontiainen et al., 2009).

The main limitations of the study include the use of self-reported measures only, and the lack of personality data from both parents and all offspring. The lack of data on offspring personality did not allow us to examine whether parental personality has influence over and above offspring's own personality or whether the intergenerational associations reflects shared genetic factors contributing to both parental and offspring personality traits. Regarding analytical approach, we examined the strength of the trade-off between offspring number and educational achievement as a function of parental personality traits irrespective of whether individuals actually optimize their reproductive behavior according to such trade-offs. It is quite possible that some individuals (e.g., those with high neuroticism) have a strong trade-off between offspring quantity and quality, but they do not adjust their reproductive behavior accordingly. Other offspring outcomes besides education need to be assessed in future studies to understand the significance of personality-dependent trade-offs in people's fertility decision making.

4.3. Conclusion

In sum, our findings show that parental personality may modify trade-offs between increasing family size and offspring educational achievement. High parental neuroticism may be beneficial for offspring of small families but for offspring of large families parental neuroticism amplifies the adverse influence of family size on offspring education. Similarly, decreasing educational achievement with increasing birth order of offspring is observed most markedly among parents with high openness to experience, suggesting progressive dilutation of parental resources. Personality-dependent associations with parental investment can provide important insights on the role of personality in family formation.

Acknowledgements

This research was supported by Kone Foundation, Research Funds of the University of Helsinki, and Academy of Finland (Grant no. 268388). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The research uses data from the Wisconsin Longitudinal Study (WLS) of the University of Wisconsin-Madison. Since 1991, the WLS has been supported principally by the National Institute on Aging (AG-9775 and AG-21079), with additional support from the Vilas Estate Trust, the National Science Foundation, the Spencer Foundation, and the Graduate School of the University of Wisconsin-Madison. A public use file of data from the Wisconsin Longitudinal Study is available from the Wisconsin Longitudinal Study, University of Wisconsin-Madison, 1180 Observatory Drive, Madison, Wisconsin 53706 and at http://www.ssc.wisc.edu/wlsresearch/data/. The interpretations, opinions, and inferences based on the data are solely the responsibility of the authors.

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