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EFFECTS OF CHILDHOOD COGNITIVE AND BEHAVIORAL DISABILITIES
ON ADULT ECONOMIC OUTCOMES

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ABSTRACT

Developmental disabilities are not rare among U.S. children and rates have been increasing in recent decades. The increases have been driven by cognitive and behavioral disorders. While some studies have investigated the effects of specific childhood conditions, particularly ADHD, on adult economic outcomes, none has considered the overall effects of cognitive and behavioral disabilities. We address this key gap by rigorously estimating effects of cognitive and behavioral impairments in childhood, which account for the bulk and increasing share of child disability cases in the U.S., on a set of salient adult economic outcomes. Using the National Longitudinal Survey of Youth 79 Child Supplement, we estimate the effects of low cognitive test scores and high behavior problem scores in childhood on receipt of disability benefits, educational attainment, employment, wages, and access to transportation and credit in adulthood, using household fixed effects models to control for potentially confounding factors that are unobserved. We find significant effects in the expected direction for both cognitive and behavioral childhood disabilities on all outcomes. The findings have important implications for well-being over the life course for a non-trivial share of the U.S. population and their families, government expenditures, and public policy.

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Developmental disabilities—defined as “impairment[s] in physical, learning, language, or behavior...that begin during the developmental period, may impact daily functioning, and usually last throughout a person’s lifetime” (CDC 2022a)—are not rare among children in the United States. For example, the prevalence of any diagnosed developmental disability in U.S. children aged 3–17 years varied from 8.6% (Zablotsky et al. 2023) to 16.9% (Zablotsky et al. 2019), depending on the specific conditions included.¹ There is evidence that child disability has been increasing over many decades (Halfon et al. 2012), that the increases have been driven by cognitive and behavioral disorders (Halfon et al. 2012; Houtrow et al. 2014), that cognitive and behavioral disorders accounted for approximately three quarters of child disability cases in recent years (Houtrow et al. 2014), and that increased rates of diagnosis cannot explain the increases in children’s cognitive and behavioral disorders (Halfon et al. 2012). According to data from the American Community Survey (ACS), cognitive disability is the most prevalent category of disability for children aged 5 to 17 (Young 2021).

Developmental disabilities can be caused by a multitude of factors including genetics, parental health and behaviors, and environmental exposures (CDC 2023b). For example, strong associations between prematurity and/or low birth weight and developmental disabilities have been established (Schieve et al. 2016; Boulet, Schieve & Boyle 2011) and maternal prenatal behaviors have been causally related to those birth outcomes (Corman et al. 2018). Other studies have identified associations between low socioeconomic status and various types of child disability (Cree et al. 2021; Zablotsky et al. 2019; Young 2021; Robinson et al. 2017).

¹ The 8.6% figure (for the years 2019–2021) includes Autism Spectrum Disorder, Intellectual Disability, and Other Developmental Delay. The 16.9% figure (for the years 2009–2017) also included Attention Deficit/Hyperactivity Disorder, Blind, Cerebral Palsy, Hearing Loss, Learning Disability, Seizures, and Stuttering/Stammering. Both studies use data from the National Health Interview Survey.

Childhood cognitive or intellectual disabilities, in particular, can be the result of genetic syndromes, (e.g., Down Syndrome) or environmental insults such as prenatal infections or substance use. Although such disabilities have no cure (Huang & Blum 2010), early intervention and/or special education programs have been shown to help children with cognitive disabilities reach their potential (Purugganan 2018) and vocational education for teens can support preparation for employment (Huang & Blum 2010).

Most existing studies of effects of childhood disability on adult economic outcomes combine all disabilities (cognitive, behavioral, physical, and sensory) into one composite group or focus on specific diagnoses. According to Zablotsky et al. (2019), over one-quarter of children diagnosed with a developmental disability do not fit into the categories typically studied or have specific diagnoses. Additionally, a dearth of research has focused on individuals with low cognitive functioning regardless of any diagnosed conditions. Finally, while most studies have accounted for family background characteristics, few have addressed potential unobserved factors that could confound associations between child disability and adult economic outcomes.

In this study, we address these gaps by rigorously estimating the effects of cognitive and behavioral impairments in childhood, which account for the bulk and increasing share of child disability cases in the U.S., on a set of salient adult economic outcomes. Specifically, we estimate the effects of low cognitive functioning and behavior problems on education, employment, and wages, as well as receipt of Supplemental Security Income (SSI) and access to transportation and credit, in adulthood while accounting for potential unobserved confounding factors. The findings have important implications for well-being over the life course for a non-trivial share of the U.S. population and their families, government expenditures, and public policy.

Background

Relationship between ability (or disability) and adult outcomes

Since the early work on human capital by Schultz (1960) and Becker (1962), economists have been investigating the role of ability on adult economic well-being. Most early studies focused on cognitive ability (e.g., Weisbrod & Karpoff 1968; Hanson, Weisbrod & Scanlon (1970); Griliches & Mason 1972) and characterized ability using class rank (Weisbrod & Karpoff 1968) or Air Force Qualifying Test (AFQT) scores (Griliches & Mason 1972; Hansen, Weisbrod & Scanlon 1970), which were assessed during late adolescence or early adulthood. In addition, they controlled for few (Griliches & Mason 1972; Hansen, Weisbrod & Scanlon 1970) or no (Weisbrod & Karpoff 1968) family background characteristics. All of these studies found that greater cognitive ability was associated with higher earnings and educational attainment. These and most subsequent studies measured ability as a continuous variable, which did not allow for a non-linear relationship between ability and outcomes. We would expect the strongest associations at the lower tail of the ability distribution, where impairments are likely to be the most consequential.

Some recent studies of effects of cognitive ability on adult economic outcomes have used cohort data to investigate effects of ability in childhood, adolescence, or early adulthood on adult economic outcomes and well-being. This approach addresses concerns about potential effects of schooling on ability. For example, Falch and Massih (2012) estimated the effects of ability measured at age 10 (using a combined measure of Intelligence Quotient (IQ) scores, grade point average, and teacher ratings) on earnings over the life cycle (from ages 20 to 65) in a 1928 Swedish cohort and found strong associations between ability and earnings and suggestive

evidence that much of the association operated through schooling. However, they did not account for potential confounding effects of family characteristics.

Heckman, Stixrud and Urzua (2006) emphasized the importance of both cognitive and non-cognitive skills when estimating the effect of ability on wages. Heckman and Kautz (2012) discussed the potential non-linear effects of abilities on outcomes, particularly at the extremes of abilities—a point that had been made earlier by Cawley, Heckman and Vytlačil (2001)—and highlighted the importance of studying those at the bottom (or top) tails of the distribution ability either through an imposed functional form or by examining groups in the tails. Heckman and Kautz (2012) also highlighted the importance of behavioral/psychological characteristics for educational attainment and earnings and suggested that personality traits in the tails of the distribution may indicate psychopathologies (i.e., behavioral disabilities).

Two studies explicitly considered potential non-linear associations between cognitive ability and earnings and found that individuals with low ability had significantly worse outcomes than those with higher ability (Hansen et al. 1970; Heineck & Anger 2010). Hansen et al. (1970) examined a group of low-ability men who were rejected for military service because of low scores on the AFQT. They found that the strong schooling/earnings relationship found in most studies did not seem to apply to this group of men. Heineck and Anger (2010) estimated the effects of being in the lowest quartile of cognitive ability on earnings of adults ages 20 to 60, using 1991–2006 data from the German Socio-Economic Panel Study. Ability (based on a short IQ-related test) and covariates were measured at the end of the study period (2005–2006), so the study was not able to address potential reverse causality or control for family background characteristics.

Other studies examined linkages between various measures of child disability and educational attainment, a more proximate outcome. In a cohort of Australian youth, Yu (2010) found that by age 18, individuals whose parents reported that they were ever diagnosed with development/learning disabilities were 20 percentage points less likely than those without such disabilities to complete 12 years of education. Loprest and Maag (2007), using the Disability Supplement of the 1994–1995 National Health Interview Survey, compared individuals with reports of early (under age 22) onset activity or functional limitations to those with no limitations and found those with an early-onset disability were significantly less likely to complete high school compared to those with no disability. Cummings & Luengo-Prado (2023) estimated associations between having a learning disability (LD) (assessed from a composite of responses to many different questions to parents, teachers, and the children themselves) and high school dropout and college completion using the PSID and found that having an LD was associated with significant reductions in the probability of completing both high school and college. Each of these studies controlled for observed family background characteristics, which have been found to be strongly related to educational achievement (see Lochner 2008 for an overview; Carlson & Corcoran 2001; Guo & Stearns 2002) and are associated with many types of child disability (Cree et al. 2021; Zablotsky et al. 2019; Young 2021; Robinson et al. 2017). However, none controlled for potentially confounding unobserved family characteristics.

Two particularly relevant studies investigated effects of specific child developmental conditions on adult socioeconomic outcomes using longitudinal data and estimating household fixed effects models. Currie et al. (2010) focused on both Attention Deficit/Hyperactivity Disorder and conduct disorders and found that both conditions were associated with increased reliance on public assistance and decreased educational attainment in young adulthood

(approximately ages 19–27). Fletcher (2014) also focused on ADHD and found negative effects on employment and earnings and positive effects of reliance on social assistance when the participants were 25–35 years old.

Overall, there is ample evidence that abilities, measured various ways, are associated with educational attainment and earnings, but few studies have considered potential non-linear relationships or focused on high-risk tails of the relevant distributions. Additionally, few studies other than those that focused solely on ADHD estimated household fixed effects models that control for all time-invariant family background characteristics. Finally, no previous studies specifically considered both cognitive and behavioral impairments as broad classes. As such, the findings from studies of more specific conditions may not be generalizable to the entire population of individuals with cognitive and/or behavioral disabilities.

Relationship between achievement test scores and cognitive ability

The studies reviewed above used a variety of measures of cognitive ability, including class rank, AFQT scores, and IQ-related test scores. As discussed by Heckman and Kautz (2012) and Currie and Thomas (2001), scores on achievement tests reflect not only cognitive ability but also personality traits (such as motivation) and family background and resources received during childhood. However, recent literature suggests that achievement test scores are reasonable proxies for cognitive ability, particularly at the low tail of ability.

Duckworth, Quinn & Tsukayama (2012) investigated differential effects of cognitive ability and self-control in predicting test scores in two different samples (10 sites in a national US study of early child care; two public schools in New York City). They found that IQ was a better predictor of standardized test scores than were measures of self-control, whereas self-control was a better predictor of grades. These findings are consistent with the work of Borghans

et al. (2016), who investigated these relationships in national data sets from the Netherlands, Britain, and the U.S. The authors found that IQ was relatively more important than personality in predicting test scores, while personality better predicted grades and was a better predictor of adult outcomes including wages and health.

We know of only two studies that examined the ability/achievement relationship by levels of academic ability. Hajovsky et al. (2023) examined the relationship between ability and achievement test scores for the normative sample for the Woodcock-Johnson (IQ) tests. They found a much stronger relationship between ability and achievement test scores for those in the lowest quartile of ability compared to those in the middle or upper quartiles. Deary et al. (2007) examined associations between age 11 IQ and academic test scores for a large cohort of British students. Specifically, the authors examined whether students “passed” their General Certificate of Secondary Education (GCSE) in five or more subjects. They found that, among individuals who scored at least one standard deviation lower than the mean on age 11 IQ, only 16% passed at least 5 GCSE exams.

In sum, the literature indicates that although achievement tests are not a direct measure of cognitive ability (traditionally measured by IQ), the two are strongly related, particularly at the low end of the distribution of cognitive ability.

Contribution of this study

We contribute to the literature by estimating overall effects of cognitive ability and behavioral problems in childhood—the classes of impairments that characterize the vast majority and an increasing share of cases of child disability in the U.S.—on a rich set of adult economic outcomes in the U.S. using cohort data from the NLSY79, measures of cognitive ability and behavioral problems from widely-used standardized tests and scales and measured at multiple

time points, and household fixed effects models. Specifically, we focus on the extreme ranges of both cognitive and behavioral abilities assessed in childhood and how they relate to adult educational attainment, employment, and earnings, as well as SSI receipt and access to credit and transportation in both population-level and within-household analyses.

Methods

We adapt a modeling framework used by Fletcher (2014). In equation (1), we start with a simple model, where current economic outcomes for adult i are a function of the individual's time-invariant characteristics (X_i), childhood (time-invariant) family background characteristics (Z_i), and a dichotomous measure of whether the individual had low levels of measured cognitive ability between the ages of 5 and 14. In equation (2), we substitute high behavioral problem scores for low cognitive ability. In these models, we attempt to control for family characteristics that have been associated with both childhood disabilities and adult economic outcomes by including a range of measured family characteristics in childhood. By considering those in the low tail of the cognitive distribution and high tail of the behavioral problems distribution, we address the issue of heterogeneous effects by level of ability and focus on the sub-populations that should be at highest risk of adverse long term economic outcomes.

$$(1) \quad y_i = \beta_0 + \beta_1 (\text{low cognitive scores}_i) + X_i \beta_2 + Z_i \beta_3 + \varepsilon_i$$

$$(2) \quad y_i = \gamma_0 + \gamma_1 (\text{high behavioral problem scores}_i) + X_i \gamma_2 + Z_i \gamma_3 + \varepsilon_i$$

Because economic outcomes are strongly associated with family background, we also estimate household fixed effects models that implicitly account for all common family attributes. In equations (3) and (4), the vector W includes characteristics that can differ across siblings such as age and gender. The fixed effects models rely on having multiple siblings in the household for

whom there are available measures of cognitive ability and/or behavior problems and adult economic outcomes. The coefficients ζ_f and λ_f account for household fixed effects.

$$(3) \quad y_{if} = \beta_0 + \beta_1 (\text{low cognitive scores}_i) + W_i \beta_2 + \zeta_f + \varepsilon_i$$

$$(4) \quad y_{if} = \gamma_0 + \gamma_1 (\text{high behavioral problem scores}_i) + W_i \gamma_2 + \lambda_f + \varepsilon_i$$

Data

We use data from the National Longitudinal Survey of Youth 1979 (NLSY79), with variables derived from both the mother's record and the Child and Young Adult Supplements. We measure outcomes in 2018, the last pre-covid survey year, for children who were at least 22 years of age at that time.² The NLSY79 follows a U.S. nationally representative sample of more than 12,000 individuals ages 14–22 years in 1979. The survey was conducted annually from 1979 until 1994 and biennially afterward (U.S. Bureau of Labor Statistics, 2023).

Measures

Cognitive and behavior scores

We use achievement test scores as proxies for cognitive ability. As discussed above, the literature has shown a strong connection between test scores and IQ-related measures. Specifically, we assess cognitive ability using scores on the Peabody Individual Achievement Tests (PIAT) for Mathematics, Reading Recognition, and Reading Comprehension, which were administered between the ages of 5 and 14.³ The NLSY normalized the PIAT scores to national distributions and created standardized scores with means of 100 and standard deviations of 15.⁴

² We used 22 as our lower-bound age because many individuals with developmental disabilities are likely to receive special education services and thus be eligible for a free public education through age 21 (U.S. Department of Education, IDEA). This would represent the year after school leaving for those who stay in school through age 21.

³ Before 1994, some children over age 14 were also tested.

⁴ For a full description of the child assessments in the NLSY79, see National Longitudinal Surveys (2023). Children were also assessed using the Peabody Picture Vocabulary Test (PPVT). However, the PPVT tests were not administered as frequently as the PIATs or BPI, and few children have multiple years of scores. Therefore, we did not use the PPVT assessments.

We defined low scores on each exam as having a score at least one standard deviation below the norm—that is, a standardized score of less than 85. We consider the standardized scores for each occasion the child was tested.

To characterize behavioral disabilities, we use the Behavior Problems Index (BPI) assessment in the NLSY79, which was based on 28 questions administered to the mother about specific behaviors of the child in the past three months. The BPI was administered on children ages 4–14.⁵ The NLSY reported percentile scores, which have been normed to national distributions for the full BPI, as well as sub-scores for each of the six BPI components—
anxious/depressed, antisocial, dependent, headstrong, hyperactive, and peer conflicts/withdrawn. A high score indicates worse behavior problems, and those at the high tails of the distributions are likely to have behavioral disabilities. We define high behavioral problems as scoring above the 85th percentile.⁶ Again, we consider these scores for each occasion the child was tested.

Because children’s performance on assessments can vary over time, we capitalize on the assessments at multiple timepoints in the NLSY to measures of low PIAT test scores and high BPI scores. For a stringent measure, low cognitive ability was defined as having a standardized score of less than 85 on the PIAT math test on at least two different occasions plus a standardized score of less than 85 on at least one of the PIAT reading tests (reading recognition or comprehension) on at least two occasions. A broader measure was defined as having a standardized PIAT score of less than 85 on math tests or either of the PIAT reading tests on at least two different occasions.⁷ A high behavior problem score was defined as having a percentile score of above 85 normalized full-scale BPI score above 115 on at least two occasions.

⁵ Some children above age 14 were assessed before 1994.

⁶ As acknowledged in the NLSY documentation, children in the NLSY sample scored worse on the behavior problems index than those in the national sample used to generate the normalized scores.

⁷ The tests were administered every two years.

We used different samples when considering cognitive and behavioral scores and, for each, when estimating full-sample or household fixed effects models (see Figure 1). From the full NLSY sample of 11,551 respondents that represented all biological children of NLSY79 mothers, we dropped 6,731 cases in which the respondents did not complete surveys in 2018, another 462 cases because the respondents were under age 22 in 2018, and another 159 cases that had missing outcomes or covariates, resulting in an eligible sample of 4,179 young adults. Of those, we dropped individuals with fewer than two test scores between the ages of 5 and 14, resulting in “full samples” of 4,011 and 3,577 for analyses of cognitive and behavioral scores, respectively. We derived the household fixed effects samples by further dropping respondents that had no siblings for whom two scores were available in the data, resulting in sample sizes of 2,591 for analyses of cognitive scores and 2,914 for analyses of behavioral scores.

Young adult economic outcomes

All outcomes are measured in 2018, when the respondents were ages 22 (by design) to 46 years. We focus on receipt of Supplemental Security Income (SSI), educational attainment, employment, and earnings, as well as car ownership and having a credit card. SSI is a means-tested program that provides cash benefits to disabled adults from the U.S. Social Security Administration; as such, it is not only an economic outcome, but it is also a proxy for disability in adulthood. Since we are interested in individuals at the low tail of cognitive ability, our measure of educational attainment is whether the individual completed high school. The measure of employment is whether the individual was working in 2018. We only measure earnings for those who worked. Annual earnings include wages, salary, commissions, and tips in the previous year.⁸ Lack of access to a car has been associated with lower levels of access to employment,

⁸ In our regressions, we use the natural logarithm of earnings.

goods, and services (Brown 2017),⁹ and credit cards can facilitate transactions and serve as a temporary form of credit (Bertaut and Haliassos 2006); both resources make it easier to fully participate in the labor market.

Covariates

For equations 1 and 2, we control for child characteristics including gender, birth order (first born), race/ethnicity, age, and region of residence, all measured in 2018, as well as the following maternal characteristics: AFQT percentile score,¹⁰ foreign-born status (measured in 1979), marital status when the child was born (based on child's date of birth and mother's marital status measured in the year or the year prior to the child's birth), age when the respondent was born (measured in 2018), and educational attainment (measured in 2018). For equations 3 and 4, we control for the following individual controls: gender, age, first birth, maternal marital status at birth, and age at time of the birth.

Results

Table 1 presents means for low cognitive scores, high behavioral problem scores, adult economic outcomes and sample characteristics for the four different analysis samples (PIAT scores, full sample; PIAT scores, household fixed effects sample; BPI scores, full sample; BPI scores, household fixed effects sample). About 8–9% of the children had low cognitive scores, as measured by the more stringent measure (at least one standard deviation below the national norm on at least two math tests and at least 2 reading recognition or reading comprehension tests), and about 19–20% had low cognitive scores using the broader measure (more than one standard

⁹ As discussed by Brown (2017), some individuals do not have cars by choice and have good access to alternative forms of transportation; however, those individuals represent a small percentage of adults who do not have cars.

¹⁰ The AFQT is a combined assessment of math reasoning, math knowledge, paragraph comprehension, and word knowledge. The skills covered in this test are similar to those covered by the PIAT, which is used in the current study. The AFQT was taken when the mother was first interviewed in the NLSY, when she was between the ages of 14 and 22.

deviation below the norms on at least 2 math or reading tests). About 23% of the children scored above the 85th percentile in behavior problems on at least two different occasions.

In all four samples, about three percent of the respondents received SSI benefits, 88% had graduated high school, 80% were employed, over two thirds (68%) owned a motor vehicle, and almost 60% had a credit card. Mean earnings among those who worked were approximately \$41,000 per year. Child and maternal characteristics were very similar across the four samples.

Panel A of Table 2 present OLS results for the full (PIAT or BPI) sample, based on Equations (1) and (2). Each cell presents results from a different regression model that controls for the child and maternal characteristics listed in Table 1. The models estimating effects of high BPI also control for the first year for which there was a BPI assessment for that child.¹¹ Estimates are presented for the stringent measure of low cognitive ability (standardized scores of <85 on 2+ math and 2+ reading PIAT tests), the broader measure of low cognitive ability (standardized scores of <85 on any of the three tests on at least 2 different occasions), and the measure of high scores on the full-scale BPI (2+ scores > 85th percentile).

For both low cognitive ability measures and high BPI scores, we find significant associations with each of the economic outcomes in the expected direction. Using the broader measure, the estimated effect of low cognitive ability in childhood on receipt of SSI in adulthood was 5.7 percentage points. Since the mean of SSI receipt was only 3.4%, this means that the percent increase in SSI relative the mean was about 170%. The estimates are even larger when using the strict measure of cognitive ability; the effect size was 12.3 percentage points, which translates to a 360% increase in SSI receipt. In addition, respondents with high BPI scores were

¹¹ As discussed, above, BPI scores for the NLSY child sample were higher than those for the national normed sample. In addition, the differences between the two distributions narrowed over time. For this reason, we control for the year of the respondent's first assessment.

almost twice as likely to receive SSI compared to those with lower BPI scores, since the effect size of 3.1 percentage points was about equal to the mean. As such, low cognitive ability and high behavior problem scores in childhood are strong predictors of disability in adulthood.¹²

For the other outcomes, estimates are uniformly larger when we use the stricter measure of low cognitive ability versus the broader measure. Respondents with low cognitive ability in childhood were 15–16 percentage points less likely to graduate high school (~18%), were 11–18 percentage points less likely to be employed (14–22%), earned 40-59% less per year if they were working, were 12–21 percentage points (17–30%) less likely to own a car, and were 14–16 percentage points (24–28%) less likely to have a credit card compared to respondents with higher cognitive ability in childhood. The estimated effects of high BPI scores were negative and significant across all these outcomes, with meaningful magnitudes that were somewhat lower than for low cognitive ability. For example, respondents with high BPI scores were almost 9 percentage points (10%) less likely to graduate high school, and about 7 percentage points (9%) less likely to be employed, and they earned about 21% less if they were working,¹³ compared to those with lower BPI scores.

In Panel B, we present corresponding OLS estimates when restricting the sample to respondents with siblings in the correct age ranges and for whom there were at least 2 cognitive test scores or at least 2 BPI scores. This allows us to compare OLS and household fixed effects results using the same sample and to compare results between full and restricted samples in OLS

¹² Not all individuals with cognitive/behavioral disabilities receive SSI. According to the authors' calculations based on the American Community Survey for individuals 22 to 49 in 2008–2019, only 41.5% receive any Social Security benefits. And, among those with mental disorders (intellectual or behavioral) ages 18–64 in 2020, only about half of those receiving any Social Security received SSI (Social Security Administration, 2021).

¹³ Calculated as $(\exp(\beta)-1)*100$

models. Comparing the results in Panel A and Panel B, we find that the estimates using the household fixed effects sample are very similar to those using the full sample.

Appendix Tables 1 and 2 show the full OLS results (including covariate estimates) of the effects of low cognitive ability and high behavior problem scores, respectively, from the models that are summarized in Table 2, Panel A (for low cognitive ability, using the most stringent measure). Appendix Tables 3 and 4 report corresponding OLS estimates using the household fixed effects sample from Table 2, Panel B. Of note is that maternal ability (as proxied by the mother's AFQT score) and education are strong independent predictors of children's adult outcomes. The mother having been married at the time of the child's birth is also an important covariate. Estimates are similar when using full and household fixed effects samples.

Estimates from household fixed effects models, which account for all non-time varying household characteristics—observed or unobserved—are presented in Table 3. These models control for the respondent's gender and age, whether the respondent was the oldest sibling in the household, whether the respondent's mother was married when the respondent was born, and the mother's age when the respondent was born. Full results including covariate estimates are in Appendix Table 5 for low cognitive ability and Appendix Table 6 for behavior problems. In Table 3, each cell presents estimates from a different model. With one exception (high BPI score on having a credit card), low cognitive scores and high BPI scores had statistically significant effects in the expected direction on all adult economic outcomes. The fact that many of the marginal effects presented in Table 3 are lower than the marginal effects presented in Panel B or Table 2, it suggests that unobserved household characteristics appear to play a role in the relationship between PIAT/BPI scores and educational attainment, earnings, and having a credit card. For example, the effect of the stringent measure of low cognitive ability on high school

graduation was reduced from 16.0 percentage points to 11.8 percentage points, and the effect of the same measure of low cognitive ability on earnings was reduced from about 62% to 50%. However, the effects remain substantial and significant. It is notable and validating that when controlling for all time-invariant household characteristics as well as some time-varying household characteristics, the estimated effects of low cognitive scores and high behavioral problem scores on adult disability, as proxied by receipt of SSI, are almost identical to those in Panel B of Table 2.

Appendix Table 7 shows estimated effects of low scores on each of the components of the PIAT: math, reading recognition, and reading comprehension. The estimated effects of the different components are similar across most outcomes. However, low reading scores are more adversely associated with employment compared to low math scores, and low math and reading recognition scores are more adversely with earnings (given employment) compared to reading comprehension scores. These results, which are suggestive of differential effects of specific types of cognitive ability on different labor market outcomes, are consistent with some previous literature, but the studies are not entirely comparable.¹⁴

In Appendix Table 8, we estimated effects of low scores on sub-scales of the BPI: antisocial, anxious or depressed, headstrong, hyperactive, dependent, and peer conflict/withdrawn. Only hyperactivity is significantly associated with receipt of SSI. Scores on many sub-scales are significantly associated with high school graduation, anxiety or depression

¹⁴ The result for employment is consistent with the work of Charette and Meng (1998), who found that the effect of adult literacy scores on weeks worked was stronger for literacy than numeracy in a large-scale Canadian study. The authors examined a full range of literacy and numeracy scores, however, and did not focus on the low end of abilities. The result for earnings is consistent with the work of Dougherty (2003), who examined data from the NLSY79 and used AFQT subject tests to predict earnings 9 to 17 years after the baseline when the individuals were aged 14–21. He found that numeracy had stronger effects on earnings than literacy for the full sample, but that the strong relationship between numeracy and earnings was weaker for individuals with scores one standard deviation below the mean, holding constant education and work tenure.

is negatively associated with employment, and personality issues such as peer conflict and headstrong temperament are negatively associated with earnings among those who worked. However, these results should be interpreted with caution since each sub-scale is based on only a few questions.

We also conducted robustness checks by considering more extreme cutoffs to define low ability cognitive ability and high behavior problem scores. The first two rows in Appendix Table 9 replicate the household fixed effects results from Table 3, which used standardized PIAT scores of less than 85 to define low cognitive ability, while the next two rows present corresponding results using standardized scores less than 80 to define low cognitive ability. The following rows replicate the household fixed effects results that used BPI scores above the 85th percentile to define high behavior problem scores and then corresponding estimates using BPI scores above the 90th percentile as the cutoff. For most outcomes, as expected, effect sizes are greater when using the more extreme cutoffs.

Finally, in Appendix Table 10, we present estimates from household fixed effects models that include low cognitive scores and high behavioral scores in the same model, as well as an indicator for both low cognitive and high behavioral scores. Of respondents who had low cognitive scores, about 33–40% also had high behavioral problem scores (calculated using means from the first column). For almost all outcomes, having both low cognitive scores and high behavioral problem scores does not appear to have effects above and beyond the contributions of each type of disability. The exception is employment, for which having both types of disability appears to uniquely contribute to adverse outcomes.

Conclusion

The results from this study indicate that children between the ages of 5 and 14 who test at least one standard deviation below the national mean on cognitive (PIAT) tests and/or who score above the 85th percentile on a behavioral assessment (BPI, ages 4–14) are more likely to be disabled and receive disability benefits, have lower educational attainment, are less likely to be employed, have lower earnings, and have barriers to employment and economic activity (lack of transportation and credit) in adulthood compared to those with more favorable scores—even controlling for observed and unobserved household characteristics.

An advantage of our research design over most previous studies is that our measures of disability do not rely on having a medical diagnosis or a particular condition; that is, the measures characterize actual cognitive or behavioral functioning, whether impairments have been diagnosed/treated or not, at relatively young ages as captured by standardized test scores and behaviors as reported by mothers using a validated assessment instrument. The findings here thus underscore the importance of ensuring that children have access to educational, social, and medical interventions that have been shown to enhance children’s cognitive development and improve their behavioral skills. Enhancing skills of children with cognitive and behavioral disabilities may improve not only their own human capital trajectories but also their health, given strong linkages between socioeconomic status and health (e.g. Chetty et al. 2006; Case and Deaton 2022), and the well-being of their families, given substantial research showing adverse economic effects of child disability on the family (see Reichman et al. 2008). It could also potentially narrow the well-known widening socioeconomic health disparities with age (Case, Lubotsky and Paxson 2002; Currie and Stabile 2003) and attenuate the increasing rates of child disability in the U.S.

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Table 1: Low childhood cognitive scores, high childhood behavioral problem scores, adult economic outcomes, and child, maternal, and family characteristics for each analysis sample

		PIAT Test Scores		BPI	
		Full Sample	Household FE Sample	Full Sample	Household FE Sample
Low childhood cognitive scores (PIAT tests) (standardized scores <85)					
	2+ math tests and 2+ reading tests (reading recognition or comprehension) (stringent measure)	0.080	0.087	N/A	N/A
	2+ reading or math tests (broader measure)	0.187	0.203	N/A	N/A
High child behavioral problem scores (BPI) >85th percentile on:					
	2+ full scale assessments	N/A	N/A	0.231	0.229
Adult economic outcomes					
	Receives SSI benefits	0.034	0.034	0.030	0.028
	High school graduate (or more)	0.879	0.869	0.889	0.886
	Employed	0.797	0.793	0.805	0.799
	Annual earnings ^a (among those employed)	\$41,034 (31,499) N = 3,205	\$41,236 (32,198) N = 1,829	\$40,370 (31,260) N = 2,886	\$40,401 (31,719) N = 1,574
	Owens a motor vehicle	0.684	0.685	0.680	0.679
	Has a credit card	0.572	0.560	0.583	0.577
Child characteristics					
	Female	0.509	0.508	0.506	0.505
	Age (years) in 2018, mean (sd)	30.68 (5.52)	30.33 (5.47)	29.51 (4.62)	29.05 (4.45)
	Oldest sibling	0.394	0.321	0.356	0.296
	Race/ethnicity				
	Non-Hispanic White	0.467	0.454	0.487	0.481
	Non-Hispanic Black	0.327	0.329	0.305	0.302
	Hispanic	0.206	0.217	0.207	0.217
	Region of residence in 2018				
	Northeast	0.130	0.130	0.132	0.134
	North central	0.239	0.254	0.242	0.263
	South	0.423	0.400	0.410	0.378
	West	0.205	0.213	0.210	0.218
Maternal characteristics					

AFQT percentile score, mean (sd)	38.20 (28.39)	38.69 (28.74)	39.86 (28.62)	41.05 (29.04)
Foreign born	0.071	0.073	0.075	0.075
Married when respondent was born	0.836	0.849	0.846	0.859
Age (years) when respondent was born				
< 20	0.137	0.130	0.0618	0.0574
20-34	0.823	0.830	0.892	0.897
35+	0.074	0.076	0.083	0.086
Education				
Less than high school	0.094	0.099	0.081	0.085
High school graduate	0.683	0.668	0.677	0.657
College or more	0.223	0.233	0.242	0.258
N	4,011	2,591	3,577	2,194

Notes: FE = Fixed effects; PIAT = Peabody Individual Achievement Test; BPI = Behavioral Problems Index; AFQT = Air Force Qualifying Test; SSI = Supplementary Security Income; sd = standard deviation. PIAT and BPI scores were assessed in multiple survey years between the ages of 5 and 14. Adult economic outcomes were measured in 2018, when respondents' ages ranged from 22 to 46 years. ^a Sample sizes are lower due to number working and missing data.

Table 2: Estimated effects of low cognitive test scores and high behavioral problem scores in childhood on adult economic outcomes, OLS models using full sample (panel A) and household fixed effects sample (panel B)

	N	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owens Motor Vehicle	Has Credit Card
<i>Panel A: Full sample</i>		Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ low reading scores and 2+ low math scores on PIAT tests (stringent measure)	4,011	0.123*** (0.021)	-0.162*** (0.027)	-0.178*** (0.029)	-0.891*** (0.103)	-0.205*** (0.030)	-0.160*** (0.027)
2+ low scores on reading or math on PIAT tests (broader measure)	4,011	0.057*** (0.012)	-0.153*** (0.017)	-0.113*** (0.020)	-0.508*** (0.061)	-0.116*** (0.021)	-0.140*** (0.021)
2+ high scores on full scale BPI	3,577	0.031*** (0.009)	-0.088*** (0.014)	-0.069*** (0.017)	-0.237*** (0.046)	-0.061*** (0.018)	-0.107*** (0.019)
<i>Panel B: Household fixed effects sample</i>							
2+ low reading scores and 2+ low math scores on PIAT tests	2,591	0.120*** (0.025)	-0.160*** (0.032)	-0.170*** (0.035)	-0.963*** (0.141)	-0.209*** (0.036)	-0.162*** (0.032)
2+ low scores on reading or math on PIAT tests	2,591	0.068*** (0.014)	-0.168*** (0.022)	-0.105*** (0.024)	-0.491*** (0.081)	-0.128*** (0.026)	-0.142*** (0.025)
2+ high scores on full scale BPI	2,194	0.032*** (0.011)	-0.071*** (0.018)	-0.081*** (0.022)	-0.222*** (0.062)	-0.055** (0.024)	-0.098*** (0.025)

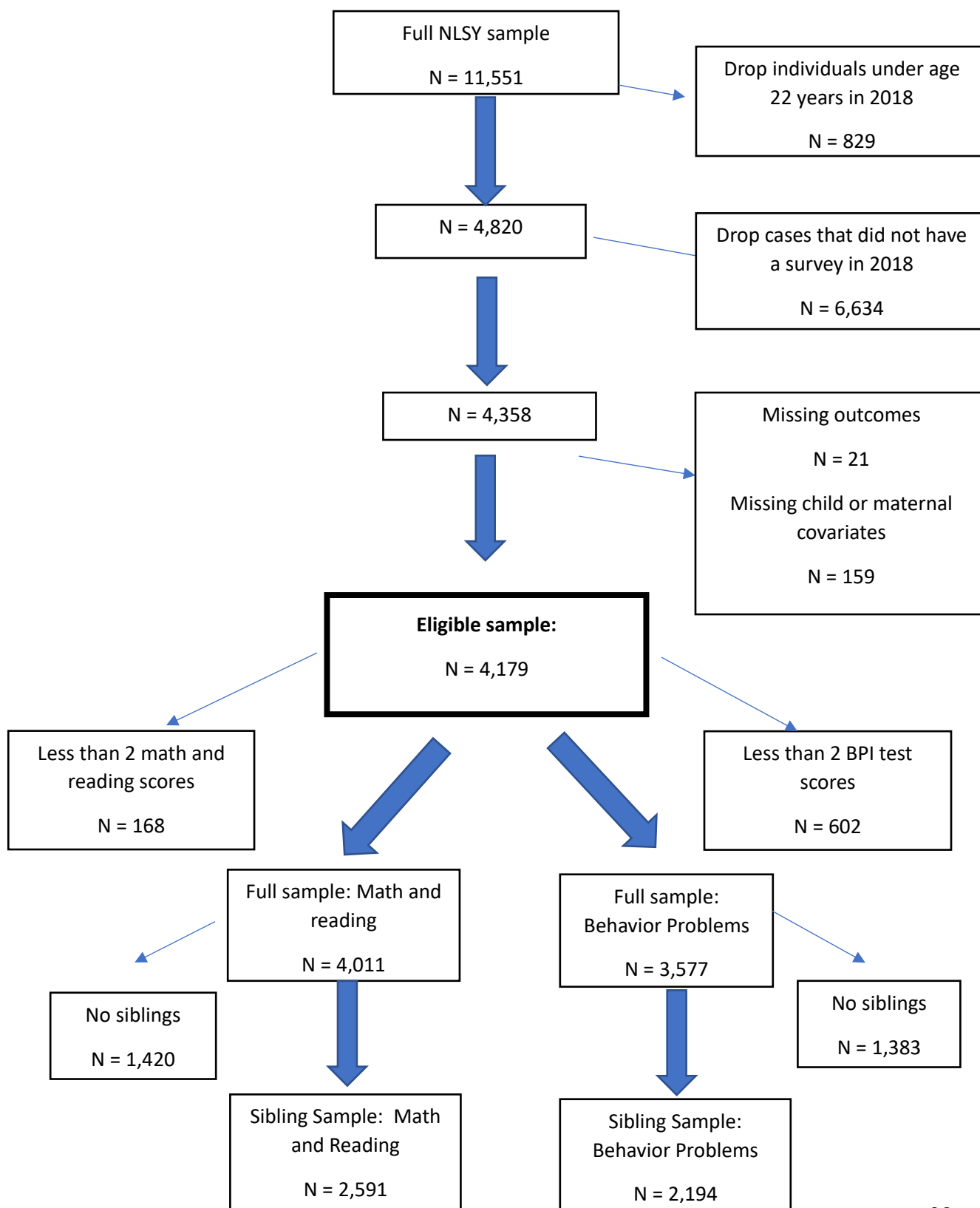
Notes: PIAT = Peabody Individual Achievement Test; BPI = Behavioral Problems Index; SE = Standard error; SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares coefficients and SEs. Each cell presents estimates from a different model specification. ***p<0.1; **p<0.05; *p<0.10. Models control for all child and maternal characteristics in Table 1. BPI models also control for the year of the respondent's first BPI assessment. ^aSample sizes for earnings are smaller than for the other outcomes owing to both missing data and number employed: N = 3,205 (Full PIAT Test sample); N = 1,829 (Household fixed effects PIAT Test sample); N = 2,886 (Full BPI sample), N = 1,574 (Household fixed effects BPI sample). PIAT and BPI scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when respondents' ages ranged from 22 to 46 years.

Table 3: Estimated effects of low cognitive test scores and high behavioral problem scores in childhood on adult economic outcomes at ages in 2018, household fixed effect models

	# of Children	# of Families	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
			Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ low reading scores and 2+ low math scores on PIAT tests (stringent measure)	2,591	1,112	0.118*** (0.035)	-0.090** (0.042)	-0.173*** (0.047)	-0.699*** (0.169)	-0.210*** (0.049)	-0.101** (0.044)
2+ low scores on reading or math on PIAT tests (broader measure)	2,591	1,112	0.063*** (0.019)	-0.114*** (0.030)	-0.070** (0.031)	-0.311*** (0.100)	-0.108*** (0.032)	-0.100*** (0.034)
2+ high scores on full scale BPI	2,194	955	0.033** (0.015)	-0.057** (0.028)	-0.087*** (0.033)	-0.160* (0.088)	-0.090** (0.036)	-0.042 (0.035)

Notes: PIAT = Peabody Individual Achievement Test; BPI = Behavioral Problems Index; SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares coefficients and standard errors (SEs). Each row presents estimates from a different model specification. ***p<0.1, **p<0.05, *p<0.10. Models control for gender, age, oldest sibling, mother married when respondent was born, and mother's age when respondent was born. BPI models also control for the year of the respondent's first BPI assessment. ^aSample sizes for earnings are smaller than for the other outcomes owing to both missing data and number employed: PIAT Test sample: Number of children = 1,829, number of families = 813. BPI sample: Number of children = 1,574, number of families = 703. PIAT and BPI scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when respondents' ages ranged from 22 to 46 years.

Figure 1: Derivation of Analysis Sample



Appendix Table 1: Estimated effects of low cognitive test scores in childhood and covariates on adult economic outcomes, OLS models using full sample

	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ low math scores and 2+ low reading scores on PIAT tests (stringent measure)	0.123*** (0.021)	-0.162*** (0.027)	-0.178*** (0.029)	-0.891*** (0.103)	-0.205*** (0.030)	-0.160*** (0.027)
Child characteristics						
Female	0.005 (0.006)	0.073*** (0.010)	-0.006 (0.013)	-0.273*** (0.033)	-0.011 (0.014)	0.046*** (0.015)
Age in 2018, years	0.002*** (0.001)	-0.006*** (0.001)	0.002 (0.002)	0.056*** (0.005)	0.012*** (0.002)	0.004** (0.002)
Oldest sibling	-0.009 (0.006)	0.027*** (0.010)	0.018 (0.014)	0.032 (0.039)	0.001 (0.016)	0.063*** (0.016)
Race/ethnicity						
Non-Hispanic Black	0.011 (0.008)	0.006 (0.014)	-0.014 (0.018)	-0.130*** (0.046)	-0.200*** (0.020)	-0.125*** (0.022)
Hispanic	-0.004 (0.009)	-0.036** (0.016)	-0.011 (0.020)	-0.045 (0.050)	-0.052** (0.021)	-0.015 (0.023)
Region of residence in 2018						
Northeast	0.003 (0.009)	-0.006 (0.016)	0.073*** (0.022)	0.013 (0.057)	-0.105*** (0.026)	0.027 (0.025)
North central	0.005 (0.008)	-0.008 (0.015)	0.050** (0.020)	-0.048 (0.053)	0.049** (0.022)	-0.035 (0.023)

	South	-0.003 (0.008)	-0.006 (0.014)	0.045** (0.019)	-0.067 (0.048)	0.034* (0.020)	-0.071*** (0.021)
Maternal characteristics							
	AFQT percentile score	-0.009 (0.012)	0.068*** (0.022)	0.036 (0.030)	0.280*** (0.079)	0.108*** (0.034)	0.295*** (0.036)
	Foreign born	0.003 (0.013)	0.056*** (0.021)	0.032 (0.027)	0.168** (0.068)	-0.005 (0.031)	0.105*** (0.031)
	Married when respondent was born	0.000 (0.010)	0.053*** (0.017)	0.036* (0.020)	0.133** (0.053)	0.044** (0.022)	0.071*** (0.022)
	Age (years) when respondent was born						
	< 20	0.008 (0.017)	-0.001 (0.031)	-0.012 (0.045)	0.241* (0.139)	0.043 (0.051)	-0.018 (0.052)
	20-34	0.005 (0.008)	0.002 (0.019)	0.017 (0.035)	0.493*** (0.114)	0.072* (0.041)	0.058 (0.040)
	Education						
	Less than high school	0.042*** (0.016)	-0.197*** (0.027)	-0.127*** (0.031)	-0.442*** (0.089)	-0.074** (0.033)	-0.147*** (0.033)
	High school graduate	0.006 (0.005)	-0.045*** (0.009)	-0.031* (0.016)	-0.088** (0.041)	0.002 (0.019)	-0.057*** (0.020)
	N	4011	4011	4011	3205	4011	4011

Notes: PIAT = Peabody Individual Achievement Test; SSI = Supplementary Security Income; AFQT = Air Force Qualifying Test. Estimates presented are Ordinary Least Squares (OLS) coefficients and standard errors (SEs). ***p<0.1, **p<0.05, *p<0.10. PIAT scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when respondents' ages ranged from 22 to 46. ^aSample sizes are lower due to number working and missing data.

Appendix Table 2: Estimated effects of high behavioral problem scores in childhood and covariates on adult economic outcomes, OLS models using full sample

	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owens Motor Vehicle	Has Credit Card
	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ high scores on full scale BPI	0.031*** (0.009)	-0.088*** (0.014)	-0.069*** (0.017)	-0.237*** (0.046)	-0.061*** (0.018)	-0.107*** (0.019)
Child characteristics						
Female	-0.002 (0.006)	0.064*** (0.010)	0.001 (0.013)	-0.241*** (0.036)	-0.002 (0.015)	0.050*** (0.015)
Age in 2018, years	0.005 (0.003)	-0.011** (0.005)	0.005 (0.007)	0.149*** (0.019)	0.019** (0.008)	0.019** (0.007)
Oldest sibling	-0.009 (0.006)	0.028*** (0.010)	0.017 (0.015)	0.044 (0.041)	0.012 (0.016)	0.065*** (0.017)
Race/ethnicity						
Non-Hispanic Black	0.014 (0.009)	0.010 (0.014)	-0.026 (0.019)	-0.215*** (0.050)	-0.217*** (0.022)	-0.128*** (0.023)
Hispanic	0.000 (0.009)	-0.037** (0.017)	-0.031 (0.021)	-0.087 (0.054)	-0.064*** (0.023)	-0.023 (0.024)
Region of residence in 2018						
Northeast	0.009 (0.009)	0.002 (0.017)	0.053** (0.023)	0.030 (0.062)	-0.103*** (0.028)	0.035 (0.026)
North central	0.006 (0.008)	0.002 (0.015)	0.048** (0.021)	-0.027 (0.056)	0.066*** (0.022)	-0.024 (0.024)
South	0.003 (0.007)	-0.001 (0.014)	0.044** (0.020)	-0.049 (0.051)	0.046** (0.021)	-0.062*** (0.022)

Maternal characteristics							
	AFQT percentile score	-0.020* (0.012)	0.081*** (0.023)	0.052* (0.031)	0.325*** (0.084)	0.116*** (0.036)	0.322*** (0.037)
	Foreign born	-0.012 (0.012)	0.054** (0.021)	0.060** (0.027)	0.114 (0.075)	0.004 (0.033)	0.091*** (0.033)
	Married when respondent was born	-0.006 (0.011)	0.043** (0.018)	0.026 (0.022)	0.107* (0.060)	0.051** (0.024)	0.075*** (0.024)
	Age (years) when respondent was born						
	< 20	0.009 (0.022)	-0.039 (0.040)	-0.044 (0.052)	0.312** (0.158)	0.002 (0.057)	-0.029 (0.059)
	20-34	0.008 (0.009)	-0.003 (0.019)	0.005 (0.037)	0.287** (0.120)	0.028 (0.043)	0.025 (0.042)
	Education						
	Less than high school	0.069*** (0.019)	-0.203*** (0.030)	-0.139*** (0.034)	-0.482*** (0.108)	-0.084** (0.037)	-0.174*** (0.036)
	High school graduate	0.006 (0.004)	-0.044*** (0.009)	-0.027* (0.016)	-0.072 (0.044)	0.008 (0.020)	-0.049** (0.020)
	N	3,577	3,577	3,577	2,866	3,577	3,577

Notes: BPI = Behavioral Problems Index; AFQT = Air Force Qualifying Test; SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares (OLS) coefficients and standard errors (SEs). Models controlled for the year of the respondent's first BPI assessment (estimates not shown). ***p<0.1, **p<0.05, *p<0.10. BPI scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when respondents' ages ranged from 22 to 46 years. ^aSample sizes are lower due to number working and missing data.

Appendix Table 3: Estimated effects of low cognitive test scores in childhood and covariates on adult economic outcomes, OLS models using household fixed effects sample

	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ low math scores and 2+ low reading scores on PIAT tests (stringent measure)	0.120*** (0.025)	-0.160*** (0.032)	-0.170*** (0.035)	-0.963*** (0.141)	-0.209*** (0.036)	-0.162*** (0.032)
Child characteristics						
Female	-0.002 (0.007)	0.073*** (0.012)	-0.027* (0.016)	-0.304*** (0.044)	-0.011 (0.017)	0.052*** (0.018)
Age in 2018, years	0.003*** (0.001)	-0.010*** (0.002)	0.001 (0.002)	0.054*** (0.006)	0.013*** (0.002)	0.001 (0.002)
Oldest sibling	-0.016* (0.008)	0.045*** (0.014)	0.042** (0.018)	0.096* (0.054)	0.011 (0.021)	0.077*** (0.021)
Race/ethnicity						
Non-Hispanic Black	0.014 (0.011)	0.014 (0.018)	-0.024 (0.022)	-0.163*** (0.062)	-0.178*** (0.026)	-0.139*** (0.027)
Hispanic	-0.007 (0.010)	-0.056*** (0.020)	-0.030 (0.025)	-0.114* (0.066)	-0.053** (0.027)	-0.032 (0.029)
Region of residence in 2018						
Northeast	0.004 (0.011)	-0.024 (0.021)	0.057** (0.028)	-0.013 (0.077)	-0.137*** (0.032)	0.060* (0.031)
North central	0.004 (0.010)	-0.003 (0.018)	0.043* (0.025)	-0.097 (0.069)	0.055** (0.026)	-0.024 (0.028)

	South	-0.008 (0.009)	-0.006 (0.018)	0.042* (0.023)	-0.140** (0.064)	0.018 (0.025)	-0.066** (0.026)
Maternal characteristics							
	AFQT percentile score	-0.014 (0.015)	0.065** (0.028)	0.014 (0.037)	0.247** (0.107)	0.173*** (0.043)	0.303*** (0.045)
	Foreign born	0.002 (0.016)	0.060** (0.029)	0.038 (0.034)	0.213** (0.088)	0.033 (0.039)	0.152*** (0.039)
	Married when respondent was born	0.018 (0.013)	0.083*** (0.023)	0.053** (0.027)	0.044 (0.071)	0.029 (0.029)	0.077*** (0.028)
	Age (years) when respondent was born						
	< 20	0.020 (0.023)	0.013 (0.041)	0.006 (0.059)	0.136 (0.177)	0.027 (0.064)	0.052 (0.063)
	20-34	-0.000 (0.011)	0.015 (0.023)	0.046 (0.044)	0.362*** (0.138)	0.075 (0.050)	0.099** (0.047)
	Education						
	Less than high school	0.021 (0.019)	-0.204*** (0.033)	-0.124*** (0.038)	-0.480*** (0.116)	-0.044 (0.040)	-0.187*** (0.040)
	High school graduate	0.002 (0.006)	-0.040*** (0.011)	-0.032* (0.019)	-0.085 (0.052)	0.025 (0.023)	-0.054** (0.024)
	N	2,591	2,591	2,591	1,829	2,591	2,591

Notes: PIAT = Peabody Individual Achievement Test; SSI = Supplementary Security Income; AFQT = Air Force Qualifying Test. Estimates presented are Ordinary Least Squares (OLS) coefficients and standard errors (SEs). ***p<0.1, **p<0.05, *p<0.10. PIAT scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when respondents' ages ranged from 22 to 46 years. *Sample sizes are lower due to number working and missing data.

Appendix Table 4: Estimated effects of high behavioral problem scores in childhood and covariates on adult economic outcomes, OLS models using household fixed effects sample

		SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
		Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ high scores on full scale BPI		0.032*** (0.011)	-0.071*** (0.018)	-0.081*** (0.022)	-0.222*** (0.062)	-0.055** (0.024)	-0.098*** (0.025)
Child characteristics							
	Female	-0.005 (0.007)	0.063*** (0.013)	-0.023 (0.017)	-0.296*** (0.049)	-0.005 (0.019)	0.060*** (0.019)
	Age in 2018, years	0.005 (0.004)	-0.009 (0.006)	-0.001 (0.009)	0.126*** (0.026)	0.015 (0.010)	0.018* (0.009)
	Oldest sibling	-0.017** (0.008)	0.051*** (0.015)	0.040** (0.020)	0.132** (0.062)	0.017 (0.023)	0.079*** (0.023)
Race/ethnicity							
	Non-Hispanic Black	0.016 (0.011)	-0.003 (0.018)	-0.028 (0.024)	-0.229*** (0.067)	-0.201*** (0.029)	-0.156*** (0.029)
	Hispanic	-0.001 (0.011)	-0.069*** (0.022)	-0.051* (0.028)	-0.137* (0.072)	-0.075** (0.030)	-0.071** (0.032)
Region of residence in 2018							
	Northeast	0.009 (0.011)	-0.013 (0.022)	0.035 (0.030)	-0.012 (0.087)	-0.133*** (0.036)	0.073** (0.033)
	North central	0.007 (0.009)	0.003 (0.019)	0.026 (0.026)	-0.085 (0.076)	0.065** (0.028)	-0.012 (0.030)
	South	-0.002 (0.009)	0.001 (0.019)	0.027 (0.025)	-0.127* (0.070)	0.016 (0.027)	-0.051* (0.028)

Maternal characteristics							
	AFQT percentile score	-0.030* (0.016)	0.064** (0.030)	0.043 (0.041)	0.370*** (0.116)	0.174*** (0.047)	0.307*** (0.048)
	Foreign born	-0.001 (0.015)	0.045 (0.030)	0.047 (0.036)	0.113 (0.100)	0.043 (0.042)	0.125*** (0.042)
	Married when respondent was born	0.022* (0.013)	0.079*** (0.025)	0.021 (0.029)	0.017 (0.082)	0.014 (0.032)	0.091*** (0.032)
	Age (years) when respondent was born						
	< 20	0.025 (0.033)	-0.035 (0.056)	0.006 (0.071)	0.300 (0.227)	-0.024 (0.076)	-0.010 (0.075)
	20-34	-0.003 (0.012)	-0.002 (0.022)	0.056 (0.049)	0.269* (0.146)	0.044 (0.053)	0.060 (0.050)
	Education						
	Less than high school	0.035* (0.021)	-0.200*** (0.038)	-0.136*** (0.044)	-0.442*** (0.147)	-0.029 (0.046)	-0.204*** (0.045)
	High school graduate	0.004 (0.005)	-0.033*** (0.011)	-0.028 (0.020)	-0.031 (0.056)	0.028 (0.025)	-0.053** (0.025)
	N	2,194	2,194	2,194	1,574	2,194	2,194

Notes: BPI = Behavioral Problems Index; AFQT = Air Force Qualifying Test; SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares (OLS) coefficients and standard errors (SEs). Models controlled for the year of the respondent's first BPI assessment (estimates not shown). ***p<0.1, **p<0.05, *p<0.10. BPI scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when respondents' ages ranged from 22 to 46 years. *Sample sizes are lower due to number working and missing data.

Appendix Table 5: Estimated effects of low cognitive test scores in childhood and child-specific covariates on adult economic outcomes, household fixed effects models

		SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
		Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
	2+ low math scores and 2+ low reading scores on PIAT tests (stringent measure)	0.118*** (0.035)	-0.090** (0.042)	-0.173*** (0.047)	-0.699*** (0.169)	-0.210*** (0.049)	-0.101** (0.044)
Child characteristics							
	Female	-0.006 (0.009)	0.072*** (0.015)	-0.029 (0.021)	-0.363*** (0.059)	-0.036* (0.021)	0.037* (0.022)
	Age in 2018, years	0.002 (0.002)	0.013*** (0.003)	0.007 (0.005)	0.051*** (0.011)	0.014*** (0.004)	0.009** (0.004)
	Oldest sibling	-0.008 (0.011)	0.032* (0.018)	0.008 (0.026)	0.081 (0.074)	0.007 (0.027)	0.039 (0.026)
Maternal characteristics							
	Married when respondent was born	0.029 (0.028)	0.073 (0.073)	0.052 (0.091)	-0.123 (0.196)	-0.073 (0.092)	0.034 (0.096)
	Age (years) when respondent was born						
	< 20	0.015 (0.031)	0.053 (0.053)	-0.081 (0.082)	0.160 (0.215)	0.082 (0.085)	0.035 (0.082)
	20-34	0.002 (0.018)	0.026 (0.035)	0.001 (0.062)	0.327** (0.164)	0.107 (0.066)	0.121* (0.062)
	# of children	2,591	2,591	2,591	1,829	2,591	2,591
	# of families	1,112	1,112	1,112	813	1,112	1,112

Notes: PIAT = Peabody Individual Achievement Test; AFQT = Air Force Qualifying Test; SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares (OLS) coefficients and standard errors (SEs). *** $p < 0.1$, ** $p < 0.05$, * $p < 0.10$. PIAT scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when respondents' ages ranged from 22 to 46 years. ^aSample sizes are lower due to number working and missing data.

Appendix Table 6: Estimated effects of high behavioral problem scores in childhood and child-specific covariates on adult economic outcomes, household fixed effects models

	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owens Motor Vehicle	Has Credit Card
	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ high scores on full scale BPI	0.033** (0.015)	-0.057** (0.028)	-0.087*** (0.033)	-0.160* (0.088)	-0.090** (0.036)	-0.042 (0.035)
Child characteristics						
Female	-0.006 (0.009)	0.065*** (0.015)	-0.027 (0.022)	-0.358*** (0.063)	-0.034 (0.024)	0.053** (0.022)
Age in 2018, years	-0.001 (0.005)	-0.007 (0.007)	0.013 (0.012)	0.123*** (0.030)	0.017 (0.013)	0.039*** (0.011)
Oldest sibling	-0.011 (0.011)	0.029 (0.018)	0.002 (0.028)	0.137* (0.082)	0.023 (0.030)	0.051* (0.028)
Maternal characteristics						
Married when respondent was born	0.039 (0.039)	0.052 (0.076)	0.055 (0.100)	-0.081 (0.217)	-0.085 (0.094)	0.124 (0.105)
Age (years) when respondent was born						
< 20	0.037 (0.044)	0.057 (0.071)	-0.063 (0.099)	0.315 (0.306)	0.035 (0.103)	0.089 (0.096)
20-34	0.014 (0.021)	0.031 (0.034)	0.018 (0.066)	0.202 (0.176)	0.124* (0.071)	0.102 (0.066)
# of children	2,194	2,194	2,194	1,574	2,194	2,194
# of families	955	955	955	703	955	955

Notes: BPI = Behavioral Problems Index. SSI = Supplementary Security Income. Estimates presented are OLS coefficients and SEs. ***p<0.1, **p<0.05, *p<0.10. BPI scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when ages ranged from 22 to 46 years. ^aSample sizes are lower due to number working and missing data.

Appendix Table 7: Estimated effects of specific types of low PIAT test scores in childhood on adult economic outcomes, household fixed effects models

	# of Children	# of Families	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
			Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ low math scores	2,458	1057	0.085*** (0.024)	-0.105*** (0.035)	-0.074* (0.038)	-0.472*** (0.121)	-0.152*** (0.038)	-0.100*** (0.036)
2+ low reading recognition scores	2,455	1056	0.095*** (0.029)	-0.091** (0.036)	-0.138*** (0.042)	-0.573*** (0.139)	-0.132*** (0.041)	-0.080** (0.040)
2+ low reading comprehension scores	2,365	1,020	0.095*** (0.027)	-0.100*** (0.037)	-0.136*** (0.042)	-0.226* (0.137)	-0.142*** (0.040)	-0.087** (0.041)

Notes: PIAT = Peabody Individual Achievement Test; SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares coefficients and standard errors (SEs). Each cell presents estimates from a different model specification. ***p<0.1, **p<0.05, *p<0.10. Models control for gender, age, oldest sibling, mother was married when respondent was born, and mother's age when the respondent was born. PIAT scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when ages ranged from 22 to 46 years. ^aSample sizes for earnings are smaller than for the other outcomes due to missing data and number employed: Number of children = 1,742 and number of families = 775 for math. Number of children = 1,741 and number of families = 775 for reading recognition. Number of children = 1,682 and number of families = 750 for reading comprehension.

Appendix Table 8: Estimated effects of high behavioral problem subscale scores in childhood on adult economic outcomes, household fixed effects models

Behavioral Problem Index (BPI) subscale	# of Children	# of Families	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
			Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ high scores on Antisocial assessments	2,190	954	0.019 (0.015)	-0.061*** (0.024)	-0.051* (0.029)	-0.086 (0.083)	-0.043 (0.034)	-0.037 (0.032)
2+ high scores on Anxious or depressed assessments	2,194	955	0.023 (0.015)	-0.055* (0.029)	-0.075** (0.033)	-0.066 (0.085)	-0.033 (0.036)	-0.054 (0.037)
2+ high scores on Headstrong assessments	2,194	955	0.023 (0.015)	0.002 (0.027)	-0.015 (0.034)	-0.211** (0.092)	-0.009 (0.039)	-0.057 (0.036)
2+ high scores on Hyperactive assessments	2,193	955	0.065*** (0.018)	-0.105*** (0.027)	-0.035 (0.034)	0.005 (0.103)	-0.064* (0.036)	-0.047 (0.034)
2+ high scores on Dependent assessments	1,839	919	-0.012 (0.020)	0.020 (0.030)	0.002 (0.033)	-0.067 (0.101)	-0.082** (0.039)	-0.051 (0.042)
2+ high scores on Peer conflict/withdrawn assessments	1,882	927	0.014 (0.012)	-0.045** (0.023)	-0.057* (0.029)	-0.219*** (0.080)	-0.017 (0.188)	0.297* (0.163)

Notes: SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares coefficients and standard errors (SEs). Each cell presents estimates from a different model specification. ***p<0.1, **p<0.05, *p<0.10. Models control for gender, age, oldest sibling, mother was married when respondent was born, mother's age when the respondent was born, and year of respondent's first BPI assessment. ^aSample sizes for earnings are smaller than for the other outcomes due to missing data and number employed: Number of children = 1,570 and number of families = 702 (Antisocial); number of children = 1,574 and number of families = 703 (Anxious or Depressed & Headstrong & Hyperactive); number of children = 1,357 and number of families = 684 (Peer conflict/withdrawn); number of children = 1,324 and number of families = 679 (Dependent). BPI scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when ages ranged from 22 to 46 years.

Appendix Table 9: Estimated effects of low cognitive test scores and high behavioral problem scores in childhood on adult economic outcomes at ages, household fixed effect models using different thresholds to determine low scores (for PIAT tests) and high scores (for BPI)

	Mean	SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
		Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
PIAT standardized scores below 85:							
2+ low math scores and 2+ low reading scores	8.72	0.118*** (0.035)	-0.090** (0.042)	-0.173*** (0.047)	-0.699*** (0.169)	-0.210*** (0.049)	-0.101** (0.044)
2+ low scores in reading or math	20.3	0.063*** (0.019)	-0.114*** (0.030)	-0.070** (0.031)	-0.311*** (0.100)	-0.108*** (0.032)	-0.100*** (0.034)
PIAT standardized scores below 80:							
2+ low math scores and 2+ low reading scores	4.09	0.171*** (0.053)	-0.094* (0.056)	-0.211*** (0.069)	-0.913*** (0.304)	-0.226*** (0.061)	-0.096 (0.065)
2+ low scores in reading or math	11.8	0.105*** (0.029)	-0.075** (0.036)	-0.098** (0.039)	-0.509*** (0.129)	-0.144*** (0.043)	-0.082** (0.040)
Number of children		2,591	2,591	2,591	1,829	2,591	2,591
Number of families		1,112	1,112	1,112	813	1,112	1,112
Behavioral problem scores above 85th percentile							

2+ high scores on full scale BPI	22.9	0.033** (0.015)	-0.057** (0.028)	-0.087*** (0.033)	-0.160* (0.088)	-0.090** (0.036)	-0.042 (0.035)
BPI scores above 90th percentile							
2+ high scores on full scale BPI	15.9	0.052*** (0.019)	-0.066** (0.033)	-0.102*** (0.037)	-0.188* (0.107)	-0.087** (0.041)	-0.107*** (0.039)
Number of children		2,194	2,194	2,194	1,574	2,194	2,194
Number of families		955	955	955	703	955	955

Notes: PIAT = Peabody Individual Achievement Test; BPI = Behavioral Problems Index; SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares coefficients and standard errors (SEs). Each cell presents estimates from a different model specification. ***p<0.1, **p<0.05, *p<0.10. Models control for gender, age, oldest sibling, mother married when respondent was born, and mother's age when respondent was born. BPI models also control for the year of the respondent's first BPI assessment. PIAT and BPI scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when ages ranged from 22 to 46 years. #Sample sizes are lower due to number working and missing data.

Appendix Table 10: Estimated effects of having both low cognitive test scores and high behavioral problem scores in childhood on adult economic outcomes, household fixed effect models

		SSI	High School Graduate (or more)	Employed	Log Earnings per year (if employed) ^a	Owns Motor Vehicle	Has Credit Card
	Mean	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
2+ low math scores and 2+ low reading scores on PIAT tests (standardized score below 85)	8.28	0.110** (0.048)	-0.124** (0.056)	-0.101* (0.062)	-0.481** (0.214)	-0.260*** (0.065)	-0.098 (0.065)
2+ high scores on full BPI scale (above the 85 th percentile)	23.08	0.027* (0.015)	-0.060** (0.028)	-0.051 (0.035)	-0.061 (0.091)	-0.085** (0.038)	-0.043 (0.038)
Low cognitive test scores and high BPI scores	3.38	0.017 (0.068)	0.071 (0.084)	-0.179** (0.086)	-0.448 (0.325)	0.079 (0.098)	0.063 (0.090)
Number of children		2,162	2,162	2,162	1,550	2,162	2,162
Number of families		941	941	941	692	941	941

Notes: PIAT = Peabody Individual Achievement Test; BPI = Behavioral Problems Index; SSI = Supplementary Security Income. Estimates presented are Ordinary Least Squares coefficients and standard errors (SEs). Each column presents estimates from a model that includes all three measures listed in the row headings and controls for gender, age, oldest sibling, mother was married when respondent was born, age of mother when respondent was born, and year of the respondent's first BPI assessment. *** p<0.1, ** p<0.05, * p<0.10. PIAT and BPI scores were assessed in multiple survey years between the ages of 5 and 14. Outcomes were measured in 2018, when ages ranged from 22 to 46 years.

^aSample sizes for earnings are smaller than for the other outcomes owing to both missing data and number employed.