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Original Article

Using monozygotic twin differences to examine the relationship between parental affection and personality: a life history account

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ABSTRACT

The relationship between maternal and paternal affection, reported in adulthood, and personality was examined using a genetically sensitive research design comparing differences between monozygotic twins. Using life history theory as a framework, it was predicted that differences in maternal and paternal affection would be predictive of differences in personality such that the twin reporting greater maternal and paternal affection would also report a personality profile reflective of a slow life history strategy. Specifically, it was predicted that the twin that reported greater maternal and paternal affection would also score high on the meta-traits of plasticity, stability, and the general factor of personality (GFP). The results supported the hypotheses, with most variance accounted for by the GFP. Additional results suggest that differences in paternal affection exhibit a stronger effect and that stability and plasticity may provide unique information about the association between differences in parental affection and differences in personality. Attachment and parental investment theories offer possible explanations for the findings, although alternative explanations are also proffered. It may also be beneficial for future research using a monozygotic twin difference approach to utilize biometric measures of life history strategy.

1. Introduction

1.1. Behavioral genetic accounts of parental influence

The extent to which parental behavior has lasting impact on children and their development is a question of immense interest (Harris, 1995; Pinker, 2002; Scarr, 1992; Steinberg, 2001). Although the effect of parental behavior can be studied experimentally in phylogenetically related species (e.g., Maestripieri, Lindell, & Higley, 2007), children cannot be randomly assigned to different parents, limiting research on this topic to correlational methods. While it is has been consistently found that warm and authoritative style parenting is positively correlated with a variety of positive psychosocial outcomes in children, and longitudinal designs can be creatively employed to assist in establishing the paths of influence (i.e., parent to child or child to parent; e.g., Kerr, Stattin, & Özdemir, 2012; Steinberg, 2001; Van der Akker, Deković, Asscher, & Prinzie, 2014), non-genetically informed studies are still open to genetic explanations for any association that is observed between parental and child behaviors (Pinker, 2002). With that caveat in mind, past research has found that supportive parenting is predictive of offspring's personality profile in which children with authoritative type parents score higher on the Big Five personality traits of openness, conscientiousness, extraversion, agreeableness, and lower on neuroticism (e.g., Dunkel, Harbke, & Papini, 2009; Robinson, Lopez, & Ramos, 2014; Van der Akker et al., 2014). Nevertheless, as parents and children also share roughly 50% of the same genetic make-up, genes may account for the association between the positive parenting behavior and the child's socially esteemed personality profile.

Indeed, behavioral genetic studies have consistently found that, at least by adulthood, individual differences are almost exclusively a function of genetic differences (i.e., heritability) and idiosyncratic experiences (i.e., nonshared environment). In contrast, aspects of the environment that make children raised in the same household similar (i.e., shared environment) have been found to have little effect (Polderman et al., 2015; Turkheimer, 2000). These results have formed the basis for the idea that, barring extreme parental behavior, the parental influence is at best negligible (Scarr, 1992). For example, Harris (1995) attributes personality to two factors. First, a genetic core as represented by the Big Five personality traits, and second, the context-specific behavioral system which is the adaptation or socialization to the specific environment. As children develop and begin to spend more time outside of the home their socialization is increasingly directed by factors outside the home, such as their peer group (e.g., Nedelec, Park, & Silver, 2016).

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However, it has also been acknowledged that parental influences are not always synonymous with the shared environment. Parents may treat their children differently, which may in turn influence differences in the children (e.g., Caspi et al., 2004; Jenkins, Rasbash, & O'Connor, 2003). In this scenario, parental behavior is influential but given its influence is differentiated across children within the same household it is slotted into the nonshared environment category in behavioral genetic research. The influence of differential parenting has been studied in genetically-informed research focusing primarily on monozygotic twins. Because monozygotic twins share 100% of their DNA (as it pertains to heritability), any differences between them must be caused by non-genetic factors (typically referred to as aspect of the environment).[1] Thus, correlating a difference in phenotype between twins with a difference in the environment experienced by the twins can illuminate the effect of that environmental influence (while controlling for shared genetic and shared environmental factors). In the current investigation we adopt this method and use a between monozygotic twin design to examine the influence of within-family differential parental affection on adult personality.

1.2. Evolutionary grounding for the influence of parental behavior on adult personality

There are several accounts as to how individual differences in personality evolved (e.g., Figueredo, Woodley, & Jacobs, 2016). Here we focus on an evolutionary-based theory of personality variance that includes a relevant role for parents (e.g., Belsky, Steinberg, & Draper, 1991). Life history (LH) theory is a mid-level evolutionary based theory premised on the idea that organisms must make trade-offs in the allocation of bioenergetic resources. One important trade-off is between mating and parenting effort. As bioenergetic resources are allocated toward mating effort, with the requisite reductions in resources allocated to parenting effort, LH strategy is said to accelerate. On the other hand, a slower LH strategy is often equated with a reproductive strategy in which fewer offspring are birthed/sired, but in which parental investment is high.

Two findings concerning individual differences in LH strategy are especially pertinent to the current investigation. First, individual differences in parental investment are not only a definitive aspect of LH strategy, but parental investment is also thought to partially direct an offspring's LH strategy such that parental investment of resources (e.g., time) act to slow a child's developing LH strategy. Early in the application of LH theory to human individual differences, warm and sensitive parenting, mediated by secure attachment, was theorized to be an important influence (Belsky et al., 1991). This idea has garnered significant empirical support (e.g., Del Giudice, 2009; Hurst & Kavanagh, 2017) with more recent findings suggesting an extended time period for parental influence, this period extending beyond the first five to seven years of life initially identified as a sensitive period for parental influence on LH strategy (Del Giudice, 2009; Dunkel, Mathes, Kesserling, Decker, & Kelts, 2015). However, the extent to which this observed influence remains in a genetically-controlled analysis is a relatively unaddressed empirical question.

Second, individual differences in LH strategy are thought to encompass individual differences in personality. Investigating the scope of the LH strategy nomological network, using the same data as used in the current study, Figueredo, Vásquez, Brumbach, and Schneider (2004), found that the Big Five personality traits intercorrelated to form a General Factor of Personality or GFP. The GFP was strongly correlated with a separate LH factor composed of numerous psychosocial variables, including the maternal and paternal relationship quality and, also noteworthy, behavioral genetic analyses indicated that the shared environment accounted for little variance in the GFP. Figueredo et al. (2004, 2016) reported a heritability for the GFP of $h^2 \approx 0.50$ with the nonshared environment accounting for the rest of the variance. Collectively, these results lead to the observation that variance in the GFP is due primarily to genetic and nonshared environmental factors (see also Rushton & Irwing, 2011).

The extraction of a GFP from personality measures has now been replicated many times (e.g., Loehlin, 2012; Musek, 2007; Rushton & Irwing, 2011; Van der Linden, Te Nijenhuis, & Bakker, 2010). Early research on the nature of the GFP was driven by the supposition that the GFP was wholly reflective of LH strategy; a high GFP seen as almost synonymous with a slow LH strategy (e.g., Rushton, Bons, & Hur, 2008; Rushton & Irwing, 2011). Although the GFP is now most commonly thought to reflect social-effectiveness (for a review of this perspective see Van der Linden, Dunkel, & Petrides, 2016), and other evolutionary mechanisms beside LH strategy have been identified as influential (Verweij et al., 2012), a substantial amount of evidence still points to LH strategy having a strong impact on the GFP (Figueredo et al., 2016).

1.3. Issues concerning the GFP

Two additional issues regarding the GFP should be broached. First, it is often suggested that the GFP is not substantive, but that it is simply a function of measurement error (i.e., response bias). For example, Bäckström and Björklund (2016) found that when they reworded personality items to make the items evaluatively neutral the GFP could not be reliably extracted (see Irwing, 2013 for contrary results). However, there is accumulating evidence that while the GFP is in part a function of response bias (i.e., impression management and overly positive self-evaluation) it also represents an important aspect of personality (Davies, Connelly, Ones, & Birkland, 2015; Dunkel, Van der Linden, Brown, & Mathes, 2016); although, it seems reasonable to expect continued disagreement as to the relative importance of the various sources of GFP variance.

The second issue concerns the relationship between the GFP and LH strategy. Prior to the recent reemergence of research on the GFP (the theoretical foundations of the GFP are attributed to Galton, 1884 with Webb, 1915 conducting the first empirical research), Digman (1997) found that the Big Five created two higher-order factors composed of agreeableness, conscientiousness, and emotional stability on the one hand, and extraversion and openness on the other hand. Digman (1997) labeled the first factor (Alpha) and the second factor (Beta), yet they are also referred to as stability and plasticity (e.g., DeYoung, 2006). Stability represents an individual's desire for stability and structure, while plasticity represents differences in the propensity for exploration and growth.

In lieu of the GFP, plasticity, and more so stability, have been posited to reflect the association between higher-order personality traits and LH strategies. Del Giudice (2012, 2014) suggested that while stability primarily aligns with a slow LH strategy, the relationship between plasticity and LH is more complex. The two traits (extraversion and openness) that compose plasticity, themselves are composed of various dimensions – some of which are associated with a slow LH strategy (e.g., social warmth as a facet of extraversion) aspects that are associated with both a slow and a fast LH strategy (e.g., motivation for dominance as a facet of extraversion). Recent research using Q-sort measures of personality and LH strategy lend support to this position; participants with a slow LH profile also exhibited a personality profile consistent with high scores on stability and mixed scores on plasticity (Manson, 2017).

While on the surface it may appear that a GFP and a plasticity/stability account of the relationship between meta-personality traits and LH strategy are at odds, we posit that the two positions can be reconciled. By definition the GFP is the shared variance among personality traits, and as stated it is thought to be significantly and positively associated with a slow LH strategy (e.g., Dunkel & Decker, 2010; Figueredo et al., 2004), which also suggests that plasticity and stability will be positively

[1] Note that these non-genetic factors (i.e., components of the nonshared environment) can still be biological in nature (e.g., epigenetic processes, nutritional differences, random mutations, etc.).

associated with a slow LH strategy. However, we posit that once the shared variance (i.e., GFP) is accounted for, the direction in which stability and plasticity are correlated with LH strategy might differ. Given the traits that make up stability are almost unidirectionally positively associated with a slow LH strategy, the unique variance of stability should still positively correlate with LH strategy. On the other hand, given that plasticity is composed of mixed traits the GFP should absorb the slow LH variance leaving the unique variance of plasticity free of LH variance.

1.4. Summary and hypotheses

Results consistently indicate that warm and supportive parenting is associated with socially defined positive offspring developmental outcomes (Steinberg, 2001). Included in this array of associations are the socially desirable personality traits of openness, conscientiousness, extraversion, agreeableness, and emotional stability (e.g., Robinson et al., 2014). This pattern of results is consistent with the theorized relationship between parenting and personality derived from LH theory. From this perspective parental investment acts as an input slowing an offspring's developing LH strategy (e.g., Belsky et al., 1991). Additionally, in the domain of personality it is thought that the manifested output of a slowing LH strategy is an increase in the GFP. This prediction accounts for the documented pattern of associations between parenting and the Big Five. However, as has been frequently noted, due to the shared genes between parent and child non-genetically informed research designs assessing the correlation between parental behavior and offspring outcomes are open to more parsimoniously genetic explanations. Thus, in the current study we examine the association between a specific aspect of parenting (i.e., maternal and paternal affection) and offspring personality using a genetically informed design. The examination is done by comparing the differences in reported parental affection received with differences in personality in a sample of monozygotic (MZ) twins. In other words, the current study isolates parental affection as a component of the nonshared environmental effect on the variance in personality by using an MZ twin difference design (which controls for the influence on phenotypic variance of shared genetic and shared non-genetic factors; Rovine, 1994) To this end the following hypotheses are posited.

It is hypothesized that differences between the parental affection reported by monozygotic twins will be correlated to differences in personality. While we posit that the effect of parental affection will be primarily at the level of the GFP (i.e., the shared variance of the personality traits) we also test an alternative which includes the unique variance of plasticity and stability. Controlling for the twin differences in the GFP, it is predicted that differences in parental affection will be positively associated with differences in stability and no longer correlate with differences in plasticity.

Further, although it is expected that there will be little difference in the direction of the effect between maternal and paternal affection, there is evidence in parenting research (e.g., Paquette, 2004) and LH research (e.g., DelPriore, Schlomer, & Ellis, 2017) for different effects, and examining maternal and paternal affection distinctly allows this possibility to be explored. Paquette (2004), for example, speculates that there are sex specific parental functions designed to balance the attachment needs of exploration and security. On average, fathers encourage exploration and openness to the world, while mothers serve as a base for security. Thus, based on DeYoung's (2006) definitions of stability as desire for stability and plasticity as the tendency to explore, one might surmise that maternal affection has a greater impact on stability and paternal affections has a greater influence on plasticity. Likewise, a line of research based on LH theory (DelPriore et al., 2017; Draper & Harpending, 1982) suggests paternal investment is an environmental cue acting to slow LH strategy; thus paternal investment maybe a particularly strong predictor of the GFP. Lastly, because the GFP includes variance accounted for by response bias (Dunkel et al., 2016) it is considered methodologically sound, when possible, to control for a positive response bias. Consequently, ancillary analyses included a measure of response bias as a statistical control.

2. Method

The foundational Midlife Development in the U.S. (MIDUS; Brim et al., 1995–1996) study was initiated to examine several aspects of human development during the middle of the lifespan using a nationally representative sample from the United States. The original study, now referred to as MIDUS I, was expanded with subsequent waves of data collection and several smaller investigations examining particular areas (e.g., cognition) built around the main sample have also been conducted.

Data collection for MIDUS I occurred in 1995–1996 with an oversampling of several populations including twins. The complete MIDUS I sample includes 7108 participants (52% female) between the ages of 24 and 75 (M = 46, SD = 13.2). The subsample of monozygotic twins is of special interest for the current investigation. Data was available for 349 monozygotic twin pairs (53.3% female). Zygosity was determined by self-report via reports of phenotypic similarity on a number of characteristics (e.g., eye color), whether or not the twin pairs were often mistaken for each other, and whether the twin pair had ever undergone testing or been informed by a physician that they were identical twins.

2.1. Measures

2.1.1. Maternal and paternal affection

Maternal and paternal affection were measured using the seven item maternal affection ($\alpha = 0.91$) and paternal affection ($\alpha = 0.93$) scales described in the MIDUS I scale codebook. Participants were instructed to respond to the following items using a Likert-type scale: (1) how would you rate your relationship with your mother (father) during the years you were growing up?; (2) how much did she (he) understand your problems and worries?; (3) how much could you confide in her (him) about things that were bothering you?; (4) how much love and affection did she (he) give you?; (5) how much time and attention did she (he) give you when you needed it?; (6) how much effort did she (he) put into watching over you and making sure you had a good upbringing?; (7) how much did she teach you about life?

2.1.2. Personality

Participants rated the degree to which a set of adjectives described them using a Likert-type scale. The items for each of the Big Five personality traits and the corresponding internal consistency for each of the scales is as follows: Openness (Creative, Imaginative, Intelligent, Curious, Broad-minded, Sophisticated; $\alpha = 0.77$), Conscientiousness (Organized, Responsible, Hardworking, Careless-reversed scored; $\alpha = 0.58$), Extraversion (Outgoing, Friendly, Lively, Active, Talkative; $\alpha = 0.78$), Agreeableness (Helpful, Warm, Caring, Softhearted, Sympathetic; $\alpha = 0.80$), Neuroticism (Moody, Worrying, Nervous, Calm-reverse scored; $\alpha = 0.74$).

Unit-weighted measures of stability and plasticity were also calculated. First, the Big Five traits were standardized (i.e., transformed to z-scores). Stability was calculated by summing the standardized values for conscientiousness and agreeableness and subtracting the standardized value of neuroticism. Plasticity was calculated by summing the standardized scores for extraversion and openness. To calculate the GFP the Big Five scale totals were factor analyzed using principal axis factoring and the first unrotated factor extracted (Van der Linden et al., 2010). The first factor had an Eigenvalue of 1.66 and accounted for 33.15% of the variance among the scales. The factor loadings for each of the Big Five scales were as follows: Openness (0.61), Conscientiousness (0.43), Extraversion (0.80), Agreeableness (0.63), Neuroticism (−0.26).

Table 1
Correlations between study variables difference scores in the full and MZ twin samples.

	1	2	3	4	5	6	7	8	9	10
1. Maternal affection	–	0.48	0.05	0.11	0.22	0.15	−0.19	0.16	0.22	0.20
2. Paternal affection	0.47	–	0.09	0.12	0.25	0.14	−0.14	0.19	0.20	0.22
3. Openness	0.09	0.10	–	0.32	0.52	0.35	−0.17	0.87	0.41	0.74
4. Conscientiousness	0.10	0.10	0.26	–	0.32	0.34	−0.19	0.37	0.75	0.62
5. Extraversion	0.17	0.17	0.51	0.27	–	0.54	−0.17	0.87	0.50	0.82
6. Agreeableness	0.13	0.15	0.34	0.28	0.53	–	−0.04	0.51	0.66	0.73
7. Neuroticism	−0.15	−0.13	−0.17	−0.20	−0.16	−0.05	–	−0.19	−0.63	−0.34
8. Plasticity	0.15	0.15	0.87	0.31	0.87	0.50	−0.19	–	0.52	0.90
9. Stability	0.18	0.19	0.38	0.74	0.47	0.66	−0.62	0.49	–	0.83
10. GFP	0.18	0.19	0.74	0.58	0.82	0.73	−0.34	0.89	0.82	–

Note. The full sample (N = 5310–5599) is below the diagonal. The MZ twin sample (N = 620–654) is above the diagonal. For the full sample all of the correlations significant at $p < 0.001$. For the MZ twin sample all correlations ≥ 0.09 or ≤−0.09 significant at $p < 0.05$.

The Likert-scale rated item "I like most parts of my personality" was used in ancillary analyses as a covariate to control for the possibility that the GFP is simply a function of a positive response bias. This item was reverse coded so that higher values indicated greater agreement with the statement.

3. Results

In order to fully test our hypotheses we first examined the associations using the full sample in the MIDUS data (i.e., singletons and siblings). Subsequently, to assess the associations while controlling for the influence of shared genetic and shared non-genetic factors we limited the analyses to the monozygotic twin subsample and employed MZ twin difference scores (see below). The values for the study variables showed little difference between the isolated MZ twin subsample and the rest of sample. Bivariate correlations for the full sample, and the MZ twin sample, between the study variables can be seen in Table 1. As illustrated in Table 1, in the full sample maternal and paternal affection were positively associated with openness, conscientiousness, extraversion, agreeableness, plasticity, stability, and the GFP. Alternatively, maternal and paternal affection were negatively associated with neuroticism. The pattern for the MZ twin sample was similar with the exception that maternal affection was not associated with openness.

Following the instructions outlined in Beaver (2013) a subsample including only monozygotic twins was created by restructuring the dataset so that each row corresponded to an MZ twin pair (single-entered dataset). We first correlated scores for all of the variables across the twin pairs; the results of these analyses can be seen in Table 2. Subtracting the correlation from 1 (i.e., $1 - r_{MZ}$) allows for an estimate of the amount of variance due to nonshared environment (plus measurement error). Although exhibiting substantial variation (from 0.26 for paternal affection to 0.66 for personality assessment), at least a quarter of the variance for each variable is attributed to the nonshared environment.

Table 2
Intrapair correlations between monozygotic twins on the study variables.

Variable	r_{MZ}
Maternal affection	0.69
Paternal affection	0.74
Openness	0.42
Conscientiousness	0.47
Extraversion	0.45
Agreeableness	0.35
Neuroticism	0.52
Plasticity	0.43
Stability	0.45
GFP	0.47

Note. Number of twin pairs 308–325. All correlations are significant at $p < 0.001$.

Next, differences scores for each of the variables were calculated by subtracting the value for each variable of the second member of the twin pair from the value of the corresponding variable of the first member of the twin pair (twin 1 and twin 2 designations were randomly assigned; Rovine, 1994). The correlations among the difference scores are displayed in Table 3. The pattern of results remained similar to those found in the overall sample with a slight increase in the strength of the relationship between the parenting and personality indices, especially with the measures of paternal affection.

To examine the possible differential effect sizes of maternal and paternal affection on plasticity, stability, and the GFP the strength of the maternal and paternal difference scores with the personality differences scores were examined using Fisher's r to z transformations. Using single-tailed significance tests, the difference for plasticity was significant, $z = 2.28$, $p < 0.05$, as was the difference for the GFP, $z = 1.68$, $p < 0.05$. The difference in effect size for stability was not significant.

Subsequently, a set of correlations testing the relationships between the parenting difference scores and the personality difference scores were recalculated while controlling for differences in the twin scores on their self-assessed overall satisfaction with their personality. These partial correlations, seen in Table 3, allow for the testing of the alternative hypothesis that parental affection may be affecting self-evaluative biases rather than the GFP. The results showed that controlling for generalized personality assessment had little effect on the relationship between the differences in parental affection and differences in personality.

Lastly, another set of partial correlations were calculated. The associations between the parental affection difference scores, the Big Five personality trait, and plasticity and stability difference scores were recalculated while controlling for GFP difference scores. These analyses allow two hypotheses to be tested. First, the partial correlations allow for an assessment of the importance of the shared variance of the Big Five (i.e., the GFP) relative to the unique variance of the individual traits in the association with parenting to be assessed. Second, controlling for the GFP allows for the hypotheses related to plasticity and stability to be tested. Note that the GFP was extracted as the latent factor in the Big Five, whereas Stability and Plasticity were based on unit-weighted scores. Subsequently, the partial correlations (controlling for the GFP) involving Stability and Plasticity include error measurement variance as well as variance that is unique to the two higher-order factors. The results of the partial correlations are displayed in Table 4. As illustrated in Table 4, controlling for the GFP reduced or changed the direction of all of the correlations of the parental affection difference scores and personality.[2]

Consistent with hypotheses the association between maternal and paternal affection differences and the stability differences remained

[2] In order to assess the potential influence of the clustered nature of the data, multivariate regression analyses using robust standard errors were also conducted (see Supplemental material). The results of the regression analyses are almost identical to those presented here.

Table 3
Bivariate and partial correlations (controlling for the item "I like most parts of my personality") for the difference scores for study variables among the MZ twins.

	1	2	3	4	5	6	7	8	9	10
1. Maternal affection	–	0.44	0.09	0.17	0.11	0.25	−0.11	0.11	0.27	0.22
2. Paternal affection	0.45	–	0.19	0.18	0.28	0.30	−0.10	0.27	0.29	0.34
3. Openness	0.07	0.20	–	0.20	0.53	0.36	−0.08	0.88	0.32	0.74
4. Conscientiousness	0.18	0.19	0.24	–	0.18	0.33	−0.22	0.22	0.77	0.55
5. Extraversion	0.11	0.29	0.54	0.21	–	0.46	−0.04	0.87	0.34	0.78
6. Agreeableness	0.26	0.30	0.36	0.33	0.47	–	−0.00	0.47	0.66	0.74
7. Neuroticism	−0.15	−0.13	−0.09	−0.23	−0.08	−0.04	–	−0.07	−0.60	−0.26
8. Plasticity	0.10	0.28	0.88	0.25	0.88	0.47	−0.10	–	0.38	0.87
9. Stability	0.28	0.30	0.33	0.76	0.37	0.67	−0.62	0.40	–	0.76
10. GFP	0.22	0.35	0.74	0.57	0.79	0.74	−0.29	0.88	0.78	–

Note. Bivariate correlations are below the diagonal. Partial correlations are above the diagonal. Number of twin pairs 293–314 for bivariate correlations. All bivariate correlations $r > 0.11$ and $r < -0.11$ significant at $p < 0.05$. Degrees of freedom for partial correlations = 286. All partial correlations $r > 0.17$ and $r < -0.17$ significant at $p < 0.01$.

positive, while the associations with the differences in plasticity actually turned negative. While these associations were significant for maternal differences, and not significant for paternal differences, using Fisher's r to z transformations showed that the maternal and paternal difference correlations did not significantly differ ($p > 0.05$; one-tailed). Therefore, we combined the maternal and paternal difference scores (i.e., parental difference scores) and reran the analyses. The partial correlation between parental difference score and the plasticity difference score while controlling for the GFP difference was, $pr(289) = -0.15$, $p < 0.05$. The partial correlation between parental difference score and the stability difference score while controlling for the GFP difference was, $pr(289) = 0.13$, $p < 0.05$.

4. Discussion

The purpose of the present study was to examine the association between differences in reported parental affection by MZ twins and differences in personality. Although it has been found that warm and sensitive parenting is predictive of offspring personality such that parental warmth is related to offspring scores reflecting high openness, conscientiousness, extraversion, agreeableness, and low neuroticism (e.g., Robinson et al., 2014), simple associations between parental behavior and offspring outcomes are open to multiple interpretations. By employing a between monozygotic twin design we aimed to control for the influence of genetic factors on phenotypic variance in personality. Using LH as the theoretical framework it was hypothesized that the monozygotic twin that reported greater maternal and paternal affection (relative to their co-twin) would also report a personality profile more reflective of a slower LH strategy (as indicated by a higher GFP).

Supporting these predictions, the within-twin pair difference in the amount of both maternal and paternal affection reported by monozygotic twins was indeed positively correlated with within-twin pair differences in the GFP and most of the effect was at the level of the GFP. However, the strength of the association varied across the two indices of parental affection. Differences in paternal affection were more strongly associated with differences in the GFP than differences in maternal affection. This finding may be seen as consistent with findings in which paternal investment acts as a LH cue (e.g., Draper & Harpending, 1982). Parental investment may contain unique information about the environment and thus could be a more useful indicator on which to refine one's LH strategy.

Differences in paternal affection were also more strongly associated with differences in plasticity. Effect sizes did not vary across the parental measures for stability. Additionally, combining maternal and paternal difference measures into an overall parental affection difference score and controlling for the GFP, the stability associations remained positive while the associations with plasticity turned negative. We interpret these results as consistent with the theoretical positions of Del Giudice (2012, 2014) in which stability is more closely associated with a slow LH strategy and Paquette (2004) in which fathers encourage their children's exploration.

Table 4
Partial correlations (controlling for the GFP) between parenting differences scores and the Big Five, plasticity, and stability differences scores among the MZ twins.

	Maternal affection	Paternal affection
Openness	−0.14*	−0.11
Conscientiousness	0.07	−0.01
Extraversion	−0.10	0.03
Agreeableness	0.13*	0.07
Neuroticism	−0.08	−0.03
Plasticity	−0.18**	−0.06
Stability	0.17**	0.05

* $p < 0.05$.
** $p < 0.01$.

4.1. Placing the findings in the context

The findings fit neatly within the context of current research in attachment. Attachment avoidance and anxiety are negatively correlated with the Big Five traits in a pattern reminiscent of the GFP (Noftle & Shaver, 2006). Additionally, although in infancy and toddlerhood the shared environment explains a significant amount of variability in attachment security, in a review of behavioral genetic studies on attachment Barbaro, Boutwell, Barnes, and Shackelford (2016) found that across the lifespan three-fifths of the variance was accounted for by nonshared environmental factors. They recommended that research focus on this nonshared environmental variance. This call for a focus on the possible origin of nonshared environmental influences is reiterated by Fearon, Shmueli-Goetz, Viding, Fonagy, and Plomin (2014). They proposed that, "It would be valuable in future studies to examine experiences that are unique to, or experienced differently by, a particular child within a family, such as parental differential treatment or sibling–sibling conflict, in order to understanding how nonshared variance in attachment in adolescence arises (p. 1039)." The application of LH theory to explain why differences in parental affection can arise in parents of MZ twins and how they could potentially affect difference in personality is consistent with this recommendation.

While attachment theory is nested within LH theory (e.g., Belsky et al., 1991; Del Giudice, 2009) and explains how parental behavior may influence developmental trajectories, evolutionary approaches to familial dynamics may be used to understand how differences between genetically identical siblings raised within the same family can arise (Schlomer, Del Giudice, & Ellis, 2011; Trivers, 1974). Parental resources are finite and parents must necessarily make choices, or trade-offs, in their investment in offspring. If two children are simultaneously requesting assistance, a parent must decide which child receives the initial care. In fact, differential parenting may be heightened in twins as parents have to care for two children of the same age. Parental stress is predictive of differential parenting (Jenkins et al., 2003) and has been shown to be higher in parents of twins relative to singletons (e.g., Glazebrook, Sheard, Cox, Oates, & Ndukwe, 2004). This also suggests that sibling competition for parental resources may play a larger role in twins.

Indeed, after observing quantitative differences in negativity directed toward the MZ twin offspring of mothers in the Environmental Risk (E-Risk) Longitudinal Twin Study, Caspi et al. (2004) conducted in-person interviews with the mothers to ascertain potential reasons for the differences. One of the common features highlighted in their qualitative data was the differential early health signs exhibited between MZ twins that mothers indicated led to differential parenting patterns and negativity directed toward children who are essentially genetic clones. As such, the importance of the direct impact of parental behavior on development remains in question. Differential parental treatment may amplify, what otherwise would be a negligible effect. This may account for small effects of parenting sometimes found between families (Harris, 1995; Scarr, 1992). Plomin and Daniels (2011) eloquently state this possibility:

> For example, a child really knows only his own parents; the child does not know if his parents love him more or less than other parents love their children. A child is likely to be painfully aware, however, that parental affection toward him is less than toward his sibling (p. 571).

The results of the current investigation suggest that differences in paternal treatment may be of special importance. One could imagine a scenario in which a father's efforts to encourage exploration in his offspring are more strongly reinforced by the more robust member of a twin pair. While some researchers have examined this area to illustrate potential differences in resource allocation, relatively few have done so using an evolutionary framework. This may be a fruitful area for future investigation.

4.2. Limitations

Comparing differences in parental affection with differences in personality in monozygotic twin pairs allows for the control of genetic and shared environmental explanations. However, while we posited an explanation for the findings in which parental affection (as a component of the nonshared environment) impacts personality, other explanations cannot be discounted. This is especially true given the retrospective nature of the parenting measures employed in the current study. The correlations between differences in parental affection and differences in personality may be spurious correlations in which a third variable causes the parenting-personality relationship to appear. For example, those with higher GFP scores may apply a more rose-colored lens to their memory of their parents that may or may not be entirely accurate. Additionally, the current study tested only one aspect of the nonshared environmental influence on phenotypic variance in personality. Other nonshared environmental effects (e.g., peer relations, intimate partnership dissolution, employment difficulties) may cause a change in personality that then colors recollections of earlier familial experiences. Thus, it is important to examine the relationship between parenting and personality longitudinally to see if differences in parenting reported by monozygotic twins earlier in development, when they are still actively being parented, are predictive of differences in personality in adulthood.

Likewise, because we use LH theory as the framework for understanding the effects it is important that future research use measures more directly representative of differences in LH strategy. If the relationship between differential parental affection and personality are a result of differences in LH strategy, one may expect that more direct, or biometric, measures of LH strategy such as age of sexual initiation and lifespan length would also be affected by differences in parental affection. Indeed personality differences, such as the GFP, are tangential indicators of psychometric (e.g., differences on Likert-type scales) LH strategy differences and the degree to which these psychometric measures overlap with biometric measures and/or are valid measures of LH strategy is a strongly debated issue (Copping, Campbell, & Muncer, 2014; Copping, Campbell, Muncer, & Richardson, 2017; Figueredo et al., 2015). And, indeed, the psychometric indices of LH strategy appear to be more heritable (Figueredo et al., 2004), than the biometric measures (Garvus-Ion et al., 2017) suggestive of greater environmental influence for biometric measures. It could be that the lower heritability for biometric indices is because they have a stronger stochastic component (Steiner & Tuljapurkara, 2015) in contrast to relatively stable traits such as personality. Nonetheless, as the current study illustrates, confidently assessing the influence of non-genetic factors necessitates a genetically sensitive design in order to isolate potential causal agents in the etiology of personality, LH strategies, and other aspects of the human condition.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.evolhumbehav.2017.09.004.

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