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ABSTRACT

Origins of Adulthood Personality: The Role of Adverse Childhood Experiences[1]

We test whether adverse childhood experiences – exposure to parental maltreatment and its indirect effect on health – are associated with age 30 personality traits. We use rich longitudinal data from a large, representative cohort of young US Americans and exploit differences across siblings to control for the confounding influences of shared environmental and genetic factors. We find that maltreatment experiences are significantly and robustly associated with neuroticism, conscientiousness, and openness to experience, but not with agreeableness and extraversion. High levels of neuroticism are linked to sexual abuse and neglect; low levels of conscientiousness and openness to experience are linked to parental neglect. The estimated associations are significantly reduced in magnitude when controlling for physical or mental health, suggesting that adolescent health could be one important pathway via which maltreatment affects adulthood personality. Maltreatment experiences, in combination with their health effects, explain a significant fraction of the relationship between adulthood conscientiousness and earnings or human capital. Our findings provide a possible explanation for why personality traits are important predictors of adulthood labor market outcomes.

JEL Classification:	J24, J13, I0
Keywords:	human capital, noncognitive skills, Big Five personality traits, adverse childhood experiences, maltreatment, Add Health, siblings-fixed effects

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1. Introduction

Human capital is one of the most important determinants of an individual's long-term economic productivity and health. Traditionally, human capital has been proxied by measures of achievement test scores, years of schooling, or the type of post-secondary qualification. In recent years, however, economists have suggested that personality traits, sometimes referred to as non-cognitive skills (NCS), soft skills, or character traits, are an important alternative form of human capital (Almlund et al., 2011). Although numerous proxies for adulthood personality traits have been considered in the literature, the Big Five personality traits are one of the most widely used (e.g. Mueller & Plug, 2006; Heineck & Anger, 2010; Heckman and Kautz, 2012; Fletcher, 2013; Lundberg, 2013; Cameron et al., 2014; Gensowski, 2014).

In this study we explore the factors that shape the Big Five personality traits between childhood and young adulthood for a large, representative US population. Specifically, we seek to shed light on the long-term personality effects of early childhood adversity related to poor parenting behavior such as abuse and neglect, and explore the potential mechanisms via which maltreatment could affect personality development. By studying children's exposure to maltreatment, our study distinguishes itself from, but contributes to an emerging literature on the economics of human development that seeks to better understand the production function of personality traits in childhood, a literature which focuses mainly on the role of positive parenting behaviors (e.g. educational investments), the education sector, and income. Our findings could be useful for researchers to better interpret the productivity-boosting effects of adulthood personality traits, and to policy makers who are concerned about windows of opportunity to shape personality traits through the education and family policy.

Our analysis relies on the finding that personality traits are not exclusively influenced by genetic predisposition. Even though a strong genetic component has been shown, at least

50% of the variation in personality traits can be attributed to personal experiences (Turkheimer, 2000; Turkheimer et al., 2003; Krueger et al., 2008; Borkenau et al., 2011). Psychologists have suggested that variations in adulthood personality may have their origins in childhood experiences associated with exposure to specific parenting styles (Eisenberg et al., 2014 on conscientiousness) and health problems (Caspi & Roberts, 2001; Caspi et al., 2005). In this study, we therefore focus our attention on adverse childhood experiences in the form of exposure to care-giver maltreatment, and their effect on adolescent mental and physical health.

Children who have experienced abuse and neglect are at increased risk for a number of problematic developmental outcomes, including learning problems, problems relating to peers, internalizing symptoms, and externalizing symptoms (Petersen & Feit, 2014 for a review). As adults, these children are more likely to suffer physical health problems, to engage in risky behaviors (Felitti et al., 1998, Widom et al., 2012), and to develop mood disorders (Kaufman et al., 2004, Fletcher, 2009, Widom et al., 2012) and psychopathologies (Putnam, 2006; Spila et al., 2008; Tyrka et al., 2009; Widom et al., 2009; Clark et al., 2010); they are also more likely to be involved in criminal activity (Currie & Tekin, 2012), which is consistent with the observation that children with maltreatment experiences are often impaired in their prosocial and ethical behavior development (Koenig et al., 2004). . It is for these reasons that we hypothesize that maltreatment experiences influence an individual's development of "enduring patterns of thoughts, feelings, and behaviors" (Roberts et al., 2006, p. 1) which define personality traits. A recent study by Hengartner et al. (2015) emphasized the importance of the link, but concluded that it is a highly "understudied field" (p. 1).

To investigate the long-term impact of maltreatment on personality, we use longitudinal data from a US American cohort study (Add Health) that followed cohort members' health trajectories from early adolescence into young adulthood. We estimate the

relationship between adverse childhood experiences and responses to an adulthood personality questionnaire that was collected years after the exposure to (before age 12) and report of (around age 22) adversity. The dataset has the advantage that it contains information on maltreatment and personality for siblings, which we exploit in our empirical framework to control for some of the confounding factors that may bias the treatment effects of interest (Bound & Solon, 1999, Conley et al., 2007, Moffit et al., 2011). We further explore whether adolescence health trajectories - that were reported between ages 15 and 22 - mediate the effect of childhood maltreatment on personality. Finally, we assess the extent to which the estimated relationship between adulthood personality and adulthood earnings (e.g. Fletcher, 2013) and educational attainment (e.g. Lundberg, 2013) is reduced when controlling for adverse childhood experiences.

2. Literature Review

A number of different personality inventories have been developed by psychologists, but the Five-Factor Model is broadly accepted as a meaningful and consistent construct for describing human differences by psychologists (McCrae and Costa, 2008).[2] Personality psychologists have demonstrated strong links between the Big Five personality traits and occupational choice (Filer, 1986), job performance (e.g. Judge et al., 1999), academic achievement (Poropat, 2009), or healthy lifestyles (e.g. Hampson et al., 2006; Roberts et al., 2007). Various studies have established that low levels of neuroticism and high levels of conscientiousness promote both physical and mental wellbeing (Goodwin & Friedman,

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[2]The American Psychological Association Dictionary (2007) describes these as follows: 1. Openness to experience (Intellect)—The tendency to be open to new aesthetic, cultural, or intellectual experiences. 2. Conscientiousness—The tendency to be organized, responsible, and hardworking. 3. Extraversion—An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience; characterized by positive affect and sociability. 4. Agreeableness—The tendency to act in a cooperative, unselfish manner. 5. Neuroticism (vs. Emotional stability)—A chronic level of emotional instability and proneness to psychological distress.

2006), and life expectancy is associated with youth conscientiousness (Kern & Friedman, 2008; Kern et al., 2009).

Economists have added to this literature by showing that emotional stability and openness to experience are strongly associated with labor market earnings (e.g. Muller & Plug, 2006, Heineck & Anger, 2010, Fletcher, 2013), even for highly-talented people (Gensowski, 2014). Both high levels of youth conscientiousness and openness to experience increase the probability to obtain a university degree (Lundberg, 2013, Schurer et al., 2015), while conscientiousness and emotional stability are associated with high performance on cognitive ability tests (Borghans et al., 2011).

What factors shape adulthood personality traits beyond genetic disposition is less well researched. Earlier work contended that individuals are born with a fixed temperament and changes between childhood and adulthood occur deterministically, a process often referred to as maturation (for an overview, see McCrae and Costa, 2000). The path dependency between childhood temperament and adulthood personality has been demonstrated multiple times (e.g. Caspi & Silva 1995, Caspi et al., 2003, Deal et al., 2005, Asendorpf et al., 2008, McAdams & Olson, 2010, Moffitt et al., 2011). The earlier work on the Five Factor Model also assumed that personality traits stabilize in young adulthood, but more recent evidence has shown that adulthood personality traits may even change beyond the age of 50 (Roberts et al., 2008; Fraley & Roberts, 2005, Roberts & DelVecchio, 2000, Roberts.et al., 2006; Roberts & Mroczek, 2008). Some studies focus on the impact of social roles (Roberts et al., 2005), life events experienced in adulthood (Specht et al., 2011, Cobb-Clark and Schurer, 2012, Luhmann et al., 2014) or adolescence (Elkins et al., 2017), secondary schooling (Dahmann and Anger, 2014), or tertiary education (Lüdtke et al., 2011, Schurer et al., 2015).

Traditionally, the role of the environment in which an individual grew up was not considered relevant, but in recent years the role that parents play in the personality formation

process has been acknowledged (e.g. Eisenberg et al., 2014). An emerging literature in the economics of human development explores the importance of positive parenting behaviors - such as educational investments and parenting styles - as inputs in the human capital formation process (see Cobb-Clark et al., 2016 for a theoretical discussion). Most of the work focuses on the development of the cognitive and non-cognitive skills of children (e.g. Cunha and Heckman, 2008; Cunha et al., 2010; Del Bono et al., 2014; Attanasio et al., 2015). Yet, little empirical research has been conducted on the effect of negative parenting behaviors - when parents fail to help their children to regulate their physiology and behavior in the early years of life - on personality development. This failure is often summarized as maltreatment and comprises sexual, psychological, or physical abuse or neglect. Abuse refers to active harm through inappropriate or aggressive behavior, whereas neglect refers to a lack of attention to the basic needs of a child.

There are many pathways via which maltreatment experiences may impact on adulthood personality. Foremost, maltreatment has a direct effect on the development of the brain. Several studies have shown the biological brain differences between maltreated and non-maltreated children (see Petersen & Feit, 2014 for references). These include differences in the areas of the brain which are involved in higher-order cognitive processes – executive function – that aid in the monitoring and control of emotions and behavior (prefrontal cortex) and the formation and storage of memories associated with emotional events (amygdala). Some argue that the personality trait conscientiousness measures executive function, while neuroticism emotional instability and urgency (e.g. Kern et al., 2009). This would suggest that maltreated children would show lower levels of conscientiousness and higher levels of neuroticism early in life, facets of a child's temperament that may have the potential to mature into fixed adulthood traits.

Childhood maltreatment experiences could be linked with adulthood personality traits because their extreme manifestations proxy behavioral or emotional problems that were triggered by those experiences. The psychological literature has demonstrated a significant link between maltreatment and childhood temperament problems (Perry et al., 1999) and the onset of a personality disorder (see Galaif et al., 2001, Spila et al., 2008, Tyrka et al., 2009). While personality traits are distinct from personality disorders, there is now a considerable body of research that understands personality disorders as maladaptive and/or extreme variants of the Five Factor Model personality structure (Widinger & Trull, 2007, Krueger & Eaton, 2010, Trull & Widiger, 2013). Samuel & Widinger (2008) and Widinger et al. (2005), who successfully mapped Axis II disorders into maladaptive variants of the 30 facets of the Five Factor Model, showed that dependent and avoidant personality disorders and borderline syndrome correlate strongly with depressive and self-conscious facets of neuroticism, obsessive-compulsive disorder correlates with conscientiousness, and schizoid personality disorder correlates with extraversion.

Alternatively, maltreatment could directly affect the mental and physical health of children and adolescents, and that it is the experience of persistent health problems that influences personality development. The evidence is ample that maltreated children tend to have a higher risk of suffering from internalizing or externalizing problems, heightened anxiety, and emotional reactivity. Victims of sexual abuse are also more likely to suffer from attention and learning difficulties (e.g. Koenen et al., 2003, Krueger et al., 2008). Consistent with suggestions made by Caspi & Roberts (2001) and Caspi et al. (2005) that adulthood personality differences may be preceded by childhood health problems, we would expect maltreatment to influence adulthood personality via its effect on health.

Finally, maltreatment experiences and adulthood personality may just be correlated because they have the same underlying causes. For instance, sustained experiences of poverty

and environmental stressors may cause independently both parents to neglect their children and personality development. These factors may also shape independently cognitive ability, physical or mental health, health behaviors, and adulthood socioeconomic status. This is a selection effect that needs to be controlled for to establish whether maltreatment leads to long-term personality problems.[3]

To the best of our knowledge, we are the first to explore in detail the relationship between adulthood personality traits and parenting-related adverse childhood experiences. The only exception is Hengartner et al. (2015), who show strong unadjusted associations between adulthood personality traits and self-reported maltreatment experiences (emotional, physical and sexual abuse and neglect) for 1170 subjects from a population–based community survey. The authors emphasize that the relationship between personality traits and maltreatment is a highly "understudied field" (Hengartner et al., 2015, p. 1).

We improve upon Hengartner et al. (2015) in four ways: (1) We conduct our analysis with data on a nationally representative cohort; (2) We are able to control for a large set of confounding factors including poverty, peers, and genetic disposition that are shared between siblings; (3) We are able to comment on the potential pathways via which adverse childhood experiences impact upon adulthood personality, under the assumption that we adequately control for other factors that influence maltreatment, personality, and mediators; and (4) Although also self-reported, our measures of maltreatment were collected 12 years before the personality traits were assessed.

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[3] It is possible that parenting styles in general are the consequence of a child's temperament, which means that parents adjust their parenting styles to the child's needs and temperament (e.g. Deal et al., 2005). Because of this simultaneity of parenting, temperament, and health, modelling the effect of parenting behavior is empirically challenging. Some studies exploited birth-order – an exogenous variation in differential parental treatment - to test whether parenting behavior affects adulthood personality, but find little evidence in favor of it (e.g. Marini & Kurtz, 2011; Sulloway, 1996). Research on China's One-Child Policy (OCP), a natural institutional experiment that led to concentrated attention on one child by all caretakers, found that children born just after the introduction of the OCP in 1979 tended to be less conscientious, more neurotic, and less optimistic than children born just before (Cameron et al. 2013).

3. Data: National Longitudinal Study of Adolescent Health

The data in this study come from the confidential version of the National Longitudinal Study of Adolescent Health (Add Health). Add Health, one of the most comprehensive surveys of adolescents ever undertaken, is a school-based, longitudinal study of the health-related behaviors of adolescents and their outcomes in young adulthood (Udry, 2003). Beginning with an in-school questionnaire administered to a nationally representative sample of students in grades 7 through 12 in 1994-95 (Wave 1: mean age 15), the study followed up with a series of in-home interviews of students approximately one year (Wave 2 in 1996: mean age 16), six years (Wave 3 in 2001/2002: mean age 22), and 12 years later (Wave 4 in 2007/2008: mean age 29).

Other sources of data include questionnaires for parents, siblings, fellow students, and school administrators. By design, the Add Health survey included a sample stratified by region, urbanicity, school type, ethnic mix, and size. Pre-existing databases (e.g. census data) have been linked with the individuals in the sample and provide information about neighborhoods and communities. Of the 20,745 students surveyed during Wave 1, nearly 15000 (75%) have been followed longitudinally in the Wave 4 survey. For 52% or 10,693 individuals of the Wave 1 sample we have personality data from Wave 4 and maltreatment information from Wave III available. There are 5,470 siblings in the full Wave 1 sample of which 3,813 are followed in Waves 3 and 4 and 3,098 are in a family where another sibling was also followed in Waves 3 and 4. Of these 3,098 eligible respondents, 2,453 have information on both maltreatment and personality measures. We lose an additional 134 individuals because either the respondent or his/her sibling has missing cognitive ability information or depression measures (which we do not impute in the data), leaving our analysis sample of 2,319. The majority of families in the siblings sample has two siblings (92%).

We assessed whether the siblings sample is systematically different in observable characteristics from the full available sample (Table A1, Technical Appendix). We find very few differences between samples, especially with respect to levels of maltreatment and baseline characteristics. We do find differences in birth weight but this is to be expected because the sibling sample includes twins. Linking the likelihood of being in our final sibling analysis sample with Wave 1 family characteristics, we find no associations between the indicator for being in our analysis sample and maternal education or an indicator for black families (Table A2, Technical Appendix). We find a very small association with family income, suggesting that a $10,000 difference in income raises the likelihood of inclusion in our analysis by less than 1 percentage point. We conclude that our siblings estimation sample is not systematically different to the full sample, and therefore sample selection bias should be negligible.

[Insert Table 1 here]

3.1. Young adulthood personality traits

In Wave 4, data were collected on personality with the 20-item short-form version of the 50-item International Personality Item Pool-Five-Factor Model (IPIP-FFM) known as the Mini-IPIP (Donnellan et al. 2006). Baldasaro et al. (2013) suggest that the Mini-IPIP has a five-factor structure that represents extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience. Most of the scales have acceptable reliability, all the scales have partial or full metric invariance, and the scales exhibit sufficient criterion validity.[4] As is standard in the literature, we use factor analysis to extract the first principal factor for each

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[4] In our full estimation sample Cronbach's alpha for each dimension is: conscientiousness 0.64, openness to experience 0.61, extraversion 0.70, agreeableness 0.68, and neuroticism 0.85.

domain and standardize it to mean 0 and standard deviation 1 (see Almlund et al. 2011, p. 32).[5] Table A3 (Technical Appendix) lists all 20 items.

3.2.Maltreatment indicators

In Wave 3, respondents were asked four questions on how their parents (or adult caretakers) treated them *before* they were in sixth grade (age 12). Specifically, they were asked whether and how often:

(1) Parents (or other adult caregivers) had not taken care of their basic needs, such as keeping them clean or providing food or clothing.

(2) Parents (or other adult caregivers) slapped, hit, or kicked them.

(3) Parents (or other adult caregivers) had touched them in a sexual way, forced them to touch him or her in a sexual way, or forced them to have sexual relations.

(4) Parents (or other adult caregivers) left them home alone when an adult should have been with them.

We use two measures to use the maltreatment information. First, we derive from factor analysis over all four response categories a continuous measure of maltreatment. This measure captures the intensity of maltreatment, without specifying the underlying causes of the maltreatment. Second, to separately identify the effects and intensity of the four variants of maltreatment, we follow Currie & Tekin (2012) to construct for each event a binary indicator that takes the value 1 if the respondent reports that he or she experienced the respective maltreatment more than 10 times, and 0 otherwise. One reason for considering only the higher frequency of traumatic events is the assumption that chronic abuse – in contrast to one-off events - will have a long-term impact on behavior. Currie & Tekin (2012)

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[5] The same measures have been used in Fletcher (2013) and Lundberg (2013).

and Fletcher (2009) provide further details that the information provided in the maltreatment report is reliable and that it was collected in an appropriate way.[6]

In our data, 50% of all sample members reported the experience of some form of abuse during their childhood. Any sexual abuse was reported by 5% of the sample (535), but on a regular basis (> 10 times) around 1% (106) of the sample reported sexual abuse. While almost one-third of the sample reports to have been ever spanked, hit, or kicked, over 6% (642) experienced physical abuse on a more regular basis (> 10 times). Regular neglect of basic needs or having been left alone (> 10 times) occurred for 3% (321) and 9% (962) of the sample, respectively. Important gender differences emerge only for the report of frequent sexual abuse: female cohort members are four times more likely of reporting sexual abuse than male cohort members.

3.3. Mediators of the effect of maltreatment on adulthood personality

3.3.1. Adolescence personality and cognitive ability

In Wave 1 cohort members were asked to answer 21 questions regarding their personality that can be mapped into three of the Five Factors - neuroticism, extraversion, and conscientiousness - using the IPIP/NEO-PI-R as guidelines (Young & Beaujean, 2011). All questions are listed in Table A4 (Technical Appendix). Young and Beaujean (2011) compared these questions with items from the IPIP (Goldberg et al., 2006) version of the NEO-PI-R (Costa & McCrae, 1992). They subjected all available items to an item-level

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[6] Self-reported measures of maltreatment are error prone. Currie & Tekin (2012) discuss the potential pitfalls of these measures, but refer to methodological papers that have shown that, "if collected properly, these data are valid" (p. 515). The participants of the AddHealth study were asked to listen to pre-recorded questions on sensitive topics through earphones and to enter their answers directly on laptops. This process ensured confidentiality and minimized the potential for interviewer or other third-party influence. In order to obtain accurate responses about the timing of events, the study members were prompted with a calendar that gave the dates of many important events. While recall bias is an important consideration for these measures, the bias could be small because the respondents were young adults when asked about childhood maltreatment. This has the advantage that young adults are mature enough to understand and report on such events (see Perkonigg et al., 2000). Another advantage is that the time window over which the respondents recall past events is relatively short (10 years on average).

factor analysis to determine what items to keep, as well as the dimensionality of the domains the items were measured. They concluded that 13 of the original 21 items can be reliably used to generate measures of childhood neuroticism (6 items), extraversion (3 items), and conscientiousness (4 items).[7] To construct an index for each childhood personality trait, we use factor analysis.

To measure cognitive ability, we follow Fletcher (2013) and Lundberg (2013) and use from Wave 1 answers to the Peabody Picture Vocabulary Test (PVT) and self-reported school math grades.

3.3.2. Adolescent physical and mental health

We construct standard measures of physical and mental health problems that were reported between Wave 1 and Wave 3. These include general health status, chronic health conditions (asthma, obesity, diabetes, obesity), various markers for sensory or motor skill problems, ADHD, learning disabilities, and depression. We construct measures of health between early to late adolescence, so that they reflect health problems that are likely to have set on after the experience of maltreatment. Table A5 (Technical Appendix) describes these variables in detail.

Table 1 presents a short description of all variables used for the analysis and their summary statistics are reported in Table A1 (Technical Appendix).

[Insert Table 1 here]

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[7] The factor structure of the items indicates that each measures only one construct and the three factor scores have internal consistency estimates ranging between 0.76 and 0.86, which are similar to the reliability coefficients for the adulthood NEO personality instruments measured with 3 to 10 times as many items (Young & Beaujean, 2011, Table 5).

4. Empirical Framework

To test whether experience of maltreatment is associated with adulthood personality, we use linear regression (OLS) and siblings fixed effects (S-FE) models. In Eq. (1) personality trait k (PT_i^k) is a linear function of maltreatment and basic control variables:

$$PT_i^k = \alpha^k + MT_i{'}\beta^k + X_i{'}\gamma^k + \varepsilon_i^k, \qquad (1)$$

where ε_i^k captures all unobservable shocks that affect personality trait k, but are independent of variables captured in vector $X_i{'}$, and α^k, β^k and γ^k are parameters to be estimated. The vector MT_i contains either a continuous summary measure of maltreatment or four binary variables that indicate whether the individual experienced regularly maltreatment before grade 6 (sexual abuse, being beaten, left alone, neglected). The vector $X_i{'}$ controls for pre-treatment characteristics including age, being female, family characteristics, and birth weight.

The above outlined model considers only variation between families and does not control for unobserved family factors that may potentially confound the treatment effects of interest. To control for some of these confounding factors, we exploit differences between siblings (S-FE model). In Eq. (2) each individual has now subscript f, which represents the family, and subscript i which represents sibling i within family f. On the right-hand side of Eq. (2) we include only variables that vary between siblings (MT_{if}, Z_{if}).

$$PT_{if}^k = \alpha^k + MT_{if}{'}\beta^k + Z_{if}{'}\gamma^k + \mu_f^k + \eta_{if}^k. \qquad (2)$$

The error term is now broken down into two components: μ_f^k is a family fixed effect and η_{if}^k the error specific to each sibling i in family f. The family fixed effect could represent, for instance, level of familial conflict, family-specific behavioral styles, or a genetic proneness to disease. To eliminate this family-fixed effect, we difference across the siblings (e.g. *1, 2*) in each family (Eq. (3)).

$$PT_{1f}^k - PT_{2f}^k = \left(MT_{1f} - MT_{2f}\right)'\beta^k + \left(Z_{1f} - Z_{2f}\right)'\gamma + (\mu_f^k - \mu_f^k) + (\eta_{1f}^k - \eta_{2f}^k). \qquad (3)$$

The S-FE approach improves upon the OLS model because it controls for difficult-to-measure shared background components. However, as with most empirical models used to analyze observational data, it has its limitations. On the one hand, the S-FE approach exploits only variation within families, and therefore is an inefficient estimator (e.g. Conley et al., 2007, p. 1095). More important is that the estimated coefficients may still be biased if the differences of unobservable factors between sibling 1 and 2 ($\eta_{1f}^k - \eta_{2f}^k$) are correlated with differences in both maltreatment and personality. This approach would fail to identify a causal effect of maltreatment on personality, if e.g. both siblings were maltreated, but only one sibling will report the abuse due to being more willing to share maltreatment experiences (e.g. being more extraverted or open to experiences) or due to inflating negative experiences (e.g. being more neurotic).As we cannot rule out such possibility with certainty, the S-FE results do not warrant a causal interpretation.

We have sufficient variation in our data between siblings on most variables, which is the main requirement for this approach to yield efficient estimates (Bound and Solon, 1999). In Table 2 we report the number of siblings who differ in outcomes and treatment. Between 84% (Agreeableness) and 87% (Extraversion) of the sibling-pairs differ in their personality scores. The numbers of sibling pairs who report differences in maltreatment are in ascending order: 41 for sexual abuse (1.8%), 160 for neglect (7.0%), 237 for slapped or beaten (10.2%), and 336 for left alone (14.5%).

[Insert Table 2 here]

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4.2. Mediation analysis

To better understand the potential pathways via which childhood maltreatment affects adulthood personality, we conduct a mediation analysis by adding blocks of variables separately that capture: (1) adolescent personality[8]; (2) adolescent cognitive skills; (3) adolescent physical health conditions, or (4) adolescent mental health conditions.

The mediation analysis is conducted on the S-FE model, as described in Eq. (4). Here $\left(C_{1f} - C_{2f}\right)$ describes the difference in the block of control variables capturing the potential mediators between sibling 1 and 2.

$$PT_{1f}^k - PT_{2f}^k = \left(MT_{1f} - MT_{2f}\right)'\beta^k + \left(Z_{1f} - Z_{2f}\right)'\gamma + (C_{1f} - C_{2f})'\pi + (\mu_f^k - \mu_f^k) + (\eta_{1f}^k - \eta_{2f}^k). \quad (4)$$

The parameters in vector π capture the association of the difference in these control variables with adulthood personality. If adding the block of variables reduces the estimated association between maltreatment and adulthood personality (β^k), then this would be evidence in favor of the hypothesis that maltreatment affects adulthood personality via this particular channel (McKinnon et al. 2007, p. 597). Three assumptions must hold to interpret the results obtained from mediation analysis using our siblings-fixed effects model as causal (see Judd and Kenny, 2010; McKinnon et al., 2007 for a review): (1) there is no reverse causality between adult personality and the mediator (e.g. adolescent mental health) or the mediator and maltreatment experiences; (2) There is no measurement error in the mediator or in reported

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[8] Instead of investigating the role of adolescent personality as possible mediator via which maltreatment affects adulthood personality, we could have included it as standard control variable in the benchmark model. This is a commonly used strategy in the literature on non-cognitive skill formation referred to as the value-added model. Such model assumes that adolescent personality is a valid proxy for previous inputs, for instance parenting behavior including maltreatment, and educational opportunities (see Cunha and Heckman, 2008 for an overview of these models).

maltreatment experiences; (3) There are no unobserved factors that cause both mental health problems and personality in adulthood.

First, in our empirical setting we are likely to exclude the case of reverse causality because of temporal precedence. Maltreatment experiences refer to a period before grade 6, the potential mediators are measured after grade 6 but before adulthood, and personality outcomes are measured strictly after maltreatment experiences and potential mediators. Second, it is likely that measurement error occurs both in the report of maltreatment experiences and the potential mediators, although of unknown magnitudes; hence we cannot exclude the possibility that our mediation analysis yields bias estimates. Finally, although the siblings-fixed effects model controls for all family-specific background variables that could affect both maltreatment and potential mediators, there is still the possibility that unobservable factors that are not shared between siblings impact independently on maltreatment experiences and the mediators. In this case it would be inappropriate to interpret reduced coefficient estimates of β^k as evidence of a causal channel running from maltreatment to adulthood personality via the mediator.[9]

Because we cannot assume with certainty that all three modelling assumptions are satisfied, we do not interpret our mediation analysis as causal. However, to make the flow of the discussion easier, we will use the term "is mediated by" or "is not mediated by" to indicate whether a potential pathway is more or less likely.

To complete our analysis, we also include all blocks of control variables simultaneously to assess whether maltreatment affects adulthood personality, over and above the influence of all early to late adolescence mediation variables. Finally, we add to this full specification

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[9] Furthermore, it also possible that the mediator variables measured in adolescence and personality measured in adulthood are strongly correlated only because they measure imperfectly the same underlying trait. This is possible if maltreatment experiences cause e.g. mental health problems in adolescence, which is an imperfect proxy of personality in adolescence, while adolescent and young adulthood personality are strongly correlated (see Elkins et al., 2017 for evidence of the latter). We thank an anonymous referee for having pointed out this possibility.

adulthood SES to assess whether childhood maltreatment is correlated with adulthood personality possibly because of its effect on adulthood SES.[10]

5. Estimation Results

In this section we discuss the estimated associations between childhood exposure to parental maltreatment – as measured by a continuous summary measure of maltreatment - and adulthood personality for both OLS and the S-FE models using a sample of 2,319 siblings. The OLS model that includes all control variables – but not adulthood SES - yields an adjusted R-squared in order of magnitudes: (1) neuroticism (12.0%), (2) openness to experience (10.5%), (3) agreeableness (10.2%), (4) conscientiousness (7.3%), and (5) extraversion (5.1%). Each block of variables adds significantly (p-value < 0.01) to the explained variation of the respective personality traits.

Figure 1 reports the estimated regression coefficient of the effect of maltreatment (standardized to mean 0, SD 1) on each of the five personality traits obtained from a basic and a full estimation model, and its 90% confidence intervals. The dark-grey spike refers to the OLS estimates, whereas the light-grey spikes refer to the S-FE models. In the OLS model with basic control variables, maltreatment experiences are significantly positively associated with neuroticism (0.15 SD) and extraversion (0.03 SD, not significant) and negatively associated with agreeableness (-0.07 SD), conscientiousness (-0.10 SD), and openness to experience (-0.05 SD, not significant). When controlling for family fixed effects, the associations for neuroticism are reduced to 0.09 SD, but they remain significant at the 1% level. The associations with openness to experience increase in magnitude to -0.06 SD and are now significant at 5% level. In contrast, family fixed effects explain to a large degree the association between maltreatment and conscientiousness, as the estimated coefficient drops

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[10] We alert that this last estimation model cannot exclude the possibility of reverse causality, because adult personality traits are measured in the same time period as adulthood SES.

by over 50% from -0.10 SD (significant at the 1% level) to -0.05 SD (not significant), and explain entirely the negative association with agreeableness (-0.01 SD).

[Insert Figure 1 here]

The association between early-life maltreatment experiences and neuroticism is also robust to the inclusion of potential confounders such as adolescent personality, cognitive ability, or physical or mental health problems. When controlling for the potential pathways via which early-life maltreatment experiences could affect adulthood neuroticism, the association remains robust and significant at the 5% level in the S-FE model (0.07 SD). Furthermore, the negative relationship between early-life maltreatment experiences and openness to experience for sibling-comparisons is even slightly stronger when controlling for these potential pathways (-0.07 SD). Finally, we observe a statistically significant relationship between maltreatment experiences and extraversion when controlling for childhood and adolescent developmental outcomes, independent of the estimation method (OLS: 0.06 SD, significant at the 5% level, S-FE 0.05 SD, significant at the 10% level).

We have therefore shown that maltreatment experiences are robustly associated with neuroticism and openness to experience, and to some extent with conscientiousness and extraversion. We find no stable relationship between maltreatment experiences and agreeableness.[11] However, these findings do not tell us which maltreatment experiences – abuse or neglect – are the driving forces in the maltreatment-personality nexus. In Table 3, we therefore report the associations between adult personality traits and four different types of frequent maltreatment experiences using the siblings fixed effects (S-FE) model only.

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[11] We have tested for the possibility that maltreatment experiences have differential effects for children from low and high SES background. For this reason, we have interacted the maltreatment measure with indicators for high and low levels of education of the mother. We find no statistically significant interaction effect of maltreatment on any of the five personality traits. The exception is for agreeableness. Children from high SES backgrounds who experience a higher level of maltreatment than their sibling tend to be less agreeable in adulthood than their siblings (-0.18 SD, significant at the 1% level). Full results are provided upon request.

Each type of maltreatment is coded as a dummy variable that takes the value 1 if the individual reported that sexual abuse (or being slapped, left alone, or neglect of basic needs) occurred more than ten times before grade 6. Column (1) reports the estimation results for the S-FE model which controls for baseline characteristics. In column (2) to (5) we add individually blocks of control variables that capture adolescent information on personality (2), cognitive ability (3), physical health (4), and mental health (5). In column (6) we add all blocks of control variables simultaneously. In column (7) we additionally add to the full estimation model from column (6) adult SES information.

[Insert Table 3 here]

The most important finding is that, when considering the nature and intensity of maltreatment, we obtain significant and robust associations between neuroticism and sexual abuse or neglect, and between conscientiousness and openness to experience and neglect. In the baseline model the association between neuroticism and sexual abuse is almost 0.50 SD (significant at the 5% level), while its association with neglect is 0.32 SD (significant at the 1% level). The relationship between neuroticism and sexual abuse remains the same when including cognitive ability, but the association is reduced by 20% when controlling for physical health (0.42 SD) or mental health problems (0.39 SD). Interestingly, the association increases by 16% when controlling for adolescent personality (0.58 SD). Including all control variables simultaneously leaves us with an association of 0.45 SD which is significant at the 5% level. Less than 10% of this association is explained by differences in adulthood SES (0.41 SD).

The association between neglect and neuroticism is stable across the various control variable specifications, ranging between 0.32 SD (baseline) and 0.25 SD (all controls).

Mental health problems have the largest influence on the association, as they explain 13% of the relationship (a change from 0.32 SD in column (1) to 0.28 SD in column (5)). Controlling for all potential pathways simultaneously reduces the association between neglect and neuroticism by 21%. Adulthood SES has no influence on the association.

Similarly, the negative association between neglect and conscientiousness ranges between -0.25 SD (baseline) and -0.24 SD (all controls), and they are significant at the 5% level. The largest reduction in this association is driven by mental health problems, but they explain less than 10% of the association (a change from -0.25 SD in column (1) to -0.23 SD in column (5)). Similar to the relationship between neuroticism and neglect, adulthood SES does not explain the association between conscientiousness and neglect. We find identical stable associations between openness to experience and neglect, which range between -0.28 SD (baseline) and -0.26 SD (all controls), and they are statistically significant at the 1% level. Finally, there is tentative evidence that siblings who felt that they were frequently left alone, relative to their sibling, are more extraverted than their sibling in young adulthood, although the association is smaller in magnitude, ranging between 0.13 SD (baseline) and 0.12 SD (all controls) and it is statistically significant, at best, at the 10% level.

As a consequence, we conclude that sexual abuse experiences are only associated with young adulthood neuroticism, while experiences of neglect are associated with higher levels of neuroticism, and lower levels of conscientiousness and openness to experience. The most important pathway via which these experiences affect young adulthood personality is mental health problems. In the next section, we therefore assess whether these adverse experiences – maltreatment and subsequent mental or physical health problems – explain the strong relationship between young adulthood personality and adulthood wages or education outcomes that have been documented in e.g. Fletcher (2013) and Lundberg (2013) using Add Health data.

6. **Do Adverse Childhood Experiences Mediate the Relationship between Adult Outcomes and Personality?**

We re-estimate the same OLS models as reported in Fletcher (2013, Table 4) and Lundberg (2013, Table 1) to predict log earnings (models (1a), (1b)) or the probability to obtain a college degree (models (2a), (2b)) with the Big Five personality traits, both measured in Wave 4. In models (a) we only control for family SES, ethnicity, education, cognitive ability, number of siblings, and geographic region. In models (b) we control additionally for adverse childhood experiences (maltreatment and physical and mental health problems). The estimation results are reported in Table 4.

[Insert Table 4 here]

Overall, the estimates of the effect of personality on earnings or the probability to obtain a college degree do not change when controlling for adverse childhood experiences. One important exception is that the estimated coefficient of the effect of conscientiousness on both earnings and educational attainment is significantly reduced when moving from models (a) to (b). In the base model for log earnings (1a), a 1 SD increase in conscientiousness is associated with a 4.2 percent increase in earnings. In the full model (1b), this effect drops significantly by 45 percent to 2.3 percent, which is not statistically different from zero. A similar result is obtained for educational attainment. In the base model for educational attainment (2a), a 1 SD increase in conscientiousness is associated with a 2.2 percentage point increase in the probability of obtaining a college degree. When also controlling for childhood maltreatment experiences and adolescent health (2b), this association drops significantly by 38 percent to 1.3 percentage points. The effect of neuroticism on educational

attainment is also significantly reduced by 26%. This suggests that the productivity and human capital boosting effects of conscientiousness are fully and partially, respectively, explained by adverse childhood experiences.

7. Discussion

This study tests to which degree the Big Five personality traits, a commonly used domain to proxy non-cognitive skills, have their origins in childhood maltreatment experiences. We use a large, nationally-representative sample of young US Americans and exploit siblings-fixed-effects models to control for the potentially confounding effects of shared environments and genes. Some adverse childhood experiences predict significantly and robustly neuroticism, conscientiousness and openness to experience, but they have no consistent impact on agreeableness and extraversion. Neuroticism is the only trait significantly associated with experience of frequent sexual abuse. Frequent parental neglect experiences are positively associated with neuroticism, and negatively associated with conscientiousness and openness to experiences.

Our findings must be considered in light of some important limitations. The amount of variation in sexual abuse between siblings may be too small to detect statistically-significant effects, which is a general limitation of siblings-fixed effects models (Conley et al., 2007, Bound & Solon, 1999). For instance, the associations between sexual abuse and agreeableness or openness are sizable (0.14 SD and -0.18 SD), but their standard errors are too large to detect effects with certainty (0.19 and 0.20).

We are also not able to fully control for reporting differences that are linked to personality. This leaves open the possibility that some of the estimated effects are driven by differences in the willingness to report maltreatment that also correlate with personality. It is impossible to say for certain that the treatment effect of parental neglect on neuroticism, conscientiousness, and openness to experience are true differences in exposure between

siblings. More neurotic personalities may be more likely to inflate negative experiences such as neglect - leading to false positives - while more open personalities may be more likely to share harmful experiences. In both cases, we would overestimate the effect of maltreatment on personality. On the other hand, frequent sexual abuse is likely to be underreported because of its stigma and criminal nature. Memories of sexual abuse may even be repressed, a phenomenon that is referred to as "dissociative amnesia", which finds strong scientific support (Schefflin & Brown, 1996). Due to these false negatives we are likely to underestimate the true effect of sexual abuse on neuroticism. The alternative to self-reported maltreatment data is administrative data on substantiated abuse and neglect from child protection services. Although more accurate, such data tend to severely under-report the occurrence of maltreatment (Petersen & Feit, 2014). For this reason, most major studies rely on self-reported data (e.g. Felitti et al., 1998, Currie & Tekin, 2012, Hengartner et al., 2015).

Although our results cannot be given a causal interpretation, they provide a clearer picture of what adulthood personality traits may capture. Importantly, the strong associations observed between conscientiousness and adulthood productivity and educational attainment are partially explained by these adverse childhood experiences. Our findings are useful to applied researchers who seek to explore the meaning of the estimated associations between adulthood personality and labor market outcomes. These findings complement the knowledge we have already about the correlates of openness to experience with intelligence (see Almlund et al., 2011 for an overview). Our results also emphasize the important role of the earlier-life family environment in shaping personality. Thus, the findings are useful to policy makers who search for windows of opportunity to boost children's non-cognitive skills through family policy.

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Table 1: Control variables for regression models

Childhood Maltreatment indicators (before grade 6, or age 12)

Sexual abuse more than 10 times (0,1)

Slapped more than 10 times (0,1)

Left alone when shouldn't have more than 10 times (0,1)

Neglected basic needs more than 10 times (0,1)

or

Continuous measure of maltreatment obtained from factor analysis

Note: Data on maltreatment experiences was collected in Wave 3, with reference to experiences that occurred before grade 6 (age 12)

Baseline control variables

Wave 1: Birth weight, sex, family characteristics

Wave 4: Age

Mediation analysis

1. **Adolescence personality (average age 15)**

Wave 1: Neuroticism, extraversion, conscientiousness

2. **Cognitive ability (average age 15)**

Wave 1: Peabody vocabulary test, math grade (self-reported)

3. **Physical health problems**

Wave 1: General health, Difficulties with hands, Difficulties with feet (average age 15)

Wave 2: Measured obesity (BMI > 30) (average age 16)

Wave 3: Asthma, Epilepsy, Blindness (average age 22)

Wave 4: Diabetes if occurred before age 18

4. **Mental health problems**

Wave 1: Depression, Learning disability (average age 15)

Wave 3: ADHD (average age 22)

5. **Adult socioeconomic status (average age 29)**

Wave 4: Years of education, weekly earnings

Table 2: Number of sibling-pairs in the Siblings-Fixed Effects model with differences in outcomes and treatment

	Nr $\Delta \neq 0$	Sample size	%
Outcome in Wave 4			
Extraversion	2018	2,319	87.02
Neuroticism	2010	2,319	86.68
Agreeableness	1956	2,319	84.35
Conscientiousness	2004	2,319	86.42
Openness to experience	1974	2,319	85.12
Treatment before grade 6			
Frequent sexual abuse	41	2,319	1.77
Frequent slapped/beaten	237	2,319	10.22
Frequent left alone	336	2,319	14.50
Frequent neglect of basic needs	160	2,319	6.90

Table 3: Estimation Results Siblings Fixed Effects Model (N=2,319)

	Baseline	+ Child Temp	+ Cogn. Ability	+ Phys. Health	+ Mental Health	+ All controls	+All control +Adult SES
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Extraversion							
Sexual abuse	-0.025	-0.104	-0.000	-0.039	-0.011	-0.089	-0.033
	(0.206)	(0.202)	(0.206)	(0.207)	(0.208)	(0.204)	(0.203)
Being slapped	0.027	0.045	0.015	0.032	0.024	0.031	0.022
	(0.088)	(0.087)	(0.088)	(0.088)	(0.088)	(0.087)	(0.087)
Left alone	0.129*	0.119	0.135*	0.113	0.136*	0.120	0.118
	(0.074)	(0.073)	(0.074)	(0.074)	(0.075)	(0.073)	(0.073)
Neglect of needs	-0.130	-0.112	-0.130	-0.120	-0.120	-0.112	-0.120
	(0.106)	(0.105)	(0.106)	(0.106)	(0.107)	(0.105)	(0.104)
R-squared	0.003	0.026	0.009	0.012	0.004	0.036	0.044
Neuroticism							
Sexual abuse	0.499**	0.578***	0.491**	0.419**	0.394*	0.446**	0.410**
	(0.212)	(0.208)	(0.211)	(0.211)	(0.212)	(0.207)	(0.207)
Being slapped	0.000	-0.005	-0.005	-0.010	0.028	-0.001	0.002
	(0.090)	(0.089)	(0.090)	(0.090)	(0.090)	(0.088)	(0.088)
Left alone	0.050	0.060	0.061	0.062	0.039	0.067	0.068
	(0.077)	(0.075)	(0.076)	(0.076)	(0.076)	(0.075)	(0.074)
Neglect of needs	0.319***	0.291***	0.300***	0.305***	0.277**	0.253**	0.257**
	(0.110)	(0.107)	(0.109)	(0.109)	(0.109)	(0.106)	(0.106)
R-squared	0.028	0.055	0.041	0.050	0.043	0.083	0.086
Agreeableness							
Sexual abuse	0.138	0.101	0.145	0.088	0.170	0.073	0.119
	(0.190)	(0.187)	(0.190)	(0.190)	(0.191)	(0.189)	(0.187)
Being slapped	0.003	0.025	0.000	-0.012	-0.006	-0.002	0.003
	(0.081)	(0.080)	(0.081)	(0.081)	(0.081)	(0.081)	(0.080)
Left alone	0.031	0.019	0.032	0.020	0.026	0.009	0.007
	(0.068)	(0.068)	(0.068)	(0.068)	(0.069)	(0.068)	(0.067)
Neglect of needs	-0.158	-0.130	-0.157	-0.176*	-0.145	-0.148	-0.148
	(0.098)	(0.097)	(0.098)	(0.098)	(0.098)	(0.097)	(0.096)
R-squared	0.104	0.112	0.105	0.115	0.107	0.123	0.136
Conscientiousness							
Sexual abuse	-0.028	-0.096	-0.014	-0.000	0.061	0.001	0.025
	(0.212)	(0.209)	(0.212)	(0.212)	(0.213)	(0.209)	(0.209)
Being slapped	-0.021	-0.029	-0.022	-0.012	-0.051	-0.050	-0.048
	(0.090)	(0.089)	(0.090)	(0.090)	(0.090)	(0.089)	(0.089)
Left alone	-0.007	-0.010	-0.005	-0.018	-0.001	-0.007	-0.009
	(0.077)	(0.075)	(0.077)	(0.076)	(0.077)	(0.075)	(0.075)
Neglect of needs	-0.249**	-0.253**	-0.246**	-0.236**	-0.229**	-0.242**	-0.242**
	(0.109)	(0.108)	(0.109)	(0.109)	(0.109)	(0.107)	(0.107)
R-squared	0.013	0.031	0.015	0.030	0.023	0.054	0.056

…to be continued on next page.

Table 3: Estimation Results Siblings Fixed Effects Model (N=2,319), continuing

	Baseline	+ Child Temp	+ Cogn. Ability	+ Phys. Health	+ Mental Health	+ All controls	+All control +Adult SES
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Open to Experience							
Sexual abuse	-0.182	-0.224	-0.193	-0.146	-0.140	-0.171	-0.120
	(0.203)	(0.200)	(0.202)	(0.203)	(0.203)	(0.200)	(0.199)
Being slapped	-0.035	-0.054	-0.035	-0.022	-0.049	-0.054	-0.057
	(0.086)	(0.085)	(0.086)	(0.086)	(0.086)	(0.085)	(0.085)
Left alone	0.077	0.070	0.062	0.064	0.065	0.043	0.041
	(0.073)	(0.072)	(0.073)	(0.073)	(0.073)	(0.072)	(0.072)
Neglect of needs	-0.275***	-0.271***	-0.261**	-0.273***	-0.257**	-0.262**	-0.267***
	(0.105)	(0.103)	(0.104)	(0.104)	(0.104)	(0.103)	(0.102)
R-squared	0.011	0.024	0.026	0.023	0.018	0.047	0.055

Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Estimated coefficient on binary variable of type of maltreatment is interpreted as standard-deviation change in personality trait k. In each model is estimated with a Siblings-Fixed Effects model (2,319 siblings). The Baseline model (1) includes controls for age, gender, family characteristics, and birth-weight. Subsequent columns (2)-(5) add separately a block of variables - adolescent personality, adolescent cognitive ability, adolescent physical health problems, and adolescent mental health problems - respectively. The all-controls model (6) includes all control variables simultaneously. Model (7) adds adult socioeconomic status variables (education, earnings) to model (6). Full estimation results for the full model reported in column (7) is reported in Table A7 Technical Appendix.

Table 4: Estimated relationship between earnings or education and personality with and without controlling for childhood health and maltreatment indicators (Reported: marginal effects)

	Dependent Variable					
	Log Earnings (1a)	Log Earnings (1b)	% Diff	College degree (2a)	College degree (2b)	% Diff
Extraversion	0.050***	0.048***	-4	-0.018***	-0.020***	8.7
	(0.014)	(0.014)		(0.004)	(0.004)	
Neuroticism	-0.086***	-0.074***	-14	-0.042***	-0.031***	26**
	(0.017)	(0.016)		(0.004)	(0.004)	
Agreeableness	0.014	0.009	-35.7	0.042***	0.042***	1.7
	(0.019)	(0.018)		(0.005)	(0.005)	
Conscientious.	0.042***	0.023	-45.2**	0.022***	0.013***	38.4**
	(0.015)	(0.015)		(0.004)	(0.004)	
Openness	-0.026	-0.029*	11.5	0.030***	0.031***	1.4
	(0.017)	(0.016)		(0.004)	(0.004)	
Family Background and Cognitive Ability	Yes	Yes		Yes	Yes	
Childhood health and maltreatment	No	Yes		No	Yes	
Observations	8,195	8,195		10,693	10,693	
R-squared	0.106	0.134		0.2174	0.2404	

Note: All models control for the full set of family background variables and cognitive ability as in Fletcher (2013) for earnings and in Lundberg (2013) for the probability to obtain a college degree. Outcomes and personality are measured in Wave 4. Models (1a) and (1b) are estimated with ordinary least squares. Models (2a) and (b) are estimated with a linear probability model. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
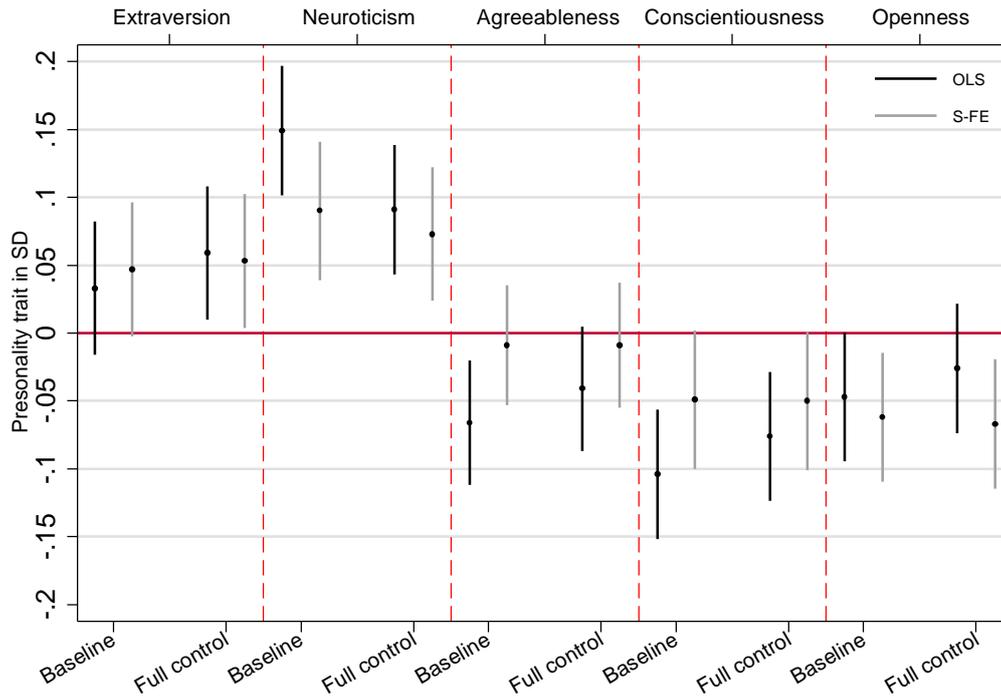
Figure 1. Estimated coefficient on continuous summary measure of maltreatment (standardized to mean 0 and standard deviation 1) for both Ordinary Least Squares (OLS) and Siblings-Fixed Effects (S-FE) models. Spikes depict 90% confidence intervals. The sample size is 2,319 siblings. The Baseline model includes controls for age, gender, family characteristics, and birth-weight. The Full control model includes additionally adolescent personality, adolescent cognitive ability, adolescent physical health problems, and adolescent mental health problems. Full estimation results are reported in Table A6 (Technical Appendix).

Technical Appendix

Table A1: Descriptive Statistics

Variable (W: Wave)	Full sample N=10,693		Siblings sample N=2,319		Diff. Sign.[a]
	Mean	SD	Mean	SD	
Extraversion (W4)	13.28	3.06	13.26	3.06	
Neuroticism (W4)	10.37	2.73	10.40	2.77	
Agreeableness (W4)	15.30	2.39	15.29	2.40	
Conscientiousness (W4)	14.69	2.69	14.80	2.66	**
Openness (W4)	14.56	2.44	14.36	2.44	***
Age (W4)	28.91	1.75	28.81	1.77	***
Female	0.54	0.50	0.54	0.50	
Missing Family Inform. (W1)	0.30	0.46	0.29	0.45	
Log(birthweight) (W1)	1.96	0.20	1.89	0.24	***
Birth weight missing (W1)	0.17	0.38	0.17	0.37	
Sex Abuse (W3)	0.01	0.09	0.01	0.10	
Physical Abuse (W3)	0.06	0.24	0.07	0.25	
Left Alone (W3)	0.09	0.28	0.09	0.29	
Basic Needs not met (W3)	0.03	0.16	0.03	0.18	
PVT Score (W1)	0.13	0.93	0.03	0.91	***
Math Grade (W1)	2.48	1.23	2.49	1.23	
General Health (W1)	3.90	0.91	3.90	0.90	
Obese (W1)	0.07	0.26	0.08	0.26	
Obese missing (W1)	0.02	0.15	0.02	0.15	
Asthma (W4)	0.15	0.35	0.15	0.35	
Diabetes (W4)	0.03	0.16	0.02	0.16	
Difficulty with hands (W1)	0.01	0.09	0.01	0.07	
Difficulty with feet (W1)	0.02	0.12	0.02	0.13	
Epilepsy (W1)	0.01	0.11	0.02	0.12	
Blindness (W1)	0.00	0.07	0.01	0.08	
Diffic. with feet miss. (W1)	0.13	0.33	0.12	0.33	
Diffic. with hands miss. (W1)	0.13	0.33	0.12	0.33	
Depressed (W1)	0.08	0.26	0.09	0.28	
ADHD (W4)	0.05	0.21	0.04	0.20	
Learning Disability (W1)	0.11	0.28	0.11	0.29	
Learning Disab. Missing (W1)	0.14	0.34	0.13	0.34	
Conscientiousness (W1)	-0.01	1.00	0.01	1.02	
Neuroticism (W1)	-0.03	0.95	-0.05	0.92	
Extraversion (W1)	0.02	1.00	0.06	0.98	
Missing Conscient. (W1)	0.01	0.10	0.01	0.09	
Missing Extraversion (W1)	0.32	0.47	0.37	0.48	***
Education (W4)	14.44	2.07	14.33	2.09	***
Earnings (W4)	36.97	38.91	34.49	32.51	***

Note: a Test result whether difference in means between full and estimation sample differ**<5%, ***<1%

Table A2: Determinants of probability to be in the siblings sample

VARIABLES	Coef. (SE)
Maternal Education	0.003
	(0.003)
Family Income (10,000s)	0.001***
	(0.000)
Black Family	-0.006
	(0.016)
Constant	0.355***
	(0.040)
Observations	5,470
R-squared	0.004

Note: Linear probability model. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A3: The Big Five Personality Traits Measured in Wave 4

Conscientiousness (C)	Characteristics are related to being reliable, responsible, and having self-control versus impulsivity and casualness
	H4PE3 3. I get chores done right away **H4PE11** 11. I often forget to put things back in their proper place **H4PE19** 19. I like order **H4PE27** 27. I make a mess of things
Openness to experience (O)	Characteristics are associated with the willingness to have new experiences, engage new ideas, and be open to one's own feelings versus being cynical and tough-minded
	H4PE5 5. I have a vivid imagination
	H4PE13 13. I am not interested in abstract ideas **H4PE21** 21. I have difficulty understanding abstract ideas **H4PE29** 29. I do not have a good imagination
Neuroticism (N)	Characteristics are related to anxiety and emotional liability versus being placid and emotionally stable
	H4PE4 4. I have frequent mood swings
	H4PE6 6. I worry about things **H4PE8** 8. I get angry easily **H4PE12** 12. I am relaxed most of the time **H4PE14** 14. I am not easily bothered by things **H4PE16** 16. I rarely get irritated **H4PE20** 20. I get upset easily **H4PE22** 22. I get stressed out easily **H4PE24** 24. I lose my temper **H4PE28** 28. I seldom feel blue **H4PE32** 32. I keep my cool
Extraversion (E)	Characteristics are associated with enthusiasm toward life's circumstances, outgoing, and surgency versus introversion gravity; encounter with oneself and one's life circumstances
	H4PE1 1. I am the life of the party **H4PE9** 9. I don't talk a lot **H4PE17** 17. I talk to a lot of different people at parties **H4PE25** 25. I keep in the background
Agreeableness (A)	Characteristics are related to an inclination toward submission to others, passivity, and subduedness versus being independent and having a strong will
	H4PE2 2. I sympathize with others' feelings **H4PE10** 10. I am not interested in other people's problems **H4PE18** 18. I feel others' emotions **H4PE26** 26. I am not really interested in others

Note: Factor analysis is used to predict the first principal factor from the four questions each. Scores are standardised to mean 0 and standard deviation 1.

Table A4. Personality Questionnaire Wave 1 (as suggested by Young and Beaujean, 2011)

Neuroticism	You have a lot of good qualities* H1PF 30
	You have a lot to be proud of* H1PF 32
	You like yourself just the way you are* H1PF33
	You feel like you are doing everything just about right* H1PF34
	You feel socially accepted* H1PF35
	You feel wanted and loved* H1PF36
Extraversion	I feel close to people at school** S62B
	I feel like I am a part of this school** S62E
	I feel socially accepted** S62O
Conscientiousness	When you have a problem to solve, one of the first things you do is get as many facts about the problem as possible* H1PF18
	When you are attempting to find a solution to a problem, you usually try to think of as many different ways to approach the problem as possible* H1PF19
	When making decisions, you generally use a systematic method for judging and comparing alternatives* H1PF20
	After carrying out a solution to a problem, you usually try to analyze what went right and what went wrong* H1PF21

Note: Child hood temperament was part of Wave 1; Young and Beaujean (2011) demonstrate the construct validity of the each facet. Cronbach's alpha for Neuroticism, Extraversion and Conscientiousness is 0.86, 0.76, and 0.76, respectively.

Table A5: Mental and Physical Health Measures

Physical Health	**General Health**: A general health status measure is constructed from a question asked in Wave 1: "In general, how is your health?". The cohort members could respond with poor, fair, good, very good, or excellent. Despite the subjectivity of this variable, research has shown that it is a strong predictor of objective health measures such as mortality and health care utilization (Miilunpalo et al., 1997).
	Asthma: We construct a binary measure of asthma from information collected in Wave 3, when the young adult respondents were asked whether they have "ever been diagnosed with asthma".
	Diabetes: Information on self-reported diabetes status was not collected until Wave 4. The key question posed to respondents was, "Has a doctor, nurse, or other health care provider ever told you that you have or had high blood sugar or diabetes?" Those answering yes for either condition were also asked for their age at diagnosis. We coded our childhood diabetes variable to take the value 1 if the individual reported that it was diagnosed before the age of 18. The same measure has been used in Fletcher and Richards (2012) to predict human capital accumulation. The disadvantage of this measure is that it does not allow us to distinguish between Type I and Type II diabetes.
	Obesity: A measure of obesity – an indicator of excessive body fat – is constructed from clinically-assessed height and weight information obtained in Wave 2. BMI is defined as weight in kilograms divided by height in meters squared. Obesity is defined as a BMI greater than 30.
	Gross motor problems: We generate binary variables that indicate problems with hands or feet (Wave 1) which are likely to affect the development of fine and gross motor skills, and epilepsy (by Wave 3).
Mental Health	**Depression**: We use 19 of the 20 items of the Center for Epidemiological Studies Depression Scale (CES-D) contained in Wave 1. The scale ranges from 0 to 57, and we use a cut-off score of 22 for male adolescents and 24 for females to construct a binary measure of depression as recommended in Robert et al. (1991). This scale has been used to examine adolescent depression and has been shown to have good measurement properties (see Fletcher (2009)).
	Learning disability: To construct an indicator variable for whether the child has a learning disability, we use the following question given to the parent respondent in Wave 1: "Does (he/she) have a specific learning disability, such as difficulties with attention, dyslexia, or some other reading, spelling, writing, or math disability?". The same indicator was used in Fletcher (2011).
	ADHD: We follow Fletcher and Wolfe (2009) to construct an indicator of childhood ADHD symptoms from eighteen questions collected during Wave 3. The questions ask respondents to think back to when they were between 5 and 12 years of age and report how often they performed a set of behaviors (e.g. squirmed in their seat, had difficulty sustaining attention in tasks). Retrospective ratings of previous health should be used with caution when examining adult outcomes. Yet, several reviews have concluded that childhood experiences are recalled with sufficient accuracy to provide useful information in retrospective studies.

Table A6: Full estimation results including all control variables (excluding adult socioeconomic status)

	OLS					Siblings Fixed Effects				
	Extra	Neur	Agree	Consc	Open	Extra	Neur	Agree	Consc	Open
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Maltreatment (Std)	0.059**	0.091***	-0.041	-0.076***	-0.026	0.053*	0.073**	-0.009	-0.050	-0.067**
	(0.030)	(0.029)	(0.028)	(0.029)	(0.029)	(0.030)	(0.030)	(0.028)	(0.031)	(0.029)
Age	-0.016	0.001	0.011	0.020*	-0.032***	-0.001	-0.007	0.029**	0.026*	-0.030**
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.014)	(0.012)	(0.014)	(0.013)
Female	0.030	0.334***	0.467***	0.131***	-0.228***	0.061	0.275***	0.645***	0.170***	-0.132***
	(0.043)	(0.042)	(0.041)	(0.042)	(0.041)	(0.046)	(0.047)	(0.043)	(0.047)	(0.045)
Family inform. miss.	0.031	-0.071	-0.040	-0.062	0.002	-0.047	-0.126	-0.197***	-0.220***	-0.035
	(0.052)	(0.051)	(0.050)	(0.051)	(0.051)	(0.075)	(0.077)	(0.070)	(0.077)	(0.074)
Log birth weight	0.063	-0.052	-0.104	0.043	-0.101	-0.035	-0.018	0.037	0.104	0.133
	(0.086)	(0.084)	(0.083)	(0.084)	(0.083)	(0.130)	(0.132)	(0.120)	(0.133)	(0.127)
Birth weight missing	-0.038	-0.039	0.235**	0.081	0.215**	-0.091	-0.188*	0.257**	0.164	0.109
	(0.098)	(0.095)	(0.094)	(0.095)	(0.094)	(0.109)	(0.111)	(0.101)	(0.112)	(0.107)
PVT score Wave 1	-0.019	-0.110***	0.164***	-0.063***	0.250***	-0.101***	-0.085***	-0.029	-0.069**	0.139***
	(0.024)	(0.023)	(0.023)	(0.023)	(0.023)	(0.031)	(0.031)	(0.029)	(0.032)	(0.030)
Math grade Wave 1	0.006	-0.040*	0.025	0.040*	-0.014	0.028	-0.052**	0.004	0.004	0.013
	(0.021)	(0.021)	(0.020)	(0.021)	(0.021)	(0.021)	(0.022)	(0.020)	(0.022)	(0.021)
Math grade missing	-0.020	0.030	-0.007	-0.039	0.021	-0.129	-0.027	-0.034	0.010	-0.095
	(0.095)	(0.092)	(0.091)	(0.092)	(0.092)	(0.092)	(0.094)	(0.086)	(0.095)	(0.091)
General health Wave 1	0.061**	-0.024	0.025	0.029	0.063***	0.042*	-0.025	0.022	0.073***	0.025
	(0.025)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.025)	(0.023)	(0.025)	(0.024)
Obesity Wave 1	0.129	-0.018	-0.051	-0.241***	0.016	0.104	0.001	-0.033	-0.172**	-0.130
	(0.080)	(0.078)	(0.076)	(0.078)	(0.077)	(0.083)	(0.084)	(0.077)	(0.085)	(0.081)
Obesity Missing	0.047	-0.099	0.176	0.110	0.015	-0.050	-0.229*	-0.071	-0.053	-0.029
	(0.134)	(0.130)	(0.128)	(0.130)	(0.129)	(0.133)	(0.135)	(0.123)	(0.136)	(0.130)
Asthma Wave 4	0.039	0.139**	0.067	-0.039	0.129**	0.030	0.081	-0.039	0.062	0.029
	(0.058)	(0.057)	(0.056)	(0.057)	(0.056)	(0.056)	(0.057)	(0.052)	(0.057)	(0.055)

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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Diabetes Wave 4	0.032	0.415***	0.090	-0.079	-0.127	0.028	0.547***	0.345***	-0.188	-0.371***
	(0.131)	(0.128)	(0.126)	(0.127)	(0.126)	(0.125)	(0.127)	(0.116)	(0.128)	(0.123)
Diff. hands Wave 1	0.078	-0.048	0.154	-0.314	-0.031	0.004	-0.309	0.024	0.407	0.167
	(0.326)	(0.317)	(0.313)	(0.317)	(0.314)	(0.306)	(0.311)	(0.283)	(0.314)	(0.300)
Difficulty feet Wave 1	0.198	0.277*	-0.031	0.051	0.071	0.261	-0.124	-0.175	0.034	-0.073
	(0.171)	(0.166)	(0.164)	(0.166)	(0.165)	(0.172)	(0.175)	(0.159)	(0.176)	(0.169)
Epilepsy Wave 4	0.205	0.272*	-0.057	-0.243	-0.115	0.243	0.196	-0.159	-0.293*	0.115
	(0.159)	(0.154)	(0.152)	(0.154)	(0.153)	(0.148)	(0.151)	(0.137)	(0.152)	(0.145)
Blindness Wave 4	0.054	0.349	-0.224	-0.310	0.039	-0.258	0.223	-0.752***	-0.270	-0.357
	(0.291)	(0.283)	(0.279)	(0.283)	(0.281)	(0.272)	(0.277)	(0.252)	(0.279)	(0.267)
Diff feet missing	-0.659*	0.287	-0.463	0.197	-0.134	-0.065	0.578	-0.415	-0.327	-0.502
	(0.393)	(0.382)	(0.376)	(0.382)	(0.379)	(0.369)	(0.375)	(0.341)	(0.378)	(0.362)
Diff hands missing	0.533	-0.145	0.458	0.201	0.288	0.117	-0.202	0.365	0.351	0.766**
	(0.379)	(0.369)	(0.363)	(0.369)	(0.366)	(0.353)	(0.359)	(0.327)	(0.362)	(0.346)
Depressed Wave 1	0.124	0.317***	-0.008	0.106	0.089	0.005	0.157**	-0.020	0.168**	-0.003
	(0.079)	(0.077)	(0.076)	(0.077)	(0.077)	(0.072)	(0.073)	(0.067)	(0.074)	(0.071)
ADHD Wave 4	0.042	0.108	0.043	-0.276***	0.103	-0.073	0.170	-0.002	-0.206*	0.060
	(0.107)	(0.104)	(0.103)	(0.104)	(0.103)	(0.108)	(0.110)	(0.100)	(0.111)	(0.106)
Learning disab. Wave 1	-0.047	0.082	-0.114*	-0.227***	-0.215***	-0.004	0.084	-0.119*	-0.243***	-0.176**
	(0.072)	(0.070)	(0.069)	(0.070)	(0.070)	(0.074)	(0.076)	(0.069)	(0.076)	(0.073)
Learning disability missing	0.030	-0.035	-0.206	-0.471***	-0.238	0.009	0.008	-0.013	-0.202	-0.164
	(0.171)	(0.166)	(0.163)	(0.166)	(0.164)	(0.162)	(0.165)	(0.150)	(0.166)	(0.159)
Conscientiousness Wave 1	-0.027	0.006	-0.030	-0.092***	-0.052**	-0.041**	0.011	0.016	-0.075***	-0.048**
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.020)	(0.022)	(0.021)
Neuroticism Wave 1	-0.140***	0.092***	-0.009	-0.108***	-0.073***	-0.104***	-0.131***	-0.069***	-0.087***	-0.057**
	(0.027)	(0.026)	(0.026)	(0.026)	(0.026)	(0.027)	(0.028)	(0.025)	(0.028)	(0.027)
Extraversion Wave 1	0.106***	-0.073***	0.061***	0.028	0.008	0.069***	-0.034	0.044**	0.033	0.001
	(0.022)	(0.021)	(0.021)	(0.021)	(0.021)	(0.022)	(0.022)	(0.020)	(0.023)	(0.022)
Conscientiousness Wave 1 Missing	-0.361*	-0.081	-0.127	0.214	0.153	0.001	-0.423*	-0.112	0.136	0.197
	(0.218)	(0.212)	(0.208)	(0.212)	(0.210)	(0.227)	(0.231)	(0.210)	(0.233)	(0.223)
Extraversion Wave 1 Missing	0.018	0.090**	-0.063	0.000	-0.019	0.012	0.031	-0.041	0.011	-0.109**

	(0.043)	(0.042)	(0.042)	(0.042)	(0.042)	(0.044)	(0.045)	(0.041)	(0.045)	(0.043)
Education Wave 4										
Earnings Wave 4										
Constant	0.052	-0.026	-0.475	-0.777*	0.914**	-0.062	0.292	-1.259***	-1.208**	0.620
	(0.442)	(0.430)	(0.423)	(0.430)	(0.426)	(0.509)	(0.518)	(0.471)	(0.521)	(0.499)
Observations	2,319	2,319	2,319	2,319	2,319	2,319	2,319	2,319	2,319	2,319
R-squared	0.051	0.120	0.102	0.073	0.105	0.036	0.081	0.122	0.052	0.046

Note: Personality traits are standardized to mean 0 and standard deviation 1. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A7: Full estimation results with indicator variables for maltreatment type (Siblings-Fixed Effects model)

	Extra (1)	Neur (2)	Agree (3)	Consc (4)	Open (5)
Sexual abuse	-0.033	0.410**	0.119	0.025	-0.120
	(0.203)	(0.207)	(0.187)	(0.209)	(0.199)
Being slapped	0.022	0.002	0.003	-0.048	-0.057
	(0.087)	(0.088)	(0.080)	(0.089)	(0.085)
Left alone	0.118	0.068	0.007	-0.009	0.041
	(0.073)	(0.074)	(0.067)	(0.075)	(0.072)
Neglect of needs	-0.120	0.257**	-0.148	-0.242**	-0.267***
	(0.104)	(0.106)	(0.096)	(0.107)	(0.102)
Age	-0.008	-0.004	0.027**	0.025*	-0.034***
	(0.013)	(0.014)	(0.012)	(0.014)	(0.013)
Female	0.045	0.285***	0.589***	0.146***	-0.158***
	(0.047)	(0.048)	(0.043)	(0.048)	(0.046)
Family inform. miss.	-0.030	-0.135*	-0.186***	-0.216***	-0.023
	(0.075)	(0.077)	(0.069)	(0.077)	(0.074)
Log birth weight	-0.068	0.002	0.042	0.105	0.118
	(0.130)	(0.132)	(0.119)	(0.133)	(0.127)
Birth weight missing	-0.085	-0.173	0.247**	0.156	0.101
	(0.109)	(0.111)	(0.100)	(0.112)	(0.107)
PVT score Wave 1	-0.121***	-0.070**	-0.056*	-0.084***	0.115***
	(0.031)	(0.032)	(0.029)	(0.032)	(0.031)
Math grade Wave 1	0.013	-0.042*	-0.012	-0.003	-0.000
	(0.022)	(0.022)	(0.020)	(0.022)	(0.021)
Math grade missing	-0.099	-0.058	0.014	0.032	-0.057
	(0.093)	(0.094)	(0.085)	(0.095)	(0.091)
General health Wave 1	0.034	-0.020	0.013	0.069***	0.017
	(0.024)	(0.025)	(0.023)	(0.025)	(0.024)
Obesity Wave 1	0.102	0.004	-0.059	-0.182**	-0.139*
	(0.083)	(0.084)	(0.076)	(0.085)	(0.081)
Obesity Missing	-0.044	-0.234*	-0.054	-0.045	-0.021
	(0.132)	(0.135)	(0.122)	(0.136)	(0.130)
Asthma Wave 4	0.030	0.081	-0.040	0.061	0.028
	(0.056)	(0.057)	(0.052)	(0.057)	(0.055)
Diabetes Wave 4	0.086	0.504***	0.404***	-0.161	-0.319***
	(0.125)	(0.128)	(0.116)	(0.129)	(0.123)
Diff. hands Wave 1	0.065	-0.345	0.059	0.426	0.219
	(0.305)	(0.311)	(0.281)	(0.313)	(0.299)
Difficulty feet Wave 1	0.269	-0.122	-0.165	0.020	-0.084
	(0.171)	(0.175)	(0.158)	(0.176)	(0.168)
Epilepsy Wave 4	0.243*	0.189	-0.124	-0.275*	0.130
	(0.148)	(0.150)	(0.136)	(0.152)	(0.145)
Blindness Wave 4	-0.252	0.261	-0.730***	-0.276	-0.353
	(0.273)	(0.278)	(0.251)	(0.280)	(0.267)
Diff feet missing	-0.048	0.572	-0.364	-0.321	-0.478
	(0.367)	(0.374)	(0.339)	(0.377)	(0.361)

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Diff hands missing	0.056	-0.178	0.250	0.323	0.710**
	(0.353)	(0.359)	(0.325)	(0.362)	(0.346)
Depressed Wave 1	0.014	0.155**	-0.026	0.164**	-0.006
	(0.072)	(0.073)	(0.066)	(0.074)	(0.071)
ADHD Wave 4	-0.056	0.149	-0.022	-0.218*	0.049
	(0.108)	(0.110)	(0.100)	(0.111)	(0.106)
Learning disab. Wave 1	0.028	0.055	-0.076	-0.220***	-0.135*
	(0.075)	(0.076)	(0.069)	(0.077)	(0.073)
Learning disability missing	0.045	-0.040	0.039	-0.175	-0.121
	(0.162)	(0.165)	(0.149)	(0.166)	(0.159)
Conscientiousness Wave 1	-0.043**	0.011	0.013	-0.078***	-0.049**
	(0.021)	(0.021)	(0.019)	(0.022)	(0.021)
Neuroticism Wave 1	-0.096***	0.129***	-0.063**	-0.083***	-0.051*
	(0.027)	(0.028)	(0.025)	(0.028)	(0.027)
Extraversion Wave 1	0.067***	-0.034	0.041**	0.031	-0.002
	(0.022)	(0.022)	(0.020)	(0.023)	(0.022)
Conscientiousness Wave 1 Missing	0.002	-0.423*	-0.099	0.145	0.205
	(0.227)	(0.231)	(0.209)	(0.233)	(0.222)
Extraversion Wave 1 Missing	0.021	0.027	-0.035	0.014	-0.102**
	(0.044)	(0.045)	(0.041)	(0.045)	(0.043)
Education Wave 4	0.044***	-0.034**	0.072***	0.034**	0.053***
	(0.013)	(0.014)	(0.012)	(0.014)	(0.013)
Earnings Wave 4	0.002**	-0.001	-0.001**	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.432	0.663	-2.135***	-1.616***	0.034
	(0.533)	(0.543)	(0.491)	(0.547)	(0.523)
Observations	2,319	2,319	2,319	2,319	2,319
R-squared	0.044	0.086	0.136	0.056	0.055

Note: Personality traits are standardized to mean 0 and standard deviation 1. Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.