Title

The Nature and Nurture of Parenting Behavior: Association of Parental Serotonin Transporter Genotype and Personality Traits with Self-Reported and Observed Parenting Behavior

Author

Lau Schumann, Lynette

Publication Date

2014

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

The Nature and Nurture of Parenting Behavior:

Association of Parental Serotonin Transporter Genotype and Personality Traits with Self-Reported and Observed Parenting Behavior

A dissertation submitted in partial satisfaction of the requirements for the degree

Doctor of Philosophy in Psychology

by

Lynette Lau Schumann

2014

ABSTRACT OF THE DISSERTATION

The Nature and Nurture of Parenting Behavior:
Association of Parental Serotonin Transporter Genotype and Personality Traits
with Self-Reported and Observed Parenting Behavior

by

Lynette Lau Schumann
Doctor of Philosophy in Psychology
University of California, Los Angeles, 2014
Professor Steve S. Lee, Chair

Given that parenting behavior is central to children's physical, academic, and socio-emotional outcomes, improved understanding about the correlates of human parenting behavior will benefit children's development. This dissertation utilized two separate ethnically and socio-economically diverse community-based samples (177 parents of 6-9 year-old children with and without ADHD; and a subset of 56 mothers and 57 fathers selected from a larger study of newlywed marriage and family development) recruited from the same metropolitan area in the western United States. Our goals were three-fold: (1) to examine the association of parental 5-HTTLPR genotype and personality traits (i.e., neuroticism, extraversion, and agreeableness) with self-reported and observed parenting behavior; (2) to evaluate parenting stress and negative child behavior as moderators of the relationship between parental personality traits and parenting behavior; (3) and to test parental personality traits as independent and collective mediators of the relationship between 5-HTTLPR and parenting behavior. Several key innovations were featured, including stringent control of parental depression and negative child

behavior, use of normed measures of parental personality, and employment of rigorous boostrapping procedures to evaluate multiple mediation. In the first sample, elevated parental extraversion was individually and independently associated with increased observed positive parenting behavior; parenting stress and child negative behavior separately moderated the relationship between agreeableness level and positive parenting behavior; *s*-allele carriers (i.e., *s*/*s* or *s*/*l*) displayed fewer instances of observed negative parenting behavior; and parental extraversion mediated the association of 5-HTTLPR with self-reported positive parenting and self-reported parental involvement. In the second sample, child negativity moderated the relationship between parental neuroticism and observed parental supportiveness, without control of parental depression, whereas parenting stress moderated the relationship between parental agreeableness level and observed cognitive nurturance (regardless of whether parental depression was controlled). We consider emerging evidence on the correlates of individual differences in human parenting behavior and discuss implications for future research and parenting interventions.

The dissertation of Lynette Lau Schumann is approved.

Thomas N. Bradbury

Jennifer L. Krull

Christina Palmer

Steve S. Lee, Committee Chair

University of California, Los Angeles

2014

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Acknowledgements

The completion of this dissertation has been a tremendous learning experience. I would like to acknowledge and express my gratitude towards my parents for having always encouraged my dreams, the members of the UCLA Marriage and Family Development Laboratory and the UCLA ADHD Study for the countless hours invested in interviewing families and coding parent-child interactions, Dr. Thomas N. Bradbury for the opportunity to develop early research skills, my committee members for their time and suggestions, and Dr. Steve S. Lee for his sensitivity, responsiveness, and dedication to providing excellent mentorship during my graduate training. Finally, accomplishing this milestone would have been unpleasantly lonely, if not entirely impossible, if not for the ceaseless patience, encouragement, support, and nurturance from my clinical supervisors, friends, dogs, and spouse. For always: thank you.

Curriculum Vita

Education

2012	CPhil	Clinical Psychology (Minor: Quantitative Psychology), UCLA
2009	MA	Clinical Psychology (Minor: Quantitative Psychology), UCLA
2004	BA	Psychology (Minors: Applied Developmental Psychology, Education), cum laude, UCLA

Employment

Sept 2014 – Aug 2015	Postdoctoral Fellow in Psychology, Children's Institute, Inc., Los Angeles, California.
Sept 2013 – Aug 2014	Predoctoral Intern in Psychology, Children's Institute, Inc., Los Angeles, California.
Jun 2010 – Sept 2013	Project Manager, National Children's Study (NCS) at the Los Angeles-Ventura Study Center, Los Angeles, California.
Oct 2006 – Dec 2008	Programmer/Analyst, Higher Education Research Institute, Los Angeles, California. .
Oct 2004 – Dec 2006	Staff Research Associate, UCLA Marriage and Family Study, Los Angeles, California.
Aug 2002 – Sept 2004	Research Assistant, UCLA Marriage and Family Study, Los Angeles, California.

Grants

Psi Chi National Psychology Honor Society, Summer Research Grant, Intergenerational transmission of attributional styles, $3,500, 2003. Lynette Lau, Principal Investigator. Under the supervision of Rebecca Cobb, PhD, & Thomas Bradbury, PhD.

Publications

Granger, D. A., Johnson, S. B., Szanton, S. L., Out, D., Lau Schumann, L. (2012). Incorporating salivary biomarkers into nursing research: An overview and review of best practices. *Biological Research in Nursing (14),* 4, 347-356.

Lau Schumann, L. & Lee, S. S. (Manuscript Under Review). Association of parental personality traits and observed parenting behavior: Moderation by parenting stress and negative child behavior

Lau Schumann, L. & Lee, S. S. (Manuscript Under Review). Association of parental serotonin transporter (5-HTTLPR) genotype and parenting behavior: Mediation by personality traits.

Presentations

Nicholas, W., Lau Schumann, L., Pedrazzani, S., Herman, D., Halfon, N. (2012). Application of rapid cycle improvement methods to optimize recruitment strategies for the National Children's Study. Poster presented at the annual meeting of the American Public Health Association, San Francisco, CA.

Lee, S. S. & Lau Schumann, L. (2012). Interactive Effects of serotonin transporter genotype and stressful life events on parenting behavior. Symposium talk presented at the annual meeting of the Association for Psychological Science, Chicago, IL.

Lau Schumann, L. & National Children's Study Health Disparities Workgroup. (2012). Measuring Child Health Disparities--What Works and Doesn't Work: Lessons from the National Children's Study (NCS) Child Health Disparities Project. Workshop presented at the annual meeting of the Pediatric Academic Societies, Boston, MA.

Lau Schumann, L. & Lee, S. S. (2011). Effects of the serotonin transporter gene polymorphism on parenting: Exploring trait neuroticism as a possible endophenotype. Poster presented at the biennial meeting of the Society for Research in Child Development, Montreal, Canada.

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Begum, G., Gonzaga, G., Setrakian, H. A., Lau, L., Bradbury, T. N., & Tanner, L. R. (2006). The intergenerational transmission of positive communication styles. Paper presented at the meeting of the Society of Personality and Social Psychology, Palm Springs, CA.

Setrakian, H. A., Gonzaga, G., Lau, L., Begum, G., & Bradbury, T. N. (2006). Responsiveness to personal positive events in married couples predicts positive relationship outcomes. Paper presented at the meeting of the Society of Personality and Social Psychology, Palm Springs, CA

The Nature and Nurture of Parenting Behavior: Association of Serotonin Transporter Genotype, Personality Traits, and Stress with Parenting Behavior

Parenting behavior, and parent nurturing behavior more generally, is necessary for species survival and vital for offspring development. Reflecting its important role in species adaptation, important aspects of parenting are conserved across human and non-human animals. Among mammals, parents are responsible for the care and survival of their offspring by providing food, shelter, protection, and socialization. In humans, children are typically dependent on their parents for a longer period of time than other species. Indeed, human parenting not only affects offspring physical and health outcomes (e.g., diabetes, obesity), but also their cognitive, behavioral, and socio-emotional development (e.g., peer relationships, depression, substance use, academic achievement).

Despite the clinical and public health significance of parenting behavior to offspring development, the limited knowledge about the factors that potentially influence individual differences in parenting is surprising. This minimal evidence base is surprising given that parents generally represent the most direct influence on child development. For example, the proximity and importance of parenting is reflected in Bronfenbrenner's (1979) ecological model of child development where parenting is contained in the microsystem, the layer consisting of the most proximal and direct influence on the individual child. Crucially, understanding the determinants of parenting would facilitate the development of interventions to promote optimal parenting practices that could promote positive child outcomes and potentially prevent maladaptive outcomes. Thus, there is a significant dissociation between the well-developed literature on parenting and child development compared to knowledge about factors that influence it.

In humans, individual differences in parenting have been diversely conceptualized, measured, and operationalized. For example, whereas Baumrind (1971) proposed three prototypes of parenting style (i.e., authoritarian, permissive, and authoritative parenting),

Maccoby and Martin (1983) characterized parenting according to parental responsiveness and parental demandingness; based on these dimensions, they also added rejecting-neglecting parenting. Each of these different parenting styles is comprised of different combinations of parental responsiveness and parental demandingness. Authoritative parents, for example, are high in both demandingness and responsiveness whereas authoritarian parents are high in demandingness but low in responsiveness. Similarly, neglecting parents are low in both demandingness and responsiveness whereas permissive parents are high in responsiveness but low in demandingness. Parenting styles reflect broad and affective dimensions of parenting (e.g., attitudes towards one's children) that arguably form the basis for subsequent parenting behavior.

Whereas parenting style is a broad measurement of parenting which encompasses multiple affective and behavioral dimensions, conceptual and empirical work on parenting has also focused on *parenting behavior* which consists of specific parenting practices. Parenting behavior is a complex form of social behavior that has often been described by constructs such as: (1) warmth, the extent to which parents are attuned to and supportive of their children's needs; (2) behavioral control, the level of sensitivity parents have towards their children's cues and the extent to which they follow such cues to then provide clear and consistent limits; and (3) autonomy support, the extent to which parents encourage their children to actively explore and formulate an understanding of their own views and goals as opposed to asserting dominion over their children. Parenting behavior has also been operationalized along more global terms such as positive parenting behavior (e.g., praise) and negative parenting behavior (e.g., harsh criticism of the child). Despite considerable knowledge about the potential consequences of parenting behavior, far less is known about factors that affect parenting behavior.

Because of the complex and multidimensional nature of parenting behavior overall, this dissertation implemented rigorous methods from developmental psychopathology and genetic epidemiology to characterize factors that are associated with individual differences in parenting

behavior. Specifically, the current dissertation will prioritize theoretically salient and plausible variables that have been implicated in parenting behavior such as parental depression, parent-related stress, parent personality traits, and child negative behavior. Further, this dissertation examines the association of these variables with both self-reported and observed parenting behavior in two separate samples: families of children with and without attention deficit/hyperactivity disorder (ADHD) and the other consisting of families from a prospective longitudinal study of marriage and family development. Improved understanding of these specific factors might allow for the development of targeted parenting interventions to ameliorate and possibly prevent maladaptive child outcomes.

Study 1a: Association of Parent Personality Traits and Observed Parenting Behavior: Moderation by Parenting Stress and Child Behavior

Parenting behavior, and parent nurturing behavior more generally, is necessary for species survival and optimal offspring development. Reflecting its important role in species adaptation, critical aspects of parenting and nurturing behavior (e.g., socialization) are conserved across diverse model systems (Maestripieri, 2011; Mileva-Seitz & Fleming, 2011). In humans, offspring are dependent on their caregivers for a longer period of time than most species, and parenting reliably predicts offspring physical/health outcomes (e.g., diabetes, obesity) as well as their cognitive, behavioral, and socio-emotional development (e.g., peer relationships, depression, substance use, academic achievement) (Baumrind, 1991; S. M. Lee, Daniels, & Kissinger, 2006; Loth, MacLehose, Fulkerson, Crow, & Neumark-Sztainer, 2013; Wake, Nicholson, Hardy, & Smith, 2007; Wen & Hui, 2012; Zhou et al., 2002). Parents represent the most proximal and direct influence on child development (Bronfenbrenner, 1979), and given its reliable prediction of clinically significant child outcomes, improved understanding about correlates of human parenting behavior is an important public health concern. For example, identifying predictors of positive parenting is critical given that supportive parenting behavior is a replicated resilience-promoting factor across multiple risk factors including children's exposure to traumatic events, partner violence, and poverty (Gewirtz, Forgatch, & Wieling, 2008; Kiernan & Mensah, 2011; Sturge-Apple, Davies, Cicchetti, & Manning, 2010). Thus, innovations in the development of parenting interventions are likely to follow from greater understanding about the correlates of positive and negative parenting behavior (Luthar, Sawyer, & Brown, 2006).

Personality Traits and Parenting Behavior

Personality traits reliably predict health behavior, relationship satisfaction, psychopathology, as well as educational and occupational attainment (Goodwin & Friedman, 2006; Johnson, Batey, & Holdsworth, 2009; Kern & Friedman, 2011; Roberts, Kuncel, Shiner,

Caspi, & Goldberg, 2007). Unsurprisingly, given the pervasive nature of personality traits, there is replicated evidence that parental personality traits influence parenting behavior. The Five Factor model of personality identifies five critical facets (i.e., neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) that are robust across languages, cultures, rating sources, and theoretical orientation (Digman, 1990). Of these five traits, neuroticism has generally been associated with increased maladaptive parenting behavior (e.g., parental intrusiveness, negative affect), whereas extraversion and agreeableness have generally been associated with increased nurturing parenting behavior (e.g., high warmth, high responsiveness, cognitive stimulation; Belsky, Crnic, & Woodworth, 1995; Kochanska, Clark, & Goldman, 1997). Although less commonly studied, conscientiousness was associated with parental involvement and ease of limit setting, whereas openness to experience was related to parental restrictiveness (Metsäpelto & Pulkkinen, 2003; Oliver, Guerin, & Coffman, 2009). A recent meta-analysis of 30 studies suggests that parental personality traits are meaningfully and robustly associated with individual differences in parenting behavior across reporter and assessment methods (Prinzie, Stams, Deković, Reijntjes, & Belsky, 2009). Although effect sizes were generally small in magnitude, Prinzie, et al. (2009) found that parental neuroticism, extraversion, agreeableness, conscientiousness, and openness to experience were associated with parental warmth and behavioral control; however, only neuroticism and agreeableness were associated with autonomy support.

Although these preliminary findings suggest that personality traits are plausible correlates of parenting behavior, several important questions remain unanswered. First, despite their covariation, studies have typically focused on individual personal traits (Ellenbogen & Hodgins, 2004), thus failing to discern which traits, if any, are *independently* associated with parenting behavior and ignoring potential accumulative effects. For example, different combinations of trait neuroticism and extraversion were differentially associated with distinct clusters of parenting (Metsäpelto & Pulkkinen, 2003). Second, despite the unique advantages

afforded by normed rating scales, existing studies frequently relied on raw scores (e.g., sum or mean) or composites (Kochanska, Kim, & Koenig Nordling, 2012). Crucially, normed measures yield meaningful designations that facilitate comparisons across studies and limit the problems associated with sample-specific distributions. Third, few studies have systematically evaluated potential moderators of the association between parental personality traits and parenting behavior, despite the plausibility of interactive associations underlying parenting behavior (Abidin, 1992; Belsky, Jaffee, & Cohen, 2006). For example, parental neuroticism and agreeableness were less likely to be associated with parental warmth as parents and children aged (Prinzie et al., 2009). Thus, future studies of parental personality and parenting behavior would enhance the specificity of current models by considering the combined influence of personality traits, utilizing normative measures of personality traits, and assessing for potential moderators.

Predictions of Parenting Behavior: Parent Personality Traits x Parenting Stress

Parental stress is central to theoretical and empirical models of human and non-human parenting behavior (Abidin, 1992; Barrett & Fleming, 2010; Belsky, 1984; Maestripieri, 2011). Life stress may decrease parents' availability and responsiveness to their children's needs, as well as increase the frequency of harsh and punitive parenting behaviors (Erel & Burman, 1995; Krishnakumar & Buehler, 2000; Middlebrook & Forehand, 1985). Beyond its direct association with parenting behavior, interactive associations with personality traits are plausible for several reasons. Parental stress is positively associated with perceptions of child behavior as being deviant and use of negative parenting behavior (Middlebrook & Forehand, 1985). Next, stress (i.e., daily hassles) mediated the link between high maternal trait agreeableness with respect to maternal engagement and cognitive stimulation, as well as the association of high maternal neuroticism with increased negative affect and youth-directed insensitivity (Belsky et al., 1995). Finally, a composite of adversity (e.g., parental education, income, age, marital satisfaction), a potential proxy for overall stress, interacted with mother's trait agreeableness to predict more

positive parenting behavior at lower levels of adversity (Kochanska et al., 2012). Despite the plausibility of personality trait x stress predictions of parenting behavior, few studies have directly tested this model, particularly with respect to specified sources of stress. Stress emanates from multiple domains (e.g., work, financial, marital, child-related), requiring that different sources of stress are properly disentangled. Specifically, parenting stress is more consistently predictive of negative parenting behavior (e.g., inconsistent discipline, coercive parenting) and is more strongly and directly related to parenting behavior compared to stress from other domains (Abidin, 1992; Creasey & Reese, 1996; Rodgers, 1998; Webster-Stratton, 1990). Given its salience to parenting behavior, the present study thus uniquely tested the moderating role of parenting stress with respect to multiple personality traits (i.e., neuroticism, extraversion, and agreeableness) and their associations with objectively measured observations of positive and negative parenting behavior.

Predictions of Parenting Behavior: Parent Personality Traits x Negative Child Behavior

Individual differences in child behavior reliably predict parenting behavior, underscoring the importance of reciprocal and transactional influences with respect to family interaction and child development more generally (Abidin, 1992; Bell, 1968; Belsky, 1984; Sameroff, 1975; Patterson et al., 1989). Negative child behavior elicits more instances of directive adult behavior (Bell & Chapman, 1986), even from adoptive parents (suggesting that the covariation of negative parenting and negative child behavior does not exclusively reflect shared genetic influences; see O'Connor, Deater-Deckard, Fulker, Rutter, & Plomin, 1998). Additionally, there is replicated experimental evidence that negative parental responses are associated with increased exposure to disruptive child behaviors (Anderson, Lytton, & Romney, 1986; Barkley & Cunningham, 1979). However, few studies have explicitly examined potential interactive influences involving parent personality traits and child behavior with respect to parenting behavior. In one study, high maternal neuroticism was more strongly associated with overprotective parenting with shy children whereas high maternal agreeableness was less

strongly associated with harsh/coercive parenting strategies with emotionally-dysregulated children (Coplan, Reichel, & Rowan, 2009). Similarly, empathic mothers of young infants (empathy being strongly associated with trait agreeableness (Watson, Clark, & Harkness, 1994) engaged in more power-assertive parenting when their child was high versus low on negative emotionality (Clark, Kochanska, & Read, 2000). These preliminary findings suggest that individual differences in negative child behavior may moderate the association of parental personality and parenting behavior. The current study addresses this directly to clarify whether negative child behavior significantly moderates the association of parental personality traits with separate measures of observed positive and negative parenting behavior.

Study Hypotheses

Prosecuting the determinants of naturally-occurring individual differences in positive and negative human parenting behavior is an important public health concern because of the centrality of parenting behavior to child development. Although parental personality traits are associated with parenting behavior, previous studies are limited by individual examination of personality traits, use of measures that were vulnerable to the unique characteristics of each sample, and did not systematically consider interactive influences with parenting stress and negative child behavior. Using a large and ethnically-diverse study of families of children with and without attention-deficit/hyperactivity disorder (ADHD), we explored the independent association of self-reported parental trait neuroticism, trait extraversion, and trait agreeableness with separate measures of observed positive and negative parenting behavior, controlling for child age, child sex, and negative child behavior (i.e., the number of child ADHD symptoms). We hypothesized that parental neuroticism would be positively associated with negative parenting behavior and negatively associated with positive parenting behavior, whereas parental extraversion and agreeableness would be conversely associated with negative parenting behavior and positively associated with positive parenting behavior. We also tested specific interactions involving parent personality traits and both parenting stress and negative child

behavior, but given the modest literature, we did not propose directional hypotheses for interactive effects.

Methods

Participants

Participants include 177 ethnically diverse (*n* = 125 Caucasian; *n* = 23 African-American; *n* = 33 Hispanic; *n* = 20 Asian; *n* = 2 Native American; *n* = 38 Mixed; *n* = 7 Other)[i] children and their parents from a large metropolitan city in the western U.S. Parents ranged in age from 25 to 58 years of age (*M* = 40.90, *SD* = 6.37, 85% mothers) and children were 5 to 10 years of age (*M* = 7.36, *SD* = 1.13, 71% male). Approximately half the children in the study were diagnosed with ADHD (n = 88) according to the Diagnostic Interview Schedule for Children, 4th edition (DISC-IV) (Shaffer et al., 2000), a fully structured diagnostic interview with the parent keyed to all DSM-IV criteria including age of onset and cross-situational impairment. Non-ADHD comparison youth (*n* = 89) were allowed to meet diagnostic criteria for any disorder other than ADHD (the most common diagnosis was separation anxiety and specific phobia). ADHD and non-ADHD youth were comparable with respect to age, sex, and race-ethnicity.

Procedures

Families were recruited via presentations to ADHD self-help groups, referrals from local mental health service providers, and advertisements and flyers posted to local elementary schools, clinical service providers, and pediatric offices. To be eligible for the study, all participants were required to have a Full Scale IQ greater than 70, to live with one biological parent at least half of the time, and to be fluent in English. Exclusion criteria for the study included current or previous diagnosis of mental retardation, seizure, autism, or other pervasive developmental disorder. Exclusion criteria were determined during a brief telephone screening with the parent. Eligible and interested families were then scheduled for a laboratory visit and mailed rating scales of family demographics, child behavior, and self-reported personality, and psychopathology.

During the laboratory session, parents and children were consented/assented by trained interviewers. Parents then completed diagnostic interviews about their child and completed self-report measures of their own psychopathology as well as parenting behavior whereas children completed standardized tests of cognitive ability and achievement. Finally, parent-child dyads participated in a structured parent-child interaction (detailed below). Approximately 85% of children were evaluated during the laboratory session unmedicated and all parents were asked to rate the child's unmedicated behavior.

Measures

Personality Traits. Parents completed the NEO Five Factor Inventory (NEO-FFI; Costa Jr & McCrae, 1992), a well-validated 60-item measure of personality. Each item was rated on a 5-point Likert scale across all five traits including: Extraversion (e.g., "I am a cheerful, high-spirited person", "I would rather go my own way than be a leader of others"), Agreeableness (e.g., "I would rather cooperate with others than compete with them", "I often get into arguments with my family and co-workers"), Conscientiousness (e.g., "I have a clear set of goals and work toward them in an orderly fashion", "Sometimes I'm not as dependable or reliable as I should be"), Neuroticism (e.g., "I am not a worrier", "I rarely feel lonely or blue"), and Openness (e.g., "Once I find the right way to do something, I stick to it", "I often enjoy playing with theories or abstract ideas"). Raw scores for each personality factor were converted into T-scores, based on gender norms in the large NEO normative sample. Internal consistency was good in the current sample: Neuroticism, α =.88; Extraversion, α =.80; and Agreeableness, α =.76.

Parenting Stress. We used the Parental Distress (PD) subscale of the 36-item Parenting Stress Interview-Short Form (PSI-SF) to specifically examine parent-related stress rather than more generalized forms of stress (Abidin, 1995; Rodgers, 1998). Items on the PD subscale assess stress from their role as a parent and other parent-level factors (e.g., "I often have the feeling that I cannot handle things very well", "I feel trapped by my responsibilities as a parent", "Having a child has caused more problems than I expected", etc.). Items were rated on

a 5-point Likert scale. The PSI has good overall and test-retest reliability (Abidin, 1995) and the internal consistency in the current study for the total sum on the PD subscale was strong at α =.86.

Observed Parenting Behavior. Parenting behavior was coded using the Dyadic Parent-Child Interaction Coding System (DPICS; Eyberg, Nelson, Duke, & Boggs, 2004), a well-validated categorical observation system designed to assess the quality of dyadic interactions between parents and their children. Parents and children were provided with standardized instructions and asked to complete a series of dyadic tasks during the laboratory session involving child-led play (10 minutes), parent-led play (10 minutes), and a clean-up session during which parents had to direct their children without providing any assistance (5 minutes). Interactions were broken down into 10-second segments, and each segment was coded for parents' verbalizations and children's correspondent level of compliance, based on the categories described in the DPICS manual (Eyberg et al., 2004). Examples of coded parent verbalizations include: Negative Talk, Direct Commands, Indirect Commands, Labeled Praise, Unlabeled Praise, Descriptive Questions, and Information Questions. Negative Talk was used as a measure of observed negative parenting whereas the Labeled Praise and Unlabeled Praise categories were collapsed to form a composite measure of observed positive parenting (Chronis-Tuscano et al., 2008; Eyberg et al., 2001); the total raw score from each collapsed category was divided by the total length of the interaction to account for slight temporal variation across participants.

Previous studies using the DPICS have demonstrated good overall and test-retest reliability across the various DPICS categories, including in a sample of parent-child dyads of abused and non-abused children, aged 8 to 12 (Brestan, Foote, & Eyberg, 2004; Hakman, Chaffin, Funderburk, & Silovsky, 2009; McCabe, Yeh, Lau, Argote, & Liang, 2010). Intraclass correlations (ICC) in the current study were strong (Negative Parenting, ICC = .75 and Positive

Parenting, ICC = .88). Additional details about coding procedures and psychometrics of the parenting data are available in Li & Lee (2013).

Negative Child Behavior. Negative child behavior was estimated from the total number of child ADHD symptoms reported by the parent from the DISC-IV. The ADHD module of the DISC-IV-P has good psychometric properties, including high test-retest reliability (r = .79 after one year) and internal consistency (α = .84 for symptoms and α = .77 for criterion) for parent ratings in a large community sample (see Shaffer et al., 2000); the internal consistency in the current study was strong at α =.91.

Parental Depression. Depression was assessed using the Beck Depression Inventory (BDI-II), a well-validated 21-item self-report measure of depression (Beck, Steer, & Brown, 1996). Participants rated items on a 4-point Likert scale to indicate the severity of each depressive symptom [e.g., "I do not feel sad" (0), "I feel sad" (1), "I am sad all the time and I can't snap out of it" (2), or "I am so sad or unhappy that I can't stand it" (4)]. The BDI-II has good construct validity (α =.93) and test-retest reliability (α =.96) in outpatient and college student samples (Beck et al., 1996; Sprinkle et al., 2002). A total score reflecting the severity of depression was calculated and demonstrated good internal consistency in the sample (α =.84).

Data Analytic Procedures

To review, our first goal was to test the independent association of parental trait neuroticism, extraversion, and agreeableness with respect to separate measures of observed positive and negative parenting behavior. First, we controlled for the child's age and sex, as well as negative child behavior (i.e., total number of ADHD symptoms) in order to improve the specificity of observed associations. In particular, because this study over-sampled for children with ADHD and given the contribution of negative child behavior to differences in parenting behavior, we included the number of child ADHD symptoms as a covariate. We began by analyzing the individual association of parental neuroticism, extraversion, and agreeableness with respect to parenting behavior; we then separately analyzed the combined influence of

neuroticism, extraversion, and agreeableness to elucidate potential independent predictions from individual personality traits. We constructed separate hierarchical linear regressions for positive and negative parenting behavior where the first block of variables consisted of the child's age, sex, and number of ADHD symptoms; the second block consisted of parental neuroticism, extraversion, and agreeableness (entered both separately and simultaneously, as described above).

To evaluate the potential moderating roles of parenting stress and negative child behavior (i.e., total number of child ADHD symptoms), we created separate personality trait x parenting stress and personality trait x negative child behavior interaction terms with each moderator centered at their respective means. Separate hierarchical linear regressions were then constructed for positive and negative parenting behavior with the first block consisting of covariates (i.e., child's age and sex), the second block consisting of the individual personality trait (e.g., agreeableness) and the centered terms for parenting stress and negative child behavior, and the final block consisting of separate personality trait x parenting stress and personality trait x negative child behavior interactions. This model was then reproduced for each personality trait across positive and negative parenting behavior.

Finally, parental depression is often ignored in studies of the association of parental personality traits and parenting behavior. However, parental depression is associated with personality traits (e.g., neuroticism; Kendler, Kuhn, & Prescott, 2004) (e.g., neuroticism; Kendler, 2004) and is independently associated with individual differences in positive and negative parenting behavior (Belsky, 1984; Carter, Garrity-Rokous, Chazan-Cohen, Little, & Briggs-Gowan, 2001; Embry & Dawson, 2002; Lovejoy, Graczyk, O'Hare, & Neuman, 2000; National Research Council & Institute of Medicine, 2009). Although the association of personality traits and parenting behavior may reflect the indirect influence of transient moods (Belsky et al., 1995), we know of no published study that has tested the unique association of multiple personality traits and parental depression with respect to parenting behavior. Thus, analyses in the current

study examined the association of personality traits and parenting behavior and then were reproduced with parental depression as a covariate.

Results

Association of Individual Personality Traits with Positive and Negative Observed Parenting

Controlling for the child's age, sex, and the total number of child ADHD symptoms, elevated parental extraversion was significantly associated with increased observed positive parenting behavior (Study 1a, Table 1; β=.16, p=.04), but unrelated to observed negative parenting behavior. Parental neuroticism and agreeableness were also unrelated to either observed positive or negative parenting behavior. When parental depression was included as a covariate, this pattern of findings remained consistent across each trait for both observed positive and negative parenting behavior. That is, after controlling for parental depression, parental extraversion remained positively associated with observed positive parenting behavior (Study 1a, Table 2; β=.19, p=.03).

Independent Association of Personality Traits with Observed Positive and Negative Parenting

We were next interested in whether parental neuroticism, extraversion, and agreeableness were independently associated with observed positive and negative parenting behavior. Thus, we constructed models to assess these traits simultaneously. Controlling for the child's age, sex, and the total number of child ADHD symptoms, parental neuroticism, extraversion, and agreeableness were each unrelated to observed negative parenting behavior and observed positive parenting behavior. However, when parental depression was included as a covariate, parental extraversion was marginally positively associated with observed positive parenting behavior (Study 1a, Table 3; β=.18, p=.06); parental extraversion remained unrelated to observed negative parenting behavior. Similarly, parental neuroticism and agreeableness each remained unrelated to observed positive and negative parenting behavior.

Moderation By Negative Child Behavior and Parenting Stress

To review, we constructed separate hierarchical linear regressions for observed positive and negative parenting behavior. Each model consisted of the identical covariates described above (i.e., child's age, sex, parental depression), an individual personality trait (e.g., neuroticism), as well as separate trait x parenting stress and trait x negative child behavior interactions. With or without parental depression as a covariate, no significant interactions were observed for either observed positive parenting behavior or observed negative parenting behavior.

Extreme Groups Analyses

The overall lack of significant findings with regard to the influence of parental neuroticism, extraversion, and agreeableness on observed positive and negative parenting behavior is surprising given previous studies documenting robust links between parental personality traits and parenting behavior (Prinzie et al., 2009). Extreme groups analyses are used to detect general trends in exploratory research and oversampling for extreme observations has been recommended as a means of overcoming the difficulties inherent in detecting interaction effects in observational research (McClelland & Judd, 1993; Preacher, Rucker, MacCallum, & Nicewander, 2005). Thus, to address possible sample-specific problems with underpowered effects in the current study and given limited evidence with regard to how parenting stress and negative child behavior may moderate predictions of parenting behavior from parental personality traits, we categorized parental neuroticism, extraversion, and agreeableness into three groups based on established T-score cut-offs (i.e., low: $T < 35$, average: $35 \leq T \leq 65$, and high: $T > 65$) to maximize the likelihood of detecting potential main effects and interactions. Each personality trait was dummy coded with the high personality trait group (i.e., $T > 65$) specified as the reference group; separate personality trait group x parenting stress and personality trait group x negative child behavior interactions were constructed based on these dummy-coded variables. Finally, we replicated the above-specified hierarchical linear

regressions for assessing each personality trait individually, all three personality traits simultaneously, and the moderating influence of negative child behavior and parenting stress; separate models were constructed for observed positive and negative parenting behavior using these dummy-coded variables.

When each trait was assessed individually, controlling for the child's age, sex, and the total number of child ADHD symptoms, parents with high agreeableness engaged in significantly more observed positive parenting behavior compared to parents with low and average agreeableness (Study 1a, Table 4; β=-.67, $p<.01$ and β=-.69, $p<.01$, respectively), but unrelated to observed negative parenting behavior. There were no differences between groups for parental neuroticism and extraversion with regard to either observed positive or negative parenting behavior. When traits were assessed simultaneously, controlling for the child's age, sex, and the total number of child ADHD symptoms, parents with high agreeableness continued to engage in significantly more observed positive parenting behavior compared to parents with low and average agreeableness (Study 1a, Table 6; β=-.71, $p<.01$ and β=-.712, $p<.01$, respectively). Similarly, there were no differences between groups for parental agreeableness with respect to observed negative parenting behavior, as well as for parental neuroticism and extraversion with regard to both observed positive and negative parenting behavior. This pattern of results for the individual and simultaneous assessment of the relationship between parental personality traits and parenting behavior remained consistent even after adding parental depression as a covariate (results are presented in Study 1a, Table 5 and Study 1a, Table 7, respectively). Finally, we observed no evidence of significant moderation by parenting stress or negative child behavior with respect to predictions of observed positive and negative parenting behavior from parental neuroticism, extraversion, or agreeableness.

Discussion

Preliminary evidence suggests parental personality traits may be associated with parenting behavior, but previous studies have been limited by the use of non-standardized

personality measures and data analytic approaches which assess the influence of each personality trait individually. Additionally, few studies have considered potential moderators of the association between parental personality and parenting behavior. Using a well-characterized and diverse sample of children with and without ADHD, we examined the individual and independent association of parental neuroticism, extraversion, and agreeableness with respect to separate measures of observed positive and negative parenting behavior using a normed measure of personality traits; we also assessed potential moderation by parenting stress and negative child behavior. When personality traits were treated as continuous variables and assessed individually, parental extraversion was significantly associated with observed positive parenting behavior, with and without control of parental depression. Next, when parental neuroticism, extraversion, and agreeableness were considered simultaneously, parental extraversion was significantly associated with observed positive parenting behavior but only when parental depression was included as a covariate. In contrast, when parental personality traits were trichotomized, significant between-group differences emerged with parents with high agreeableness engaging in significantly more positive parenting behavior compared to parents with low or average agreeableness. There were no between group differences for parental neuroticism or extraversion with regard to observed positive or negative parenting behavior. Finally, neither parenting stress nor negative child behavior significantly moderated predictions of observed parenting behavior from parental neuroticism, extraversion, or agreeableness whether personality traits were treated as continuous variables or trichotomized into groups of low, average, and high levels based on established T-score cut-offs.

The individual association of parental extraversion with observed positive parenting behavior is unsurprising given that elevated extraversion is associated with increased positive emotionality and increased demonstrations of affection (McCrae & Costa Jr, 1999). However, that the association between parental extraversion and observed positive parenting was rendered non-significant when considered simultaneously with parental neuroticism and

agreeableness suggests several potential explanatory processes. First, our analytic strategy of examining multiple personality traits concurrently may have attenuated effects. For example, although trait agreeableness and extraversion were each related to maternal differential positivity, only trait agreeableness was uniquely predictive when both traits were considered simultaneously (Browne, Meunier, O'Connor, & Jenkins, 2012); similarly, in the same study, Browne et al. (2012) also reported that trait agreeableness and neuroticism were no longer significantly associated with paternal differential positivity when both traits were included simultaneously. Second, the current findings may also reflect cumulative personality trait effects. In other words, rather than traditional variable-based perspectives, unique constellations of multiple personality traits may underlie individual differences in parenting behavior. For example, cross-classification of standardized parental neuroticism and extraversion scores indicated that varying combinations of these two traits were related with different parenting types (e.g., engaged, authoritarian, etc.; Metsäpelto & Pulkkinen, 2003). Thus, future studies of parenting behavior must consider both individual and combined effects of parental personality traits, as well as explore possible trait x trait interactions.

Notably, the independent association of parental extraversion with observed positive parenting behavior remained significant even with rigorous control of parental depression. Because previous studies typically ignored concurrent parental depression (Belsky et al., 1995; Kochanska et al., 1997; Metsäpelto & Pulkkinen, 2003; Smith et al., 2007), it remains unclear whether the association of personality traits and parenting behavior is robust to parental depression. This is especially important with regard to trait neuroticism and extraversion given that they are particularly sensitive to depression relative to other traits (e.g., agreeableness) (Bagby, Joffe, Parker, Kalemba, & Harkness, 1995; Kotov, Gamez, Schmidt, & Watson, 2010). For example, although parents with high trait neuroticism engaged in more negative parenting behaviors (e.g., negative affect, intrusiveness) and parents with high trait extraversion engaged in more positive parenting behaviors (e.g., positive affect, sensitivity, and cognitive stimulation),

it is unclear to what extent these findings reflect the association of personality traits with parenting behavior given that parental psychopathology was not formally considered (Belsky et al., 1995; Smith et al., 2007). The current pattern of findings thus alludes to the importance of considering concurrent parental depression and, perhaps more generally, underscores the need for rigorous consideration of parent psychopathology (e.g., anxiety, depression) that are reliably associated with personality traits (Kotov et al., 2010) and parenting behavior.

Another important consideration with respect to the current association between parental extraversion and observed positive parenting behavior is the use of normative personality trait data whereas most previous studies used raw scores or a composite of different measures to estimate personality traits (Kochanska et al., 1997, 2012; Metsäpelto & Pulkkinen, 2003). Standard rating scales are subject to sample-specific distributions, especially with respect to probing interactions at different levels of constructs. Norm-referenced variables and empirically-informed, group-based designations are thus valuable in controlling for sample-specific biases – a particularly important issue, given the ethnic homogeneity common in previous studies (Kochanska et al., 1997; Metsäpelto & Pulkkinen, 2003). For example, because raw personality trait scores from the NEO-FFI were used instead of norm-referenced scores, the significant differences observed in trait neuroticism of parents with versus parents without ADHD may reflect the overrepresentation of mothers in the ADHD parent group rather than actual differences between groups (Steinhausen et al., 2013). In contrast, in the presence of significant differences in age and gender ratios between the testing and control samples, norm-referenced trait scores allowed more for accurate and generalizable interpretations of the differential effects of personality on adult ADHD (Jacob et al., 2007). Future studies of personality traits and parenting would benefit from continued use of norm-referenced personality trait scores.

Finally, it is also unsurprising that parents with higher levels of agreeableness would engage in increased observed positive parenting behavior, given that agreeableness is characterized, in part, by an individual's capacity for engaging in nurturing, caring, and

emotionally supportive behavior (Digman, 1990). However, the emergence of significant differences between groups only *after* parental agreeableness was trichotomized and treated as a categorical variable suggests that certain effects of personality traits may occur only at the extreme ends of the spectrum. Categorizing a continuous variable and performing extreme groups analyses facilitated the discovery of this association. However, albeit based on established and recommended T-score cut-offs, the classification of parents into groups of low, average, and high personality trait levels may reflect arbitrary designations on an otherwise continuous variable and introduce the risk of erroneously assuming within-group homogeneity (Bennette & Vickers, 2012). Furthermore, the categorization of parental personality traits based on the established T-score cut-offs created extreme groupings in which approximately 80% of parents were grouped into the average condition, while remaining 16% of parents were divided into the low and the high conditions, respectively. Although extreme groups analyses maximizes the likelihood of detecting general trends in exploratory research and interaction effects in observational research (Selvin, 2004; L. P. Zhao & Kolonel, 1992), the marked unevenness in group sizes after dummy-coding to reference the high trait level group may also be prone to confounding and reductions in statistical power. Thus, the above-described association of parental agreeableness with observed positive parenting behavior should be considered in light of these limitations.

There were several additional important limitations in the current study. First, the predominantly maternal (85%) composition in the current sample prohibits inferences about parenting behavior among fathers, a persistent limitation in the field of parenting and families (Coplan et al., 2009; Repetti & Wood, 1997; Smith et al., 2007). Similarly, although the predominantly male composition (71%) in our sample is consistent with the epidemiology of ADHD, and thus allows us to conduct a detailed comparison of parenting behavior at varying levels of child disruptive behavior, alternative sample strategies (e.g., girls with ADHD, parenting behavior in fathers) are necessary to capture the full range of parenting behavior.

Despite these limitations, the current study highlights the importance of parental extraversion in predicting observed positive parenting behavior and represents an important preliminary effort to identify moderators of the relationship between parental personality traits and observed parenting behavior. Further, the current study offers several innovations over previous studies of personality and parenting and demonstrates the importance of considering personality traits both individually and simultaneously to parse out the independent contributions from each trait towards parenting behavior, rigorously controlling for parental psychopathology to isolate the effects of personality on parenting behavior, and using norm-referenced categories to increase the generalizability of results. Future studies on parental personality and parenting behavior should continue assessing for potential moderating influences on the relationship between parental personality traits and parenting behavior, as well as consider incorporating the methodological innovations in the current study.

Study 1a, Table 1. *Association of Parental Extraversion with Observed Positive Parenting (n=150)*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.06	0.03	-.14	-0.06	0.03	-.14
Child Gender	-0.07	0.07	-.07	-0.07	0.07	-.07
Negative Child Behavior	0.00	0.01	.02	0.00	0.01	.04
Parent Trait Extraversion				0.01*	0.00	.16*
R^2	.03			.05		
Adjusted R^2	.01			.03		
F for change in R^2	1.48			4.18*		

Note: *p < .05; **p < .01.

Study 1a, Table 2. *Association of Parental Extraversion with Observed Positive Parenting, Controlling for Parental Depression (n=150)*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.05	0.03	-.13	-0.05	0.03	-.12
Child Gender	-0.07	0.01	-.07	-0.06	0.08	-.06
Negative Child Behavior	0.00	0.01	.03	0.00	0.01	.04
Parental Depression	-0.00	0.01	-.05	0.00	0.01	.02
Parent Trait Extraversion				0.01*	0.00	.19*
R^2	.03			.06		
Adjusted R^2	.00			.03		
F for change in R^2	1.00			4.80*		

Note: *p < .05; **p < .01.

Study 1a, Table 3. *Independent Association of Parental Neuroticism, Extraversion, and Agreeableness with Observed Positive Parenting, Controlling for Parental Depression (n=150)*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.05	0.03	-.23	-0.05	0.03	-.12
Child Gender	-0.06	0.08	-.06	-0.05	0.08	-.06
Negative Child Behavior	0.00	0.02	.03	0.00	0.02	.03
Parental Depression	-0.00	0.02	-.05	0.00	0.02	.01
Parent Trait Neuroticism				0.00	0.02	.07
Parent Trait Extraversion				0.02	0.00	.18†
Parent Trait Agreeableness				0.00	0.00	.10
R^2	.02			.06		
Adjusted R^2	-.01			.01		
F for change in R^2	.80			1.85		

Note: †p < .1; *p < .05; **p < .01.

Study 1a, Table 4. *Association of Parental Agreeableness Levels with Observed Positive Parenting (n=150)*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.05	0.03	-.12	-0.03	0.03	-.08
Child Gender	-0.06	0.07	-.07	-0.10	0.07	-.11
Negative Child Behavior	0.00	0.01	.01	0.003	0.01	.03
Parent Trait Agreeableness (low)				-1.02	0.22	-.67**
Parent Trait Agreeableness (average)				-0.93	0.19	-.69**
R^2	.02			.16		
Adjusted R^2	.001			.13		
F for change in R^2	1.04			12.80**		

Note: *p < .05; **p < .01.

Study 1a, Table 5. *Association of Parental Agreeableness Levels with Observed Positive Parenting, Controlling for Parental Depression (n=150)*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.04	0.03	-.11	-0.03	0.03	-.07
Child Gender	-0.06	0.08	-.06	-0.10	0.07	-.11
Negative Child Behavior	0.001	0.01	.02	0.003	0.01	.04
Parental Depression	-0.004	0.01	-.05	-0.001	0.01	-.02
Parent Trait Agreeableness (low)				-1.01	0.23	-.62**
Parent Trait Agreeableness (average)				-0.92	0.19	-.66**
R^2	.02			.16		
Adjusted R^2	-.01			.12		
F for change in R^2	0.72			12.02**		

Note: *p < .05; **p < .01.

Study 1a, Table 6. *Independent Association of Parental Neuroticism, Extraversion, and Agreeableness Levels with Observed Positive Parenting (n=150)*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.05	0.3	-.12	-0.03	0.03	-.08
Child Gender	-0.06	0.08	-.07	-0.09	0.07	-.10
Negative Child Behavior	0.001	0.01	.01	0.002	0.01	.03
Parent Trait Neuroticism (low)				-0.30	0.21	-.17
Parent Trait Neuroticism (average)				-0.17	0.16	-.13
Parent Trait Extraversion (low)				-0.22	0.17	-.14
Parent Trait Extraversion (average)				-0.14	0.12	-.12
Parent Trait Agreeableness (low)				-1.09	0.22	-.71**
Parent Trait Agreeableness (average)				-0.95	0.19	-.71**
R^2	.02			.18		
Adjusted R^2	.00			.13		
F for change in R^2	1.01			4.69**		

Note: *p < .05; **p < .01.

Study 1a, Table 7. *Independent Association of Parental Neuroticism, Extraversion, and Agreeableness Levels with Observed Positive Parenting, Controlling for Parental Depression (n=150)*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.04	0.03	-.10	-0.02	0.03	-.05
Child Gender	-0.06	0.08	-.06	-0.09	0.07	-.09
Negative Child Behavior	0.002	0.01	.02	0.003	0.01	.04
Parental Depression	-0.004	0.01	-.05	-0.005	0.01	-.07
Parent Trait Neuroticism (low)				-0.41	0.25	-.23†
Parent Trait Neuroticism (average)				-0.26	0.20	-.19
Parent Trait Extraversion (low)				-0.24	0.18	-.15
Parent Trait Extraversion (average)				-0.15	0.13	-.13
Parent Trait Agreeableness (low)				-1.05	0.23	-.64**
Parent Trait Agreeableness (average)				-0.95	0.19	-.68**
R^2	.02			.18		
Adjusted R^2	-.01			.12		
F for change in R^2	0.70			4.60**		

Note: †p < .1; *p < .05; **p < .01.

Study 1b: Further Prosecuting the Association between Parent Personality Traits and Observed Parental Supportiveness and Hostility

In Study 1a, we uncovered preliminary evidence that parental extraversion was positively associated with observed positive parenting behavior, but did not find any support for moderation by either parenting stress or negative child behavior. In Study 1b, we pursued a highly similar question in a completely independent sample than the one that was featured in Study 1a. The rationale for both studies is identical: namely, that individual differences in parent personality traits are plausibly associated with parenting behavior, but these patterns have yet to be well-characterized. To improve traction on this important issue, Study 1b further prosecuted the association of parent personality traits with respect to multiple dimensions of observed parenting behavior. Additionally, whereas Study 1a consisted predominantly of mothers, Study 1b is drawn from a community-based sample of ethnically-diverse parent-child dyads with equal numbers of fathers and mothers. Our goal was to explore the independent association of self-reported parental neuroticism, extraversion, and agreeableness with separate measures of observed parental supportiveness, intrusiveness, cognitive nurturance, quality of assistance, and efficacy. These models also rigorously controlled for child age, child sex, and child negativity, thereby enhancing the specificity of observed associations and combating “child effects” (i.e., parenting behavior simply as a response to child characteristics). Additionally, we specifically tested how child negativity and parenting stress interacted with parent personality traits; however, given the modest literature, we did not propose directional hypotheses for interactive effects.

Methods

Participants

Participants were a subset of 167 ethnically and socio-economically diverse parents (84 mothers, 83 fathers) drawn from a larger community-based sample of 172 couples who were recruited between May 1993 and January 1994 from marriage license applications in a

metropolitan area of the Western United States. Couples were excluded if either partner was over 35 years of age, had been previously married, or had children at the time of recruitment. Within 6 months of their marriage (Time 1), the couples completed questionnaires about their relationship once every six months and participated in a laboratory session during which they completed a series of videotaped dyadic interactions. After approximately 9 years (Time 2; M=9.36, SD=0.52), couples were invited back to the laboratory with their firstborn child if he or she was between 5-8 years of age. Eighty-eight couples from the original sample were excluded in the current study because they were divorced/separated, did not have a child in the target age range, or were otherwise unable to participate at Time 2; the remaining 84 couples who were included completed questionnaires about themselves, their marital relationship, and their firstborn child (41 boys, 43 girls; M=6.72, SD=0.72), as well as a series of videotaped dyadic couple and parent-child interactions. At Time 1, fathers averaged 27.84 years of age (SD=3.89, range 21–37) and mothers averaged 26.33 years of age (SD=3.46, range 20–34); at Time 2, fathers averaged 37.33 years of age (SD=3.87, range 30–46) and mothers averaged 35.83 years of age (SD=3.35, range 29–43). Parents were predominantly Caucasian (65% fathers, 63% mothers), followed by Hispanic (18% fathers, 17% mothers), Asian-American/Pacific Islander (12% fathers, 13% mothers), African American (5% fathers, 5% mothers), and Middle Eastern (2% mothers).

Measures

Parental Personality Traits. At Time 1, Parents completed the NEO Five Factor Inventory (NEO-FFI) (Costa Jr & McCrae, 1992), a widely validated 60-item self-report measure of personality based on the five factor model of personality. Participants' responses on each dimension on the NEO-FFI were summed to attain each individual's raw score, which were subsequently converted into gender-based T-scores based on the normative sample from the NEO-FFI manual. Previous studies have demonstrated that the NEO-FFI has good overall and test-retest reliability. Estimates of internal consistency for the NEO-FFI have ranged from 0.68

(Agreeableness) to 0.89 (Neuroticism), and scores across the various factors from the NEO-FFI are highly correlated with those from the NEO-PI-R, with coefficients ranging between 0.77 and 0.92 (Costa Jr & McCrae, 1992). Internal consistencies in the current sample were adequate, as follows: Neuroticism (α =.85), Extraversion (α =.76), and Agreeableness (α =.59).

Parenting Stress. At Time 2, parents completed the Parenting Stress Interview-Short Form (PSI-SF; Abidin, 1995), a well-validated 24-item measure of parenting stress. Items on the PSI-SF are rated on a 5-point Likert scale and yield three subdomains: parental distress, difficult child characteristics, and dysfunctional parent-child interaction. To specifically capture parent-related stress rather than more generalized forms of stress that may be a function of external factors (Abidin, 1995; Rodgers, 1998), we used the parental distress subscale which assesses stress stemming from an individual's role as a parent and other parent-level factors (e.g., "I often have the feeling that I cannot handle things very well", "I feel trapped by my responsibilities as a parent", "Having a child has caused more problems than I expected", etc.). The PSI has good overall and test-retest reliability (Abidin, 1995) and the internal consistency in the current study for the total sum on the parental distress subscale was strong at α =.86.The internal consistency for the PD subscale was strong (α =.85).

Observed Parenting Behavior. At Time 2, parents participated in a series of tasks with their child consisting of 5 minutes of free play with puppets, 5 minutes of an etch-a-sketch maze task where parents and children were directed to jointly complete the maze with the parent manipulating one dial and the child manipulating the other dial, and 5 minutes of a tangram puzzle task where the parent was directed to let their child do as much as they could on their own without help. These interactions were videotaped and coded based on the 54-Month Parent-Child Structured Interaction Qualitative Rating Scales (PSIQRS; NICHD Study of Early Child Care), a categorical observation system designed to assess the quality of dyadic interactions between parents and their children. A team of trained research assistants rated parent behavior, child behavior, and overall characteristics of the dyadic interaction on a 7-point

Likert scale. Ratings were made at three points during each 5 minute play segment, and all ratings were averaged on each dimension to reflect total functioning across the entire 15-minute interaction. Parents were rated on their level of supportiveness (i.e., capacity for expressing positive regard and providing emotional support), intrusiveness (i.e., respect for child autonomy), cognitive nurturance (i.e., ability to foster their child's cognitive development), hostility (i.e., negative emotions, rejection, or criticism directed towards their child), quality of assistance provided to their child, and sense of parenting efficacy (i.e., demonstrates confidence when interacting with their child). Higher scores (i.e., 7) indicated higher levels on each of these parenting dimensions except for parental intrusiveness, where lower scores (i.e., 1) indicated higher levels of intrusiveness. A randomly selected 44% of parent-child interactions were double coded for reliability. ICCs were adequate for parent supportiveness (.82), intrusiveness (.73), cognitive nurturance (.72), quality of assistance (.76), and parenting efficacy (.72). Due to a floor effect and poor ICC for hostility (-.006), these ratings were dropped from the current analyses.

Observed Child Behavior. Child behavior was assessed at Time 2 as part of the parent-child interaction described above. Children were rated on their level of agency (i.e., active interest, confidence), negativity (i.e., expressed anger, dislike, resistance, or hostility towards their parent), task persistence, and overall experience of the session (i.e., demonstrated confidence in parent-child relationship, feelings of success). As previous studies have demonstrated deleterious effects of negative child behavior on parenting behavior (Bell & Chapman, 1986; Pelham et al., 1997), child negativity was utilized to control for child effects. Ratings of child negativity were dichotomized to reflect either its presence or absence during the parent-child interaction because of an observed floor effect (similar to parent expressed hostility) such that ratings of child negativity were clustered around the low end; ICC for the dichotomous child negativity variable was acceptable (.60, $p<.01$).

Parental Depression. At Time 2, parents completed the Beck Depression Inventory (BDI-II; Beck et al., 1996), a widely used and validated 21-item self-report measure of

depression based on symptoms listed in the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV; 1994). The total score estimates the severity of depressive symptoms, with higher scores reflecting increased severity. The BDI-II has good construct validity (α =.93) and test-retest reliability (α =.96) in outpatient and college student samples (Beck et al., 1996; Sprinkle et al., 2002); per the BDI-II manual, tests conducted with both clinical and non-clinical samples indicate a high degree of internal consistency (α =.92 and .93, respectively). There was a good level of internal consistency in the current sample (α =.96).

Data Analytic Procedures

To review, our first goal was to test the independent association of parental neuroticism, extraversion, and agreeableness with respect to separate measures of observed parental supportiveness, intrusiveness, cognitive nurturance, hostility, quality of assistance provided, and parenting efficacy. We utilized the MIXED procedure in SPSS version 21 to construct multilevel maximum likelihood regression models, nesting individual parents in families, to account for the inclusion of parents from the same family unit. To improve the specificity of observed associations, we included child's age and sex, child negativity, and parent sex (i.e., father/mother) as covariates. Separate models were constructed for each aforementioned parenting dimension with either parental neuroticism, extraversion, or agreeableness to determine the individual association of each personality trait with parenting behavior. These analyses were subsequently replicated with simultaneous entry of parental neuroticism, extraversion, and agreeableness to conservatively evaluate the independent association of parental neuroticism, extraversion, and agreeableness.

Next, to evaluate the potential moderating roles of parenting stress and child negativity, we constructed multilevel maximum likelihood regression models, again nesting individual parents in families to account for the inclusion of parents from the same family unit and including child's age and sex, child negativity, and parent sex (i.e., father/mother) as covariates to improve the specificity of observed associations. Parental neuroticism, extraversion, and

agreeableness, as well as parenting stress and child negativity were centered and subsequently used to construct personality trait x parenting stress and personality trait x child negativity interaction terms. Separate models were constructed for each personality trait across parental supportiveness, intrusiveness, cognitive nurturance, hostility, quality of assistance provided, and parenting efficacy.

Finally, given the individual association of parental depression with personality traits (e.g., neuroticism; Kendler et al., 2004) and parenting behavior (Belsky, 1984; Carter et al., 2001; Embry & Dawson, 2002; Lovejoy et al., 2000; National Research Council & Institute of Medicine, 2009), all analyses were reproduced with the addition of parental depression as a covariate to isolate the unique association of personality traits and parental depression with respect to parenting behavior.

Results

Association of Individual Personality Traits with Observed Parenting Behavior

Controlling for the child's age, sex, observed child negativity, and parent's gender, parental neuroticism, extraversion, and agreeableness were individually unrelated to parental supportiveness, intrusiveness, cognitive nurturance, hostility, quality of assistance provided, and parenting efficacy. This pattern of findings did not change with the addition of parental depression as a covariate.

Independent Association of Personality Traits with Positive and Negative Observed Parenting

Having assessed the individual association of parental neuroticism, extraversion, and agreeableness on observed parenting behavior, we assessed these traits simultaneously to ascertain their independent association with observed parenting behavior. Controlling for the child's age, sex, observed child negativity, and parent's gender, parental neuroticism, extraversion, and agreeableness were independently unrelated to parental supportiveness, intrusiveness, cognitive nurturance, hostility, quality of assistance provided, and parenting

efficacy. This pattern of findings was robust to the inclusion of parental depression as a covariate.

Moderation By Observed Child Negativity and Parenting Stress

To review, we constructed separate multilevel maximum likelihood regression models to examine whether the association of personality traits and observed parenting behavior was significantly moderated by observed child negativity and parenting stress. Each model consisted of the covariates described above (i.e., child's age, sex, parent sex), an individual personality trait (e.g., neuroticism), as well as separate trait x parenting stress and trait x child negativity interactions. Child negativity significantly moderated the association of parental neuroticism with observed parental supportiveness without control of parental depression (Study 1b, Table 8, 95% CI: -0.05 – -0.00001); however, this interaction was non-significant when we controlled for parental depression. No other significant interactions by parenting stress or child negativity were observed across the parenting dimensions assessed.

Following Aiken and West (1991), we deconstructed the significant parental neuroticism x child negativity interaction by evaluating the simple slopes at three levels of child negativity (i.e., grand mean, +1 SD, -1 SD). Overall, although parental neuroticism was generally inversely associated with observed cognitive nurturance, parents with elevated neuroticism were less likely to engage in cognitive nurturance in the presence of elevated child negativity compared to parents with diminished neuroticism (Study 1b, Figure 1, -1 SD: β=-.01, p=.94; grand mean: β=-.02, p=.88; and +1 SD: β=-.03, p=.85). Thus, the simple slopes differed significantly from one another; however, post-hoc analyses indicated that none of the simple slopes differed significantly from zero and this pattern remained consistent even when we evaluated the simple slopes at more extreme values (i.e., +/- 2 SD).

Extreme Groups Analyses

The current lack of significant main effects of parental neuroticism, extraversion, and agreeableness on observed positive and negative parenting behavior is surprising, given

previous studies supporting robust associations between parental personality traits and parenting behavior (Prinzie et al., 2009). Extreme groups analyses are recommended as a means of detecting trends in exploratory research and overcoming difficulties inherent in detecting interaction effects in observational research (McClelland & Judd, 1993; Preacher et al., 2005). Thus, to address potential sample-specific problems with underpowered effects in the current study and maximize the likelihood of detecting potential interactions in this relatively novel area of study, we trichotomized parental neuroticism, extraversion, and agreeableness based on established T-score cut-offs (i.e., low: $t < 35$, average: $35 \leq t \leq 65$, and high: $t > 65$), with the high trait group serving as the reference group in the dummy codes. Separate parent personality trait x parenting stress and personality trait x child negativity interaction terms were computed using the dummy codes, and we replicated the multilevel maximum likelihood regression models described above for assessing each personality trait individually, all three personality traits simultaneously, and the moderating influence of negative child behavior and parenting stress using these new terms; separate models were constructed for each dimension of observed parenting behavior.

When personality traits were assessed individually, controlling for the child's age, sex, observed child negativity, and parent's gender, parents in the low extraversion group provided significantly more cognitive nurturance compared to parents in the high extraversion group (Study 1b, Table 9; estimate of fixed effect = 1.26, p=.01). There were no other significant group differences for parental neuroticism, extraversion, or agreeableness with regard to the other dimensions of observed parenting behavior examined. Next, after adding parental depression as a covariate, parents in the low extraversion group continued to provide significantly more cognitive nurturance compared to their counterparts in the high extraversion group (Study 1b, Table 9; estimate of fixed effect = 1.99, p=.03), but additionally, parents in the low neuroticism group exhibited marginally less parental supportiveness compared to parents in the high neuroticism group (Study 1b, Table 10; estimate of fixed effect = -0.76, p=.08), and parents in

the low and average neuroticism groups provided significantly less cognitive nurturance than parents in the high neuroticism group (Study 1b, Table 11; estimate of fixed effect = -0.84, p=.04 and estimate of fixed effect = -0.74, p=.04, respectively). When personality traits were assessed simultaneously, controlling for the child's age, sex, observed child negativity, and parent's gender, parents in the low extraversion group continued to provide significantly more cognitive nurturance compared to parents in the high extraversion group, robust to the exclusion or inclusion of parental depression as a covariate (Study 1b, Table 12; estimate of fixed effect = 1.23, p=.01 and estimate of fixed effect = 1.00, p=.03, respectively). Additionally, after controlling for parental depression, parents in the low and average neuroticism groups exhibited less cognitive nurturance (Study 1b, Table 12; estimate of fixed effect = -0.85, p=.04 and estimate of fixed effect = -0.73, p=.04, respectively) and parental supportiveness (Study 1b, Table 13; estimate of fixed effect = -0.92, p=.03 and estimate of fixed effect = -0.62, p=.09, respectively) compared to their counterparts in the high neuroticism group, and parents in the low extraversion group demonstrated more cognitive nurturance (Study 1b, Table 12; estimate of fixed effect = 0.91, p=.04) compared to their counterparts in the high extraversion group. Finally, although extreme groups analyses facilitated the discovery of previously obscured main effects of parental personality on observed parenting behavior, with or without control of parental depression, neither parenting stress nor child negativity significantly moderated the association of parental neuroticism, extraversion, and agreeableness with any of the observed parenting dimensions.

Discussion

There is replicated evidence suggesting that parental personality traits are associated with parenting behavior (Prinzie et al., 2009). The current study improves upon the existing literature by utilizing normative measures of personality traits to identify the independent association of parental neuroticism, extraversion, and agreeableness with respect to multiple dimensions of observed parenting behavior. Additionally, we extended existing knowledge

having evaluated the potential moderating roles of parenting stress and observed child negativity with respect to these associations. Using continuous T-scores, no main effects of personality traits were observed either when assessing personality traits individually or simultaneously; however, extreme groups analyses using a trichotomized personality categorization revealed multiple associations between parental personality traits and observed parenting behavior. Additionally, using continuous T-scores, child negativity amplified the negative association of parental neuroticism with observed parental supportiveness, but *only* when parental depression was excluded as a covariate (although the simple slopes were non-significant); there was no support for moderation by either parenting stress or child negativity when using the trichotomized personality categories.

The attenuation of the significant parental neuroticism x child negativity interaction after controlling for parental depression suggests the potential importance of considering parental psychopathology in studies of parental personality and parenting behavior. The finding that elevated parental neuroticism was associated with decreased cognitive nurturance, without control of parental depression, is consistent with previous studies wherein elevated parental neuroticism was associated with more negative and fewer positive parenting behaviors (Belsky et al., 1995; Smith et al., 2007). However, previous studies have not systematically disentangled the influence of parental personality and psychopathology on parenting behavior. Yet, elevated neuroticism is frequently associated with higher incidences of psychopathology (Kendler et al., 2004), and both elevated neuroticism and parental psychopathology are individually associated with maladaptive parenting behavior (Lovejoy et al., 2000; Prinzie et al., 2009). Arguably, elevated neuroticism reflects increased risk for rather than actual psychopathology. While not within the scope of the current study, it is possible that parental depression mediates the association of parental personality traits with parenting behavior. Clearly, future studies must thus incorporate stringent control of co-occurring depression because of the significant inter-correlation between neuroticism, depression, and parenting behavior.

Next, it was surprising that parents in the low extraversion group were more likely to provide cognitive nurturance compared to parents in the high extraversion group, considering that highly extraverted individuals are partially characterized by their degree of sociability, activity, and talkativeness (Digman, 1990), and cognitive nurturance involves increased talking and interactions with one's child. Similarly, it may initially appear counterintuitive for parents in the low neuroticism group to exhibit less parental supportiveness compared to parents in the high neuroticism group, given that highly neurotic individuals are prone to negative emotionality, depression, and anxiety (McCrae & Costa Jr, 1999). These unexpected findings may be related to sample-specific characteristics, such as parents' marital status (i.e., all parents were from intact families) and the elevated levels of marital satisfaction endorsed by the participants in the current sample. Additionally, because the association of parental neuroticism and parental supportiveness emerged only after controlling for parental depression, these results might be a reflection of behavioral elements of parenting influenced by personality instead of parental depression. As mentioned above, because previous studies have not systematically attempted to disambiguate the effects of parental depression and parental personality on parenting behavior, these findings likely represent initial efforts at isolating the effects of parental personality on parenting behavior.

The divergent pattern of findings based on treatment of parental personality traits as a continuous measure (i.e., T-scores) versus categorical measure also raises potentially important methodological considerations. Whereas the use of continuous T-scores resulted in no significant main effects of parental personality traits on observed parenting behavior, the use of categorical personality variables revealed several between-group differences in observed parenting behavior. Categorization arguably amplifies between-group differences so that subtle effects may be more easily detected in novel areas of research or when investigating interactive effects using observational data (McClelland & Judd, 1993; Preacher et al., 2005), and the current pattern of findings appears consistent with this amplification effect. It should be noted,

however, that although the trichotomization of personality traits in the current study was based on well-established T-scores cut-offs (Costa Jr & McCrae, 1992), such categorization also imposes artificial limits upon a continuous variable and makes assumptions about within-group homogeneity (Bennette & Vickers, 2012). Thus, categorization of a continuous variable discards information that would otherwise be available for analyses (Selvin, 2004; L. P. Zhao & Kolonel, 1992) and analyses based on these variables may be prone to model misspecification and inflated standardized effect sizes (Brunswik, 1955; Cortina & DeShon, 1998; Feldt, 1961; Pitts, 1993). Accordingly, the above reported main effects based on categorical personality variables must be considered in light of these limitations and no conclusions should be drawn from these results with respect to the standardized effect size in terms of the percentage of variance explained.

There are several additional limitations which must be considered in the current study. First, measurement of personality traits was completed approximately 9 years prior to the observation of parenting behavior. Although rank ordering of personality traits is fairly stable over time, personality traits are known to vary in response to shifts in social roles, normative changes, and major life events (Löckenhoff, Terracciano, Patriciu, Eaton, & Costa, 2009; Roberts, Wood, & Smith, 2005; Scollon & Diener, 2006). For example, experiencing the birth of a child was significantly associated with changes in conscientiousness and marginally associated with changes in agreeableness (Specht, Egloff, & Schmukle, 2011). Given that parents in the current study experienced multiple major life events, including the transition to parenthood, subsequent to their personality trait assessment at Time 1, an additional measurement of personality traits more proximal to Time 2 may have improved our assessment of personality. Next, parents in the current study were relatively unique compared to the general population given that parents were in their first marriage, were relatively well-educated, and in healthier and more satisfying marital relationships (see Tanner Stapleton & Bradbury, 2012). Thus, it is unclear how parent personality traits and parenting behavior may be associated in

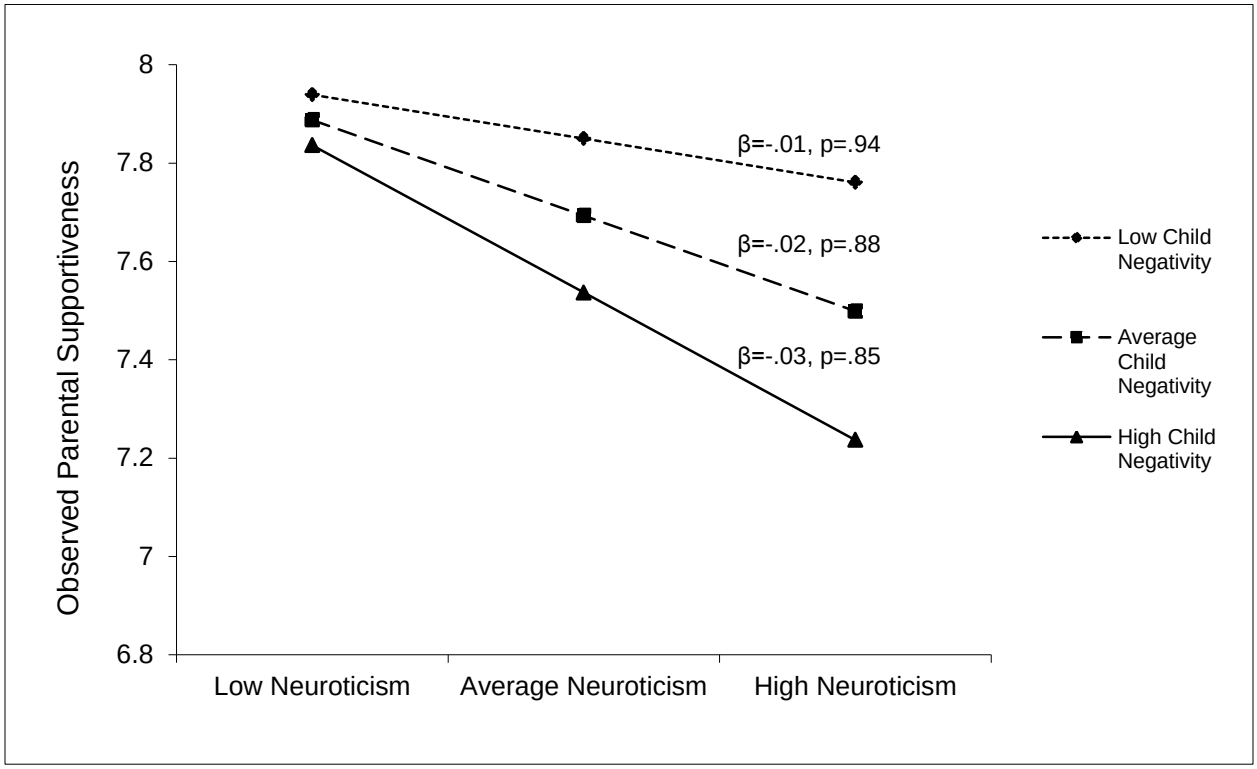
samples who differ with respect to divorced or martially distressed parents, given their association with parenting differences (Katz & Gottman, 1996; McHale, 1995; Sandler et al., 2012). Next, although the inclusion of fathers and mothers was a strength of the current study, we did not examine co-parenting, a relevant consideration given that the parenting identity and behavior of fathers may be affected by their spouse (Dudley, Roy, Kelk, & Bernard, 2001; Stueve & Pleck, 2001). Finally, the laboratory setting and the parenting tasks used to estimate parenting behavior may not reasonably approximate parenting behavior in the home. For example, Repetti et al. (2012) provide a detailed discussion of a naturalistic approach for understanding parenting behavior and the rich detail that may be derived from such, but also acknowledge the substantial barriers involved in naturalistic data collection.

Despite these limitations, the current study meaningfully explored associations of parental neuroticism, extraversion, and agreeableness with observed parenting behavior, having incorporated a normed measure of personality and stringent control of parental depression and negative child behavior. In addition to a preliminary characterization of differences in observed parenting behavior at varying personality trait levels and child negativity as a moderator of the relations between parental neuroticism and observed parental supportiveness, we provide several methodological considerations and directions for future studies of parenting behavior.

Study 1b, Table 8. *Estimates of fixed effects for the association of parental neuroticism with observed parental supportiveness: Moderation by parenting stress and negative child behavior.*

		95% Confidence Intervals	
	Point Estimate	Lower Limit	Upper Limit
Without Controlling for Parental Depression			
Child Age**	**-0.23**	**-0.40**	**-0.07**
Child Sex	0.12	-0.11	0.36
Parent Sex	-0.01	-0.20	0.18
Parental Neuroticism Level	-0.01	-0.05	0.03
Parenting Stress	-0.06	-0.14	0.02
Child Negativity	0.91	-0.37	2.19
Neuroticism x Parenting Stress	0.00	0.00	0.00
Neuroticism x Child Negativity*	**-0.03**	**-0.05**	**0.00**
Controlling for Parental Depression			
Child Age**	**-0.21**	**-0.37**	**-0.05**
Child Sex	0.11	-0.11	0.34
Parent Sex	-0.05	-0.24	0.15
Parental Depression*	**-0.01**	**-0.02**	**0.00**
Parental Neuroticism Level	-0.02	-0.05	0.02
Parenting Stress	-0.08	-0.16	0.00
Child Negativity	0.89	-0.38	2.15
Neuroticism x Parenting Stress	0.00	0.00	0.00
Neuroticism x Child Negativity†	-0.02	-0.05	0.00

†p ≤ 0.1; * p ≤ 0.5; ** p ≤ 0.01



Study 1b, Figure 1. Interaction Between Parental Neuroticism and Child Negativity.

This figure shows changes in observed parental supportiveness as a function of self-reported parental neuroticism and observed child negativity.

Study 1b, Table 9. *Estimates of fixed effects for the association of parental extraversion with observed parental cognitive nurturance.*

	Point Estimate	95% Confidence Intervals	
		Lower Limit	Upper Limit
Without Controlling for Parental Depression			
Child Age**	-0.45	-0.61	-0.28
Child Sex	0.11	-0.12	0.35
Child Negativity*	-0.26	-0.48	-0.04
Parent Sex	0.04	-0.13	0.21
Parental Extraversion (low)**	**1.26**	**0.36**	**2.17**
Parental Extraversion (average)	0.08	-0.20	0.35
Controlling for Parental Depression			
Child Age**	-0.43	-0.58	-0.27
Child Sex	0.12	-0.10	0.34
Child Negativity*	-0.24	-0.46	-0.03
Parent Sex	0.02	-0.14	0.19
Parental Depression**	-0.02	-0.03	-0.01
Parental Extraversion (low)*	**1.00**	**0.12**	**1.88**
Parental Extraversion (average)	0.05	-0.22	0.31

†p ≤ 0.1; * p ≤ 0.5; ** p ≤ 0.01

Study 1b, Table 10. *Estimates of fixed effects for the association of parental neuroticism levels with observed parental supportiveness.*

	Point Estimate	95% Confidence Intervals	
		Lower Limit	Upper Limit
Without Controlling for Parental Depression			
Child Age	-0.23	-0.39	-0.07
Child Sex	0.12	-0.11	0.36
Child Negativity	-0.35	-0.59	-0.10
Parent Sex	-0.01	-0.21	0.20
Parental Neuroticism (low)	-0.51	-1.38	0.35
Parental Neuroticism (average)	-0.37	-1.12	0.39
Controlling for Parental Depression			
Child Age	-0.21	-0.37	-0.06
Child Sex	0.13	-0.09	0.36
Child Negativity	-0.32	-0.56	-0.08
Parent Sex	-0.03	-0.23	0.18
Parental Depression	-0.02	-0.03	-0.01
Parental Neuroticism (low)†	**-0.76**	**-1.60**	**0.09**
Parental Neuroticism (average)	-0.56	-1.30	0.17

†p ≤ 0.1; * p ≤ 0.5; ** p ≤ 0.01

Study 1b, Table 11. *Estimates of fixed effects for the association of parental neuroticism with observed parental cognitive nurturance.*

		95% Confidence Intervals	
	Point Estimate	Lower Limit	Upper Limit
Without Controlling for Parental Depression			
Child Age**	-0.43	-0.60	-0.27
Child Sex	0.15	-0.09	0.39
Child Negativity**	-0.31	-0.53	-0.09
Parent Sex	0.06	-0.11	0.23
Parental Neuroticism (low)	-0.46	-1.32	0.41
Parental Neuroticism (average)	-0.42	-1.19	0.36
Controlling for Parental Depression			
Child Age**	-0.41	-0.56	-0.27
Child Sex	0.17	-0.04	0.39
Child Negativity**	-0.29	-0.50	-0.08
Parent Sex	0.03	-0.14	0.20
Parental Depression**	-0.03	-0.04	-0.02
Parental Neuroticism (low)*	-0.84	-1.63	-0.05
Parental Neuroticism (average)*	-0.74	-1.44	-0.04

†p ≤ 0.1; * p ≤ 0.5; ** p ≤ 0.01

Study 1b, Table 12. *Estimates of fixed effects for the simultaneous association of parental neuroticism, extraversion, and agreeableness with observed parental cognitive nurturance.*

		95% Confidence Intervals	
	Point Estimate	Lower Limit	Upper Limit
Without Controlling for Parental Depression			
Child Age**	-0.45	-0.61	-0.29
Child Sex	0.15	-0.09	0.39
Child Negativity*	-0.28	-0.51	-0.06
Parent Sex	0.04	-0.14	0.21
Parental Neuroticism (low)	-0.47	-1.34	0.39
Parental Neuroticism (average)	-0.41	-1.18	0.36
Parental Extraversion (low)	**1.23**	**0.33**	**2.12**
Parental Extraversion (average)	0.03	-0.24	0.31
Parental Agreeableness (low)	0.20	-0.79	1.19
Parental Agreeableness (average)	0.26	-0.44	0.97
Controlling for Parental Depression			
Child Age**	-0.43	-0.58	-0.28
Child Sex	0.17	-0.04	0.39
Child Negativity*	-0.27	-0.48	-0.06
Parent Sex	0.02	-0.15	0.19
Parental Depression**	-0.02	-0.03	-0.01
Parental Neuroticism (low)*	**-0.86**	**-1.66**	**-0.06**
Parental Neuroticism (average)*	**-0.73**	**-1.43**	**-0.03**
Parental Extraversion (low)*	**0.91**	**0.05**	**1.77**
Parental Extraversion (average)	-0.01	-0.28	0.25
Parental Agreeableness (low)	0.32	-0.63	1.27
Parental Agreeableness (average)	0.33	-0.35	1.00

†p ≤ 0.1; * p ≤ 0.5; ** p ≤ 0.01

Study 1b, Table 13. *Estimates of fixed effects for the simultaneous association of parental neuroticism, extraversion, and agreeableness with observed parental supportiveness.*

		95% Confidence Intervals	
	Point Estimate	Lower Limit	Upper Limit
Without Controlling for Parental Depression			
Child Age**	-0.25	-0.41	-0.09
Child Sex	0.14	-0.09	0.38
Child Negativity**	-0.34	-0.58	-0.09
Parent Sex	0.00	-0.21	0.21
Parental Neuroticism (low)	-0.64	-1.51	0.23
Parental Neuroticism (average)	-0.41	-1.16	0.34
Parental Extraversion (low)	0.21	-0.79	1.22
Parental Extraversion (average)	-0.20	-0.51	0.11
Parental Agreeableness (low)	0.08	-1.03	1.20
Parental Agreeableness (average)	0.08	-0.71	0.88
Controlling for Parental Depression			
Child Age**	-0.23	-0.38	-0.08
Child Sex	0.15	-0.07	0.37
Child Negativity*	-0.31	-0.55	-0.07
Parent Sex	-0.01	-0.22	0.20
Parental Depression**	-0.02	-0.03	-0.01
Parental Neuroticism (low)*	**-0.92**	**-1.77**	**-0.07**
Parental Neuroticism (average)†	-0.62	-1.34	0.10
Parental Extraversion (low)	-0.05	-1.05	0.95
Parental Extraversion (average)	-0.25	-0.56	0.06
Parental Agreeableness (low)	0.27	-0.82	1.36
Parental Agreeableness (average)	0.18	-0.60	0.96

†p ≤ 0.1; * p ≤ 0.5; ** p ≤ 0.01

Study 2a: Association of Parental Serotonin Transporter (5-HTTLPR) Genotype and Parenting Behavior: Mediation by Parental Personality Traits

Individual differences in positive and negative parenting behavior are uniquely associated with children's physical, academic, and socio-emotional well-being, including obesity, peer relationships, self-esteem, substance use, and academic achievement (S. M. Lee et al., 2006; Wen & Hui, 2012). These associations may reflect *causal influences,* given experimental evidence that intervention-induced changes in parenting behavior significantly alter child outcomes (Gardner, Hutchings, Bywater, & Whitaker, 2010). Thus, parenting behavior is a risk factor, and likely causal risk factor, for clinically significant public health outcomes. Despite considerable evidence on predictions of child outcome *from* parenting behavior, far less is known about correlates of parenting behavior – that is, why parents parent the way they do.

Previous studies have identified clinical and psychosocial correlates of parenting behavior such as maternal depression, marital distress, life stress, and negative child behavior (Lovejoy et al., 2000; Rodgers, 1998), suggesting that parenting behavior is sensitive to experiential, affective, and cognitive influences (Belsky et al., 2006). Interestingly, neurobiological correlates of parenting/nurturing behavior in non-human animals are well-characterized (Barrett & Fleming, 2010). Neural (e.g., medial preoptic area, ventral bed nucleus of the stria terminalis) and hormonal (e.g., estradiol, prolactin) factors, as well as neurotransmitters (e.g., dopamine, serotonin), are associated with nurturing behavior (Johns et al., 2005; A. Lee, Clancy, & Fleming, 1999). Non-human animal studies further suggest that genetic variants (e.g., FBJ murine osteosarcoma viral oncogene homolog B gene, dopamine transporter gene) are central to nurturing behavior (Brown, Ye, Bronson, Dikkes, & Greenberg, 1996; Spielewoy et al., 2000). Given that parenting and nurturing behavior are highly consistent across diverse models systems, the biological systems underlying human parenting behavior may be conserved and sensitive to similar biological influences (Maestripieri, 1999).

In humans, neural regions (e.g., substantia nigra, globus pallidus) with similar functional properties to non-human animals are implicated in parenthood and parenting behavior (Swain, 2011). Neural changes (e.g., hypothalamus, amygdala, olfactory bulb, etc.) also emerge with the transition to parenthood to putatively prepare the mother for and in response to the onset of parenting behavior, suggesting that maternal appraisals of their children are sensitive to neural systems that may affect parenting behavior. Multiple human twin studies suggest that dimensions of parenting behavior are moderately heritable (for a review, see McGuire, 2003), but only recently have studies identified specific genetic polymorphisms relevant to human parenting behavior. Maternal DAT1 genotype was associated with observed negative parenting behavior (S. S. Lee et al., 2010), even with control of SES, race-ethnicity, parental depression, as well as child ADHD and disruptive behavior; crucially, child disruptive behavior moderated this association such that mothers with a 10-repeat allele exhibited more negative parenting as children's disruptive behavior increased. Mothers who were homozygous for the short allele (*s*-allele) of 5-HTTLPR (i.e., *s*/*s*) and mothers who had at least one A-allele of OXTR (i.e., A/A or A/G) exhibited less maternal sensitivity, even with control of maternal education, depression and marital discord (Bakermans-Kranenburg & van IJzendoorn, 2008). Finally, less efficient variants of COMT and DRD4 (i.e., val/val and 7-repeat, respectively) were associated with decreased parenting sensitivity when parents were exposed to increased levels of daily hassles (van IJzendoorn, Bakermans-Kranenburg, & Mesman, 2007). Interestingly, these COMT and DRD4 variants were associated with more parenting sensitivity when parents had fewer daily hassles, suggesting potential differential susceptibility for parenting behavior (Belsky & Pluess, 2009; van IJzendoorn et al., 2007). To identify causal influences on parenting behavior, which will facilitate efforts to change maladaptive parenting behavior in beneficial ways, biologically plausible studies of functional genetic polymorphisms for human parenting behavior are an important priority.

Serotonin neurotransmission is plausibly related to individual differences in human parenting behavior because of its role in affective and behavioral constructs (e.g., depression, personality traits) which are correlated with parenting behavior (Graeff, Guimarães, De Andrade, & Deakin, 1996; Higley et al., 1996). 5-HTTLPR *s*-allele carriers had more depressive symptoms, diagnosable depression, and suicidality than homozygous *l*-allele individuals, particularly when exposed to stressful life events (Karg, Burmeister, Shedden, & Sen, 2011); parental depression is also consistently correlated with negative/maladaptive parenting (Lovejoy et al., 2000). With respect to personality traits, *s*-allele carriers had elevated neuroticism as well as diminished trait agreeableness and extraversion (Gillihan, Farah, Sankoorikal, Breland, & Brodkin, 2007; Jang et al., 2001). Notably, whereas neuroticism was positively associated with harsh parenting, parental intrusiveness, and negative affect during parent-child interactions, extraversion and agreeableness were associated with parental warmth/responsiveness (Belsky et al., 1995; Prinzie et al., 2009).

Despite the compelling theoretical and empirical basis for individual differences in personality traits as intermediate constructs in the association between 5-HTTLPR genotype and parenting behavior, this model has not been formally evaluated. In fact, relative to the sizable literature on the association of parental depression and parenting behavior (see Lovejoy et al., 2000), far less is known with respect to personality traits and parenting behavior. Problematically, studies often ignore the strong association of personality traits and depression. For example, parental depression is independently associated with personality traits (e.g., neuroticism; Kendler et al., 2004) and parenting behavior (Lovejoy et al., 2000). Consequently, to achieve *specificity*, studies must simultaneously consider personality traits and parental depression with respect to parenting behavior. Next, studies typically relied on self-reported parenting behavior, which is susceptible to inaccurate recall, social desirability, and perceptions of risk in honest disclosure (Morsbach & Prinz, 2006), in addition to more general cognitive distortions (Gotlib & Joormann, 2010). Critically, observed parenting behavior may be less

susceptible to these problems and in concert with other multi-method measures, self-report data may become more valid (Del Boca & Noll, 2000). Third, the use of raw personality scores or composites (Kochanska et al., 2012) are likely to reflect sample-specific distributions and characteristics. For example, personality traits were significantly associated with parenting behavior (Metsäpelto & Pulkkinen, 2003), but inferences from this ethnically homogeneous Finnish sample is complicated by use of the Big Five Personality Inventory, a non-standardized personality measure (Pulver, Allik, Pulkkinen, & Hämäläinen, 1995). Normed personality measures are necessary for meaningful cross-study comparisons as well as person-centered approaches (Ellenbogen & Hodgins, 2004). Finally, despite covariation among personality traits, it is unclear whether individual personality traits are uniquely associated with parenting behavior. Studies must meaningfully dissociate depression from personality traits, employ observational measures, and capitalize on normative personality data to prosecute the pathways underlying the association of 5-HTTLPR and parenting behavior.

Despite the theoretical and biological plausibility of the association of 5-HTTLPR with individual differences in parenting behavior, this association is poorly understood, particularly with respect to the intermediate pathways (i.e., mediators). Using a well-characterized study of families of children with and without attention-deficit/hyperactivity disorder (ADHD), we examined norm-referenced parental personality traits (i.e., neuroticism, extraversion, and agreeableness) as mediators underlying predictions of positive and negative parenting behavior from 5-HTTLPR genotype. To enhance specificity of this model, we stringently control for parental depression, child age/sex, and the number of child ADHD symptoms. We also implemented state-of-the-art multiple mediation procedures to examine the combined and independent mediating role of neuroticism, extraversion, and agreeableness on the association of 5-HTTLPR with self-reported and observed measures of parenting.

Methods

Participants

168 ethnically and socioeconomically diverse children and their parents were recruited from a large city in the Western United States through referrals from local mental health service providers, and advertisements and flyers posted to local elementary schools, clinical service providers, and pediatric offices. Parents ranged in age from 25 to 58 years of age (*M* = 40.90, *SD* = 6.37) and the sample was comprised primarily of mothers (85%). Children were 5 to 10 years of age (*M* = 7.36, *SD* = 1.13) and primarily male (71%). Approximately half the children were diagnosed with ADHD (*n* = 85) according to parent report on the Diagnostic Interview Schedule for Children, 4th edition (DISC-IV) (Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). Non-ADHD comparison children (*n* = 83) were allowed to meet diagnostic criteria for any disorder other than ADHD (separation anxiety and specific phobia were the most common) and did not differ from ADHD probands with respect to age, sex, and race-ethnicity.

Procedures

Interested families completed a brief telephone screening to determine eligibility. Eligible families were then invited for a laboratory-based assessment if the target child satisfied the following inclusion criteria: living with at least one biological parent, English fluency, and Full Scale IQ greater than 70. Exclusion criteria for all participants consisted of mental retardation, seizure, autism, or other pervasive developmental disorder. During the laboratory assessment, parents and youth were separately evaluated: parents completed diagnostic interviews about their child and completed self-report measures of parenting and their own psychopathology. At the same time, children completed standardized tests of cognitive ability and academic achievement. All participants provided saliva samples for genotyping and completed a structured parent-child interaction (detailed below). More than 85% of children who were treated with psychiatric medication (mostly stimulants) were unmediated during the laboratory session; similarly, all parents were asked to rate the child's unmedicated behavior.

Measures

Genotype. DNA was extracted from saliva collected with DNA Genotek Oragene^{TM} self-collection kits. The 48-base pair (bp) insertion/deletion polymorphism in the 5-HTT-linked polymorphic region was genotyped using standard primers, resulting in either 484-bp or 528-bp fragments. Because the precise mode of transmission for 5-HTTLPR is unknown, we examined both *s*-allele dominant and *s*-allele additive models. Distribution of genotypes in the sample were as follows: short/short (*s*/*s*, n=49), long/long alleles (*l*/*l*, n=52), and short/long (*s*/*l*, n=77). Alleleic frequencies did not deviate from Hardy-Weinberg expectations ($\chi^2 = 3.22$, df = 2, p = 0.19).

Parenting behavior. Self-reported parenting behavior was assessed using the Alabama Parenting Questionnaire (APQ; Frick, 1991), a 42-item measure of parenting behavior rated on a 5-point Likert scale to produce five dimensions: parental involvement (e.g., "you talk to your child about his/her friends"), positive parenting (e.g., "you compliment your child when he/she does something well"), poor monitoring/supervision (e.g., "your child stays out late in the evening past the time that he/she is supposed to be home"), inconsistent discipline (e.g., "you threaten to punish your child and then do not actually punish him/her"), and corporal punishment (e.g., "you spank your child with your hand when he/she has done something wrong"). The factor structure of the APQ has varied from three to five factors in previous studies; exploratory factor analysis was thus necessary to confirm the factor structure in the current sample. Using SPSS 21 with maximum likelihood extraction and promax rotation, we uncovered four factors (i.e., parental involvement, positive parenting, poor monitoring/supervision, and corporal punishment) with Eigenvalues of over 1.0, which correlated highly with the original factors. Of these four factors, we excluded parental monitoring/poor supervision from analyses because the items on this scale pertained more to adolescent antisocial behavior whereas the current sample consisted of school-age children (Frick, Christian, & Wootton, 1999). Internal consistency of the three factors examined was good in the current sample (parental involvement,

α =.78; positive parenting, α =.80; corporal punishment, α =.76). We examine each of these three factors separately to enhance the specificity of observed findings.

Observed parenting behavior was assessed using the Dyadic Parent-Child Interaction Coding System (DPICS; Eyberg et al., 2004), a previously validated categorical observation system designed to assess the quality of parent-child interaction. Dyads were provided with standardized instructions and asked to complete a series of tasks during the laboratory session involving child-led play (10 minutes), parent-led play (10 minutes), and a clean-up session during which parents had to direct their children without providing any assistance (5 minutes). Interactions were broken down into 10-second segments, and each segment was coded for parents' verbalizations and children's correspondent level of compliance, based on the categories described in the DPICS manual (Eyberg et al., 2004), including: Negative Talk, Direct Commands, Indirect Commands, Labeled Praise, Unlabeled Praise, Descriptive Questions, and Information Questions. Negative Talk was used as a measure of observed negative parenting, while the Labeled Praise and Unlabeled Praise categories were collapsed to form a measure of observed positive parenting. The overall frequency of observed negative parenting and observed positive parenting was divided by the total length of the interaction to account for slight variation in the length of the parent-child interaction across families. Previous studies using the DPICS have demonstrated good overall and test-retest reliability across the various DPICS categories (McCabe et al., 2010). Intraclass correlations (ICC) in the current study were strong (observed negative parenting, ICC = .75 and observed positive parenting, ICC = .88). Additional details about coding procedures and psychometrics of the parenting data are available in Li & Lee (2013).

Parental personality traits. Parental personality traits was assessed using the NEO Five Factor Inventory (NEO-FFI; Costa Jr & McCrae, 1992), a well-validated 60-item measure based on the five factor model of personality. Parents rated each item on a 5-point Likert scale across five personality dimensions, including: extraversion (e.g., "I am a cheerful, high-spirited

person", "I would rather go my own way than be a leader of others"), agreeableness (e.g., "I would rather cooperate with others than compete with them", "I often get into arguments with my family and co-workers"), conscientiousness (e.g., "I have a clear set of goals and work toward them in an orderly fashion", "Sometimes I'm not as dependable or reliable as I should be"), neuroticism (e.g., "I am not a worrier", "I rarely feel lonely or blue"), and openness (e.g., "Once I find the right way to do something, I stick to it", "I often enjoy playing with theories or abstract ideas"). To increase the generalizability of our findings, we utilized gender-based T-scores for each trait. Previous studies suggest that the NEO-FFI has good overall and test-retest reliability (Costa Jr & McCrae, 1992). Internal consistency was good in the current sample (neuroticism, α =.88; extraversion, α =.80; agreeableness, α =.76).

Parental depression. Depression was assessed using the Beck Depression Inventory (BDI-II), a well-validated 21-item self-report measure of depression (Beck et al., 1996). Participants rated items on a 4-point Likert scale to indicate the severity of depressive symptoms [e.g., "I do not feel sad" (0), "I feel sad" (1), "I am sad all the time and I can't snap out of it" (2), or "I am so sad or unhappy that I can't stand it" (4)]. The BDI-II has good construct validity (α =.93) and test-retest reliability (α =.96) in outpatient and college student samples (Beck et al., 1996; Sprinkle et al., 2002). A total score reflecting the severity of depression was calculated and demonstrated good internal consistency in the sample (α =.84).

Negative child behavior. Negative child behavior was estimated from the total number of child ADHD symptoms reported by the parent from the DISC-IV. The ADHD module of the DISC-IV-P has good psychometric properties, including high test-retest reliability (r = .79 after one year) and internal consistency (α = .84 for symptoms and α = .77 for criterion) for parent ratings in a large community sample (Shaffer et al., 2000); the internal consistency in the current study was α =.91.

Data Analytic Procedures

To review, our first goal was to test the association of parental 5-HTTLPR genotype with respect to multi-method measures of positive and negative parenting behavior. Separate hierarchical regression equations were constructed for each of the three self-reported parenting factors (i.e., parental involvement, positive parenting, and corporal punishment) as well as the two observed parenting dimensions (i.e., observed negative parenting and observed positive parenting). Child's age and sex, negative child behavior (i.e., total number of ADHD symptoms), and parental depression were entered in the first step as covariates, followed by genotype (coded as *l*/*l* = 0, [*s*/*l* or *s*/*s*] = 1) in the second step. Because the precise model of transmission of 5-HTTLPR is not known, separately analyses were based on a dominant model and then reproduced with an additive 5-HTTLPR model based on the number of *s*-alleles present (i.e., 0, 1, or 2 short alleles).

Our second goal was to evaluate parental neuroticism, extraversion, and agreeableness as mediators of the association of 5-HTTLPR genotype and parenting behavior. We used Model 4 of the PROCESS v2.10 macro (Hayes, 2013) with bootstrapping (k = 5,000) to assess the simultaneous and independent meditational role of neuroticism, extraversion, and agreeableness on parenting behavior. Bootstrapping is a non-parametric resampling procedure which estimates indirect effects by empirically estimating confidence intervals through repeated sampling; bootstrapping is also robust to non-normal data and thus provides more robust parameter estimates compared to normal theory approach (Hayes, 2013). Unlike traditional guidelines for mediation (Baron & Kenny, 1986), direct effects are not required in order for significant mediation (Preacher & Hayes, 2008; X. Zhao, Lynch, & Chen, 2010). We calculated 95% bias-corrected confidence intervals for the parameter estimates of the indirect effects; parameter estimates are significant if the confidence interval does not contain zero. Separate models were constructed for observed and self-reported positive and negative parenting behavior.

Results

Association of 5-HTTLPR with Observed and Self-Reported Parenting Behavior

Study 2a, Table 14 presents the regression results for the relationship between 5-HTTLPR genotype and observed negative parenting behavior. Controlling for the child's age, sex, the total number of child ADHD symptoms, and parental depression, 5-HTTLPR *s*-allele genotype (dominant model) was associated with significantly less observed negative parenting behavior (β=-.22, p=.01) relative to the *l/l* genotype. Based on the number of *s*-alleles (i.e., additive model), 5-HTTLPR was similarly associated with less frequent use of observed negative parenting behavior (β=-.20, p=.03). 5-HTTLPR was unrelated to observed positive parenting behavior, self-reported parenting involvement, self-reported positive parenting, and self-reported corporal punishment.

Parental Personality Traits As Mediators of 5-HTTLPR and Parenting Behavior

Self-reported parenting behavior. We first examined the 5-HTTLPR *s*-allele dominant model. Excluding mediators (i.e., neuroticism, extraversion, and agreeableness) from the model, and controlling for the child's age/sex, the total number of child ADHD symptoms, and parental depression (Study 2a, Figure 2A), there was no significant total effect of 5-HTTLPR on parental involvement (B=0.53, SE=0.51, p=.30), but 5-HTTLPR was positively associated with extraversion (B=4.67, SE=1.98, p=.02), marginally associated with neuroticism (B=-2.86, SE=1.73, p=.10), and unrelated to agreeableness (B=0.86, SE=1.98, p=.43). Next, extraversion was significantly and positively associated with parental involvement (B=0.11, SE=0.02, p<.01), but neuroticism (B=0.03, SE=0.03, p=.31) and agreeableness (B=0.03, SE=0.02, p=.13) were unrelated to parental involvement. Finally, when including the mediators in the model, there was no significant direct effect of 5-HTTLPR on parental involvement (B=0.08, SE=0.47, p=.86). Using 5,000 bootstraps, the total indirect effect (i.e., point estimate of the difference between the total effect and direct effect through the three mediators) significantly differed from zero (95% BC CI: 0.004 – 1.12) such that extraversion, but not neuroticism and agreeableness,

significantly and uniquely mediated the association of *s*-allele with respect to parental involvement (Study 2a, Table 16). Thus, the effect of the 5-HTTLPR *s*-allele on parental involvement was conveyed through parental extraversion such that compared to *l/l* homozygous individuals, *s*-allele carriers had elevated trait extraversion and subsequently reported higher levels of parental involvement.

We then produced identical models for positive parenting (Study 2a, Figure 2B) and corporal punishment (Study 2a, Figure 2C). Given that the associations of *s*-allele (dominant model) with personality traits were previously described, they are not reported again here. We thus present only the total, direct, and indirect effects for the remaining self-reported parenting variables. There were no significant total and direct effects of 5-HTTLPR with respect to positive parenting behavior (B=0.56, SE=0.53, p=.29 and B=0.31, SE=0.54, p=.57, respectively), and the total indirect effect of 5-HTTLPR on positive parenting through neuroticism, extraversion, and agreeableness similarly did not differ significantly from zero (Study 2a, Table 16, 95% BC CI: -0.05 – 0.75). However, there was a significant specific indirect effect of 5-HTTLPR on self-reported positive parenting through extraversion (Study 2a, Table 16, 95% BC CI: 0.01 – 0.77), indicating that the effect of the 5-HTTLPR *s*-allele genotype was convayed through parental extraversion. Specifically, *s*-allele carriers had elevated extraversion and thus reported more frequent use of positive parenting practices compared to *l/l* homozygous individuals. Next, for corporal punishment, there was no significant total or direct effect of 5-HTTLPR (B=-0.12, SE=0.25, p=.64 and B=-0.11, SE=0.25, p=.67, respectively) and the total indirect effect of 5-HTTLPR on corporal punishment through neuroticism, extraversion, and agreeableness did not differ significantly from zero (Study 2a, Table 16, 95% BC CI: -0.17 – 0.15). Further, there were no significant specific indirect effects of 5-HTTLPR on corporal punishment through neuroticism, extraversion, or agreeableness.

Because the association of 5-HTTLPR and parenting behavior may reflect additive transmission, we reproduced the above models where 5-HTTLPR was coded as 0, 1, and 2

according to the number of short alleles. Excluding mediators (i.e., neuroticism, extraversion, and agreeableness) from the model, and controlling for the child's age/sex, the total number of child ADHD symptoms, and parental depression (Study 2a, Figure 3A), there was no total effect of the number of *s*-alleles on parental involvement (B=0.42, SE=0. 31, p=.18). Additional *s*-alleles were marginally associated with increased extraversion (B=2.34, SE=1.23, p=.06) and decreased neuroticism (B=-1.75, SE=1.06, p=.10), but unrelated to agreeableness (B=.04, SE=1.22, p=.97). Controlling for all mediators, there was no significant association between the number of *s*-alleles and parental involvement (B=0.23, SE=0.29, p=.44). Next, although the total indirect effect of the number of *s*-alleles on parental involvement did not differ significantly from zero (Study 2a, Table 17, 95% BC CI: -0.06 – 0.57), there was a significant specific indirect effect of the number of *s*-alleles on parental involvement through extraversion (Study 2a, Table 17, 95% BC CI: 0.02 – 0.61). To avoid redundancy in reporting associations of the number of *s*-alleles with personality traits, we next present the total, direct, and indirect effects for positive parenting and corporal punishment. The total and direct effects of the number of *s*-alleles on positive parenting were non-significant (Study 2a, Figure 3B; B=0.25, SE=0.33, p=.45 and B=0.12, SE=0.33, p=.71, respectively). Further, the total indirect effect of the number of *s*-alleles on positive parenting through neuroticism, extraversion, and agreeableness did not differ significantly from zero (Study 2a, Table 17, 95% BC CI: -0.06 – 0.40), and there were no specific indirect effects through neuroticism, extraversion, or agreeableness. Similarly, there were no significant total and direct effects of the number of *s*-alleles with respect to corporal punishment (Study 2a, Figure 3C; B=0.07, SE=0.15, p=.66 and B=0.06, SE=0.16, p=.68, respectively); the total indirect effect of the number of *s*-alleles on corporal punishment through traits neuroticism, extraversion, and agreeableness did not differ significantly from zero (Study 2a, Table 17, 95% BC CI: -0.08 – 0.10), and there were no specific indirect effects through neuroticism, extraversion, or agreeableness.

Observed parenting behavior. Following the same data analytic procedures for self-reported parenting behavior, we evaluated mediation with respect to observed positive and negative parenting behavior. Excluding mediators (i.e., neuroticism, extraversion, and agreeableness) from the model, and controlling for the child's age/sex, the total number of child ADHD symptoms, and parental depression (Study 2a, Figure 4A), there was no significant total effect of 5-HTTLPR on observed positive parenting (B=0.01, SE=0.09, p=.92), and 5-HTTLPR was unrelated to neuroticism (B=-2.81, SE=1.72, p=.11) and agreeableness (B=0.65, SE=2.00, p=.75), but positively associated with extraversion (B=4.86, SE=2.00, p=.02). Next, neuroticism, extraversion, and agreeableness were each unrelated to observed positive parenting (B=0.003, SE=0.01, p=.60; B=0.01, SE=0.004, p=.16; B=0.003, SE=0.004, p=.53, respectively). Finally, when including mediators in the model, there was no significant direct effect of 5-HTTLPR on observed positive parenting (B=-0.02, SE=0.09, p=.86). Once again using 5,000 bootstraps, the total indirect effect did not differ significantly from zero (95% BC CI: -0.03 – 0.10) and no significant specific indirect effects were observed (Study 2a, Table 16). In contrast, the total and direct effects of 5-HTTLPR on observed negative parenting were significant (Study 2a, Figure 4B; B=-0.18, SE=0.07, p=.01 and B=-0.19, SE=0.07, p=.01, respectively). However, the total indirect effects through neuroticism, extraversion, and agreeableness did not differ significantly from zero (95% BC CI: -0.03 – 0.06), and no significant specific indirect effects were observed (Study 2a, Table 16).

We again reproduced these models to explore an additive 5-HTTLPR *s*-allele model. For both observed positive parenting and observed negative parenting, the number of *s*-alleles was positively associated with extraversion (B=2.60, SE=1.23, p=.04), but unrelated to neuroticism (B=-1.66, SE=1.05, p=.12) and agreeableness (B=-0.26, SE=1.22, p=.83). Excluding the personality trait mediators, and controlling for the child's age/sex, the total number of child ADHD symptoms, and parental depression (Study 2a, Figure 5A), the total and direct effects of the number of *s*-alleles on observed positive parenting were non-significant (B=0.01, SE=0.05,

p=.83 and B=0.001, SE=0.05, p=.98, respectively). The total indirect effect of the number of *s*-alleles on observed positive parenting through neuroticism, extraversion, and agreeableness did not differ significantly from zero (Study 2a, Table 17, 95% BC CI: -0.02 – 0.05) and no significant specific indirect effects were observed. Unlike observed positive parenting, there were significant total and direct effects of the number of *s*-alleles on observed negative parenting (Study 2a, Figure 5B; B=-0.10, SE=0.04, p=.03 and B= -0.11, SE=0.05, p=.02, respectively). However, as with observed positive parenting, the total indirect effect of the number of *s*-alleles on observed negative parenting through neuroticism, extraversion, and agreeableness did not differ significantly from zero (Study 2a, Table 17, 95% BC CI: -0.02 – 0.04) and no specific indirect effects were observed.

Discussion

There is a dearth of knowledge about determinants of parenting behavior, especially with respect to biological influences. Integrating knowledge from the relatively more well-developed literature on the biological substrates of nurturing behavior in non-human animals and emerging studies on biological processes underlying human behavior (and human parenting, in particular), we explored the potential association of 5-HTTLPR with self-reported and observed parenting behavior in 177 families. We applied state of the art multiple mediation procedures to evaluate the possible mediating influence of parental neuroticism, extraversion, and agreeableness using a well-characterized and diverse sample of children with and without ADHD, controlling for the child's age, sex, negative behavior (i.e., number of ADHD symptoms), and parental depression. 5-HTTLPR *s*-allele genotype (in separate dominant and additive models) was significantly associated with decreased observed negative parenting behavior, but unrelated to all other observed and self-reported indices of parenting behavior examined. Additionally, controlling for the other mediators (i.e., parental neuroticism and agreeableness), extraversion significantly mediated the association of 5-HTTLPR *s*-allele dominant model with separate measures of self-reported parental involvement and self-reported positive parenting. However, in the additive

models examined, extraversion specifically mediated the association of 5-HTTLPR only with self-reported parental involvement.

Although previous studies have implicated the important influence of the *s*-allele for some negative outcomes (Caspi, Hariri, Holmes, Uher, & Moffitt, 2010), results have not been consistently replicated and the extent to which the *s*-allele confers risk for maladaptive functioning is unclear (Fergusson, Horwood, Miller, & Kennedy, 2011). Although the inverse association of the *s*-allele with observed negative parenting behavior in the current study was somewhat unexpected, differential susceptibility suggests that *s*-allele carriers may simply be more sensitive to their environment (Homberg & Lesch, 2011). Thus, *s*-allele carriers would exhibit maladaptive functioning in the presence of external stressors or positive outcome in the presence of protective factors (van IJzendoorn, Belsky, & Bakermans-Kranenburg, 2012). For example, strong associations between a greater population frequency of *s*-allele carriers, increased cultural collectivism, and decreased prevalence of anxiety and mood disorders support this differential susceptibility perspective and suggest co-evolution of culture and genes wherein *s*-allele carriers are naturally selected for their tendency to thrive in collectivistic societies (Chiao & Blizinsky, 2010). A review of non-human and human studies suggests that the *s*-allele is associated with environmental hypervigilance, which may confer the advantage of being able to simultaneously avert risk and pursue optimal outcomes when negative environmental factors trigger maladaptive emotional or behavioral responses are absent (Homberg & Lesch, 2011). The current findings may reflect unmeasured differential susceptibility, highlighting the importance of assessing moderating influences on parenting behavior that might confer risk versus resilient parenting, a completely unexplored area of inquiry (Belsky & Jaffee, 2006).

The association of personality traits with respect to anxiety and mood disorders suggests that personality traits may potentially mediate the association of 5-HTTLPR and negative mood and emotion dysregulation. The emergence of parental extraversion as a mediator of the

positive relationships of *s*-allele dominant model with self-reported parental involvement and self-reported positive parenting is potentially noteworthy for several reasons. First, the current findings suggest that *s*-allele carriers may be more involved with their children and engage in more positive parenting practices than *l*/*l* homozygotes, partly due to elevated extraversion. Given that individuals with high extraversion tend to be sociable, engaging, and active, it seems natural for these individuals to thus also be more involved and positive in their parenting practices. However, the association of the *s*-allele with higher extraversion (and marginally less neuroticism) deviates from previous studies where *s*-allele carriers had higher neuroticism and lower extraversion scores (Gillihan et al., 2007; Jang et al., 2001; Munafò, Clark, Roberts, & Johnstone, 2006). One possible explanation for this deviation may be that associations between 5-HTTLPR and personality traits differ across ethnic groups: previous studies utilized primarily Caucasian participants (Gillihan et al., 2007; Munafò et al., 2006), whereas almost 50% of the participants in the current study endorsed being non-Caucasian or mixed ethnicity. As discussed above, the possible co-evolution of genes and culture may result in phenotypic variation with regards to complex traits. These preliminary findings suggest that future studies may benefit from sufficiently large samples to adequately facilitate cross-cultural comparisons with respect to 5-HTTLPR and social behavior.

Next, extraversion uniquely mediated the relationship between 5-HTTLPR and self-reported positive parenting, but not observed positive parenting. Important methodological and phenomenological differences likely underlie the widely reported, including in the present study, modest association between self-reported positive and observed positive parenting behavior. Self-reported behavior is generally considered less reliable than observed data as the former is may be influenced by cognitive biases, including evidence that individuals who are prone to social desirability may be motivated to report more positive events (Holtgraves, 2004). For instance, individuals who were asked to deliberately distort their answers to appear socially desirable scored higher on extraversion and lower on neuroticism (Furnham & Henderson,

1982). Another potential explanatory factor is that individuals with high extraversion may simply be more attuned to positivity: for example, highly extraverted individuals were predisposed to positive cues (Derryberry & Reed, 1994) and experienced more objective positive events (Magnus, Diener, Fujita, & Pavot, 1993) compared to their counterparts. Although it is uncertain whether the current self-reported parenting data were influenced by cognitive biases, these findings underscore the importance of incorporating and utilizing multi-method measures such as semi-structured interviews or observational data to more fully capture the range of possible parenting behaviors. As previously discussed, this ability to accurately capture a full range of parenting behaviors is especially salient when assessing sensitive parenting domains such as harsh parenting practices and maltreatment, where individuals may be more likely to want to preserve social desirability (Morsbach & Prinz, 2006).

Several study limitations should be considered when evaluating the current findings. First, the cross-sectional nature of these data prevents temporal sequencing of our predictors, mediators, and outcome variables, which consequently prohibits the development of true causal inferences from our results (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001). However, we contend on theoretical grounds that genetics precede personality development and the development of parenting practices; as such, our data are thus, arguably, temporally sequenced. Secondly, although a common limitation in studies of parenting behavior, the predominantly maternal (85%) composition in the current sample prohibits the generalization of our findings as well as inferences about parenting behavior among fathers (Coplan et al., 2009). Similarly, despite being consistent with the epidemiology of ADHD, the predominantly male composition (71%) in our sample prohibits generalization of our findings to the population at large. Finally, because we did not genotype the rs25531 (L_G) allelic variant of 5-HTTLPR, we were unable to fully assess the functionality of the *l*-allele.

The current study fills a gap in the literature by assessing the viability of 5-HTTLPR as a biological substrate of human parenting behavior. Additionally, the current study utilized a state-

of-the art multiple mediation approach to explore the potentially mediating influences of individual parental personality traits. The presence of *s*-alleles was associated with decreased observed negative parenting behavior and parental extraversion emerged as a mediator of the association of 5-HTTLPR with self-reported parental involvement and self-reported positive parenting. The current study represents a preliminary effort at understanding parenting behavior; we contend that future genetically- and environmentally-driven studies will be important for the development of individually-sensitive parenting interventions.

Study 2a, Table 14. *Summary of multiple regression analysis for association between 5-HTTLPR s-dominant genotype and observed negative parenting behavior.*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.001	0.03	-.002	-0.01	0.03	-.02
Child Gender	-0.02	0.07	-.03	-0.05	0.07	-.06
Negative Child Behavior	0.01	0.01	.18†	0.01	0.01	.18*
Parental Depression	0.002	0.01	.03	0.001	0.01	.02
5-HTTLPR *s*-Dominant Genotype				-0.18	0.07	-.22**
R^2	.04			.08		
Adjusted R^2	.01			.05		
F for change in R^2	1.22			6.18**		

Note: $^{\dagger}p \leq 0.10$, $^{*}p \leq .05$; $^{**}p \leq .01$.

Study 2a, Table 15. *Summary of multiple regression analysis for association between 5-HTTLPR s-additive genotype and observed negative parenting behavior.*

	Model 1			Model 2		
Variable	B	SE B	β	B	SE B	β
Child Age	-0.001	0.03	-.002	-.002	.03	-.01
Child Gender	-0.02	0.07	-.03	-.04	.07	-.05
Negative Child Behavior	0.01	0.01	.18†	.01	.01	.17†
Parental Depression	0.002	0.01	.03	.002	.01	.03
5-HTTLPR *s*-Additive Genotype				-.10	.04	-.20*
R^2	.04			.08		
Adjusted R^2	.01			.04		
F for change in R^2	1.22			5.13*		

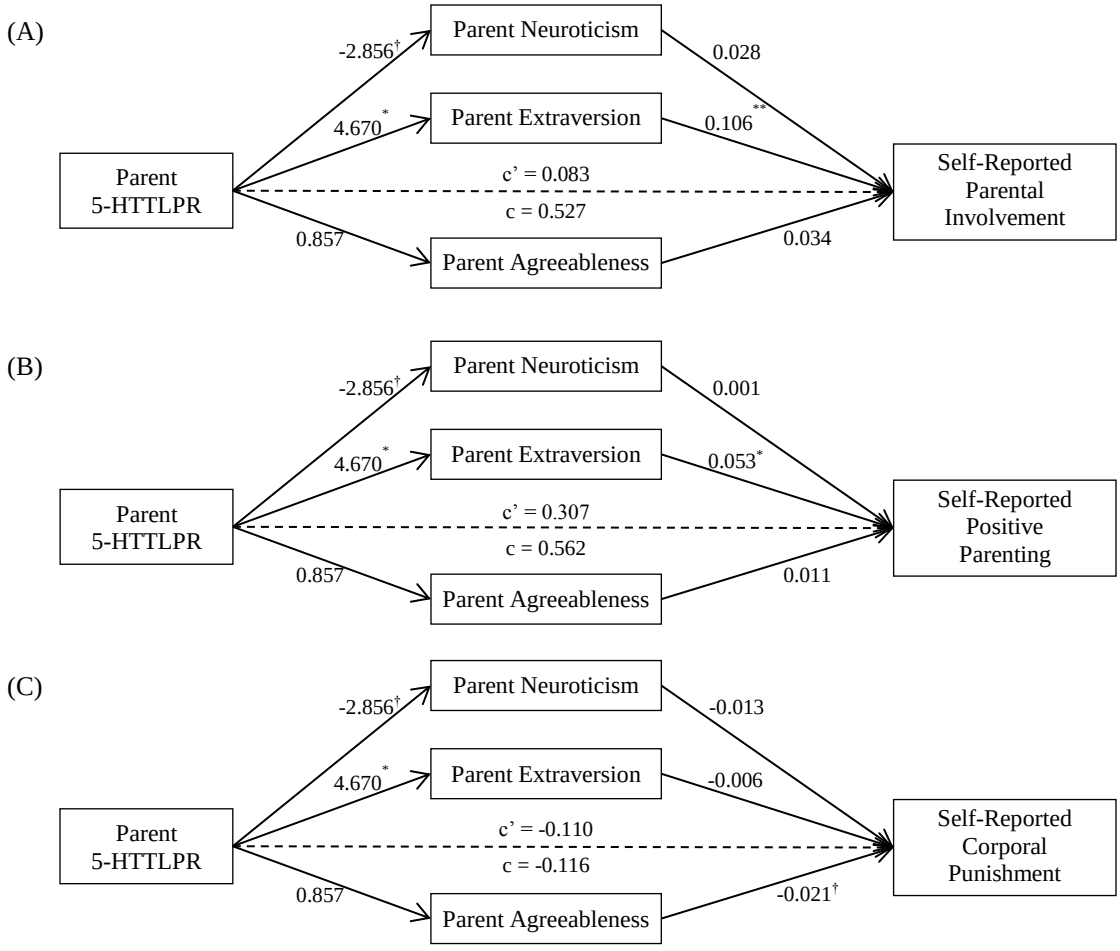
Note: $^{*}p \leq .05$; $^{**}p \leq .01$.

Study 2a, Table 16. *Point estimates, standard error, and 95% bias-corrected confidence intervals for indirect effects of parent personality traits on parenting behavior, s-dominant models.*

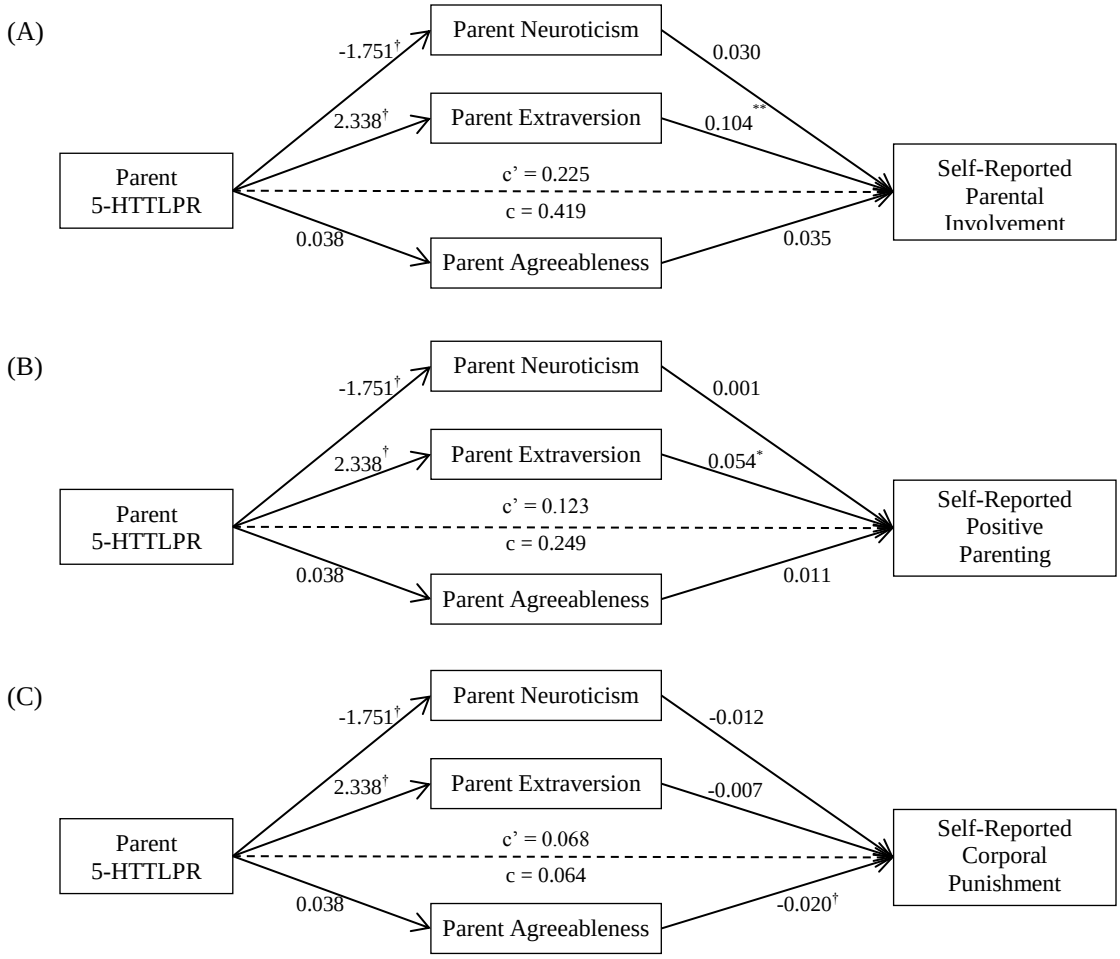
		95% Bias-Corrected Confidence Intervals (k=5,000)	
	Point Estimate	Lower Limit	Upper Limit
Self-Reported Parenting			
Parental Involvement			
Total	**0.44***	**0.004**	**1.12**
Neuroticism	-0.08	-0.49	0.05
Extraversion	**0. 50***	**0.11**	**1.17**
Agreeableness	0.03	-0.07	0.33
Positive Parenting			
Total	0.25	-0.05	0.75
Neuroticism	-0.002	-0.26	0.24
Extraversion	**0.25***	**0.01**	**0.77**
Agreeableness	0.01	-0.05	0.21
Corporal Punishment			
Total	-0.01	-0.17	0.15
Neuroticism	0.04	-0.02	0.24
Extraversion	-0.03	-0.20	0.08
Agreeableness	-0.02	-0.16	0.05
Observed Parenting			
Observed Positive Parenting			
Total	0.02	-0.03	0.10
Neuroticism	-0.01	-0.07	0.01
Extraversion	0.03	-0.01	0.10
Agreeableness	0.002	-0.01	0.04
Observed Negative Parenting			
Total	0.01	-0.32	0.06
Neuroticism	0.02	-0.003	0.09
Extraversion	-0.01	-0.57	0.02
Agreeableness	-0.001	-0.03	0.01

Study 2a, Table 17. *Point estimates, standard error, and 95% bias-corrected confidence intervals for indirect effects of parent personality traits on parenting behavior, s-additive models.*

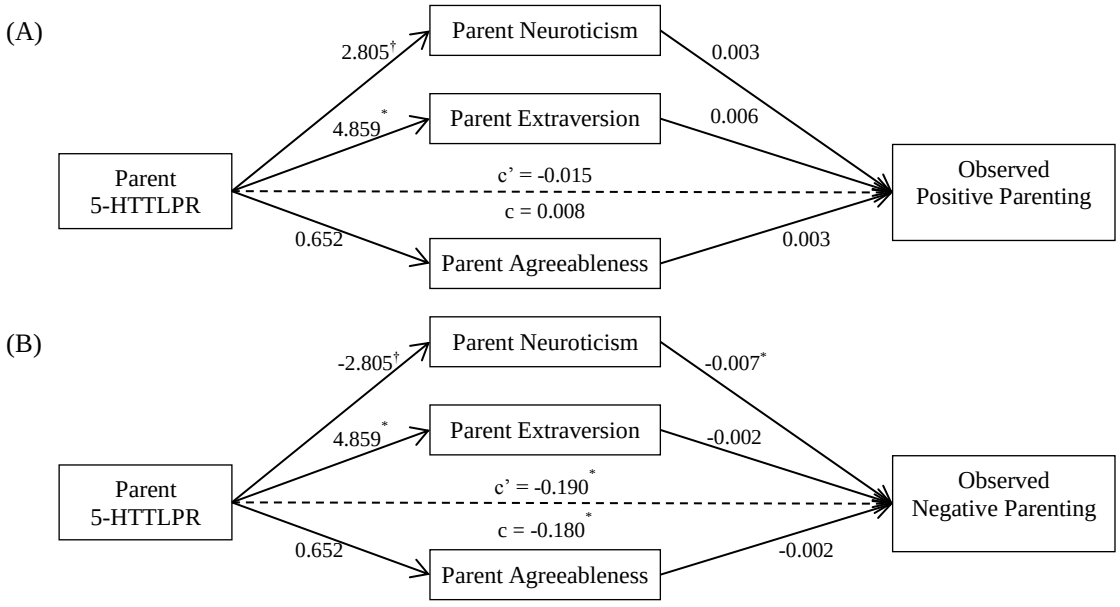
		95% Bias-Corrected Confidence Intervals (k=5,000)	
	Point Estimate	Lower Limit	Upper Limit
Self-Reported Parenting			
Parental Involvement			
Total	0.19	-0.06	0.57
Neuroticism	-0.05	-0.31	0.03
Extraversion	**0.24**	**0.02**	**0.61**
Agreeableness	0.001	-0.08	0.12
Positive Parenting			
Total	0.13	-0.06	0.40
Neuroticism	-0.001	-0.16	0.15
Extraversion	0.13	-0.002	0.42
Agreeableness	0.0004	-0.55	0.07
Corporal Punishment			
Total	0.004	-0.08	0.10
Neuroticism	0.02	-0.02	0.13
Extraversion	-0.02	-0.10	0.03
Agreeableness	-0.0008	-0.06	0.05
Observed Parenting			
Observed Positive Parenting			
Total	0.01	-0.02	0.05
Neuroticism	-0.004	-0.04	0.008
Extraversion	0.02	-0.003	0.05
Agreeableness	-0.0007	-0.02	0.006
Observed Negative Parenting			
Total	0.007	-0.02	0.04
Neuroticism	0.01	-0.002	0.05
Extraversion	-0.01	-0.04	0.01
Agreeableness	-0.0005	-0.005	0.01



Study 2a, Figure 2. Conceptual diagram showing total and direct effects, as well as specific indirect effects, of 5-HTTLPR (dominant model) on self-reported A) parental involvement, B) positive parenting, and C) corporal punishment, with personality traits as mediators. Significance levels: $^{**}p \leq 0.01$, $^{*}p \leq 0.05$, $^{\dagger}p \leq 0.10$.

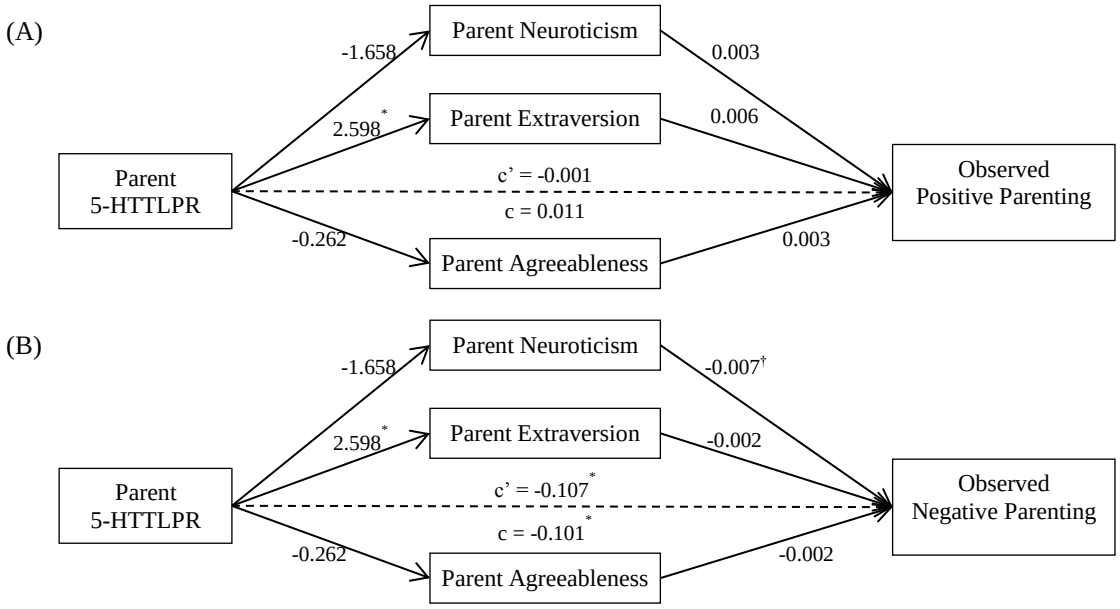


Study 2a, Figure 3. Conceptual diagram showing total and direct effects, as well as specific indirect effects, of the number of 5-HTTLPR s-alleles on self-reported A) parental involvement, B) positive parenting, and C) corporal punishment, with personality traits as mediators. Significance levels: **p ≤ 0.01, *p ≤ 0.05, †p ≤ 0.10.



Study 2a, Figure 4. Conceptual diagram showing total and direct effects, as well as specific indirect effects, of 5-HTTLPR (dominant model) on A) observed positive parenting and B) observed negative parenting, with personality traits as mediators.

Significance levels: $^{*}p \leq 0.05$, $^{\dagger}p \leq 0.10$.



Study 2a, Figure 5. Conceptual diagram showing total and direct effects, as well as specific indirect effects, of the number of 5-HTTLPR s-alleles on A) observed positive parenting and B) observed negative parenting, with personality traits as mediators.

Significance levels: $^{*}p \leq 0.05$, $^{\dagger}p \leq 0.10$.

Study 2b: Association of Parental Serotonin Transporter (5-HTTLPR) Genotype with Parental Supportiveness and Hostility: Mediation by Parental Personality Traits

Study 2a provided preliminary evidence that parental 5-HTTLPR was significantly associated with observed negative parenting behavior and that individual differences in parental extraversion partially mediated the association of parental 5-HTTLPR and self-reported positive parenting. In Study 2b, we once again sought to further prosecute these patterns of association in an independent sample with respect to parental 5-HTTLPR and observed parenting behavior (e.g., parental supportiveness, intrusiveness, efficacy). As with Study 2a, the rationale for Study 2b reflects that despite its role in diverse child outcomes with considerable public health significance, limited knowledge about determinants of parenting behavior, especially with regard to biological influences, is an obstacle to changing parenting behavior in beneficial ways. Theoretical and emerging biological evidence supports the plausibility of 5-HTTLPR as a contributing factor to individual differences in human parenting behavior, but there are few direct tests of this association; moreover, potential mediating constructs are virtually unknown. We therefore examined the association of parental 5-HTTLPR and observed human parenting behavior in a community-based sample of 113 ethnically and socio-economically diverse parent-child dyads. Additionally, we implemented state-of-the-art multiple mediation procedures to examine the combined and independent mediating role of norm-referenced parental trait neuroticism, extraversion, and agreeableness on the association of 5-HTTLPR with observed parenting behavior. Thus, most previous studies, which have been limited their predominantly maternal samples, the current study features equal numbers of fathers and mothers. Finally, to enhance the specificity of models, we stringently controlled for parent sex, parental depression, child age/sex, and child effects (i.e., child negativity).

Methods

Participants

Participants were 113 ethnically and socioeconomically diverse parents (56 mothers, 57 fathers) drawn from a larger community-based sample of 172 couples who were recruited from a metropolitan area in the Western United States to participate in a longitudinal, prospective study of marriage and family development. Participants were recruited between May 1993 and January 1994 from public marriage license applications and exclusion criteria at recruitment included: either partner being over 35 years of age, having been previously married, or having had children. Within 3 to 6 months of their marriage (Time 1), couples individually completed self-report questionnaires about themselves and their relationship, followed by a laboratory session during which they participated in dyadic interactions with one another. At that time, fathers in the current subset of 113 parents ranged from 21 to 37 years of age (M=27.67, SD=4.03) while mothers ranged from 20 to 34 years of age (M=26.61, SD=3.88).

After approximately 9 years (Time 2; M=9.40, SD=0.52), couples were invited to return to the laboratory with their firstborn child if the latter were between 5 to 8 years of age. At Time 2, parents individually completed self-report questionnaires about themselves and their children, and attended a laboratory session during which they participated in a videotaped dyadic interaction with their firstborn child. Additionally, parents were asked to provide saliva samples for genotyping analyses. One hundred and thirteen couples from the original study were not included in the current study because they were divorced/separated, did not have a child in the target age range, or otherwise unable to participate at Time 2; the remaining 59 couples who were included completed questionnaires about themselves, their marital relationship, and their firstborn child (30 boys, 29 girls; M=6.70, SD=0.79), provided a saliva sample for genotyping analysis, and completed a series of videotaped dyadic couple and parent-child interactions; of the 118 parents from these couples, 5 parents were excluded from current analyses due to missing data. At Time 2, fathers ranged from 30 to 46 years of age (M=37.23, SD=3.97) and

mothers ranged from 29 to 43 years of age (M=36.13, SD=3.70. Parents in the current sample were predominantly Caucasian (71.9% fathers, 67.9% mothers), followed by Latino/Chicano (12.5% fathers and 14.0% mothers), Asian-American (12.3% fathers, 14.3% mothers), African-American (1.8% fathers and mothers), and Middle Eastern (3.6% mothers).

Measures

Parental Genotype. DNA was extracted from saliva collected with DNA Genotek Oragene^{TM} self-collection kits. The 48-base pair (bp) insertion/deletion polymorphism in the 5-HTT-linked polymorphic region was genotyped using standard primers, resulting in either 484-bp or 528-bp fragments. Because the precise mode of transmission for 5-HTTLPR is unknown, we examined both *s*-allele dominant and *s*-allele additive models. Genotypic distribution in the current sample was as follows: short/short (*s/s*, n=25), long/long alleles (*l/l*, n=23), and short/long (*s/l*, n=65). Allele frequencies in the sample did not deviate from Hardy-Weinberg expectations ($\chi^2 = 2.57$, df = 2, p = 0.28).

Parental Personality Traits. Parents' personality traits were assessed during Time 1 using the NEO Five Factor Inventory (NEO-FFI) (Costa Jr & McCrae, 1992), a widely validated 60-item self-report measure of personality based on the five-factor model of personality. Items on the NEO-FFI are rated on a 5-point Likert scale and are then summed to yield five dimensions of personality: neuroticism, extraversion, openness, agreeableness, and conscientiousness. Participants' raw scores on each NEO-FFI personality dimension were converted into T-scores based on the gender-referenced normative sample from the NEO-FFI manual. Previous studies have demonstrated that the NEO-FFI has good overall and test-retest reliability. Estimates of internal consistency for the NEO-FFI have ranged from 0.68 (agreeableness) to 0.89 (neuroticism), and scores across the various factors from the NEO-FFI are highly correlated (ranging from 0.77 to 0.92) with those from the NEO-PI-R, (Costa Jr & McCrae, 1992). Internal consistency in the current sample were acceptable for the neuroticism (α =.85), extraversion (α =.70), and agreeableness (α =.60) dimensions.

Parenting Stress. Parents completed the Parenting Stress Interview-Short Form (PSI-SF; Abidin, 1995) at Time 2. The PSI-SF is comprised of 24-items which are rated on a 5-point Likert scale and yield three subdomains: parental distress, difficult child characteristics, and dysfunctional parent-child interaction. We used the parental distress subscale, which had good internal consistency (α =.83) in the current sample, to specifically isolate parent-related stress from more generalized forms of stress which may affect parenting behavior less directly (Abidin, 1995; Rodgers, 1998).

Observed Parenting Behavior. At Time 2, parents and children participated in 5 minutes of dyadic free play with puppets, 5 minutes of an etch-a-sketch maze task where parents and children were directed to jointly complete the maze with the parent manipulating one dial and the child manipulating the other dial, and 5 minutes of a tangram puzzle task where the parent was directed to let their child do as much as they could on their own without help. These dyadic interactions were videotaped and subsequently coded by a team of trained research assistants based on the 54-Month Parent-Child Structured Interaction Qualitative Rating Scales (PSIQRS; NICHD Study of Early Child Care), a categorical observation system designed to assess the quality of dyadic interactions between parents and their children on a 7-point Likert scale. Observer ratings of parent supportiveness (i.e., capacity for expressing positive regard and providing emotional support), intrusiveness (i.e., respect for child autonomy), cognitive nurturance (i.e., ability to foster their child's cognitive development), hostility (i.e., negative emotions, rejection, or criticism directed towards their child), quality of assistance provided to their child, and sense of parenting efficacy (i.e., demonstrates confidence when interacting with their child) were made at 3 distinct points during each 5-minute play segment. Ratings were averaged on each dimension to reflect total functioning across the entire 15-minute interaction. Higher scores (i.e., 7) indicated higher levels on each of these parenting dimensions except for parental intrusiveness, where lower scores (i.e., 1) indicated higher levels of intrusiveness. A randomly selected 44% of parent-child interactions were double coded for

reliability. ICCs were adequate for parent supportiveness (.82), intrusiveness (.73), cognitive nurturance (.72), quality of assistance (.76), and parenting efficacy (.72). Due to a floor effect and poor ICC for hostility (-.006), these ratings were dropped from the current analyses.

Child Negativity. Child behavior was assessed at Time 2 as part of the dyadic parent-child interaction described above. As with parent behavior, research assistants rated children on their level of agency (i.e., active interest, confidence), negativity (i.e., expressed anger, dislike, resistance, or hostility towards their parent), task persistence, and overall experience of the session (i.e., demonstrated confidence in parent-child relationship, feelings of success) at three distinct points during each 5-minute play segment, then averaged these ratings to provide a measure of each dimension across the entire 15-minute interaction. Similarly, high scores on each dimension (i.e., 7) reflected high levels of each respective child behavior. As previous studies have demonstrated that negative child behavior increases parenting stress and maladaptive parenting behavior (Bell & Chapman, 1986; Pelham et al., 1997), observed child negativity was utilized to control for child effects. Additionally, due to a floor effect such that ratings of child negativity were positively skewed, child negativity was dichotomized as a variable to reflect either its presence or absence during the parent-child. ICC for the dichotomous child negativity variable was acceptable (.60).

Parental Depression. At Time 2, parents completed the Beck Depression Inventory (BDI-II; Beck et al., 1996), a widely used and validated 21-item self-report measure of depression based on symptoms listed in the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV; 1994). Participants' responses were summed to attain a total score that indicates the severity of depressive symptoms that they may be experiencing, with higher scores reflecting increased severity. The BDI-II has good construct validity (α =.93) and test-retest reliability (α =.96) in outpatient and college student samples (Beck et al., 1996; Sprinkle et al., 2002); per the BDI-II manual, tests conducted with both clinical and non-clinical

samples indicate a high degree of internal consistency (α =.92 and .93, respectively). There was good internal consistency in the current sample (α =.97).

Data Analytic Procedures

To review, our first goal was to test the association of parental 5-HTTLPR genotype with separate measures of observed parental supportiveness, intrusiveness, cognitive nurturance, quality of assistance, and efficacy. Using the MIXED procedure in SPSS version 21, multilevel maximum likelihood regression equations nesting parents within families were constructed for each of these observed parenting dimensions to account for mothers and fathers from the same family unit. Child's age and sex, child negativity, as well as parent sex were included as covariates to enhance model specificity. Next, because parental depression is associated with personality traits (e.g., neuroticism; Kendler et al., 2004) and parenting behavior (Belsky, 1984; Carter et al., 2001; Embry & Dawson, 2002; Lovejoy et al., 2000; National Research Council & Institute of Medicine, 2009), we reproduced the above model including parental depression as a covariate to isolate the unique association of personality traits and parental depression with respect to parenting behavior. Additionally, because the precise model of transmission of 5-HTTLPR is not known, separate models were constructed for dominant (parental genotype coded as *l*/*l* = 0, [s/*l* or *s*/*s*] = 1) and additive models (parental genotype coded based on the number of *s*-alleles, i.e., 0, 1, or 2 short alleles).

Our second goal was to evaluate norm-referenced parental neuroticism, extraversion, and agreeableness as mediators of the association of 5-HTTLPR genotype and observed parenting behavior. Using the XTMIXED procedure in Stata 12, multilevel multiple mediator models nesting parents in families were constructed to assess the simultaneous and independent meditational role of neuroticism, extraversion, and agreeableness on observed parental supportiveness, intrusiveness, cognitive nurturance, quality of assistance, and efficacy. Additionally, we utilized bootstrapping, a non-parametric resampling procedure which estimates indirect effects by empirically estimating confidence intervals through repeated sampling, to

construct 95% bias-corrected confidence intervals for the parameter estimates of the indirect effects of parental neuroticism, extraversion, and agreeableness on each of the abovementioned parenting behavior dimensions. The resampling procedure in bootstrapping allows for increased robustness in the presence of non-normal data and thus provides more powerful parameter estimates compared to normal theory approach (Hayes, 2013). In contrast to traditional mediation guidelines (Baron & Kenny, 1986), direct effects are not required in order for significant mediation to be present (Preacher & Hayes, 2008; X. Zhao et al., 2010). These analyses were first run based on a dominant model of transmission and subsequently reproduced to evaluate an additive model of transmission. Parameter estimates are significant if the confidence interval does not contain zero.

Results

Association of 5-HTTLPR and Observed Parenting Behavior

Controlling for the child's age, sex, child negativity, and parent sex, 5-HTTLPR genotype was unrelated to observed parental supportiveness, intrusiveness, cognitive nurturance, quality of assistance, and efficacy. This was evident in both the dominant and additive models for 5-HTTLPR, regardless of whether parental depression was included as a covariate.

Parental Personality Traits As Mediators of 5-HTTLPR and Parenting Behavior

We examined both the 5-HTTLPR *s*-allele dominant and *s*-allele additive models, but because the patterns of results were similar across both models, we present only the results for the former to avoid redundancy. Excluding mediators (i.e., neuroticism, extraversion, and agreeableness) from the model, and controlling for the child's age/sex, child negativity, parent sex, and parental depression (Study 2b, Figure 6A), 5-HTTLPR was unrelated to parental supportiveness (i.e., the total effect; 95% BC CI: -0.26 – 0.45), extraversion (B=1.80, SE=1.74, p=.30), and agreeableness (B=-0.21, SE=1.83, p=.91), but marginally negatively associated with neuroticism (B=-3.56, SE=1.96, p=.07). Next, neuroticism (B=0.004, SE=0.01, p=.58), extraversion (B=0.001, SE=0.01, p=.90), and agreeableness (B=0.004, SE=0.01, p=.64) were

unrelated to parental supportiveness. Finally, when including the mediators in the model, there was no significant direct effect of 5-HTTLPR on parental supportiveness (B=0.01, SE=0.17, p=.94). Using 5,000 bootstraps, the total indirect effect (i.e., point estimate of the difference between the total effect and direct effect through the three mediators) did not differ significantly from zero (95% BC CI: -0.11 – 0.11), and there were no specific indirect effects for neuroticism, extraversion, or agreeableness.

We then produced identical models for parental intrusiveness, cognitive nurturance, quality of assistance, and efficacy. Given that the associations of *s*-allele (dominant model) with personality traits were previously described in the above paragraph, they are not reported again here. We thus present only the total, direct, and indirect effects for the remaining self-reported parenting variables. There were no significant total and direct effects of 5-HTTLPR with respect to parental intrusiveness (Study 2b, Figure 6B; 95% BC CI: -0.15 – 0.26 and -0.18 – 0.27, respectively), and the total indirect effect of 5-HTTLPR on parental intrusiveness through neuroticism, extraversion, and agreeableness similarly did not differ significantly from zero (Study 2b, Table 18, 95% BC CI: -0.11 – 0.15). Additionally, there were no specific indirect effects of 5-HTTLPR on parental intrusiveness through either neuroticism, extraversion, or agreeableness. Next, for cognitive nurturance, there was no significant total or direct effect of 5-HTTLPR (Study 2b, Figure 6C; 95% BC CI: -0.31 – 0.37 and -0.30 – 0.39, respectively) and the total indirect effect of 5-HTTLPR on cognitive nurturance through neuroticism, extraversion, and agreeableness did not differ significantly from zero (Study 2b, Table 18, 95% BC CI: -0.17 – 0.07). There were no significant specific indirect effects of 5-HTTLPR on cognitive nurturance through neuroticism, extraversion, or agreeableness. For quality of assistance, there was no significant total or direct effect of 5-HTTLPR (Study 2b, Figure 6D; 95% BC CI: -0.06 – 0.44 and -0.09 – 0.43, respectively) and the total indirect effect of 5-HTTLPR on quality of assistance through neuroticism, extraversion, and agreeableness did not differ significantly from zero (Study 2b, Table 18, 95% BC CI: -0.10 – 0.16). There were no significant specific indirect effects

of 5-HTTLPR on quality of assistance through neuroticism, extraversion, or agreeableness. Finally, for parental efficacy, there was no significant total or direct effect of 5-HTTLPR (Study 2b, Figure 6E; 95% BC CI: -0.08 – 0.39 and -0.14 – 0.41, respectively) and the total indirect effect of 5-HTTLPR on cognitive nurturance through neuroticism, extraversion, and agreeableness did not differ significantly from zero (Study 2b, Table 18, 95% BC CI: -0.09 – 0.16). There were no significant specific indirect effects of 5-HTTLPR on cognitive nurturance through neuroticism, extraversion, or agreeableness.

Discussion

Considerable evidence from non-human animal studies establishes biological plausibility and human twin studies demonstrate the heritability of parenting behavior. Yet, there is a significant gap in the literature with respect to biological determinants of human parenting behavior. Non-human animal studies and emerging molecular genetic studies of human behavior suggest 5-HTTLPR genotype may be associated with individual differences in human parenting behavior. The current study thus explored the potential association of 5-HTTLPR with observed parental supportiveness, intrusiveness, cognitive nurturance, quality of assistance, and efficacy in 113 parents (from 59 families). Controlling for the child's age, sex, observed child negativity, parent sex, and parental depression, 5-HTTLPR *s*-allele genotype (in separate dominant and additive models) was unrelated to all indices of observed parenting behavior examined. Because main effects may be subject to suppression and emerge only after the addition of a tertiary mediator variable (MacKinnon, Krull, & Lockwood, 2000), and given preliminary evidence of associations between 5-HTTLPR and personality traits (Greenberg et al., 2000; Munafò et al., 2009; Takano et al., 2007), we further implemented multiple mediation procedures to evaluate the possible simultaneous and unique mediating influence of parental neuroticism, extraversion, and agreeableness. Nevertheless, there was no evidence of mediation by any of the parental personality traits examined (individually or collectively).

Currently, there are three published studies that suggest that *s*-allele carriers demonstrate diminished maternal sensitivity (Bakermans-Kranenburg & van IJzendoorn, 2008; Mileva-Seitz et al., 2011; Sturge-Apple, Cicchetti, Davies, & Suor, 2012). Notably, these three studies were conducted with mothers of young children (i.e., aged 0-5 years) and focused exclusively on maternal sensitivity. In contrast, we assessed five separate dimensions of observed parenting behavior in both mothers and fathers of school-aged children and found no significant association of 5-HTTLPR with respect to observed parenting behavior. Several key differences may thus underlie our observed non-significant association between 5-HTTLPR and observed parenting behavior. First, because different periods of childhood exert shifting demands on parents, we did not specifically assess parental sensitivity, in favor of more developmentally salient dimensions of parenting behavior (e.g., cognitive nurturance, quality of assistance) with regards to our sample of parents with school-aged children. Thus, the dimensions of observed parenting behavior in the current study may differ meaningfully from the construct of maternal sensitivity. Next, whereas the inclusion of both mothers and fathers is a distinct strength in the current study, the inclusion of parents from the same family may alter the manner in which a parent might interact with their child due to the anticipated presence of and comparison to a co-parent (Dudley et al., 2001; Stueve & Pleck, 2001). Additionally, although we controlled for parental sex, sex differences in parenting behavior may necessitate separate analytic procedures or analysis of sex-moderated differences (Lindsey & Caldera, 2006; Walling, Stamper, Smiseth, & Moore, 2008); this is particularly salient given replicated evidence of sex-moderated differences in individual behavior based on 5-HTTLPR genotype (Brummett et al., 2008; Walderhaug et al., 2007).

The non-significant association of 5-HTTLPR with observed parenting behavior should also be considered in light of the distal nature of genetic influences on complex behavioral phenotypes. Despite efforts to delineate parenting behavior according to empirically separable facets (e.g., parental supportiveness), such dimensions remain phenotypically complex, thus

challenging discernment of direct genotypic associations (Gottesman & Gould, 2003). To address this issue, putative endophenotypes which are conceptualized as intermediate constructs underlying complex phenotypes and assumed to be more proximal to biological underpinnings (Flint & Munafò, 2007) may improve traction on identifying genotypic influences on complex phenotypes. Thus, even in the absence of significant main effects, mediational analyses may be used to evaluate possible endophenotypes of parenting behavior.

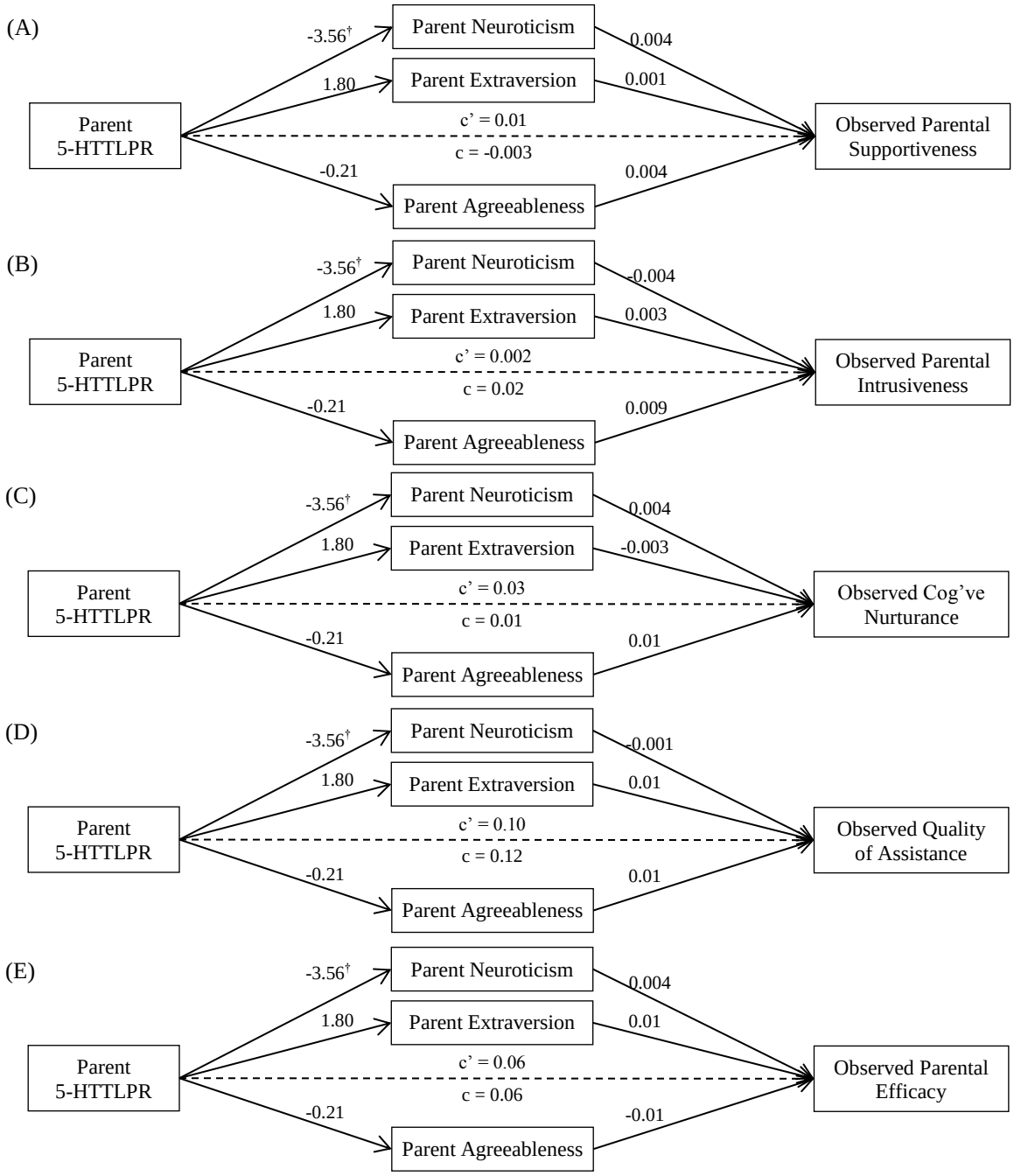
Relatively few studies have formally prosecuted mediating endophenotypes for parenting behavior (and perhaps social behavior more generally). Of note, using a multiple mediation framework, Sturge-Apple et al. (2012) failed to find evidence that parental depression and emotional closeness simultaneously mediated the association of 5-HTTLPR and parenting behavior. Similarly, parental personality traits were not supported as mediators of the relationship between 5-HTTLPR and parenting behavior in the current study. One potential direction for future studies to address the lack of significant findings from mediational analyses might be to consider other proximal factors as endophenotypes for parenting behavior. For example, stress vulnerability (a component of neuroticism) may have potential as an endophenotype for parenting behavior given that *s*-allele homozygotes demonstrated increased cortisol levels and decreased cortisol recovery in response to a laboratory-administered stress task (Gotlib, Joormann, Minor, & Hallmayer, 2008). Alternatively, future studies might also elaborate on previously identified gene x environment interactions by investigating potential determinants of between-group differences. For example, as the self-reported quality of care received during early childhood increased, mothers carrying the *s*-allele oriented away from their child less frequently and reported higher levels of attachment to their child (Mileva-Seitz et al., 2011). Post-hoc mediation analyses focused exclusively on *s*-allele carriers would clarify the nature of the relationship observed between 5-HTTLPR and parenting behavior, as well as potentially elucidate other potential pathways influencing parenting behavior.

The following study limitations should be taken into account when considering the current findings. First, the relatively small sample of 113 parents and the unique characteristics of this sample (e.g., well-educated, higher than average marital adjustment) may not have yielded sufficient variation in the key parenting constructs. For example, we were unable to explore possible differential susceptibility and it is unclear how 5-HTTLPR and parenting behavior may be associated in samples who differ with respect to divorce status or marital adjustment, given their association with parenting behavior (Katz & Gottman, 1996; McHale, 1995; Sandler et al., 2012). Next, the highly structured laboratory setting and dyadic parent-child interactions may not accurately reflect parenting behavior in naturalistic settings. Repetti et al. (2012) present important considerations for the use of naturalistic approaches in understanding parenting behavior. Finally, measurement of personality traits was completed approximately 9 years prior to the observation of parenting behavior. While this temporal sequencing facilitates causal inferences, experiencing the birth of a child was significantly associated with mean-level changes in conscientiousness and marginally associated with changes in agreeableness (Specht et al., 2011). Given the likelihood of multiple major life events (including the transition to parenthood) occurring for the parents in the current study subsequent to their personality trait assessment at Time 1, an additional measurement of personality traits more proximal to Time 2 to account for possible mean-level or rank-order changes would have enhanced the validity of our personality measurement.

Despite these limitations, the current study meaningfully explored parental 5-HTTLPR as a biological determinant of parenting having incorporated fathers, use of multi-method assessment strategies, and stringent control of parental depression and negative child behavior. Despite lack of significant main and mediation effects, we provide several methodological considerations and directions for future studies on the biological determinants of parenting.

Study 2b, Table 18. *Point estimates, standard error, and 95% bias-corrected confidence intervals for indirect effects of parent personality traits on parenting behavior, s-dominant models.*

	Point Estimate	95% Bias-Corrected Confidence Intervals (k=5,000)	
		Lower Limit	Upper Limit
Parental Supportiveness			
Total	-0.01	-0.11	0.11
Neuroticism	-0.02	-0.07	0.11
Extraversion	0.002	-0.05	0.06
Agreeableness	-0.001	-0.09	0.03
Parental Intrusiveness			
Total	0.02	-0.11	0.15
Neuroticism	0.02	-0.04	0.13
Extraversion	0.005	-0.05	0.07
Agreeableness	-0.002	-0.10	0.05
Cognitive nurturance			
Total	-0.02	-0.17	0.07
Neuroticism	-0.01	-0.08	0.08
Extraversion	-0.01	-0.10	0.04
Agreeableness	-0.002	-0.09	0.03
Quality of assistance			
Total	0.01	-0.10	0.16
Neuroticism	0.004	-0.06	0.14
Extraversion	0.01	-0.04	0.10
Agreeableness	-0.002	-0.19	0.05
Parental Efficacy			
Total	0.0004	-0.08	0.39
Neuroticism	-0.02	-0.08	0.09
Extraversion	0.02	-0.04	0.12
Agreeableness	0.001	-0.05	0.07



Study 2b, Figure 6. Conceptual diagram showing total and direct effects, as well as specific indirect effects, of the number of 5-HTTLPR s-alleles on observed A) parental supportiveness, B) parental intrusiveness, C) cognitive nurturance, D) quality of assistance, and E) parental efficacy, with personality traits as mediators.

Significance levels: $^{*}p \leq 0.05$, $^{\dagger}p \leq 0.10$.

General Discussion

Given its central role in children's physical, socio-emotional, and academic development, parenting behavior is a significant public health concern (Baumrind, 1991; S. M. Lee et al., 2006; Loth et al., 2013; Wake et al., 2007; Wen & Hui, 2012; Zhou et al., 2002). Understanding the determinants of parenting behavior, particularly potential causal influences, is necessary to inform intervention and prevention efforts as well as child/family policy decisions. This dissertation evaluated the association of parental trait neuroticism, extraversion, and agreeableness with respect to individual differences in multi-method (i.e., observed, self-reported) parenting behavior. In two separate samples, this dissertation innovatively employed norm-referenced measures of parental personality traits and stringently controlled for parental depression: one sample consisted of families of school-aged children with and without ADHD and the second sample consisted of families of school-aged children from a prospective longitudinal study of marriage and family development. Several key methods facilitated comparisons between these two studies: first, all participants were recruited from the same metropolitan area in the western United States, consisted of similarly aged youth (i.e., children between the ages of 5-10 years), and employed identical measures of key constructs (e.g., gender-based T-scores from the NEO-FFI, Parenting Stress Index). However, the first sample was predominantly maternal with a larger proportion of male children (in part, due to specific sampling for children with ADHD), whereas the second sample comprised equal proportions of mothers and fathers as well as male and female firstborn children. Samples also crucially diverged in the assessment of parenting behavior (i.e., Alabama Parenting Questionnaire and Dyadic Parent-Child Interaction Coding System in the first sample compared to the Parent-Child Structured Interaction Qualitative Rating Scales from the NICHD Study of Early Child Care in the second sample). Thus, these two samples provided a useful, preliminary characterization of the association of parent personality traits and individual differences in positive and negative parenting behavior.

In the first half of the dissertation, we prosecuted the association of parental neuroticism, extraversion, and agreeableness with parenting behavior by examining these personality traits individually and simultaneously; we then additionally evaluated the potential moderating influences of parenting stress and negative child behavior in these predictive models. To review, parental extraversion was positively associated with observed positive parenting in the first sample, regardless of whether it was assessed individually or simultaneously with the other parental personality traits. However, when considered simultaneously alongside other traits, the independent association of parental extraversion with observed positive parenting was significant only when we controlled for parental depression. Given the covariation between parental depression and personality traits (Bagby et al., 1995), these findings underscore the importance of controlling for depression in future studies of personality traits. Individually or in combination with the other parental personality traits assessed, and with or without control of parental depression, there were no other main effects of parental neuroticism, extraversion, or agreeableness on observed parenting behavior in either sample. Although the initially non-significant association of parental neuroticism, extraversion, and agreeableness was somewhat surprising, given previous evidence (Prinzie et al., 2009), important methodological differences may underlie this pattern of divergent findings. First, although parenting behavior is separable into constructs such as warmth, behavioral control, and autonomy support (Skinner, Johnson, & Snyder, 2005), these constructs are operationalized differently across studies (Bornstein, Hahn, & Haynes, 2011; Koenig, Barry, & Kochanska, 2010), thus potentially resulting in variation across study outcomes. Additionally, variation in parenting behavior and attitudes associated with parental sex (Lindsey & Caldera, 2006), and racial/ethnic differences in parenting behavior and attitudes persist even after controlling for socioeconomic status (Hofferth, 2003). Unlike the racial-ethnic diversity and inclusion of fathers in the current study, the majority of previous studies consist of predominantly maternal and White participants. Thus, it may be possible that these findings may reflect methodological or sample-specific differences.

Next, we observed important differences in each sample based on how parental personality variables were defined (i.e., continuous personality trait T-scores compared to categorical levels of personality traits based on T-score cut-offs). With continuous personality trait T-scores, we did not observe any significant moderation by negative child behavior or parenting stress in the first sample; however, child negativity significantly moderated the association of neuroticism with observed parental supportiveness in the second sample. In contrast, when personality traits were based on categorical T-score cut-offs, there was no support for mediation by either child negativity or parenting stress in either sample examined. Furthermore, personality traits associated with observed parenting behavior differently, depending on the treatment of personality traits variables as continuous or categorical. One possibility is that parental personality traits may exert an influence on parenting behavior only within specific ranges; the emergence of significant differences in observed positive parenting behavior between parents with low and high levels of agreeableness only after personality traits were trichotomized and subject to extreme groups analyses alludes to such effects at extreme ranges of personality. Additionally, as discussed above, the categorization of parental personality traits would have simplified and arguably amplified the differences between groups at varying levels of each trait. Thus, the lack of significant findings with regard to moderation when parental personality traits were trichotomized is surprising. Overall, however, we reiterate that there are several benefits to utilizing continuous variables including maximizing the amount of information available for analyses (Selvin, 2004; L. P. Zhao & Kolonel, 1992), reducing the risk of model misspecification and inflated standardized effect sizes (Brunswik, 1955; Cortina & DeShon, 1998; Feldt, 1961; Pitts, 1993), and avoiding artificially-imposed limits on the data as well as any consequent assumptions about within-group homogeneity (Bennette & Vickers, 2012).

In the second half of the dissertation, we examined parental neuroticism, extraversion, and agreeableness as unique and collective mediators of the association of parental 5-HTTLPR

genotype with parenting behavior. As was the case in the first half of this dissertation, we observed mixed findings across the two samples: parental 5-HTTLPR s-allele genotype was inversely associated with observed negative parenting behavior but unrelated to observed positive parenting behavior in the first sample, and unrelated to each of the various indices of observed parenting behavior assessed in the second sample. Although these differences may reflect the measurement of different dimensions of parenting behavior, as well as the construct itself, these results also converge with the inconsistency with respect to the association of 5-HTTLPR and social behavior (Uher & McGuffin, 2010). Notably, despite a similar lack of main effects with regard to the influence of 5-HTTLPR on maternal sensitivity and harsh/punitive parenting, Sturge-Apple et al. (2012) found evidence of differential susceptibility in the context of interparental conflict x 5-HTTLPR interactions.

Finally, parental extraversion significantly mediated the association of 5-HTTLPR with self-reported parental involvement and self-reported positive parenting in the first sample, but there was no support for mediation with regard to observed parenting variables in either the first or second sample. In a meta-analysis of 54 studies examining the role of 5-HTTLPR in moderating the relationship between stress and depression, Karg et al. (2011) found that type of stress (i.e. chronic stressors) and method of stress assessment (i.e., objective ratings and in-person interviews) frequently influenced study outcomes. Although we specifically focused on parenting stress, we relied on self-reported ratings of parenting stress, which Karg et al. (2011) argue are less likely to support robust associations with respect to 5-HTTLPR. Interestingly, parental extraversion significantly mediated the association of 5-HTTLPR with self-reported but not observed indices of parenting behavior. As discussed above, the variation in findings as a function of the method of assessing parenting behavior may be related the predisposition of highly extraverted individuals to positive cues and events (Derryberry & Reed, 1994; Magnus et al., 1993) or cognitive biases inherent in self-report methods of assessment (Furnham & Henderson, 1982; Holtgraves, 2004; Morsbach & Prinz, 2006). In combination with previous

findings with regards to the importance of behavioral assessment methodology in studies of 5-HTTLPR (Karg et al., 2011), these results underscore the importance of multi-method measures and the need for systematic exploration of differences between methods in future studies of 5-HTTLPR and parenting behavior.

In conclusion, this dissertation highlighted the gaps in knowledge that remain with respect to psychological and biological correlates of human parenting behavior. It enhances existing studies of parental personality by implementing rigorous control of parental depression and negative child behavior, utilizing stringent gender-based normative measures of parental personality, and exploring theoretically salient moderators of the relationship between parental personality and parenting behavior. Additionally, this dissertation extended current knowledge with regard to the role of a polymorphism of the serotonin transporter gene in behavioral outcomes and bolsters the small but growing literature on biological determinants of human parenting behavior.

[i] Participants may be included in multiple categories, depending on the number of racial/ethnic groups they endorsed

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