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The Neuropsychological Underpinnings to Psychopathic Personality Traits in a Nationally Representative and Longitudinal Sample

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Abstract Although psychopathy is a major area of research in psychology and criminology, much remains unknown about its etiological underpinnings. Drawing on data from the National Longitudinal Study of Adolescent Health, the current study explored the association between neuropsychological deficits and psychopathic personality traits and produced three key findings. First, four neuropsychological deficits measures were consistently related to the measure of psychopathic personality traits both longitudinally and cross-sectionally. Second, neuropsychological deficits measures predicted variation in psychopathic personality traits for both males and females and the magnitude of the association between neuropsychological deficits and psychopathic personality traits did not vary as a function of gender. Third, parental socialization measures had relatively small and inconsistent effects on psychopathic personality traits. Suggestions for future research are offered.

Keywords Psychopathy · Neuropsychological deficits · Psychopathic personality · Neuropsychology

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Introduction

Psychopathy is a personality disorder usually marked by a range of affective, interpersonal, behavioral, and lifestyle traits, the most glaring of which are callousness, lack of empathy, shallow emotion, guiltlessness, and remorselessness [10, 26, 28]. Empirical research has revealed that measures of psychopathic traits are strong and consistent predictors of a wide range of antisocial and criminal behaviors (the literature currently views psychopathy as a continuously distributed disorder, thus we use the phrases psychopathic traits or psychopathic personality traits throughout. In addition, psychopathy is a more acute condition than Antisocial Personality Disorder which is specified in the DSM-IV). Indeed, there is accumulating evidence suggesting that psychopaths account for a disproportionate number of the most pathological, chronic, and serious violent offenders [1, 14, 58–60]. As a result, it is not surprising that some estimates suggest that psychopaths are 25 times more prevalent in prison populations than in the general population [26].

Given the robust link between psychopathic traits and antisocial behaviors, there is a strong research interest in trying to identify its underlying causes. Recent research examining the etiology of psychopathic personality traits has employed behavioral genetic research designs as a way to estimate the relative influence of genetic and environmental factors. The results of these studies, which were summarized in a recent meta-analysis, indicate that genetic factors account for about 49% of the variance in measures of psychopathic personality traits [61]. The remaining variance was attributable to nonshared environmental factors—that is, non-genetic factors that make siblings different from each other.

Although these behavioral genetic studies have been instrumental in underscoring the influence of both genetic and environmental factors in the etiology of psychopathic traits, they have not provided information as to the specific factors that are associated with the disorder. One factor, however, that is compatible with the results of the behavioral genetic studies is neuropsychological functioning. Neuropsychological functioning is largely the result of genetic factors [20, 54], but it has also been found to be affected by factors that fall under the rubric of nonshared environmental influences, such as prenatal environments, postnatal malnutrition, and accidental injuries. These and other environmental factors are also implicated in the etiology of psychopathic personality [5, 21, 22, 49]. For instance, Beaver and colleagues [5] discovered an association between prenatal exposure to cigarette smoke and household structure and psychopathic personality traits during adolescence. Overall, a sizeable body of empirical research has revealed that various measures of neuropsychological functioning are consistently related to measures of psychopathy, violent offending, and chronic criminality [43, 47, 64].

Concomitantly, a line of neuroimaging research has emerged examining the potential roles that neuropsychological functioning and brain structure have on the development of psychopathic personality traits. A number of studies assessed whether various measures of brain functioning and brain structure are associated with the disorder (e.g., [7, 32, 33]). Taken together, the results of these studies have provided evidence linking neuropsychological deficits to psychopathic personality [32, 50]. For example, in one study Raine et al. [51] found psychopaths (persons scoring 30 or more on the Psychopathy Checklist Revised (PCL-R; [27])) to have an 11% reduction in gray matter volume when compared to two control groups of non-psychopaths. Other studies have revealed structural and functional differences in the corpus callosum as well as the amygdala between the brains of psychopaths and non-psychopaths [8, 23, 52]. The available evidence thus suggests that neuropsychological deficits are associated with variation in psychopathic personality traits.

Current Focus

Despite the sizeable research linking neuropsychological deficits to psychopathic personality traits, there are three gaps in the extant literature that the current study will attempt to address. First, much of the literature examining the link between neuropsychological deficits and psychopathy has treated the disorder as a categorical trait as opposed to continuous traits and has employed psychopathy measures that are comprised of antisocial behavior assessment rather than "pure" personality assessment. The current study employs a continuous measure of psychopathic personality traits to examine whether the previously identified link between neuropsychological deficits and psychopathy will remain statistically significant. Second, the samples analyzed in previous research are not nationally representative thereby raising the question of whether the results would be generalizable to other samples. Unlike these previous studies, the current study employs a large, nationally representative sample of Americans to explore the potential link between neuropsychological deficits and psychopathic personality traits. Third, there is a paucity of research testing for an association between neuropsychological deficits and psychopathic personality traits for males and females. We address this gap in the literature by estimating all of the statistical models separately for males and females.

Method

Data and Participants

Data for this study were drawn from the National Longitudinal Study of Adolescent Health (Add Health; [57]). The Add Health is a four-wave prospective study comprised of a nationally representative sample of American youths who were enrolled in middle or high school during the 1994–1995 school year. A sample of 132 schools were selected and all students attending these schools were then administered a self-report survey. More than 90,000 students participated in the wave 1 in-school component of the study. Youths were asked a wide array of questions pertaining to their demographics, their social relationships, and their experiences at school. A subsample of adolescents was then selected to participate in the wave 1 in-home component to the study. The wave 1 in-home surveys were designed to ask more detailed questions and questions about issues that were sensitive in nature. For example, youths were asked about their involvement in acts of delinquency, their use of drugs and alcohol, and their sexual experiences. A total of 20,745 adolescents and 17,700 of their primary caregivers (usually their mother) participated in this part of the study [30].

The second wave of data was collected in 1996 when 14,738 of the participants were successfully reinterviewed. Since relatively little time lapsed between waves, most of the respondents were still adolescents. As a result, the questions included on the wave 2 survey instruments were very similar to those on the wave 1 surveys. The third round of interviews was completed in 2001–2002. Most of the respondents were young adults at wave 3 and thus the surveys were modified to include questions that were more age appropriate. For example, participants were asked about their employment history, their lifetime contact with the criminal justice system, and their marital status. Overall, 15,197 respondents participated in the wave 3 component of the study [30]. The fourth and final wave of data was collected during 2007–2008 when the Add Health subjects were between the ages of 24 and 32 years old. Questions asked to the respondents were wide and varied and included

topics related to family life, educational history, as well as questions designed to measure personality. A total of 15,701 participants were successfully interviewed at wave 4.

Measures

Outcome Measure

Psychopathic Personality Traits

During wave 4 interviews, respondents were asked a series of thirty questions that were drawn from instruments that were originally designed to measure personality traits derived from the five factor model (FFM). We build on prior research [36] and use a subset of these items to create a measure that reflects the FFM conceptualization of psychopathic personality traits. The creation of the psychopathic personality traits scale followed a number of steps. First, we identified a pool of questions that overlapped with items that have been used in previous research [15, 25, 36]. Second, we then factor analyzed the items and any that did not load together were deleted from the scale. Third, we estimated the internal reliability of the items via Cronbach's alpha. Any items that significantly reduced the internal consistency were removed from the scale. After this process was completed, a total of 23 items remained that measured various elements of psychopathic personality traits. For example, respondents were asked whether they sympathize with others' feelings, whether they get angry easily, and whether they feel others' emotions. Responses to all items were originally coded as follows: 1 = strongly agree, 2 = agree, 3 = neither agree nor disagree, 4 = disagree, and 5 = strongly disagree. However, some of the items were reverse-coded so that higher scores on all of the items reflected more psychopathological tendencies. Responses to the items were then summed together to create the psychopathic personality traits scale ($\alpha = .81$). See Appendix for a complete listing of all the items included in this scale.

Neuropsychological Measures

Peabody Picture Vocabulary Test (PPVT)

Some of the most widely used protocols to evaluate neuropsychological deficits are standardized tests that measure individual variation in verbal skills [38, 41, 46]. In the Add Health data, verbal abilities were assessed with a modified version of the Peabody Picture Vocabulary Test (PPVT). Prior research has examined the psychometric properties of the PPVT and found it to be a valid and reliable way to assess variation in verbal skills and receptive vocabulary [13, 16]. The PPVT was administered to participants during wave 1 interviews and again during wave 3 interviews. The PPVT scores were originally coded such that higher values reflected more verbal skills. In the current study, the PPVT was reverse-coded (in the multivariate models) so that higher scores corresponded to more neuropsychological deficits.

Number Recall Test

During wave 4 interviews, participants also were administered a number recall test. In this test, respondents were asked to listen to a string of numbers and then asked to repeat them

in the reverse order from which they were originally read. The string of numbers became progressively longer at each level (up through seven levels) and respondents were provided with two chances to accurately recall the digit strings in reverse order. The final score represented the highest level achieved. Scores on the number recall test were then reverse coded such that higher scores reflect more neuropsychological deficits. Prior research has revealed that tests designed to measure number recall/memory provide one way to quantify neuropsychological deficits [41, 42, 45, 53].

Word Recall Test

Add Health respondents also completed a word recall test during wave 4 interviews. For this test, the respondent was instructed to listen carefully to a list of 15 words that would be read aloud by the interviewer. They were also instructed that they would be asked to repeat as many of the words as possible (in any particular order) after the list was read. Immediately after the last word was read, the respondent was asked to repeat as many as the words as they could remember during a 90-s time frame. The value on the word recall test indexes the total number of words that the respondent accurately remembered. Scores on this test were then reverse coded such that higher values correspond to more neuropsychological deficits. Prior research has revealed that tests measuring word recall/memory are reliable and valid instruments to measure neuropsychological deficits [41, 42, 45, 53].

Composite Neuropsychological Deficits

A composite neuropsychological deficits measure was also created by combining together scores on the two PVT scales, the number recall test, and the word recall test. Prior to summing them together, the four individual neuropsychological deficits measures were standardized. After they were standardized, they were added together to create a composite neuropsychological deficits profile. Higher scores on this composite measure represent more neuropsychological deficits.

Socialization Measures

Maternal Involvement

There is some evidence indicating that children who have parents who are uninvolved are at risk for displaying antisocial tendencies [34, 48]. To address this possibility, we included a ten-item maternal involvement index. During wave 1 interviews, youths were presented with a list of ten different activities and were asked to report which ones they had done with their mother during the previous month. Youths, for instance, were asked whether they had gone shopping with their mother, whether they had played a sport with their mother, and whether they had worked on a project for school with their mothers. Each item was coded dichotomously (0 = no, 1 = yes). In line with previous research [12], the responses were summed together to create the maternal involvement index ($\alpha = .55$).

Maternal Attachment

Adequate levels of parental attachment are needed for children and adolescents to develop normally [24, 34]. To examine whether maternal attachment is also related to the

development of adulthood psychopathy, we included a two-item maternal attachment scale that has been used previously [55]. During wave 1 interviews, adolescents were asked to indicate how close they feel to their mothers and how much they think their mothers care about them. These two items were summed together to create the maternal attachment scale ($\alpha = .64$), where higher values reflect more maternal attachment.

Maternal Disengagement

Adolescents who are raised by cold, withdrawn, and detached parents are at risk for displaying signs of violence and aggression [18, 19]. As a result, we included a five-item maternal disengagement scale that has been used previously [2]. During wave 1 interviews, adolescents were asked to report how warm and loving their mother was, how much they talk with their mother, and the overall quality of their relationship with their mother. Responses to the items were then summed together to create the maternal disengagement scale ($\alpha = .84$), where higher values represent more maternal disengagement.

Parental Permissiveness

Parents who fail to monitor and supervise their children are at risk for raising children and adolescents who engage in antisocial behavior [19, 24, 35]. To take this finding into account, we included a seven-item parental permissiveness scale. During wave 1 interviews, adolescents were asked whether their parents allow them to make their own decisions about their curfews, about what they eat, about their bedtime, and about their friends. Responses to these items were coded dichotomously (0 = no, 1 = yes). In line with previous research, the responses to these items were summed together to create the parental permissiveness scale ($\alpha = .63$).

Delinquent Peers

To examine whether peer socialization is related to adulthood psychopathy, a three-item delinquent peers scale was included in the analyses. During wave 1 interviews, youths were asked to indicate how many of their three best friends smoke at least one cigarette per day, use marijuana more than once per month, and consume alcohol at least once per month. The response code for these three items was as follows: 0 = zero friends, 1 = one friend, 2 = two friends, and 3 = three friends. Responses to the items were added together to create the delinquent peers scale ($\alpha = .76$). This scale has been used by previous researchers analyzing the Add Health data [3, 6].

Neighborhood Disadvantage

Adolescents who are reared in disadvantaged neighborhoods are at risk for a range of maladaptive and antisocial outcomes. As a result, we included a three-item neighborhood disadvantage scale in the analyses. During wave 1 interviews, the primary caregiver was asked to indicate whether litter and trash is a big problem in their neighborhood, whether drug dealers and drug users are a big problem in their neighborhoods, and whether they would like to move away from their neighborhood. Responses to these three items were summed together to create the neighborhood disadvantage scale ($\alpha = .66$). Higher scores on this scale indicate more neighborhood disadvantage.

Control Variables

Low Birth Weight

Low birth weight has been found to be associated with a range of antisocial outcomes [53, 56] and it has also been found to be associated with neuropsychological deficits [62]. As a result, we included a low birth weight variable in the analysis. Following prior research [41], this variable was coded dichotomously, where 0 = a birth weight >5.5 lb and 1 = a birth weight ≤5.5 lb.

Race

To control for the potentially confounding effects of race, we included a dichotomous dummy variable measuring the respondent's self-reported race. If the respondent reported that they were Caucasian, non-Hispanic they were assigned a "0"; otherwise, they were assigned a value of "1."

Age

To help rule out the possibility that any significant results were being driven in part by the respondent's age, we included a one-item measure of age in all of the analyses. Age was included as a continuous variable measured in years.

Analysis

The analysis for this study proceeded in three steps. First, we examined whether neuropsychological deficits were associated with scores on the psychopathic personality traits scale using ordinary least squares (OLS) regression. To do so, four different equations were estimated: one for each of the individual neuropsychological deficits measures (i.e., wave 1 PVT, wave 3 PVT, number recall test, and word recall test). All of these equations included the socialization measures along with the control variables. Second, the association between the composite neuropsychological deficits scale and psychopathic personality traits was examined by once again calculating OLS regression models. To help clarify the effect size, the psychopathy scale and the composite neuropsychological deficits scale were transformed into z-scores and the predicted values for the psychopathic personality traits scale were plotted against different scores on the composite neuropsychological deficits scale. Third, because antisocial behavior and psychopathic personality traits vary significantly between males and females [17], we examined whether there were statistically significant mean differences across the measures. As Table 1 reveals, mean scores on most of the scales differed significantly between males and females. As a result, all of the models were estimated separately for males and females. Note that the neuropsychological deficits measures are not reverse coded in Table 1; the means for these variables are preserved with their original coding to make them more easily interpretable.

Table 1 Mean differences between males and females on selected add health study variables

	Mean for males	Mean for females	*t*-value
Psychopathic personality traits	53.98	54.59	4.12*
Wave 1 PVT	99.28	97.87	6.37*
Wave 3 PVT	100.96	99.84	4.03*
Number recall test	4.20	4.12	2.99*
Word recall test	6.33	6.88	17.37*
Maternal involvement	3.59	4.23	24.08*
Maternal attachment	9.45	9.29	10.19*
Maternal disengagement	8.86	9.26	7.97*
Parental permissiveness	5.15	5.16	0.66
Delinquent peers	2.67	2.43	6.53*
Neighborhood disadvantage	4.63	4.65	0.84
Low birth weight	0.08	0.10	5.10*
Race	0.37	0.38	1.67
Age	16.23	16.07	6.52*

* $P < .001$

Results

The analysis began by examining the association between neuropsychological deficits and psychopathic personality traits for males. Table 2 presents the results of these models. In this table, the columns indicate which neuropsychological deficits measure is included in that particular model. The first row of the table displays the coefficient corresponding to the neuropsychological measure in that equation. As the first column reveals, there is a statistically significant and positive association between scores on the wave 1 PVT and scores on the psychopathic personality traits scale. The only other two variables to emerge as being associated with psychopathic personality traits are maternal disengagement and delinquent peers, both of which maintain positive associations with psychopathy. A very similar pattern of results is observed for the other three neuropsychological deficits measures—that is, they all maintain positive and statistically significant associations with psychopathic personality traits, with all of the effect sizes being approximately the same. In contrast to the first model, the neighborhood disadvantage scale surfaces as a significant predictor of psychopathic personality traits in these last three models.

The next statistical models presented in Table 3 are duplicates of the ones in Table 2 except that the sample of females is analyzed instead of males. Across all four of the models four of the socialization measures are consistent predictors of adulthood psychopathic personality traits. Specifically, maternal involvement is associated with lower scores on the psychopathic personality traits scale, whereas maternal disengagement, delinquent peers, and neighborhood disadvantage are all associated with higher scores on the psychopathic personality traits scale. Of particular interest, however, are the effects of the neuropsychological deficits measures. In line with the results garnered with the male sample, all four of the neuropsychological deficits measures maintain a statistically significant and positive association with scores on the adulthood psychopathic personality traits scale.

Table 2 The association between neuropsychological deficits and psychopathic personality traits for males

	Wave 1 PVT		Wave 3 PVT		Number recall test		Word recall test	
	b	*β*	*b*	*β*	*b*	*β*	*b*	*β*
Neuropsychological deficit	.11	.16*	.09	.14*	.86	.14*	.63	.13*
	(.01)		(.01)		(.09)		(.07)	
Maternal involvement	−.21	−.04	−.21	−.04	−.24	−.05*	−.24	−.05*
	(.07)		(.08)		(.07)		(.07)	
Maternal attachment	−.26	−.03	−.28	−.03	−.24	−.02	−.29	−.03
	(.16)		(.19)		(.16)		(.16)	
Maternal disengagement	.20	.07*	.19	.06*	.18	.06*	.17	.06*
	(.05)		(.06)		(.05)		(.05)	
Parental permissiveness	−.11	−.02	−.16	−.03	−.18	−.03	−.19	−.03
	(.09)		(.10)		(.09)		(.09)	
Delinquent peers	.28	.08*	.29	.08*	.28	.08*	.29	.08*
	(.05)		(.06)		(.05)		(.05)	
Neighborhood disadvantage	.25	.04	.38	.06*	.30	.05*	.32	.05*
	(.09)		(.10)		(.09)		(.09)	
Low birth weight	.96	.03	.81	.02	.70	.02	.78	.02
	(.50)		(.54)		(.49)		(.49)	
Race	−.92	−.05	−.86	−.04	−.41	−.02	−.34	−.02
	(.30)		(.33)		(.29)		(.29)	
Age	−.15	−.03	−.08	−.01	−.11	−.02	−.12	−.02
	(.09)		(.10)		(.09)		(.09)	
N	4,763		3,969		4,974		4,964	

* $P < .001$

Last, we examined the association between the composite neuropsychological deficits scale and psychopathic personality traits for males and females. To do so, both of the scales were transformed into z-scores and the association between them was estimated using OLS regression and controlling for all of the variables/scales that were included in Tables 2 and 3. The predicted scores on the psychopathic personality traits scale were then plotted against various scores on the composite neuropsychological deficits scale. The results are presented in Fig. 1. As can be seen, there is a relatively moderate increase in psychopathic personality traits scores as scores on the neuropsychological deficits scale increase. To put the results in context, males who score 3 standard deviations below the mean on the composite neuropsychological deficits scale score, on average, .71 standard deviations below the mean on the psychopathic personality traits scale. In contrast, males who score 3 standard deviations above the mean on the composite neuropsychological deficits scale score, on average .61 standard deviations above the mean on the psychopathic personality traits scale. Similar effects are detected for females. For example, females who score 3 standard deviations below the mean on the composite neuropsychological deficits scale score, on average, .57 standard deviations below the mean on the psychopathic personality traits scale. In contrast, females who score 3 standard deviations above the mean on the composite neuropsychological deficits scale score, on average, .63 standard deviations above the mean on the psychopathic personality traits scale.

Table 3 The association between neuropsychological deficits and psychopathic personality traits for females

	Wave 1 PVT		Wave 3 PVT		Number recall test		Word recall test	
	b	*β*	*b*	*β*	*b*	*β*	*b*	*β*
Neuropsychological deficit	.08	.13*	.08	.13*	.56	.09*	.50	.11*
	(.01)		(.01)		(.08)		(.05)	
Maternal involvement	−.31	−.07*	−.31	−.07*	−.33	−.07*	−.33	−.06*
	(.06)		(.07)		(.06)		(.13)	
Maternal attachment	−.12	−.02	−.11	−.02	−.05	−.01	−.04	−.01
	(.13)		(.14)		(.13)		(.13)	
Maternal disengagement	.21	.09*	.22	.09*	.21	.09*	.21	.09*
	(.04)		(.05)		(.04)		(.04)	
Parental permissiveness	−.18	−.03	−.19	−.03	−.28	−.05*	−.28	−.05*
	(.09)		(.09)		(.08)		(.08)	
Delinquent peers	.27	.08*	.28	.08*	.28	.08*	.29	.08*
	(.05)		(.05)		(.05)		(.05)	
Neighborhood disadvantage	.37	.06*	.43	.07*	.44	.07*	.41	.07*
	(.08)		(.09)		(.08)		(.08)	
Low birth weight	.81	.03	1.05	.04	.87	.03	.86	.03
	(.40)		(.43)		(.39)		(.39)	
Race	−.10	−.01	−.11	−.01	.34	.02	.24	.01
	(.27)		(.28)		(.25)		(.25)	
Age	−.14	−.03	−.10	−.02	−.13	−.02	−.13	−.02
	(.08)		(.08)		(.07)		(.07)	
N	5,533		4,814		5,747		5,745	

* $P < .001$

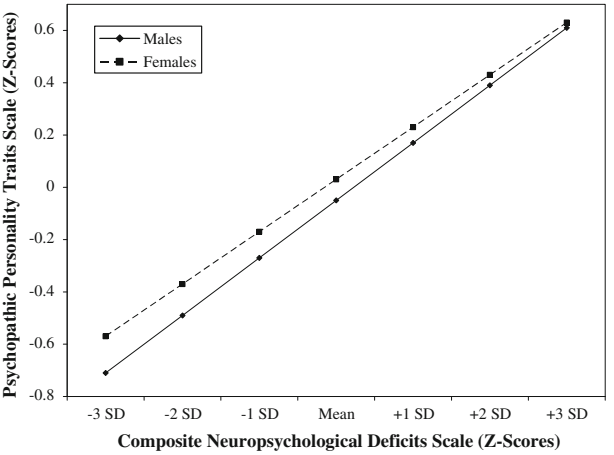

Fig. 1 The association between the composite neuropsychological deficits scale and psychopathic personality traits for males and females. *Note*: All other variables/scales set at their mean

Discussion

Given the vast amount of destruction that psychopaths inflict on society, there is a strong interest in trying to identify the potential causes of psychopathic personality traits. The current study sought to add to this body of research by examining the association between neuropsychological deficits and psychopathic personality traits. Analysis of data drawn from the Add Health—a large prospective and nationally representative sample—revealed three broad findings. First, and consistent with expectations, all four of the neuropsychological deficits measures were consistently related to the measure of psychopathic personality traits. Recall that the statistical models were estimated both longitudinally as well as cross-sectionally. The longitudinal models spanned more than 10 years of human development, wherein measures of neuropsychological deficits measured in adolescence predicted variation in psychopathic personality traits in adulthood. The ability of neuropsychological deficits to predict psychopathic personality traits so far into the future further underscores the robustness of this association.

The second key finding to emerge from the analyses was that the neuropsychological deficits measures predicted variation in psychopathic personality traits for both males and females. Supplemental analyses (not presented) revealed that the effect sizes of the neuropsychological deficits measures were not significantly different between males and females, meaning that the magnitude of the association between neuropsychological deficits and psychopathic personality traits did not vary as a function of gender. These results are in line with other research indicating that the etiology of antisocial traits and behaviors for males and females follow similar developmental pathways [44]. However, given that males are much more likely than females to engage in serious violent criminal behaviors [11, 17], future research should begin to explore in greater detail the potential factors that might explain male–female differences in the criminal behaviors that emanate from psychopathic personality traits.

The third main finding of the current study was that the parental socialization measures had relatively small and inconsistent effects on psychopathic personality traits. For example, the only measure to predict variation in psychopathic personality traits for males was maternal disengagement, while for females both maternal attachment and maternal disengagement were related to scores on the psychopathic personality traits scale. Caution should be exercised in interpreting these associations as causal for at least two main reasons. First, we did not control for genetic factors that are shared between parents and their children. As a result, it is possible that the observed effects would be rendered spurious had we controlled for genetic factors [29, 63]. Second, we did not control for child-driven effects and so the causal direction could be from child-to-parent instead of from parent-to-child [4, 9]. While we did lag the socialization measures, it is quite likely that psychopathic personality traits remain relatively stable [39]. If that is the case, then the observed association could still be the result of a child-driven effect despite the fact that the models were estimated longitudinally. Overall, however, the small effects of the parental socialization measures should not be surprising given that behavioral genetic studies have revealed that shared environmental effects tend to be near zero in the etiology of psychopathic personality traits. Whether these socialization measures could be conceptualized as salient nonshared environments remains an open empirical question awaiting future investigation.

The results of our study provide additional evidence linking neuropsychological deficits to psychopathic personality traits. Nonetheless, these results need to be interpreted with caution due to a number of limitations. First, the items used to create the psychopathy scale were not originally designed to measure variation in psychopathic personality traits but instead the broad structure of personality. Previous research on conceptualizing psychopathy as a continuous

dimension within the five factor model paradigm, however, has shown that these types of measures provide relatively reliable and valid assessments of individual variation in psychopathy [31, 37]. These measures also have the advantage of not using items that directly assess antisocial behavior thus avoiding the tautological processes. Second, given that the sample was drawn from a non-clinical population, it is likely that relatively few chronic, violent psychopathic offenders were included in the analyses. What this necessarily means is that the results generated in this study may not be generalizable to clinical samples or to samples that include large numbers of violent psychopaths. Third, the neuropsychological measures were indirect measures of neuropsychological functioning, not direct ones. Although previous research has advocated the use of these scales to measure neuropsychological functioning [38, 41, 46], ideally we would have employed brain imaging techniques to assess neuropsychological functioning. Replication studies are needed to address these limitations to determine the robustness of our results across different samples, different research designs, and different measures of psychopathic personality traits.

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Appendix: Items included in the psychopathy scale

1. I sympathize with others' feelings
2 I get angry easily
3. I am not interested in other people's problems
4. I often forget to put things back in their proper place
5. I am relaxed most of the time
6. I am not easily bothered by things
7. I rarely get irritated
8. I talk to a lot of different people at parties
9. I feel others' emotions
10. I get upset easily
11. I get stressed out easily
12. I lose my temper
13. I keep in the background
14. I am not really interested in others
15. I seldom feel blue
16. I don't worry about things that have already happened
17. I keep my cool
18. I go out of my way to avoid having to deal with problems in my life
19. When making a decision, I go with my 'gut feeling' and don't think much about the consequences of each alternative
20. I live my life without much thought for the future
21. Other people determine most of what I can and cannot do
22. There are many things that interfere with what I want to do
23. There is really no way I can solve the problems I have

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