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Reassessing the relationship between general intelligence and self-control in childhood

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ABSTRACT

Intelligence has consistently been recognized as a robust correlate of health, life success, and behavior. Evidence also suggests that intelligence may contribute to another key correlate of behavior: self-control. The current study builds on recent work in this area by examining the association between intelligence and self-control across multiple raters and when accounting for potential confounding influences not accounted for in prior research. Results based on a national sample of U.S. children indicates that higher scores for intelligence are associated with more self-control in both cross-sectional and longitudinal models, even when accounting for prior self-control, child executive functioning, maternal intelligence, and maternal self-control. Moreover, the association persisted across both teacher and mother ratings of child self-control. As such, these findings support and extend prior work examining the nexus between intelligence and self-control, and may explain why both traits are important for understanding success across a host of life outcomes in humans.

1. Intelligence and life success

In the wake of Spearman's century old observation that a single latent trait seemed to explain the inter-correlations between multiple cognitive domains, research on the topic of general intelligence has exploded (Deary, Penke, & Johnson, 2010; Jensen, 1998; Ritchie, 2015; Spearman, 1904, 1927). Decades of psychometric work have yielded increasingly precise measures of intelligence that are linked to a range of important life outcomes. Everything from health (Batty, Deary, & Gottfredson, 2007; Gottfredson, 2004; Luciano et al., 2010; Schou, Østergaard, Rasmussen, Rydahl-Hansen, & Phanareth, 2012), and mortality (Batty et al., 2009; Batty, Wennerstad, Smith, Gunnell, Deary, et al., 2007; Whalley & Deary, 2001), to occupational and career success (Gottfredson, 1997, 2003) has correlated with indicators of general intelligence.

Antisocial behavior and criminal activity are also no exception to the reach of intelligence, as variation on intelligence scores consistently correlate with tendencies to break the law and violate social norms (Herrnstein & Murray, 1994; Hirschi & Hindelang, 1977; Lynam, Moffitt, & Stouthamer-Loeber, 1993; Moffitt, Gabrielli, Mednick, & Schulsinger, 1981; Raine et al., 2005). Beaver, Schwartz, et al. (2013), for example, used a nationally representative sample to demonstrate that the IQ-crime relationship persisted even when utilizing a conservative measure of criminal behavior, for all race and gender subgroups. Moreover, low intelligence, in conjunction with a history of violence, has been found to account for racial disparities in arrest and incarceration rates (Beaver, DeLisi, Wright, Boutwell, Barnes, & Vaughn, 2013). In short, the relationship between intelligence and life outcomes (both legal and illegal) appears well supported.

Concurrently, researchers across several disciplines have produced a large body of evidence suggesting that another construct— self-control—also appears closely connected to general success in life, including engaging in prosocial behavior (and avoiding antisocial behavior), as well as accruing wealth and achieving economic stability (Gottfredson & Hirschi, 1990; Moffitt, Poulton, & Caspi, 2013; Moffitt et al., 2011; Pratt & Cullen, 2000). The ability to self-regulate impulsive desires represents a host of executive functions, including emotional, attentional, and inhibitory control, and the ability to pursue long-term goals (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013; Duckworth & Carlson, 2013; Gottfredson & Hirschi, 1990; Posner & Rothbart, 1998, 2007). Like intelligence, self-control has been used to explain similar life outcomes ranging from health and wealth, to crime and various forms of antisocial behavior (Moffitt et al., 2011; de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012).

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2. The intersection between intelligence and self-control

What is also becoming clear is that when pitted against one another as predictors of life success, both constructs—intelligence and self-control—remain relevant across long swaths of development. For example, Moffitt et al. (2011) found that low self-control in childhood was a predictor of a wide range of negative life outcomes for adults, independent of intelligence, social class, or family life. Physical and mental health, money-management and socioeconomic status, and criminal convictions were all significantly associated with self-control. Remarkably, variation in self-control predicted outcomes in adulthood about as well as intelligence and poor socioeconomic status in childhood. Other researchers have also reported evidence that self-control and intelligence are both associated with measures of academic achievement (Duckworth, Quinn, & Tsukayama, 2012). Specifically, intelligence accounts for changes in standardized achievement test scores over time, while self-control has been found to be more strongly associated with school grades. Duckworth et al. (2012) concluded that intelligence may influence an individual's ability to learn and solve problems independent of whether or not they receive instruction, yet self-control facilitates achievement by contributing to an individual's ability to study (a task which requires focus and allocation of time), complete tasks and assignments, and the tendency to take an active role in classroom participation.

Given the consistent importance of both intelligence and self-control for a variety of outcomes, researchers have considered whether one phenotype might directly impact the development of the other. In particular, scholars have argued that variation in levels of intelligence might impact individual variation in levels of self-control (Bridgett et al., 2013; Shamosh et al., 2008). In this regard, empirical research has indicated that intelligence may influence the development of self-control, detectable even in childhood. Studies of this nature began appearing in the literature nearly 25 years ago (e.g., Lynam et al., 1993), and research continues to focus on the link between intelligence and self-control today (e.g., Berg et al., 2014; Boisvert, Stadler, Vaske, Wright, & Nelson, 2013; Petkovsek & Boutwell, 2014). For example, Petkovsek and Boutwell (2014) found that higher scores on indicators of intelligence were associated with greater self-control in children when the two constructs were assessed at the same time. In a similar manner, other research finds that intellectual achievement accounts for later variation in levels of self-control during adolescence (Boisvert et al., 2013). Moreover, research examining delay of gratification—a key component of self-control—has linked it with intelligence in children (Mischel & Metzner, 1962) and adolescents (Funder & Block, 1989). Despite this accumulating evidence, there are important caveats regarding many of the studies that have assessed the potential influence of intelligence on self-control. Such concerns, detailed below, prompt additional research and guide the goals of the current study.

3. The current study

Intelligence and self-control represent two of the most important correlates of life success. Examined separately, deficiencies in either trait are associated with deviant and antisocial behaviors, as well as low achievement in one's career and personal endeavors. The overlap among the life outcomes and cognitive skills associated with both intelligence and self-control suggest that one trait may have a direct impact on the development of the other (Boisvert et al., 2013; Lynam et al., 1993; Petkovsek & Boutwell, 2014), but additional research is required before more definitive conclusions can be inferred. Specifically, while prior work suggests intelligence may influence self-control, the current study represents one of the few attempts to examine the longitudinal association between the two constructs; most studies have examined the association using cross-sectional data (e.g., Berg et al., 2014; Lynam et al., 1993; Petkovsek & Boutwell, 2014; but see Boisvert et al., 2013).

In addition, the current study examines this association using multiple informants to measure child self-control and when accounting for a range of key covariates. Specifically, we make use of both teacher and mother reports of child and adolescent self-control in order to assess the robustness of the association between intelligence and self-control. Further, we account for important covariates (i.e., maternal intelligence, maternal low self-control, and child executive functioning), and consider whether the association between intelligence and self-control remains when controlling for prior self-control. Accounting for such variables is critical given their known associations with both intelligence and self-control, yet we are unaware of any prior work that has accounted for each of these potential confounding influences within the same study. Thus, the current study provides a number of important advances over prior work and provides a rigorous assessment of the potential influence of intelligence on self-control. Furthermore, it is important to note that, given the heightened awareness of the need to replicate prior work in the psychological sciences in recent years (Open Science Collaboration, 2015; Ritchie, Wiseman, & French, 2012; Schmidt, 2009), the opportunity to further examine extant findings in a more rigorous manner with new data is a critically important enterprise.

4. Methods

4.1. Data

Data for this study were drawn from the National Institute of Child Health and Human Development's Study of Early Child Care and Youth Development (SECCYD), which was conducted from 1991 through 2007. As detailed below, these data are well suited to assessing the short and long-term association between child intelligence and self-control. In particular, they enable us to temporally distinguish our key variables: child intelligence was assessed during fourth grade, while child self-control was assessed by teachers during fourth grade, fifth grade, and sixth grade and by mothers at fourth grade, fifth grade, sixth grade, and at age 15. Further, key background variables, including maternal intelligence, maternal low self-control, and parental socialization, were assessed prior to the measurement of child intelligence.

Study families were originally recruited for inclusion in the SECCYD at hospitals in ten cities that were selected after the lead investigators reviewed applications submitted by researchers at major universities across the continental United States. The sites were selected on the basis of the quality of the applications received, and although the data cannot be considered nationally-representative, the selected sites represent a diverse set of cities: Little Rock, AR; Irvine, CA; Lawrence, KS; Wellesley, MA; Philadelphia, PA; Pittsburgh, PA; Morganton, NC; Charlottesville, VA; Seattle, WA; and Madison, WI.

Of the families eligible for inclusion, 3015 families were conditionally randomly sampled based on recent births at hospitals in the ten cities. These families were contacted for an interview two weeks after the birth of the target child,[1] but some could not be reached or refused to participate, while others experienced circumstances that interfered with participation (e.g., the child remained in the hospital for an extended period). The total number of eligible families willing to participate was 1526. One month after the target child's birth, 1364 (89%) families completed the first interview and were enrolled in the long-term study. Over the next 15 years, data were collected from the parents (most often mothers), the child, teachers, and others, with the last data collection period occurring when study children were 15 years old. For the current study, we utilize data up to and including the age 15 assessment period.

As is true with any longitudinal, multi-site study, some families dropped out, and both wave and item missing data were evident. Of

[1] The conditioning assured representation (at least 10% marginally) of single parent households, mothers with less than a high school education, and ethnic minority mothers.

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the 1364 families who initially comprised the study sample shortly after the birth of each target child, approximately 1000 remained by the time children reached age 15. As an additional point of emphasis, our analyses make use of data reported on by mothers, different teachers, and standardized laboratory assessments. While beneficial from an analytical standpoint, the use of multi-method, multi-informant data further contributes to missing data. To consider whether attrition and/or item/wave missing was selective up to age 15, we constructed a dummy variable, where a value of 1 indicated a case was missing data for *any* variable in our analyses, and where a value of 0 indicated a case had complete data for the *entirety* of our analyses. We correlated this dummy variable with five demographic and background variables assessed at the very start of the SECCYD: child sex, child race, maternal education, family structure, and maternal age. There was evidence of selective attrition, as cases who dropped out of the study by age 15 or had item/wave missing data were more likely to be male ($r = 0.06$, $p < 0.05$), more likely to be non-white ($r = 0.12$, $p < 0.05$), more likely to score lower on maternal education at the time of the child's birth ($r = 0.13$, $p < 0.05$), less likely to come from a two-parent nuclear family ($r = -0.13$, $p < 0.05$) and more likely to be younger mothers ($r = 0.14$, $p < 0.05$). We control for each of these variables in our analyses, but readers should keep in mind the selective sample attrition when interpreting our results; we comment further on the selective attrition later in the paper.

5. Measures

5.1. Child intelligence

For this study child intelligence was measured during the fourth grade based on scores from the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999), a short estimate of general cognitive abilities that has been used in a number of prior studies (e.g., Duckworth et al., 2012; Russo, De Pascalis, Varriale, & Barratt, 2008).[2] For the SECCYD, four subtests were administered at fourth grade: Vocabulary (ability to name objects and define words), Block Design (ability to copy abstract designs using blocks), Similarities (ability to describe similarities between two concepts), and Matrix Reasoning (nonverbal reasoning and visual organizational skills). From the four subtests, a Full Scale IQ score was computed by SECCYD researchers by first converting raw scores to T-scores for each subtest and then summing the T-scores and converting summed scores to an overall IQ score. Actual scores in the sample range from 62 to 147, with higher values indicating a higher IQ and greater cognitive abilities.

5.2. Child self-control

The measure for self-control used in this study is based on 9 items drawn from the Child Behavior Checklist (CBCL; Achenbach, 1991), which was completed by different teachers at fourth, fifth, and sixth grades and by mothers at fourth, fifth, and sixth grades as well as at age 15.[3] Items from the CBCL have frequently been used to measure self-control (e.g., Boisvert et al., 2013; Hay & Forrest, 2006; Meldrum, Young, Hay, & Flexon, 2012). For this study, nine items were selected that closely parallel those appearing in Chapple (2005) and Boisvert et al. (2013): "Child bullies, is cruel, or mean," "Child does not feel guilty after misbehaving," "Child is impulsive or acts without thinking," "child is restless, overly active, or cannot sit still," "Child is stubborn, sullen, or irritable," "Child has strong temper," "Child cheats or tells lies," "Child argues too much," and "Child has difficulty concentrating or cannot pay attention."

Given that individuals who are low in self-control are described as impulsive, insensitive, risk-seeking, short-sighted, physical-oriented, and short-tempered (see Gottfredson & Hirschi, 1990, p. 90), the above items are well suited for serving as indicators of self-control. For each of the items, responses ranged from "Not True" ($=0$) to "Often True" ($=2$). All items were reverse-coded and averaged together at each of the assessment points (separately for both teacher and mother reports) to create an aggregated score, with higher values reflecting greater self-control. The scale demonstrated adequate reliability across all assessments ($\alpha = 0.88$ fourth grade teacher report; 0.87 fifth grade teacher report; 0.87 sixth grade teacher report; 0.81 fourth grade mother report; 0.82 fifth grade mother report; 0.81 sixth grade mother report; 0.83 age 15 mother report).

5.3. Control variables

Several important control variables were included in the analysis, focusing on both the mother and child. First, maternal intelligence was assessed using standardized scores for the Peabody Picture Vocabulary Test - Revised (PPVT-R; Dunn & Dunn, 1981), completed by mothers when their children were three years old. The PPVT-R is a written multiple choice test that assesses verbal intelligence through measuring an individual's receptive knowledge of vocabulary (D'Amato, Gray, & Dean, 1988); higher scores on the PPVT-R indicate greater verbal intelligence. Indicative of its construct validity, it is strongly correlated with the measure of child intelligence previously described ($r = 0.54$).

Second, we constructed a measure of maternal low self-control assessed when study children were six months old. Controlling for maternal low self-control is important given evidence of the intergenerational transmission of self-control (Boutwell & Beaver, 2010; Meldrum, Young, & Lehmann, 2015; Nofziger, 2008). In the absence of a standard measure of maternal impulsivity or self-control in the SECCYD data, we selected four items from the Neuroticism-Extraversion-Openness Inventory (Costa & McCrae, 1989) to measure maternal low self-control. The four items were: "I often get into arguments with my family and co-workers," "I often get angry at the way people treat me," "Too often, when things go wrong, I get discouraged and feel like giving up," and "I often feel helpless and want someone else to solve my problems." For each item, mothers answered on a scale from "strongly disagree" ($=1$) to "strongly agree" ($=5$). For the analysis, the scores for the four items were averaged together, with higher scores indicative of lower maternal self-control ($\alpha = 0.70$).

To be clear, we recognize that the measure we constructed may only serve as a proxy for maternal low self-control. That being said, the selected items are consistent with conceptualizations of low self-control that reflect being insensitive to others, being easily angered, lacking persistence in tasks, and having low frustration tolerance (Gottfredson & Hirschi, 1990; Moffitt et al., 2013). Furthermore, as would be expected from a valid measure of maternal low self-control, it is negatively associated with maternal education ($r = -0.25$), negatively associated with maternal intelligence ($r = -0.22$), and negatively associated with child self-control (rs ranging from -0.17 to -0.27). This, despite the fact that there was nearly a 10-year gap between the measurement of maternal low self-control and child self-control starting at fourth grade.

Third, child executive functioning was assessed during third grade using the Tower of Hanoi (TOH) procedure (see Welsh, 1991), which obtains a measure of the child's planning and problem solving skills. The TOH procedure involves moving three rings of different diameters

[2] In supplementary analyses we report results when the measure for intelligence is based on standardized scores for nine different Woodcock-Johnson Psycho-educational Battery -Revised (WJ-R; Woodcock & Johnson, 1989) tests administered at third grade. The nine tests administered were: memory for names, memory for sentences, picture vocabulary, verbal analogies, letter-word identification, passage comprehension, calculation, applied problems, and word attack. Using standardized scores for each test, we created an indicator for intelligence at third grade by averaging together the scores for the nine separate tests ($\alpha = 0.91$). As will be discussed later in the paper, the same substantive conclusions emerged using this alternative indicator for child intelligence.

[3] The CBCL was not administered to teachers after the sixth grade, which is why teacher reports of child self-control are limited to the fourth through sixth grades. As a further point of clarification, data collection at age 15 was the only major point of data collection following data collection during the sixth grade, which is why there is a 3-year gap for the maternal reports.

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and colors among three vertical pegs. The rings are presented in an initial configuration, and the goal is to move the rings among the three pegs in order to construct a tower on a specified peg, such that the rings are ordered by size with the largest ring on the bottom and the smallest on the top. The movement of the rings is constrained by three rules: (1) only one ring can be moved at a time; (2) larger rings cannot be placed on smaller rings; and (3) a ring must be on a peg or in the player's hand. To complete this task successfully, the individual must not only construct the tower but also do so in the fewest number of moves. The TOH procedure has been used among children, adolescents, and young adults (see Borys, Spitz, & Dorans, 1982). For the analysis we used the total planning efficiency score created by the SECCYD research team, which ranged from 0 to 35, with higher scores indicative of greater executive functioning at third grade.

Fourth, we controlled for a 19-item measure of parental socialization based on two different inventories administered at third grade to mothers. Items reflect the degree of attachment between mothers and their child (e.g., "I share affection and have a warm relationship with my child"), maternal monitoring practices (e.g., "You let your child watch whatever television he or she wants" [reverse-coded]), and maternal disciplinary practices (e.g., "You show you understand the child's feelings before you punish him or her"). The 19 items (some of which were reverse-coded) were first standardized, as the 6 items tapping attachment were measured on a different scale (1 = definitely does not apply, 5 = definitely applies) than the 13 items tapping monitoring and discipline (1 = definitely no, 4 = definitely yes). After standardizing each of the items, an average was taken and used as the measure for parental socialization, where higher scores reflect greater attachment, monitoring, and effective disciplinary practices ($\alpha = 0.77$).

In addition, five demographic and background variables were also included as controls. Specifically, we controlled for child sex (Male = 1) and child race (Non-White = 1); we utilized a dichotomous measure for race given that <20% of the sample was a race other than White/Caucasian. Maternal education was assessed when children were one month old using an ordinal coding scheme ranging from a low score of 7 (7th grade) to a high score of 21 (doctoral degree). Maternal age was measured in whole years when the child was born. Last, we included a dichotomous indicator for family structure at the time the child was born (1 = two-parent nuclear family, 0 = all others). Given the birth cohort design of the SECCYD, age was treated as a constant. Table 1 provides the descriptive statistics for each of the variables included in the analysis.

Table 1
Descriptive statistics.

Variable	N	Mean	SD	Min	Max
Child sex (1 = male)	1364	0.52	–	0	1
Child race (Non-White = 1)	1364	0.20	–	0	1
Maternal education at birth	1364	14.23	2.51	7	21
Family structure at birth	1364	0.71	–	0	1
Maternal age at birth	1364	28.11	5.63	18	46
Maternal low self-control at 6 months	1273	2.20	0.67	1	5
Maternal intelligence at age 3	1167	99.01	18.35	40	159
Parental socialization at grade 3	1028	−0.001	0.44	−2.41	0.82
Child executive functioning at grade 3	1011	17.18	7.69	0	35
Child intelligence at grade 4	1012	106.86	14.44	62	147
Teacher reported child self-control (untransformed values)					
Self-control at grade 4	915	1.73	0.39	0.11	2.00
Self-control at grade 5	930	1.72	0.38	0	2.00
Self-control at grade 6	858	1.74	0.37	0	2.00
Mother reported child self-control (untransformed values)					
Self-control at grade 4	1022	1.65	0.33	0.33	2.00
Self-control at grade 5	1020	1.69	0.33	0.33	2.00
Self-control at grade 6	1023	1.71	0.31	0.11	2.00
Self-control at age 15	975	1.74	0.32	0.11	2.00

6. Plan of analysis

Our primary aim was to assess the short and long-term association between child intelligence and child self-control when accounting for each of the aforementioned covariates.

To accomplish this, we estimated a series of OLS regression equations where child self-control was regressed on child intelligence and each of the nine covariates. As child self-control was assessed at three separate points in time based on teacher reports, three OLS regression equations pertain to teacher-reported self-control assessed at fourth, fifth, and sixth grades. Mother-reported child self-control, however, was assessed at four separate points in time. Thus, four OLS regression equations pertain to mother-reported self-control assessed at fourth, fifth, and sixth grades, as well as at age 15. For both the teacher-reported models and mother-reported models, we began by first estimating the contemporaneous association between child intelligence and child self-control during fourth grade, along with each of the covariates. We then proceeded to lag the dependent variable for the assessments of self-control during fifth and sixth grades for teacher-reported self-control and during fifth and sixth grades and at age 15 for mother-reported self-control. This plan of analysis, then, provides an assessment of the contemporaneous and longitudinal association between child intelligence and child self-control across both teacher and mother reports.

Before presenting the results of our analysis, it is important to point out that for each of the assessments of teacher-reported and mother-reported self-control, the distribution of scores exhibited substantive negative skew. To reduce this skew and help to normalize the distributions of self-control scores, we first reflected scores by adding 1.00 to the largest value for self-control across each assessment (2.00) and then subtracting the self-control score for each child. After reflecting the scores, we then computed the inverse of the reflected scores (1.00 divided by the reflected score). This procedure, then, produces a self-control score across each assessment with a possible range of values from 0 to 1. This range of values based on the transformation employed should be kept in mind when interpreting the unstandardized regression coefficients and confidence intervals presented.

7. Results

The results based on the teacher-reports of self-control are presented in Table 2. Beginning with model 1 examining the contemporaneous association between child intelligence and child self-control during fourth grade, the results indicate child intelligence is positively associated with child self-control ($\beta = 0.15$, $p < 0.001$). Several of the covariates are also associated with child self-control. Child executive functioning ($\beta = 0.12$, $p < 0.001$) maternal age at birth ($\beta = 0.11$, $p < 0.01$), a nuclear family structure ($\beta = 0.09$, $p < 0.05$) and parental socialization ($\beta = 0.09$, $p < 0.01$) are each positively associated with child self-control, while being male ($\beta = -0.19$, $p < 0.001$) and non-White ($\beta = -0.10$, $p < 0.01$) are each negatively associated with child self-control. The model accounts for 20% of the variation in self-control during fourth grade.

The results are very similar for Model 2, which lags the dependent variable by one year. Child intelligence during fourth grade is positively associated with child self-control during fifth grade ($\beta = 0.13$, $p < 0.01$). Also similar to Model 1, being male ($\beta = -0.23$, $p < 0.001$) and non-White ($\beta = -0.08$, $p < 0.05$) are each negatively associated with self-control; maternal low self-control ($\beta = -0.10$, $p < 0.01$) is also negatively associated with self-control in Model 2. Child executive functioning ($\beta = 0.11$, $p < 0.01$) remains positively associated with child self-control. Model 2 accounts for 15% of the variation in self-control during fifth grade.

Model 3, which lags the dependent variable by two years, produce results consistent with Model 1 and Model 2 with regard to the association between child intelligence and child self-control – child intelligence during fourth grade remains positively associated with child

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Table 2
OLS regressions of teacher reported child self-control at G4, G5, and G6 on child intelligence at G4 and controls.

Predictors	Model 1: self-control G4 (N = 762)[a]			Model 2: self-control G5 (N = 773)[a]			Model 3: self-control G6 (N = 718)[a]		
	b	95% CI	B	b	95% CI	B	b	95% CI	B
Child sex (male = 1)	−0.066***	(−0.089, −0.043)	−0.19	−0.082***	(−0.106, −0.059)	−0.23	−0.093***	(−0.116, −0.070)	−0.27
Child race (Non-White = 1)	−0.049**	(−0.085, −0.013)	−0.10	−0.039*	(−0.076, −0.001)	−0.08	−0.047*	(−0.083, −0.011)	−0.10
Maternal education	0.001	(−0.006, 0.007)	0.01	−0.001	(−0.008, 0.005)	−0.02	−0.000	(−0.007, 0.006)	−0.01
Nuclear family structure at birth	0.037*	(0.005, 0.068)	0.09	−0.009	(−0.042, 0.024)	−0.02	0.013	(−0.019, 0.044)	0.03
Maternal age at birth	0.004**	(0.001, 0.006)	0.11	0.002	(−0.001, 0.004)	0.05	0.001	(−0.001, 0.004)	0.04
Maternal low self-control	−0.016	(−0.034, 0.003)	−0.06	−0.027**	(−0.046, −0.007)	−0.10	−0.014	(−0.033, 0.005)	−0.05
Maternal intelligence	−0.000	(−0.001, 0.001)	−0.01	0.001	(−0.000, 0.002)	0.06	0.000	(−0.001, 0.001)	0.01
Parental socialization at G3	0.036**	(0.009, 0.063)	0.09	0.004	(−0.025, 0.033)	0.01	0.022	(−0.005, 0.050)	0.05
Child executive functioning at G3	0.003***	(0.001, 0.004)	0.12	0.0025**	(0.001, 0.004)	0.11	0.0024**	(0.001, 0.004)	0.10
Child intelligence at G4	0.0020***	(0.0010, 0.0029)	0.15	0.0017**	(0.0007, 0.0027)	0.13	0.0026***	(0.0016, 0.0036)	0.21
Adjusted R^2			0.20			0.15			0.21

b = unstandardized regression coefficient; CI = confidence interval; B = standardized regression coefficient.
[a] Values reflected and inversed to reduce skew.
* $p < 0.05$ (two-tailed).
** $p < 0.01$ (two-tailed).
*** $p < 0.001$ (two-tailed).

self-control during sixth grade (β = 0.21, $p < 0.001$); the same is true for child executive functioning (β = 0.10, $p < 0.01$). In addition, being male (β = −0.27, $p < 0.001$) and non-White (β = −0.10, $p < 0.01$) each remain negatively associated with child self-control. By sixth grade, the effect of maternal low self-control is no longer significant. Model 3 accounts for 21% of the variation in child self-control during sixth grade.

Having found significant cross-sectional and longitudinal associations between child intelligence and child self-control based on teacher-reports of self-control, attention next turned to investigating these associations when based on mother-reports of self-control. These results are presented in Table 3. Beginning with Model 1 examining the contemporaneous association between child intelligence and child self-control during fourth grade, the results indicate child intelligence is positively associated with child self-control (β = 0.17, $p < 0.001$). In addition, maternal age at birth (β = 0.14, $p < 0.001$) and parental socialization (β = 0.15, $p < 0.001$) are each positively associated with self-control, while being male (β = −0.08, $p < 0.01$) and maternal low self-control (β = −0.19, $p < 0.001$) are each negatively associated with self-control. The model accounts for 16% of the variation in mother-reported self-control during fourth grade.

Moving to Model 2, which lags the dependent variable by one year, the results provide additional evidence of an association between child intelligence and child self-control. In particular, child intelligence during fourth grade is positively associated with child self-control during fifth grade (β = 0.12, $p < 0.01$). Also similar to Model 1, being male (β = −0.07, $p < 0.05$) and maternal low self-control (β = −0.18, $p < 0.001$) are each negatively associated with self-control, while being non-White (β = 0.11, $p < 0.01$), maternal age at birth (β = 0.15, $p < 0.001$), and parental socialization (β = 0.17, $p < 0.001$) are each positively associated with self-control. Model 2 accounts for 14% of the variation in mother-reported self-control during fifth grade.

Model 3, which lags the dependent variable by two years, produce results consistent with Model 1 and Model 2 with regard to the association between child intelligence and child self-control – child intelligence

Table 3
OLS regressions of mother reported child self-control at G4, G5, G6, and age 15 on child intelligence at G4 and controls.

Predictors	Model 1: self-control G4 (N = 864)[a]			Model 2: self-control G5 (N = 848)[a]			Model 3: self-control G6 (N = 846)[a]			Model 4: self-control Age 15 (N = 811)[a]		
	b	95% CI	B	b	95% CI	B	b	95% CI	B	b	95% CI	B
Child sex (male = 1)	−0.026*	(−0.046, −0.005)	−0.08	−0.022*	(−0.043, −0.001)	−0.07	−0.025*	(−0.046, −0.005)	−0.08	−0.012	(−0.034, 0.009)	−0.04
Child race (Non-White = 1)	0.030	(−0.002, 0.061)	0.06	0.048**	(0.016, 0.081)	0.11	0.027	(−0.006, 0.059)	0.06	0.011	(−0.022, 0.045)	0.03
Maternal education	0.002	(−0.004, 0.008)	0.03	0.005	(−0.001, 0.011)	0.07	0.001	(−0.004, 0.007)	0.02	0.003	(−0.003, 0.009)	0.05
Nuclear family structure at birth	0.006	(−0.022, 0.034)	0.02	−0.002	(−0.031, 0.027)	−0.01	0.013	(−0.015, 0.042)	0.04	0.000	(−0.029, 0.030)	0.00
Maternal age at birth	0.004***	(0.002, 0.006)	0.14	0.004***	(0.002, 0.007)	0.15	0.004**	(0.002, 0.006)	0.13	0.003**	(0.001, 0.006)	0.11
Maternal low self-control	−0.047***	(−0.064, −0.031)	−0.19	−0.045***	(−0.062, −0.028)	−0.18	−0.050***	(−0.067, −0.033)	−0.20	−0.057***	(−0.075, −0.040)	−0.23
Maternal intelligence	−0.001	(−0.001, 0.0001)	−0.08	−0.001	(−0.002, 0.0001)	−0.08	−0.001*	(−0.002, −0.0001)	−0.10	−0.001**	(−0.002, −0.0004)	−0.14
Parental socialization at G3	0.059***	(0.035, 0.084)	0.15	0.068***	(0.043, 0.093)	0.17	0.051***	(0.026, 0.076)	0.13	0.058***	(0.032, 0.083)	0.15
Child executive functioning at G3	0.001	(−0.0001, 0.003)	0.06	0.001	(−0.0004, 0.002)	0.04	0.001	(−0.0009, 0.002)	0.03	0.001	(−0.00001, 0.003)	0.06
Child intelligence at G4	0.0020***	(0.0011, 0.0028)	0.17	0.0014**	(0.0004, 0.0023)	0.12	0.0015**	(0.0006, 0.0025)	0.13	0.0017***	(0.0008, 0.0026)	0.15
Adjusted R^2			0.16			0.14			0.13			0.14

b = unstandardized regression coefficient; CI = confidence interval; B = standardized regression coefficient.
[a] Values reflected and inversed to reduce skew.
* $p < 0.05$ (two-tailed).
** $p < 0.01$ (two-tailed).
*** $p < 0.001$ (two-tailed).

during fourth grade remains positively associated with child self-control during sixth grade ($\beta = 0.13$, $p < 0.01$). In addition, being male ($\beta = -0.08$, $p < 0.05$) and maternal low self-control ($\beta = -0.20$, $p < 0.001$) each remain negatively associated with child self-control, whereas maternal age at birth ($\beta = 0.13$, $p < 0.01$) and parental socialization ($\beta = 0.13$, $p < 0.001$) each remain positively associated with self-control. A somewhat anomalous result is also produced in that maternal intelligence is negatively associated with self-control ($\beta = -0.10$, $p < 0.05$). Model 3 accounts for 13% of the variation in mother-reported self-control during sixth grade.

Model 4, which lags self-control by approximately five years, again provides evidence of a significant longitudinal association between child intelligence and self-control. Specifically, net of all covariates, there is a significant, positive association between child intelligence during fourth grade and adolescent self-control at age 15 ($\beta = 0.15$, $p < 0.001$). In addition, maternal age at birth ($\beta = 0.11$, $p < 0.01$) and parental socialization ($\beta = 0.15$, $p < 0.001$) each remain positively associated with self-control, while maternal low self-control ($\beta = -0.23$, $p < 0.001$) and maternal intelligence each remain negatively associated with self-control ($\beta = -0.14$, $p < 0.01$). Model 4 accounts for 14% of the variation in mother-reported self-control at age 15.

7.1. Supplementary analyses

The results above provide compelling evidence of a significant association between child intelligence and child self-control that persists over time and across informants when accounting for key covariates. In this regard, we conducted three additional sets of supplemental analyses to further probe this association. First, to see how well the results would replicate when using a different measure of intelligence, we substituted the WASI measure for intelligence from fourth grade with a third grade measure of intelligence (referred to in a prior footnote) based on scores for nine Woodcock-Johnson Revised (WJ-R) tests; as would be expected, the WASI and WJ-R scores were highly correlated ($r = 0.77$). Using the WJ-R measure in place of the WASI, we examined the lagged association between intelligence at third grade and each of the teacher-reported (fourth, fifth, and sixth grades) and mother-reported (fourth, fifth, sixth grades, and age 15) indicators of self-control when controlling for the same covariates included in our main analyses. The results of this supplementary set of analyses revealed a statistically significant effect of intelligence at third grade on teacher-reported self-control at grades four through six (all βs > 0.11, $p < 0.01$). Likewise, statistically significant effects were found for the models based on maternal-reported self-control, though the effect sizes were slightly smaller (average $\beta = 0.09$, $p < 0.05$). Thus, the same pattern of results emerged using an alternative measure of intelligence.

Second, we re-estimated all of the models presented in Tables 2 and 3 when controlling for prior child self-control assessed during the third grade (teacher-reported and mother-reported self-control, respectively) to guard against the possibility that prior self-control could be driving the observed associations between child intelligence and self-control. Informatively, with the exception of the model predicting maternal-reported self-control at fifth grade, all other models indicated that a statistically significant association ($p < 0.05$) between child intelligence and self-control remained when accounting for prior self-control. Specifically, the standardized effects for the association between child intelligence at fourth grade and teacher-reported self-control were as follows: 0.09 (predicting self-control at fourth grade); 0.08 (predicting self-control at fifth grade); 0.17 (predicting self-control at sixth grade). The standardized effects for the association between child intelligence at fourth grade and mother-reported self-control were as follows: 0.09 (predicting self-control at fourth grade); 0.04 (predicting self-control at fifth grade, non-significant); 0.07 (predicting self-control at sixth grade); 0.09 (predicting self-control at age 15).

A third set of supplemental analyses considered whether child intelligence is associated with *growth* in self-control among the study children. Considering this question requires analytical methods such as growth curve modeling, which enables researchers to not only assess whether child intelligence is associated with self-control at an initial assessment (i.e. fourth grade), but whether child intelligence is associated with growth parameters for self-control. In this regard we estimated second-order latent growth curves for self-control separately for the teacher-reported assessments and the mother-reported assessments. These models are provided in Appendix A and Appendix B, and we briefly describe here what they reveal.

The unconditional growth curve model for teacher-reported self-control showed considerable variation between individuals in their levels of self-control (i.e. the intercept variance), but no differences between individuals in their rate of change over time (i.e. the slope variance). The finding that there was no evidence of growth in self-control from fourth through sixth grades is a result not altogether unexpected given that the mean values for teacher-reported self-control reported in Table 1 exhibited little change across the three waves. Regarding the conditional growth curve model for the teacher-reports of self-control, the findings indicated, as did our OLS models, that child intelligence was significantly associated with self-control, net of all covariates. Specifically, individuals with higher levels of child intelligence were reported to have higher levels of self-control across the periods of study. Thus, the results of the growth curve analysis for teacher-reported self-control produce equivalent interpretations of the data as the OLS models.

As it pertains to the growth curve model estimated based on mother-reported self-control from fourth grade through age 15, the model fit statistics indicated a poor fit of the data to the model. Upon closer inspection, this stems from the requirement that factor loadings for the self-control items are constrained to be equal across each of the waves included in the growth curve (i.e. measurement invariance restriction). Yet, perhaps because of the 3-year gap between the assessment at sixth grade and age 15, the factor loadings for the items measuring self-control at age 15 differed from those at grades four through six. Given this, the growth curve model for maternal-reported self-control was re-estimated when only including self-control at grades four through six. Fit statistics for this model were ideal, and like the results based on teacher reports of self-control, the conditional growth curve model showed that child intelligence was positively associated with initial levels of self-control. Also consistent with the teacher-reported growth curve, there was little evidence of overall growth in self-control from fourth through sixth grades. And, while the model did provide evidence that there were small, statistically significant differences between individuals in their rate of change in self-control, none of the predictor variables in the model, including child intelligence, accounted for the between person differences in their within-individual changes in self-control.

8. Discussion

The current study was intended to build on prior work examining the interconnections of intelligence and self-control by considering the longitudinal association between the two constructs, across multiple raters, when accounting for important covariates omitted from prior research. Using data drawn from a national sample of children in the United States, our findings aligned with previous empirical work revealing a positive and significant association between intelligence and self-control (e.g., Berg et al., 2014; Boisvert et al., 2013; Petkovsek & Boutwell, 2014). Impressively, this association persisted across time and across different raters, despite adjusting for prior self-control, maternal intelligence and self-control, and child executive functioning.[4] What our findings suggest is that, at the phenotypic level, intelligence is associated with a greater ability to regulate one's impulses, emotions, and behavior, and may further explain why these two traits (intelligence and self-control) in general are so closely related to important life outcomes such as success in

[4] Our supplementary analyses also showed the association held across an alternative measure of intelligence taken from the third grade (WJ-R measure).

primary and secondary education, economic achievement, and avoiding contact with the criminal justice system (Beaver, Schwartz, et al., 2013; Gottfredson, 1997; Moffitt et al., 2011).

Though our findings offer further evidence of the association between intelligence and self-control, they should be interpreted in the light of certain limitations – many of the same limitations that apply to prior research in this area as well. First, all of the key measures included in our models are under some degree of genetic influence (Polderman et al., 2015). This raises the possibility that at least some of the phenotypic correlation observed herein is the product of correlated genetic influences (Barnes, Boutwell, Beaver, Gibson, & Wright, 2014; Engelhardt et al., 2016). Arguably, the best method for dealing with potential genetic confounds involves the implementation of behavior genetic designs (Barnes et al., 2014). Unfortunately, the current dataset lacked the requisite elements for using behavior genetic methods given that only one child per household was the focus of the SECCYD. Given the lingering possibility of genetic confounding, it remains important to avoid strong causal inference in our results until genetic influences can be parsed from environmental influences in future studies on this topic.

Second, issues with attrition in the sample were identified. Sample attrition is a common limitation in longitudinal research, and the impact of attrition on statistical findings is difficult to estimate. That being said, we identified that attrition was more common among families whose children were male and where mothers were younger and less educated. This likely had the effect of restricting the variability in child intelligence and child self-control for the present analyses, which would have made it more difficult to detect statistically significant associations. As such, the estimates for the association between intelligence and self-control found in this study might be viewed as conservative. Third, concerns also exist around the generalizability of the results, as although the sample of children from which the current data were collected come from diverse locations throughout the U.S., the sample is not nationally representative. Thus, more research is called for to determine the relevance of our findings in the general population using nationally representative data.

For a number of years now social scientists have emphasized the primacy of social factors in predicting individual variation in self-regulatory traits (Gottfredson & Hirschi, 1990). Less time was spent considering the role that intelligence might play in explaining why humans differ in their capacity to regulate their impulses, govern their desires, and focus their attention toward long-term goal acquisition. The correlation between intelligence and self-control is not necessarily surprising, however, research has spent less time trying to parse the connections of these traits at a phenotypic level, and more time trying to search out sources of variation in the family experiences of children (Gottfredson & Hirschi, 1990). This may be an approach unlikely to yield much fruit, however, given the relatively minor importance of the shared environment revealed in twin studies (Polderman et al., 2015). Our findings highlight the importance of intelligence in the etiology of self-control above and beyond socialization. For now, at least, there appears to be a convincing body of evidence accumulating which suggests that intelligence is closely tied to the development of self-control in the early stages of the life course.

Appendix A. Unconditional second-order latent growth curve models for self-control.

	Teacher reported (G4–G6)		Maternal reported (G4–G6)	
	Estimate	SE	Estimate	SE
Terms				
Means				
Intercept	0.000	–	0.000	–
Slope	0.165	0.288	0.181	0.165
Variances				
Intercept	0.617***	0.072	0.566***	0.045
Slope	0.023	0.043	0.071**	0.028
Covariances				
Intercept/slope	−0.010	0.870	−0.004	0.043
Model fit				
Chi-square (df)	1501 (336)		1432 (336)	
CFI	0.942		0.939	
NFI	0.939		0.932	
RMSEA	0.048		0.043	

** $p < 0.01$ (two-tailed).
*** $p < 0.001$ (two-tailed).

Appendix B. Conditional second-order latent growth curve models for self-control.

	Teacher reported (G4–G6)			Maternal reported (G4–G6)		
	Standardized Estimate	Unstandardized Estimate	SE	Standardized Estimate	Unstandardized Estimate	SE
Terms						
Predicting intercept						
Child intelligence	0.156***	0.010***	0.003	0.162***	0.008***	0.002
Male	−0.236***	−0.428***	0.072	−0.077*	−0.110*	0.050
Non-White	−0.132***	−0.325***	0.104	0.054	0.105	0.075
Mother's education	0.097*	0.037*	0.019	0.105**	0.031**	0.013
Maternal low self-control	−0.096**	−0.136**	0.014	−0.216***	−0.242***	0.042
Maternal intelligence	0.036	0.002	0.003	−0.026	−0.001	0.002
Parental socialization	0.117*	0.165*	0.083	0.168***	0.281***	0.062
Executive functioning	0.156**	0.014**	0.005	0.058	0.005	0.003

(continued on next page)

(continued)

	Teacher reported (G4–G6)			Maternal reported (G4–G6)		
	Standardized Estimate	Unstandardized Estimate	SE	Standardized Estimate	Unstandardized Estimate	SE
Predicting slope						
Child Intelligence	–	–	–	0.055	0.002	0.003
Male	–	–	–	−0.080	−0.068	0.059
Non-White	–	–	–	0.059	0.068	0.071
Mother's education	–	–	–	0.110	0.019	0.016
Maternal low self-control	–	–	–	−0.158	−0.105	0.087
Maternal intelligence	–	–	–	−0.060	−0.001	0.002
Parental Socialization	–	–	–	0.120	0.119	0.101
Executive functioning	–	–	–	0.018	0.001	0.003
Model fit						
Chi-Square (df)	1549 (536)			1097 (536)		
CFI	0.921			0.928		
NFI	0.917			0.918		
RMSEA	0.047			0.044		

* $p < 0.05$ (two-tailed).
** $p < 0.01$ (two-tailed).
*** $p < 0.001$ (two-tailed).

References

Achenbach, T. M. (1991). *Manual for the child behavior checklist/4–18 and 1991 profile*. Burlington, VT: University of Vermont, Department of Psychiatry.

Barnes, J. C., Boutwell, B. B., Beaver, K. M., Gibson, C. L., & Wright, J. P. (2014a). On the consequences of ignoring genetic influences in criminological research. *Journal of Criminal Justice*, *42*(6), 471–482.

Barnes, J. C., Wright, J. P., Boutwell, B. B., Schwartz, J. A., Connolly, E. J., Nedelec, J. L., & Beaver, K. M. (2014b). Demonstrating the validity of twin research in criminology. *Criminology*, *52*(4), 588–626.

Batty, G. D., Deary, I. J., & Gottfredson, L. S. (2007). Premorbid (early life) IQ and later mortality risk: Systematic review. *Annals of Epidemiology*, *17*(4), 278–288.

Batty, G. D., Wennerstad, K. M., Smith, G. D., Gunnell, D., Deary, I. J., Tynelius, P., & Rasmussen, F. (2009). IQ in early adulthood and mortality by middle age: Cohort study of 1 million Swedish men. *Epidemiology*, *20*(1), 100–109.

Beaver, K. M., DeLisi, M., Wright, J. P., Boutwell, B. B., Barnes, J. C., & Vaughn, M. G. (2013a). No evidence of racial discrimination in criminal justice processing: Results from the National Longitudinal Study of Adolescent Health. *Personality and Individual Differences*, *55*(1), 29–34.

Beaver, K. M., Schwartz, J. A., Nedelec, J. L., Connolly, E. J., Boutwell, B. B., & Barnes, J. C. (2013b). Intelligence is associated with criminal justice processing: Arrest through incarceration. *Intelligence*, *41*(5), 277–288.

Berg, C. A., Hughes, A. E., King, P. S., Korbel, C., Fortenberry, K. T., Donaldson, D., ... Wiebe, D. J. (2014). Self-control as a mediator of the link between intelligence and HbA1c during adolescence. *Children's Health Care*, *43*(2), 120–131.

Boisvert, D., Stadler, W., Vaske, J., Wright, J. P., & Nelson, M. (2013). The interconnection between intellectual achievement and self-control. *Criminal Justice and Behavior*, *40*(1), 80–94.

Borys, S. V., Spitz, H. H., & Dorans, B. A. (1982). Tower of Hanoi performance of retarded young adults and nonretarded children as a function of solution length and goal state. *Journal of Experimental Child Psychology*, *33*(1), 87–110.

Boutwell, B. B., & Beaver, K. M. (2010). The intergenerational transmission of low self-control. *Journal of Research in Crime and Delinquency*, *47*(2), 174–209.

Bridgett, D. J., Oddi, K. B., Laake, L. M., Murdock, K. W., & Bachmann, M. N. (2013). Integrating and differentiating aspects of self-regulation: Effortful control, executive functioning, and links to negative affectivity. *Emotion*, *13*(1), 47–63.

Chapple, C. L. (2005). Self-control, peer relations, and delinquency. *Justice Quarterly*, *22*(1), 89–106.

Costa, P., & McCrae, R. (1989). *NEO five-factor inventory (NEO-FFI)*. Odessa, FL: Psychological Assessment Resources.

D'Amato, R. C., Gray, J. W., & Dean, R. S. (1988). Construct validity of the PPVT with neuropsychological, intellectual, and achievement measures. *Journal of Clinical Psychology*, *44*, 934–939.

de Ridder, D. T., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control a meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality and Social Psychology Review*, *16*(1), 76–99.

Deary, I. J., Penke, L., & Johnson, W. (2010). The neuroscience of human intelligence differences. *Nature Reviews Neuroscience*, *11*(3), 201–211.

Duckworth, A. L., & Carlson, S. M. (2013). Self-regulation and school success. *Self-regulation and autonomy: Social and developmental dimensions of human conduct. 40*. (pp. 208–230).

Duckworth, A. L., Quinn, P. D., & Tsukayama, E. (2012). What no child left behind leaves behind: The roles of IQ and self-control in predicting standardized achievement test scores and report card grades. *Journal of Educational Psychology*, *104*(2), 439–451.

Dunn, L. M., & Dunn, L. M. (1981). *Manual for the Peabody picture vocabulary test-revised*. Circle Pines, MN: American Guidance Service.

Engelhardt, Laura E., Mann, Frank D., Briley, Daniel A., Church, Jessica A., Harden, K. Paige, & Tucker-Drob, Elliot M. (2016). Strong genetic overlap between executive functions and intelligence. *Journal of Experimental Psychology*, *145*(9), 1141–1159.

Funder, D. C., & Block, J. (1989). The role of ego-control, ego-resiliency, and IQ in delay of gratification in adolescence. *Journal of Personality and Social Psychology*, *57*(6), 1041–1050.

Gottfredson, L. S. (1997). Why g matters: The complexity of everyday life. *Intelligence*, *24*(1), 79–132.

Gottfredson, L. S. (2003). G, jobs and life. In H. Nyborg (Ed.), *The scientific study of general intelligence: Tribute to Arthur R. Jensen* (pp. 293–342). Amsterdam: Pergamon.

Gottfredson, L. S. (2004). Intelligence: Is it the epidemiologists' elusive "fundamental cause" of social class inequalities in health? *Journal of Personality and Social Psychology*, *86*(1), 174–199.

Gottfredson, M. R., & Hirschi, T. (1990). *A general theory of crime*. Stanford University Press.

Hay, C., & Forrest, W. (2006). The development of self-control: Examining self-control theory's stability thesis. *Criminology*, *44*(4), 739–774.

Herrnstein, R. J., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life*. New York, NY: The Free Press.

Hirschi, T., & Hindelang, M. (1977). Intelligence and delinquency: A revisionist review. *American Sociological Review*, *42*(4), 571–587.

Jensen, A. R. (1998). *The g factor: The science of mental ability*. New York, NY: Praeger.

Luciano, M., Batty, G. D., McGilchrist, M., Linksted, P., Fitzpatrick, B., Jackson, C., ... Porteous, D. (2010). Shared genetic aetiology between cognitive ability and cardiovascular disease risk factors: Generation Scotland's Scottish family health study. *Intelligence*, *38*(3), 304–313.

Lynam, D., Moffitt, T. E., & Stouthamer-Loeber, M. (1993). Explaining the relation between IQ and delinquency: Class, race, test motivation, school failure, or self-control? *Journal of Abnormal Psychology*, *102*(2), 187–196.

Meldrum, R. C., Young, J. T., Hay, C., & Flexon, J. L. (2012). Does self-control influence maternal attachment? A reciprocal effects analysis from early childhood through middle adolescence. *Journal of Quantitative Criminology*, *28*(4), 673–699.

Meldrum, R. C., Young, J. T., & Lehmann, P. S. (2015). Parental low self-control, parental socialization, young adult low self-control, and offending a retrospective study. *Criminal Justice and Behavior*, *42*(11), 1183–1199.

Mischel, W., & Metzner, R. (1962). Preference for delayed reward as a function of age, intelligence, and length of delay interval. *The Journal of Abnormal and Social Psychology*, *64*(6), 425.

Moffitt, T. E., Gabrielli, W. F., Mednick, S. A., & Schulsinger, F. (1981). Socioeconomic status, IQ, and delinquency. *Journal of Abnormal Psychology*, *90*(2), 152–156.

Moffitt, T. E., Arsenault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H. L., ... Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693–2698.

Moffitt, T. E., Poulton, R., & Caspi, A. (2013). Lifelong impact of early self-control. *American Scientist*, *101*(5), 352–359.

Nofziger, S. (2008). The "cause" of low self-control the influence of maternal self-control. *Journal of Research in Crime and Delinquency*, *45*(2), 191–224.

Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, *349*(6251), aac4716.

Petkovsek, M. A., & Boutwell, B. B. (2014). Childhood intelligence and the emergence of self-control. *Criminal Justice and Behavior*, *41*(10), 1232–1249.

Polderman, T. J., Benyamin, B., De Leeuw, C. A., Sullivan, P. F., Van Bochoven, A., Visscher, P. M., & Posthuma, D. (2015). Meta-analysis of the heritability of human traits based on fifty years of twin studies. *Nature Genetics*, *47*, 702–709.

Posner, M. I., & Rothbart, M. K. (1998). Attention, self-regulation and consciousness. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *353*(1377), 1915–1927.

Posner, M. I., & Rothbart, M. K. (2007). Research on attention networks as a model for the integration of psychological science. *Annual Review of Psychology*, *58*, 1–23.

Pratt, T. C., & Cullen, F. T. (2000). The empirical status of Gottfredson and Hirschi's general theory of crime. *Criminology*, *38*, 931–964.

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Raine, A., Moffitt, T. E., Caspi, A., Loeber, R., Stouthamer-Loeber, M., & Lynam, D. (2005). Neurocognitive impairments in boys on the life-course persistent antisocial path. *Journal of Abnormal Psychology*, *114*, 38–49.

Ritchie, S. J. (2015). *Intelligence: All that matters.* Hodder & Stoughton.

Ritchie, S. J., Wiseman, R., & French, C. C. (2012). Replication, replication, replication. *The psychologist*. *25*. (pp. 346–348).

Russo, P., De Pascalis, V., Varriale, V., & Barratt, E. S. (2008). Impulsivity, intelligence, and P300 wave: An empirical study. *International Journal of Psychophysiology*, *69*, 112–118.

Schmidt, S. (2009). Shall we really do it again? The powerful concept of replication is neglected in the social sciences. *Review of General Psychology*, *13*(2), 90–100.

Schou, L., Østergaard, B., Rasmussen, L. S., Rydahl-Hansen, S., & Phanareth, K. (2012). Cognitive dysfunction in patients with chronic obstructive pulmonary disease—a systematic review. *Respiratory Medicine*, *106*(8), 1071–1081.

Shamosh, N. A., DeYoung, C. G., Green, A. E., Reis, D. L., Johnson, M. R., Conway, A. R., ... Gray, J. R. (2008). Individual differences in delay discounting relation to intelligence, working memory, and anterior prefrontal cortex. *Psychological Science*, *19*(9), 904–911.

Spearman, C. E. (1904). General intelligence, objectively determined and measured. *American Journal of Psychology*, *15*, 201–293.

Spearman, C. E. (1927). *The abilities of man.* New York: Macmillan.

Wechsler, D. (1999). *WASI manual.* San Antonio: Psychological Corporation.

Welsh, M. C. (1991). Rule-guided behavior and self-monitoring on the Tower of Hanoi disk-transfer task. *Cognitive Development*, *6*(1), 59–76.

Whalley, L. J., & Deary, I. J. (2001). Longitudinal cohort study of childhood IQ and survival up to age 76. *British Medical Journal*, *322*, 819–822.

Woodcock, R. W., & Johnson, M. B. (1989). *Woodcock–Johnson psycho-educational battery–revised.* Allen, TX: Developmental Learning Materials.

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