Can You Ever Be Too Smart for Your Own Good?
Comparing Linear and Nonlinear Effects of Cognitive Ability on Life Outcomes

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Abstract

Despite a longstanding expert consensus about the importance of cognitive ability for life outcomes, contrary views continue to proliferate in scholarly and popular literature. This divergence of beliefs presents an obstacle for evidence-based policy and decision-making in a variety of settings. One commonly held idea is that greater cognitive ability does not matter or is actually harmful beyond a certain point (sometimes stated as greater than 100 or 120 IQ points). We empirically test these notions using data from four longitudinal, representative cohort studies comprising a total of 48,558 participants in the U.S. and U.K. from 1957 to the present. We find that ability measured in youth has a positive association with most occupational, educational, health, and social outcomes later in life. Most effects were characterized by a moderate-to-strong linear trend or a practically null effect (mean R^2 = .002 to .256). Nearly all nonlinear effects were practically insignificant in magnitude (mean incremental R^2 = .001) or did not replicate across cohorts or survey waves. We found no support for any downside to higher ability and no evidence for a threshold beyond which greater scores cease to be beneficial. Thus, greater cognitive ability is generally advantageous—and virtually never detrimental.

Keywords: individual differences, cognition, cognitive ability, intelligence, IQ, curvilinear, longitudinal study

Decades of evidence shows that intelligence or cognitive ability is one of the strongest and most consistent predictors of important outcomes in life (Kuncel et al., 2004; Deary, 2000; Hunt, 2010). Cognitive ability predicts job performance and training success in the U.S. (Schmidt & Hunter,1998; 2004) and abroad (Bertua et al., 2005), income (Judge et al., 2010), occupational stratification (Warren et al., 2002; Cheng & Furnham, 2012), leadership (Judge et al., 2004), unemployment (Caspi et al., 1998), educational attainment (Berry et al., 2006), and academic performance (Kuncel & Hezlett, 2007). Scholars who understand this evidence often recommend cognitive ability tests as a component of selection processes in educational and organizational settings (e.g., Schmidt & Hunter, 2000; Sackett et al., 2008).

The positive influence of cognitive ability extends beyond work and education. Results of large-scale epidemiological studies indicate that cognitive ability predicts longevity and various health outcomes, beyond the effects of socioeconomic status or social class (Gottfredson & Deary, 2004). These protective effects have been observed for both physical and mental health later in adulthood (Deary et al., 2010; Wraw et al., 2016). Greater cognitive ability in adolescence has also been reported to be linked to health behaviors in adulthood, such as greater physical activity (Batty et al., 2007) and less consumption of alcohol or tobacco (Judge et al., 2010). In addition, cognitive ability is positively related to subjective measures of well-being and health, including greater life satisfaction (Gonzalez-Mule et al., 2017), happiness (Nikolaev & McGee, 2016), and self-ratings of health (Wrulich et al., 2014). This body of research suggests that cognitive ability plays an important role in many aspects of everyday life.

Popular Beliefs about Cognitive Ability are Often Not Based on Evidence

Despite general expert agreement on the positive effects of cognitive ability, some researchers and popular authors have deprecated the importance of cognitive ability or even dismissed it entirely. One popular idea is that in the real world, cognitive ability is simply not as valuable as it may be in academia, and not as important as claimed in the academic literature. Many authors have argued that cognitive ability is irrelevant for most meaningful outcomes in life (e.g., Alloway & Alloway, 2013; Brooks, 2011). Several popular, best-selling books have also emphasized the importance of effort and resilience in achieving success in life, while simultaneously suggesting that cognitive ability has little, if any, impact (e.g., Colvin, 2008; Gladwell, 2008). According to these and similar works (e.g., Coyle, 2009), virtually anyone can reach high levels of performance or achievement in their lives simply by devoting enough time and practice. Not only do these works ignore the role of cognitive ability in the development of expertise or learning (Kaufman et al., 2010), but empirical evidence indicates that ability is often more strongly related to achievement than either motivation (Van Iddekinge et al., 2018) or deliberate practice alone (Macnamara et al., 2014).

Beyond the general skepticism about the usefulness of cognitive ability in everyday life, there is also the idea in popular culture that there is a cost to having too much cognitive ability—that you can be “too smart for your own good.” Examples of this idea can be found in many works of nonfiction and fiction; for examples, see Table 1. Highly intelligent characters are often portrayed as cynical (e.g., Sherlock Holmes or Frank Underwood), villainous (e.g., Dr. Evil, Dr. No, or Dr. Octopus), socially inept (e.g., Sheldon Cooper or Richard Hendricks), or suffering from a psychological disorder (e.g. John Forbes Nash or Howard Hughes). Further examples of this notion can even be found in the content and titles of several popular nonfiction books. Even though not all of these books are explicitly about intelligence or cognitive ability (e.g., *The Smartest Guys in the Room* or *When Genius Failed*), these titles play on the idea that there are negative consequences to being the “smartest” or a “genius.”

Although cognitive ability is often not explicitly mentioned as the root cause of these negative characteristics (e.g., psychopathology, cynicism, or depression), this pairing can easily be mistaken as evidence for causality, and even high achievers (such as former world chess champion and political activist Garry Kasparov; Carlson 2010) may shy away from recognizing a role for cognitive ability in their own success. When a writer for *Der Spiegel* asked chess grandmaster (and future world champion) Magnus Carlsen what his IQ was, he demurred:

> "I have no idea. I wouldn't want to know it anyway. It might turn out to be a nasty surprise…Of course it is important for a chess player to be able to concentrate well, but being too intelligent can also be a burden. It can get in your way … I am a totally normal guy … I'm not a genius." (Chessbase, 2010).

Along these lines, researchers have observed that individuals often associate high levels of cognitive ability with negative social or emotional characteristics. For example, Stavrova and Ehlebracht (2019) observed that individuals perceived that highly cynical people have greater cognitive ability despite finding a consistently negative relationship when directly measuring these characteristics. Other researchers have found that individuals often consider slightly above average intelligence (and not extremely high intelligence) as the most ideal level for themselves (Hornsey et al., 2018) and most attractive in a potential mate (e.g., the 90th percentile is preferred to the 99th percentile; Gignac et al., 2018; Gignac & Starbuck, 2019). Moreover, teachers have also been reported to implicitly assume that highly gifted students experience more emotional maladjustment (Preckel et al., 2015). We believe that these findings all suggest a perceived downside to having a high degree of cognitive ability.

Concern about the risk of high cognitive ability can also be found in the works of well-known authors and academic researchers (Table 2). Most recently, a widely-discussed critique of

IQ and intelligence tests claimed, among other things, that they only measure “extreme unintelligence” and their use results in selecting people who are “ill-adapted for ‘real life’” (Taleb, 2019). Likewise, a recent cover story of a prominent magazine was titled “The curse of genius,” and suggested that “brilliant children” are “miserable misfits” (Fergusson, 2019). Along similar lines, the thesis of the *Intelligence Trap* (Robson, 2019) is that high cognitive ability is potentially linked to poorer decision making and a greater susceptibility to decision biases, while Kanazawa (2012) argues in *The Intelligence Paradox* that highly intelligent individuals do worse in most important tasks in life. In sum, these claims from both popular and academic authors suggest that high levels of cognitive ability act as an obstacle or handicap for achieving success in life.

Potential Impact of Popular Beliefs about Cognitive Ability

Although popular publications are often ignored in scholarly discussions, they can influence a wider audience than academic journals. This influence is especially important given that practitioners and the general public are more likely to read books or magazines written by popular authors (e.g., business leaders, science communicators, etc.) than works written by academic researchers (Cohen, 2007). Likewise, the views and interests of researchers are thought to have an outsized influence on what research topics are studied and reported on in the academic literature (Briner & Rousseau, 2011). This disconnect between what is discussed among researchers and what is discussed in best-selling books and magazines can help create, maintain, and expand, gaps in understanding between researchers and the general public. Although concern over the divide between research and practice has been long documented (e.g., Boehm, 1980), these gaps are widely acknowledged as important obstacles to evidence-based practices in psychology, education, and management (Banks et al., 2016). Therefore, it is important to consider the potential influence of these popular publications, especially when they express ideas that contradict or misrepresent what has been reported in the research literature.

Along these lines, the usefulness of cognitive ability for hiring is one of the most frequently documented research-practice gaps in applied psychology and human resource (HR) management (Rynes, 2012). Past studies have found that many HR professionals underestimate the predictive validity of cognitive ability tests in the U.S. (Rynes et al., 2002) and in Europe and Asia (Jackson et al., 2018; Tenhiala et al., 2016) despite the large amount of published scientific research supporting the tests' predictive validity. This knowledge gap between research and practice can also lead to the misuse of ability tests. In a highly publicized court case, for example, a Connecticut police department was sued for rejecting an applicant for a job because he had scored too high on a cognitive ability test (New York Times, 1999). Subsequent research has failed to support the idea that having too much cognitive ability leads to greater voluntary turnover (Maltarich et al., 2010) and has found that objective overqualification has little impact on job satisfaction (Arvan et al., 2019) and can even lead to better performance (Hu et al., 2015). Despite these findings, many individuals and organizations still perceive overqualified job candidates to be less committed and to exert less effort (Galperin et al., 2019), and popular news accounts report the "surprising damage smart workers can cause" (Silverberg, 2017).

A similar research-practice gap can be found in the field of education. In U.S. higher education, for example, there is a growing trend to minimize the use of standardized tests in admissions (e.g., Wainer, 2011). This "test optional" movement is largely based on the idea that adverse impact is sufficient evidence of bias and in fact nearly 1,000 schools admit large numbers of undergraduate applicants without requiring standardized test scores (fairtest.org). Thus, the test-optional movement rejects or does not acknowledge the large body of evidence supporting the predictive validity of cognitive ability. Not only are institutions deciding to remove test requirements for undergraduate admissions (e.g., Anderson, 2020), even some top-ranked graduate programs in the sciences have recently dropped the Graduate Record Examination (GRE) from their admissions process, a movement publicly known as "GRExit" (Langin, 2019). Thus, a growing number of institutions have chosen to not consider test scores in student admissions, despite evidence that tests are valid predictors of academic achievement (Kuncel & Hezlett, 2007). Moreover, in a quasi-experimental field study, Belasco and colleagues (2015) observed that colleges that adopted test-optional policies did not observe greater diversity among applicants or enrolled students, compared to colleges that continued to require standardized testing. These events suggest that, despite nearly a century of research evidence, misconceptions about cognitive ability continue to be highly influential among practitioners, policymakers, and the general public.

Existing Literature on Nonlinear Effects

Several past works have reported curvilinear effects of cognitive ability on a wide range of outcomes including leadership (Antonakis et al., 2017), personality (Major et al., 2014), creativity (Jauk et al., 2013), and antisocial behavior (Silver, 2019). Others have reported that high levels of cognitive ability are related to elevated health risks, including ADHD (Karpinski et al., 2018), bipolar disorder (Gale et al., 2013), depression (Penney et al., 2015), and elevated levels of dysfunctional personality traits (Matta et al., 2019). Several of these past findings imply a "Too Much of a Good Thing" effect (TMGT; Grant & Schwartz, 2011), where greater cognitive ability may be beneficial at lower levels but potentially maladaptive at extremely high levels of ability.

Before drawing any firm conclusions from some of these past findings, however, it is important to note that several of these studies included non-representative samples and had relatively low statistical power. For example, two studies claiming that high cognitive ability is related to a greater risk of maladaptive psychological functioning based their conclusions on a between-group comparison of American Mensa members and non-random control groups (Karpinski et al., 2018; Matta et al., 2019). Not only is selection bias an alternative explanation for the study results, but without a direct measure or proxy of cognitive ability it is unclear whether these group differences should be attributed to differences in cognitive ability. Likewise, Antonakis and colleagues (2017) detected an inverted-U shaped relationship between a leader's cognitive ability and leadership (according to ratings given by their subordinates) among a sample of n = 379 leaders. Yet, these effects were not found in other studies which used larger samples and objective measures of leadership (Daly et al., 2015; Reitan & Sternberg, 2019).

In contrast, past studies using larger datasets have generally found either a linear or a mostly linear effect of cognitive ability. For example, Sackett and colleagues (Arneson et al., 2011; Coward & Sackett, 1990) have reported positive, linear effects of cognitive ability on performance in occupational and educational settings. Even though Sackett and colleagues found statistically significant quadratic effects, the ability – performance relationships remained monotonically positive across the entire ability range. These patterns were replicated across four large data sets (Project A, Project TALENT, NELS 88, and data from the College Board). More recently, Coyle (2015) observed similar results when investigating the relationships between cognitive ability and GPA across two different cohort samples (NLSY97, n = 1,950; and the College Board Validity study, n = 160,670). In addition, Ganzach and colleagues (2013) found that cognitive ability was positively related to pay and that nonlinear effects could be detected but only after controlling for the interaction between ability and job complexity. Likewise, Gaznach (1998) also observed practically no nonlinear effect of cognitive ability on self-reported job satisfaction within the NLSY79 cohort study. This past research indicates that most highly powered studies have failed to detect robust, nonlinear effects of cognitive ability. Despite the consistency of these results, however, this work focused only on a narrow set of outcomes (e.g., occupational or educational outcomes). Therefore, it is unclear whether there are any robust, nonlinear effects for cognitive ability among other important outcome measures.

Present Study

To address this knowledge gap with the hope that evidence can help inform practice, policy, or public understanding, we empirically test several popular beliefs about the effects of cognitive ability. We designed this study to make several unique contributions to the existing literature. First, we explore linear and nonlinear effects of cognitive ability across a wide variety of occupational, educational, health, and social outcomes in order to extend the findings of previous work. Second, not only do we search for nonlinear cognitive ability effects, but we also estimate whether ideal cognitive ability scores (as identified by the inflection point of the quadratic model) are consistently observed across different outcomes and different cohorts. These estimates could help identify whether there is a common cognitive ability threshold where scores beyond a certain point provide little added benefit or possibly even increase risk. Third, we explicitly test several specific hypothesized thresholds and potential forms of "reversal," including IQ thresholds of 100 and 120, and reversals of linear trends at the top 10% or 5% of IQ scores. Finally, we use data from four different longitudinal survey projects: the Wisconsin Longitudinal Survey (WLS), the 1970 British Cohort Study (BCS70), National Longitudinal Survey of Youth 1979 (NLSY79), and the National Longitudinal Survey of Youth 1997

(NLSY97) in order to determine whether any observed nonlinear effects are robust to differences across cohorts. Data from these projects have been used to study the linear effects of cognitive ability (Judge et al., 2010) but have rarely been used to search for nonlinear effects (for an exception, see Coyle, 2015). Each project administered a multifactor cognitive test during adolescence to ~10,000 participants and longitudinally tracked various outcomes during the participants' lives. Participants in each sample were randomly selected in order to be representative of the state or country at the time which reduces the potential for selection bias relative to other primary studies. These samples also provide a high degree of statistical power and allow us to attempt constructive replications across different cohorts, countries, or using measures gathered at different points in time (e.g., Lykken, 1968).

Methods

Data

We gathered data from four different longitudinal survey projects. The WLS consists of 10,317 students who were randomly sampled from high schools in the state of Wisconsin and was funded by the National Institute on Aging (R01 AG009775; R01 AG033285). All WLS participants graduated high school in 1957 and were subsequently surveyed in 1975, 1992, 2004, and 2011 (Herd et al., 2014). The BCS70 consists of 16,571 participants who were all born in England, Scotland, Wales, or Northern Ireland on a specific week in 1970 (Elliott & Shepherd, 2006). These individuals have been contacted for follow up surveys starting at age 10 (1980) and most recently at age 46 (2016). The NLSY79 consists of a nationally representative sample of 12,686 US participants who were born between 1957 and 1964. Individuals in the NSLY79 cohort have participated in 26 follow-up surveys between 1980 and 2016. Likewise, the NLSY97 consists of a nationally representative sample of 8,984 US participants who were born between 1980 and 1984. Individuals in the NLSY97 cohort have participated in 17 follow-up surveys between 1998 and 2016. We provide a full listing of all variables that we used from each project in the Supplemental Materials.

Measures

Cognitive Ability

All participants in the WLS completed the Henmon-Nelson Test of Mental Abilities (HN) while attending high school. The HN is a 30-minute test that consists of 90 items. HN content includes items designed to measure verbal, spatial, and numerical knowledge and reasoning (c.f., Stephan et al., 2018). Past research has reported strong correlations between HN scores and other standardized cognitive measures, including the Weschler Adult Intelligence Scale (WAIS; Watson & Klett, 1975).

Participants in the NLSY79 and NLSY97 completed forms of the Armed Services Vocational Aptitude Battery (ASVAB). In line with past research, we use scores from the Armed Forces Qualification Test (AFQT) as a measure of cognitive ability for NLSY79 participants (e.g., Berry et al., 2006). AFQT scores were calculated by the U.S. Department of Defense using four of the ten ASVAB subtests (arithmetic reasoning, mathematics knowledge, word knowledge, and paragraph comprehension). To be consistent with data from the NLSY79, we also use AFQT scores as a measure of cognitive ability for NLSY97 participants. Unlike the NLSY79, the AFQT scores for the NLSY97 were not officially scored by the Department of Defense but are based on the same subtest scores. Scores from the remaining 6 subtests (general science, coding speed, mechanical comprehension, electronics information, mathematics knowledge, and auto and shop information) are not included as part of the AFQT score.

Participants in the BCS70 completed a shortened version of the Edinburgh Reading Test (ERT) and the Friendly Maths Test (FMT) at age 10. The short version of the ERT consisted of 67 questions on topics including vocabulary, syntax, reading comprehension, and retention. The FMT consisted of 67 items which covered arithmetic, fractions, number skills, geometry, algebra, and statistics. Scores from these assessments were z-scored and aggregated into a unit-weighted composite in order to measure cognitive ability. Verbal and math test scores were combined in order to mirror the test content used in both NLSY79 and NLSY97.

Occupational and Educational Outcomes

The first class of outcome variables that we investigated were related to educational and work experiences. We used annual income from wages and salary as a measure of extrinsic career success (e.g., Judge et al., 2010). We also used measures of occupational prestige and job complexity to capture occupational attainment. Leadership experience was assessed using dichotomous measures of supervisor role occupancy (“Do you supervise the work of others?”) and span of supervisory control (number of direct reports; Li, Arvey, & Song, 2011). We also included annual measures of employment status as the number of weeks that the participant was unemployed. Job satisfaction was assessed using a single item (e.g., “All things considered, how satisfied are you with your job as a whole?”) or various, multiple-item scales. Educational attainment was measured as the number of years of completed formal education in the WLS, NLSY79, and NLSY97. Educational attainment in the BCS70 was assessed using the highest level of National Vocational Qualification (NVQ), which ranges from 0 (no qualifications) to 5 (higher postsecondary degrees and equivalent).

Health and Well-Being Outcomes

The second class of outcome variables that we investigated were related to health conditions and self-reported well-being. We included dichotomous measures of various health conditions that have been previously linked to cognitive ability (e.g., diabetes and high blood pressure; Wraw et al., 2015). Sleep quality was assessed using reports of the typical number of hours slept and reports of trouble sleeping. Physical health was measured using the body mass index (BMI). Self-reported mental and physical health was measured in the NLSY79 and WLS using the Short-Form Health Survey (SF-12; Ware, Kosinski, & Keller, 1996). In the BCS70, self-reported health was measured using the SF-36 and the Warwick Edinburgh Mental Well-Being scale (Tennant et al., 2007). Self-reported depression was measured using short forms of the Center for Epidemiological Studies Depression symptoms index (CES-D; Kohout, Berkman, Evans, & Cornoni-Huntley, 1993) and Rutter's Malaise inventory (Rutter, Tizard, & Whitmore, 1970). Subjective well-being was measured using the six-dimensional scale developed by Ryff and Keyes (1995) and several, one-item measures of life satisfaction.

Social Outcomes

The third class of outcome variables that we investigated were related to social behaviors. This included counts of the number of times spent with friends and relatives within the last four weeks and the number of social groups in which the participant was an active member during the past year. Civic participation was also assessed as whether the participant reported voting in local or national political elections (e.g., Hauser, 2000). Volunteering was assessed using dichotomous measures of whether the participant reported participating in volunteer work within the past year. Regarding marital status, we coded whether or not the participant was ever married and if they were ever divorced.

Results

We conducted a variety of statistical tests and comparisons to determine whether any detrimental effects of cognitive ability could be detected using conservative or liberal criteria (e.g., Karowski & Gralewski, 2013). We first tested for U-shaped effects using the Two-Lines Test (Simonsohn, 2018). The Two-Lines Test is designed to detect the presence of a U-shaped, quadratic effect within the observed range of predictor values. As such, we use this test as our primary criteria for detecting the presence of a meaningful, U-shaped effect of cognitive ability. This method first estimates a cubic spline for the relationship between predictor and outcome variables and then uses interrupted regression to estimate the linear effect of the predictor above and below the inflection point. A U-shaped effect is detected when the signs of the linear effects above and below the inflection point are different (e.g., positive before the break point and negative after the break point) and are both statistically significant ($p < .05$). According to Simonsohn (2018), this test yields fewer false positives compared to other existing methods.

Of the 214 possible relationships between cognitive ability and life outcomes across the four cohort studies, we only detected six statistically significant U-shaped effects. More importantly, we only observed two inverted U-shaped effects where cognitive ability had a negative effect at high ability levels. For cognitive ability scores greater than –0.2 SD (IQ = 97), we observed a negative relationship between ability and self-reported positive relations with others (b = –0.05, $z = 5.53$, $p < .001$). However, this nonlinear effect was weak in magnitude (incremental $R^2 = .007$) and could not be found for any of the five other psychological well-being dimensions measured in the WLS cohort (Figure 1). Likewise, we observed a negative relationship between ability and supervisory span (the number of direct reports for those holding a supervisory role) in the NLSY79 cohort. Here, the effect of cognitive ability was negative among individuals with cognitive scores greater than 0.27 SD (IQ = 104; b = –0.27, z = 2.69, p = .007) but this effect was also weak (incremental R^2 = .005) and could not be replicated in any of the other leadership outcomes in the NLSY79, WLS, or BCS70 (Figure 2). In contrast, four of the six U-shaped effects indicated stronger positive effects at higher levels of cognitive ability. We only found these effects for the average number of hours slept per night (NLSY97) and one instance of job satisfaction (NLSY79). However, these U-shaped effects were not found in any other instance of either outcome across the different cohorts (Figures 3 and 4). Based on these results, there does not appear to be any evidence for a consistent inverted-U or too much of a good thing effect for cognitive ability that can be detected beyond chance.

Polynomial Regression

Although the Two-Lines test is considered to be a more rigorous test for detecting U-shaped effects, as it relies on two independent tests both achieving statistical significance, we further explored potential non-linear relationships between cognitive ability and life outcomes using polynomial regression (Cohen et al., 2003). This method provides effect size estimates for the nonlinear term (ΔR^2) and is widely used to test for nonlinear effects in psychological research (e.g., Arneson et al., 2011; Nickel et al., 2019). We standardized all variables before entering them into each of the regression models. We used several types of regression models depending on the distribution of the outcome variable. For dichotomous outcomes, such as health conditions or supervisory role, we used binomial logistic regression. For count variables with long tails (e.g., power law distributions; Joo et al., 2017), such as the number of depression symptoms, we used Poisson logistic regression. We used linear regression for outcomes with relatively normal distributions. We also performed a logarithmic transformation for annual income, as commonly used in past research (e.g., Warren et al., 2002). We present a summary of the regression results organized by outcome category and cohort in Table 3. For each outcome, we calculated the sample-weighted mean R^2 as recommended by Hunter and Schmidt (2004). A full account of all regression models can be found in the Supplemental Materials.

Given our large sample sizes, we rely on effect sizes (incremental R^2) to determine whether a meaningful nonlinear effect is present. Based on recent guidelines for psychological and individual differences research, we consider effects of $R^2 = .01$ or greater to be of practical significance (Funder & Ozer, 2019; Gignac & Szodorai, 2016). In both papers, the authors recommend that an effect of $r = .10$ (which translates to $R^2 = .01$) be interpreted as a small but potentially consequential effect. In common language effect size terms, an increase from $R^2 = .00$ to .01 represents an improvement in the probability of correct classification from 50% to 53% (Dunlap, 1994). Results for each individual regression model are all reported in the Supplemental Materials. Overall, we failed to find a single instance where the polynomial cognitive ability term accounted for more than 1% of incremental variance in any outcome. Even after rounding adjusted R^2 estimates to two decimal places, we found that adding the polynomial term only met our threshold for practical significance in 5% of all of the regression models tested (11 out of 214; Table 3). Beyond the six U-shaped effects that we found using the Two-Lines test, we detected nonlinear effects for cognitive ability on annual income for participants in the NLSY97. These effects were similar to the nonlinear effects reported by Ganzach et al. (2013) but nonlinear effects on income could not be replicated in any of the remaining cohorts (Figure 5). We also detected a nonlinear effect of ability on educational attainment within the BCS70 cohort. In this relationship, we observed an increasingly positive effect where ability grew more strongly related to education at increasingly higher levels of ability. This effect was similar to models reported by Arneson et al. (2011) and Coyle (2015) but were not replicated in the three other cohorts (Figure 5).

In contrast, we detected practically significant linear effects in 66% of all models (141 out of 214). We illustrate the average linear and nonlinear effects by outcome in Figure 6. We observed the strongest, positive linear effects of cognitive ability among educational and occupational outcomes including educational attainment (mean R^2 = .254), occupational attainment (mean R^2 = .155), and annual income (mean R^2 = .064). Among social outcomes, individuals with higher cognitive ability were more likely to report working as a volunteer (mean R^2 = .032) and were more likely to vote in elections (mean R^2 = .013). Likewise, individuals with higher cognitive ability were slightly less depressed (mean R^2 = .029) and reported more frequent physical exercise (mean R^2 = .015). We also found that ability had practically no linear effect on self-reported subjective well-being, job satisfaction, or sleep habits. Therefore, we suggest that the predominant effect of cognitive ability is linear, and that nonlinear effects are practically negligible, for many important life outcomes.

Further Comparisons

Despite finding little evidence for robust nonlinear effects across the ability range, we continued to test for differences in the predictive validity of cognitive ability scores above and below certain points along the ability range. This methodology has been used by researchers to test threshold hypotheses where the effect of cognitive ability ceases or changes direction beyond a specific point on the ability range (Karowski & Gralewski, 2013). This analysis was prompted in part by recent arguments by Taleb (2019) that cognitive ability tests mainly measure “extreme unintelligence” and that “very low IQ may provide information while very high IQ may convey nothing better than random.” This notion is similar to Spearman’s Law of Diminishing Returns

(Blum & Holling, 2017) where the g-factor is often found to be more strongly related to cognitive task performance among individuals with lower ability. Likewise, several popular writers have alluded to an ideal IQ threshold of 120, which they sometimes attribute to notable academic researchers such as Arthur Jensen or J. P. Guilford. For example, Gladwell (2008, pp. 78-79) wrote that "(o)nce someone has reached an IQ of somewhere around 120, having additional IQ points doesn't seem to translate to any measurable, real-world advantage." Likewise, some researchers have also claimed the existence of a threshold of 120 when studying the relationship between intelligence and creativity (e.g., Andreasen, 2014). Therefore, we calculated the correlations between cognitive ability and our outcome measures after dividing our samples above and below possible thresholds at IQ = 100 and IQ = 120.

We report a summary of these results in Table 4. A full account of all correlation results can be found in the Supplemental Materials. The average effect of cognitive ability remained relatively constant above or below average ability for many of our outcome variables. There was no instance where we found a negative (harmful) effect of cognitive ability among those with above average ability. Likewise, we only observed three instances where there was a negative (harmful) effect of cognitive ability for those with relatively high ability (> 120). However, these correlations were relatively weak in magnitude. We also observed that restricting the samples based on a 120 threshold (> 120; = +1.33 SD) substantially reduced the variance in ability scores. The variability in scores among those above 120 was between 16% (NLSY97) and 39% (BCS70) of the standard deviation of scores among the full samples. This direct range restriction is a likely explanation for the slight decrease in correlation size (Hunter & Schmidt, 2004). Based on these results, greater cognitive ability does not cease to remain beneficial for individuals with above average ability or those with scores greater than IQ = 120.

Finally, to check the possibility that only very high intelligence is detrimental, we tested for outcome differences between individuals within the top 10% and top 20% of ability scores. This methodology has been used in past research on ability differences among highly gifted students (e.g., Wai et al., 2005). We performed a median split within each group (top 10% and top 20%) and compared outcome scores for individuals above or below the median using a simple *t*-test or chi-square test of proportions. Only in a minority of cases did we detect a significant difference ($p < .05$) within the top 10% (20 out of 214 comparisons, 9%) or top 20% (48 out of 214 comparisons, 22%) of cognitive ability scores. Among the rare instances where we did find a difference, higher cognitive ability was associated with worse outcomes only 13% of the time (9 out of 68 comparisons). Instead, greater cognitive ability was often associated with greater occupational prestige (50% of comparisons) and greater educational attainment (100% of comparisons) even within the top 20% or 10% of cognitive ability scores. These results further indicate that the effect of cognitive ability is highly unlikely to change direction and turn from positive to negative within the right tail even when using more liberal statistical tests. Not only is the overall relationship mostly linear in nature, but our results suggest that extremely high ability is more likely to be an extra advantage rather than a surprising limitation.

Discussion

By analyzing data from four representative longitudinal cohort studies (three in the U.S. and one in the U.K.) spanning over 60 years, we found that greater cognitive ability typically provides an advantage for the attainment of various educational, occupational, health, or social outcomes. More cognitive ability typically appears to be advantageous even at high ability levels. As often observed in past research (Beier & Oswald, 2012), we found that greater cognitive ability appears to practically never be a bad thing. At worst, cognitive ability has only a weak or null effect on some of the outcomes that we observed. For example, even though we found some negative correlations between cognitive ability and job satisfaction, the sample-weighted average effect size was practically zero (R^2 = .002) which is in line with past reviews where the effect of cognitive ability has been found to be highly mediated by job complexity and income (Ganzach, 1998; Gonzalez-Mule et al., 2017). We also observed relatively weak effects of cognitive ability on leadership role occupancy, BMI, sleep habits, and health conditions. Adding a nonlinear term did little to improve the prediction of these outcomes. These results suggest that cognitive ability may be essentially unrelated to these outcomes. On the other hand, we observed that individuals with higher cognitive ability scores were not only likely to report greater income, shorter instances of unemployment, and higher occupational and educational attainment but also better outcomes in several health and social domains. Individuals with higher cognitive ability generally reported experiencing fewer depression symptoms, performing greater amounts of physical exercise, and being more likely to vote in elections and perform volunteer work.

Across all outcomes, we generally observed that the magnitude of linear effects greatly outweighed the incremental validity to be gained from adding a nonlinear term. Even when there was practically no linear effect of cognitive ability, we also failed to detect any consistent U-shaped or nonlinear effects. These results suggest that it is unlikely that there are strong, underlying, U-shaped cognitive ability effects where greater ability becomes detrimental at high levels. It is more often the case that cognitive ability either has a positive, linear effect or practically no effect at all. Moreover, these small effect sizes indicate that most typical studies in psychological research likely lack the necessary statistical power to reliability detect nonlinear effects (e.g., Sassenberg & Ditrich, 2019; Shen et al., 2011). Based on these results, we suggest that there is little evidence for a meaningful, nonlinear effect of cognitive ability on many life outcomes.

Unlike some of the individual studies where negative or threshold effects of cognitive ability have been reported, our study has several methodological strengths. Our use of four large, longitudinal cohort samples across the U.S. and U.K. provided a large degree of statistical power. Not only does this eliminate power as an alternative explanation for a lack of nonlinear effects but also helps prevent the detection of spurious nonlinear effects due to a subset of extreme outliers. A tendency of finding interactive or nonlinear effects more easily in smaller samples was recently observed by Van Iddekinge and colleagues (2018) who reported that larger multiplicative effects of cognitive ability and motivation were most often found in studies with smaller, rather than larger, samples. In addition, the longitudinal design allows us to test the effects of cognitive ability measured in adolescence on outcomes later in life. This provides stronger evidence for the causal direction of these relationships, compared to studies using cross-sectional designs (Cook et al., 1990). Our samples also allowed us to observe whether effects found within one sample could be replicated in other longitudinal samples collected at different points in time. Because our samples were representative of broader regional or national populations and our datasets come from six decades and our respondents from multiple generations, we can have confidence in the generality of our results. Based on these characteristics, we believe that our results provide an accurate representation of the likelihood of detecting nonlinear effects of cognitive ability on many important life outcomes.

Resilience of Misconceptions about Cognitive Ability

Our findings indicate that popular ideas about the detrimental effects of high cognitive ability are not supported by empirical data. However, we suspect that these ideas may remain appealing to some, despite our research and similar reports from past studies (e.g., Arneson et al., 2011). An important direction for future research is to identify potential causes for the knowledge gaps between researchers, practitioners, and the general public regarding cognitive ability. Past studies which have examined this question report that people's beliefs or attitudes about cognitive ability may be driven by their own self-interest or values. One study found that individuals who had higher GPAs and standardized test scores (e.g., proxies for cognitive ability) believed more strongly in the validity of cognitive ability (Caprar et al., 2016). In addition, Highhouse and Rada (2015) observed that people's worldviews (e.g., belief in scientific determinism) are correlated with their perceptions about the usefulness of cognitive ability testing. This is akin to broader trends in science, where perceptions among the general public are found to conflict with those held within the scientific community (e.g., regarding the safety of vaccines or genetically modified organisms). The lack of acceptance of cognitive ability in education and other applied fields is also worth considering (e.g., Maranto & Wai, 2020; Wai et al., 2018; Wiliam, 2019).

Another possible explanation for the resiliency of these ideas about the role of cognitive ability could be a tendency to misattribute people's successes or failures. This "misattribution hypothesis" was introduced by Nickel and colleagues (2018) who proposed that people might, for example, mistakenly identify high conscientiousness as a cause of maladaptive behavior, while overlooking the true cause for the behavior (e.g., low emotional stability). We believe that this hypothesis may also explain commonly held ideas regarding threshold or negative effects of extremely high cognitive ability. Researchers and authors in the popular press often highlight fictional depictions of highly intelligent, yet ineffective, people as a way of expressing the negative effects of cognitive ability. For example, in *The Social Animal,* David Brooks (2011) describes a fictional consulting firm which emphasizes intelligence when hiring new employees. As a result, the firm's consultants are overly eager to show off their intellect but unable to develop lasting, profitable relationships with clients. Likewise, researchers have used the character of Sheldon Cooper from the popular TV series *The Big Bang Theory* as an example of how overly high cognitive ability relative to your peers may negatively impact their perceptions of you (e.g., Antonakis et al., 2017). These examples appear to suggest that high intelligence or cognitive ability causes people to be perceived as aloof, arrogant, or generally antisocial. However, research indicates that cognitive ability is weakly associated with most personality traits (Ackerman & Heggestad, 1997; Carretta & Ree, 2018). In our opinion, the problems encountered by these characters—and their real-world counterparts—are more plausibly explained by other personality traits (e.g., low agreeableness, sociability, or empathy) than by high cognitive ability.

Implications for Research and Practice

It is also important to acknowledge that high cognitive ability does not at all guarantee success or beneficial outcomes in life. Across four longitudinal cohort studies, we found that even the strongest effects only accounted for up to 25% of the variance in life outcomes. These outcomes are determined by a multitude of factors beyond cognitive ability and other individual differences, including environmental factors, luck, and chance (Pluchino et al., 2018). Past research also demonstrates that cognitive ability scores still vary even among individuals within the highest levels of educational or occupational attainment (e.g., Berry et al., 2006; Park et al., 2008; Sackett & Ostgaard, 1994).

Along these lines, the achievement of outcomes indicating traditional aspects of success in life, such as occupational prestige, income, or educational attainment, should not be necessarily construed as indicative of high ability. However, examples of successful individuals who dropped out of college (e.g., Bill Gates or Mark Zuckerberg) or are falsely claimed to have received poor academic grades (e.g., Albert Einstein) are often improperly used as evidence for the irrelevance of cognitive ability or intelligence (e.g., Gladwell, 2008). These celebrated anecdotes confound school performance or attainment with ability, they are more the exception than the rule (Wai & Rindermann, 2017), and they distract from the broad-based evidence for the beneficial effects of cognitive ability on many life outcomes.

Cognitive ability also represents only one of many potential individual and environmental causes, albeit often the strongest predictor among individual difference constructs (Schmidt & Hunter, 1998, 2004). Beyond cognitive ability, personality and motivational traits, such as conscientiousness and self-control, have also been found to be predictive of a variety of outcomes in life (Allemand et al., 2018; Roberts et al., 2007). Many of these constructs are relatively independent of cognitive ability (Ackerman & Heggestad, 1997) and provide additive prediction to many work, educational, and health-related outcomes.

Potential Limitations

Although our samples included participants from several different generations and outcomes measured at various points in life across the US and UK, most scored within the typical cognitive ability range. This is often identified as a weakness of past studies that have attempted to test for threshold effects (Ferriman-Robertson et al., 2010). However, the goal of our study was to observe whether these effects could be detected within representative samples. Prior research has identified that individual differences in cognitive ability remain positively correlated with achievement, even among the top 1% of ability. For example, even when comparing the bottom quartile of the top 1% compared to the top quartile of the top 1% in scores on the SAT-Mathematics among talented 7th graders shows that decades later those in the top quartile earned significantly more Ph.D.s, patents, and publications, and even had higher incomes and greater likelihood of university tenure (Wai et al. 2005; Park et al., 2007). Similar patterns within the top 1% are also found within representative population samples (e.g., Project TALENT; Wai, 2014). Another potential limitation is the relative age of the cohort data. Our youngest cohort (NLSY97) consists of adults who are currently between the ages of 35 and 39. Although these cohorts allow us to observe the effects of cognitive ability across different generations, they may not represent how ability will affect similar outcomes among current young adults in the U.S. or abroad. However, Ones and colleagues (2017) contend that effects of cognitive ability may be even stronger now than in the past due to the increased role of complex tools and technology in work, suggesting that our findings might be a lower bound estimate of the impact of cognitive ability on life outcomes.

Despite the methodological advantages of analyzing large datasets from representative, longitudinal studies, they contain a necessarily finite set of dependent measures, which presents an additional limitation: We cannot rule out substantial nonlinear effects of cognitive ability on outcomes (such as artistic and athletic achievement) not included in our datasets. For example, our data do not provide any indication of how participants are perceived by others. Our measures of leadership indicate the attainment of a leadership role but are not an evaluation of leadership quality or how leaders are perceived by their followers or superiors. Although we do have several measures of social relationships and behavior, they are all self-reported. This prevents us from testing theories that posit interactions, in which the effect of one’s cognitive ability is expected to depend on the ability level of others in a group (e.g. Simonton, 1985). It may be the case that nonlinear or U-shaped effects of cognitive ability either exist or are larger relative to linear effects in cases of specific or subjective outcomes provided by peers, friends, or coworkers. In addition, our datasets all consist of individuals sampled from Western countries (the U.S. and U.K.). Therefore, more research is needed to determine whether our findings are generalizable to other cultures or nations (e.g., more collectivistic ones). However, although it is possible that the importance of cognitive ability may vary in magnitude, the general cognitive ability factor (g) is consistently observed in non-Western cultures (Warne & Burningham, 2019). Lastly, we also acknowledge that our study was designed to detect nonlinear effects of general factor of cognitive ability and our results may not necessarily generalize to all narrowly defined abilities, such as spatial, verbal, or quantitative ability.

Another potential limitation of the present study is the possibility of measurement invariance or test bias based on race or ethnicity. Several early proponents of cognitive ability testing used their research findings to argue for the superiority of the "White race" (Helms, 2012). These historical ties to racist beliefs and practices have been a heated point of contention in the past and continue to impede progress in cognitive ability research today. Even though group mean differences in cognitive ability are often observed, this does not mean that the tests are inherently biased (e.g., Jensen, 1980; Sackett et al., 2008). For example, Ree and Caretta (1995) reported similar factor loadings and strength of the general factor for the AFQT, which was used to measure cognitive ability in both NLSY cohorts (79 and 97), between White, Black, and Hispanic test takers. More research is still needed to better understand the causes for these group mean differences (Cottrell et al., 2015). Despite some evidence for differences in validity in cognitive ability scores based on race or ethnicity, there is often great variability between samples (Aguinis et al., 2016) and some differences can be explained by confounding factors such as range restriction (Dahlke et al., 2019). Yet correlations between ability and success generally remain positive within racial or ethnic groups (e.g., Berry et al., 2011). Our results are not intended to suggest that disparities in life outcomes based on race or ethnicity are due to underlying differences in cognitive ability. Instead, our argument is that that greater cognitive ability is likely advantageous in many aspects of life, no matter one's race or ethnicity.

Conclusions

Contrary to many popular ideas about limited or negative effects of cognitive ability, we found that greater ability generally provides an advantage for beneficial outcomes in work, education, health, and social contexts. Most relationships between cognitive ability and life outcomes were characterized by a moderate-to-strong linear trend or a practically null effect. What nonlinear effects we did detect were very small in magnitude and were often inconsistent across samples or different points in time. Therefore, we conclude that there is little evidence for any robust detrimental effects of or risk associated with having high cognitive ability. Better understanding of why popular misconceptions about cognitive ability continue to abound and how psychological scientists and other experts can proactively counter these misconceptions may be an important avenue for future research and consideration when attempting to close the research-practice gap regarding cognitive ability and its consequences.

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Table 1.
Examples of popular works suggesting the consequences of having too much cognitive ability

Publication Year	Title
	Works of Nonfiction
2018	*The intelligence trap: Why smart people make dumb mistakes* (Robson)
2016	*The stupidity paradox: The power and pitfalls of functional stupidity at work* (Spicer & Alvesson)
2013	*Why smart people hurt: A guide for the bright, the sensitive, and the creative* (Maisel)
2012	*The intelligence paradox: Why the intelligent choice isn't always the smart one* (Kanazawa)
2003	*The smartest guys in the room: The amazing rise and fall of Enron* (McLean & Elkind)
2000	*When genius failed: The rise and fall of long-term capital management* (Lowenstein)
1996	*The price of greatness: Resolving the creativity and madness controversy* (Ludwig)
1982	*The best and the brightest* (Halberstam)
1979	*The drama of the gifted child: The search for the true self* (Miller)
	Works of Fiction
2014-2019	*Silicon Valley* (television series, HBO)
2010-2017	*Sherlock* (television series, BBC)
2007-2019	*The Big Bang Theory* (television series, CBS)
2007	*Soon I will be invincible* (novel, Grossman)
2005	*Proof* (film)
2004	*The aviator* (film based on the life of Howard Hughes)
2001	*A beautiful mind* (film based on the life of John Nash)
1998	*Pi* (film)
1966	*Flowers for Algernon* (novel, Keyes)

Table 2.
Examples of claims in popular and academic literature that there are limits to the value of having greater cognitive ability

2019	"IQ" is a stale test meant to measure mental capacity but in fact mostly measures **extreme unintelligence …** how good someone is at taking some type of exams designed by unsophisticated nerds … it ends up selecting for exam-takers, paper shufflers, obedient IYIs (intellectuals yet idiots), ill adapted for "real life." (Taleb, 2019)
2019	"Society prizes intelligence. Geniuses are viewed with awe and assumed to be guaranteed prosperity and success. Yet there is a dark side to intelligence." (Fergusson, 2019)
2018	"Those who are highly intelligent possess unique intensities and overexcitabilities which can be at once remarkable and disabling. For example, the same heightened awareness that inspires an intellectually gifted artist to create…can also potentially drive that same individual to withdraw into a deep depression." (Karpinski et al., 2018, p. 9)
2016	"The average IQ of scientists is certainly higher than the average IQ of the general population, but among scientists there is no correlation between IQ and scientific productivity…among those who have become professional scientists, a higher IQ doesn't seem to offer an advantage." (Ericsson & Pool, 2016, pp. 234-235)
2014	"Although many people continue to equate intelligence with genius, a crucial conclusion from Terman's study is that having a high IQ is not equivalent to being highly creative. Subsequent studies by other researchers have reinforced Terman's conclusions, leading to what's known as the threshold theory, which holds that above a certain level, intelligence doesn't have much effect on creativity: most creative people are pretty smart, but they don't have to be that smart, at least as measured by conventional intelligence tests. An IQ of 120, indicating that someone is very smart but not exceptionally so, is generally considered sufficient for creative genius." (Andreasen, 2014)
2009	"To these qualifications of the importance of IQ, we can add the fact that, above a certain level of intelligence, most employers do not seem to be after still more of it." (Nisbett, 2009, p. 17)
2008	"The relationship between success and IQ works only up to a point. Once someone has an IQ of somewhere around 120, having additional IQ points doesn't seem to translate into any measurable real-world advantage." (Gladwell, 2008, pp. 78-79)
2007	"[A] reasonable amount of intelligence is certainly a necessary (though not sufficient) condition to be a reasonable mathematician. But an exceptional amount of intelligence has almost no bearing on whether one is an exceptional mathematician." (Tao, 2007)
2006	"Standardized tests are thus not sufficiently predictive of future performance. Individuals are not necessarily more meritorious if they obtain the highest scores on standardized tests, thus rendering invalid the argument that students with the highest scores should have priority in admissions." (Vasquez & Jones, 2006, p. 138)
2005	"There is little evidence that those scoring at the very top of the range in standardized tests are likely to have more successful careers in the sciences. Too many other factors are involved." (Muller et al., 2005, p. 2043)

2001	"At the highest levels of creative achievement, having an exceptionally high IQ makes little or no difference. Other factors, including being strongly committed and highly motivated are much more important." (Howe, 2001, p. 163)
1974	"Guilford and most of the other psychologists who have been active in this research field are agreed that a certain level of general intelligence is required for creativity. Below that level, an individual's resources of ideas are too meager to make creative production possible. But above that level, an individual may or may not be creative. It is not clear yet, however, exactly what that intelligence threshold is, and it would not be wise to set it too high. How high an IQ one needs to be creative is still an open question." (Tyler, 1974, in reference to Guilford, 1967).

Table 3.
Summary of Polynomial Regression Results by Outcome Category

	k	Mean *n*	Linear R^2	Quad. ΔR^2
Educational & Occupational				
Educational Attainment	4	7,132	.254	.001
Occupational Attainment	10	5,498	.155	.000
Annual Income (log)	27	4,899	.064	.002
Unemployment	16	6,363	.051	.001
Leadership	13	5,520	.012	.000
Job Satisfaction	16	6,296	.002	.000
Health & Well-Being				
Depression	9	6,969	.029	.002
Physical Exercise	11	6,299	.015	.000
Self-Reported Health	16	6,328	.011	.001
Body Mass Index	13	6,233	.011	.000
Subjective Well-Being	12	6,465	.006	.002
Sleep Habits	14	6,290	.004	.002
Health Conditions	12	6,068	.004	.000
Social				
Volunteering	9	6,037	.032	.000
Civic Participation	11	5,793	.022	.000
Social Participation	13	6,283	.013	.001
Marital Status – Divorced	4	5,857	.007	.002
Marital Status – Married	4	7,775	.007	.002

Note. *k* = number of outcomes tested; All R^2 estimates are sample weighted.

Table 4.
Sample Weighted Correlations Below and Above Theorized Cognitive Ability Thresholds

	Threshold IQ = 100		Threshold IQ = 120	
	Below	Above	Below	Above
Educational & Occupational				
Educational Attainment	.267	.340	.418	.168
Occupational Attainment	.210	.240	.330	.108
Annual Income (log)	.137	.145	.209	.068
Unemployment	–.081	–.054	–.121	–.018
Leadership	.059	.066	.105	.019
Job Satisfaction	.008	.000	.017	–.005
Health & Well-Being				
Depression	–.106	–.054	–.148	–.022
Physical Exercise	.088	.075	.091	.010
Self-Reported Health	.075	.038	.086	–.002
Body Mass Index	–.038	–.057	–.080	–.026
Subjective Well-Being	.026	.025	.041	–.007
Sleep Habits	–.008	.052	.027	.019
Health Conditions	–.033	–.023	.005	–.003
Social				
Volunteering	.069	.104	.166	.051
Civic Participation	.089	.084	.137	.019
Social Participation	.045	.029	.050	–.017
Marital Status - Ever Divorced	–.019	–.070	–.049	–.051
Marital Status - Ever Married	.083	.018	.077	.006

Note. All values are sample-weighted correlations; Sleep habit outcomes were all coded such that greater values correspond to better sleep (more hours of sleep or fewer problems sleeping).

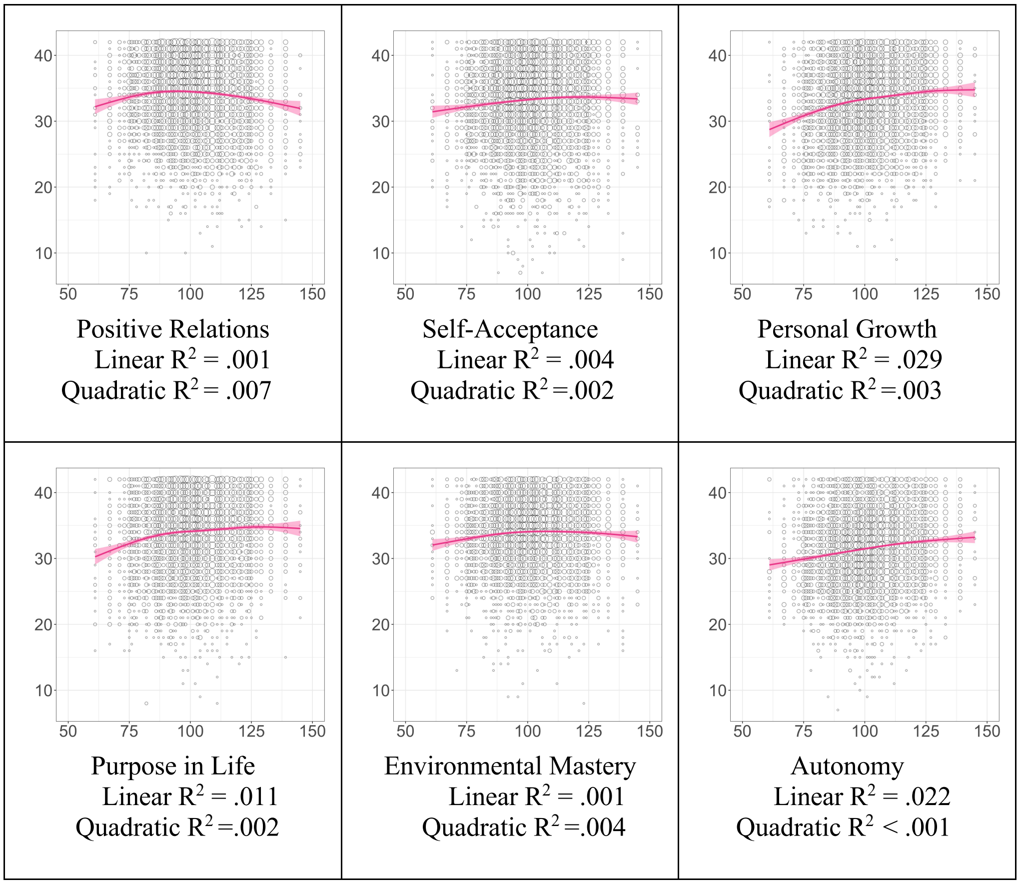
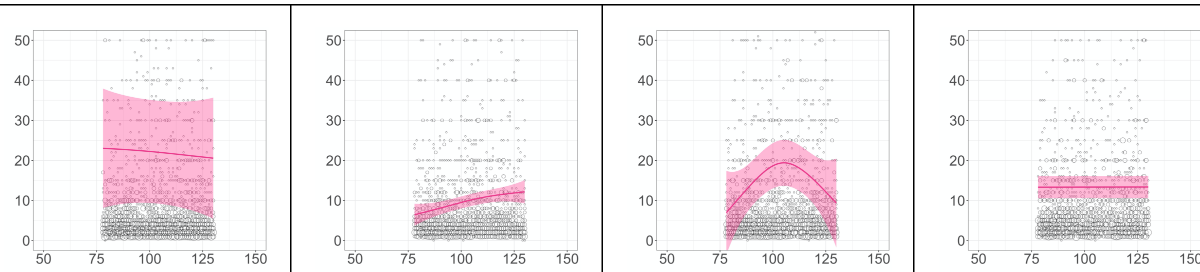


Figure 1. Locally-Weighted Regression Plots for Psychological Well-Being regressed on Cognitive Ability. Each plot represents the observed relationship for each dimension of psychological well-being in the WLS cohort. A significant U-shaped effect was detected for Positive Relations with Others but not for any of the five remaining well-being dimensions. Moreover, no U-shaped or practically significant nonlinear effects were found for life satisfaction measures in the BCS70, NLSY79, or the NLSY97.



NLSY79; 1988
Linear $R^2 < .001$
Quadratic $R^2 = .001$

NLSY79; 1990
Linear $R^2 = .004$
Quadratic $R^2 = .002$

NLSY79; 1996
Linear $R^2 = .001$
Quadratic $R^2 = .005$

NLSY79; 1998
Linear $R^2 = .006$
Quadratic $R^2 = .002$

Figure 2. Locally-Weighted Regression Plots for Number of Subordinates Regressed on Cognitive Ability. Each plot represents the observed relationship for all four instances of this outcome within the NLSY79 cohort. A significant U-shaped effect was detected for data from 1996 but was not replicated in either of the three remaining time periods.

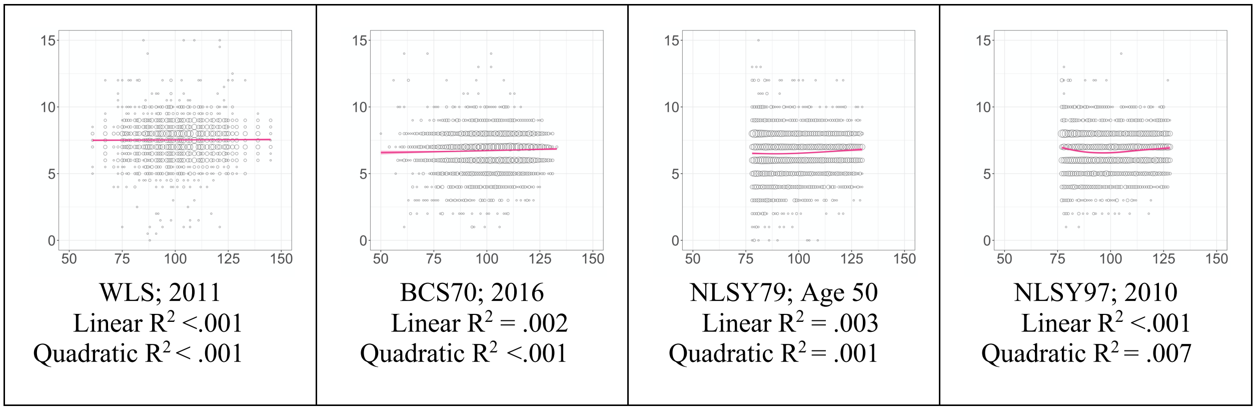


Figure 3. Locally-Weighted Regression Plots for Sleep Habits (reported number of hours slept) regressed on Cognitive Ability. Each plot represents the strongest, nonlinear effect found within each cohort. Several significant U-shaped effects were found within the NLSY97 cohort (typical hours slept per night in 2010, 2011, and 2015 survey waves) but were not replicated in either of the three remaining studies.

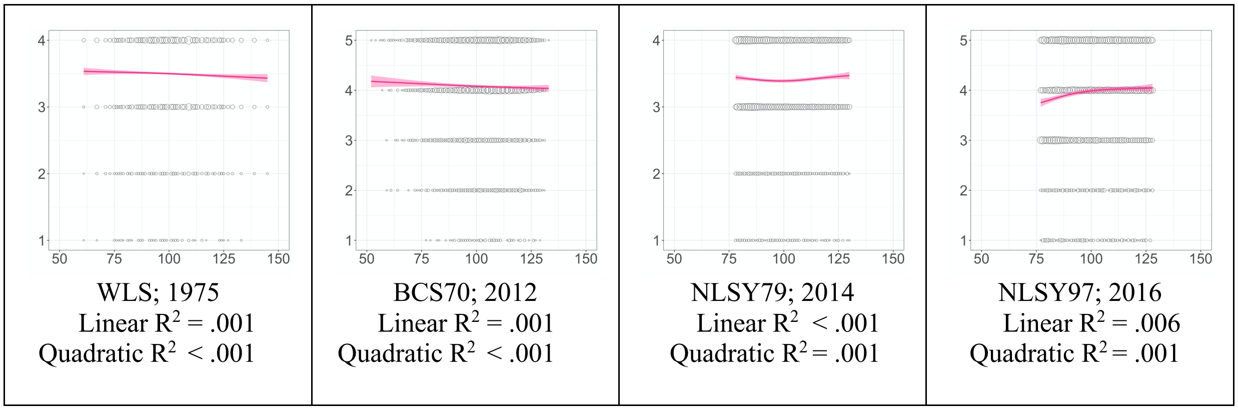


Figure 4. Locally-Weighted Regression Plots for Job Satisfaction regressed on Cognitive Ability. Each plot represents the strongest nonlinear effect observed within each cohort study. A significant U-shaped effect was detected in NLSY79 (job satisfaction ratings in 2014) but was not replicated in either of the three remaining cohorts.

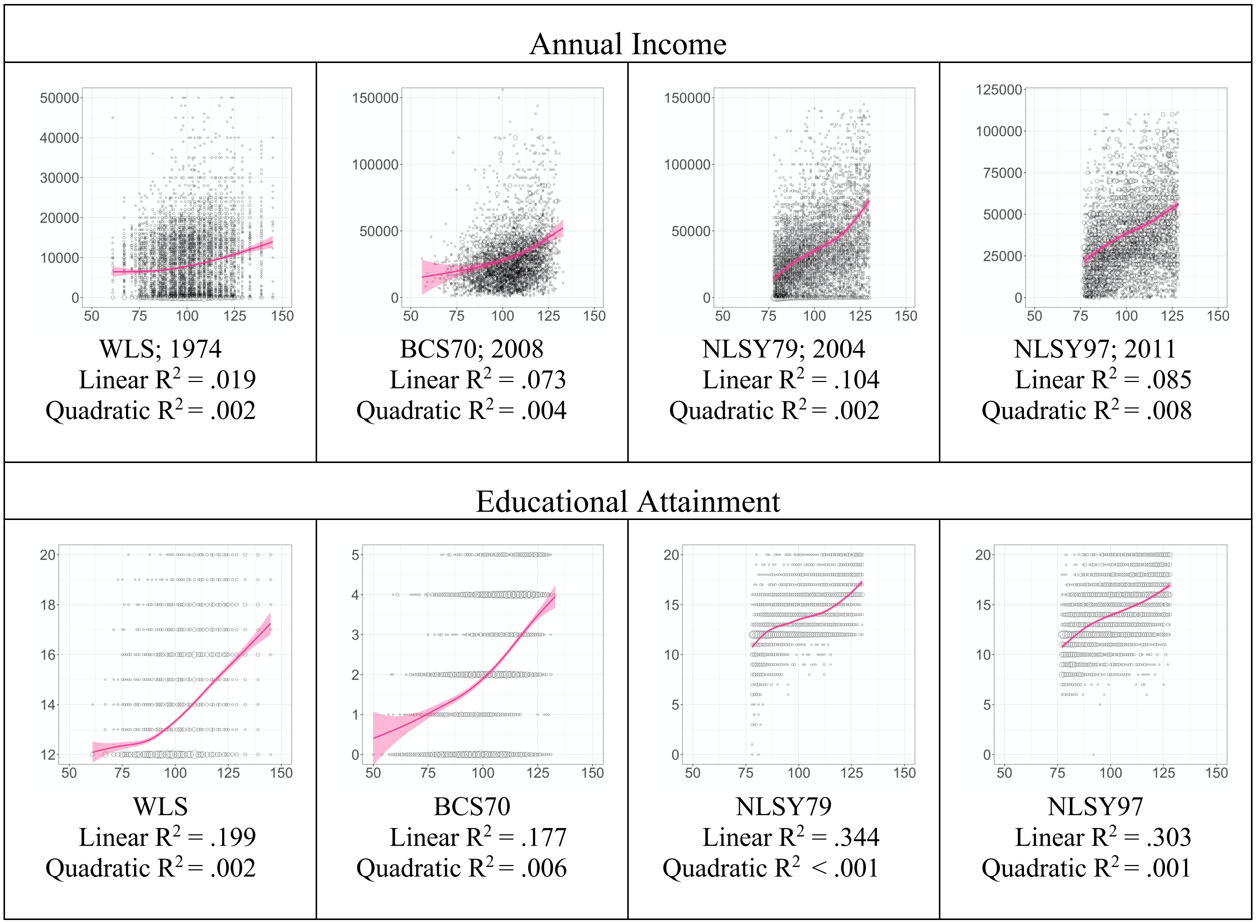


Figure 5. Locally-Weighted Regression Plots for Annual Income (top row) and Educational Attainment (bottom row) regressed on Cognitive Ability. Annual income is displayed in dollars (or pounds) without a log transformation. A practically significant nonlinear effect was found for annual income within the NLSY97 cohort (survey waves 2008, 2009, 2010, and 2011) but not in any of the remaining three cohorts. Educational attainment is reported in number of years (WLS, NLSY79, and NLSY97) or using the National Vocational Qualification (NVQ; BCS70). A practically significant nonlinear effect was found for educational attainment in the BCS70 but not in any of the remaining cohorts.

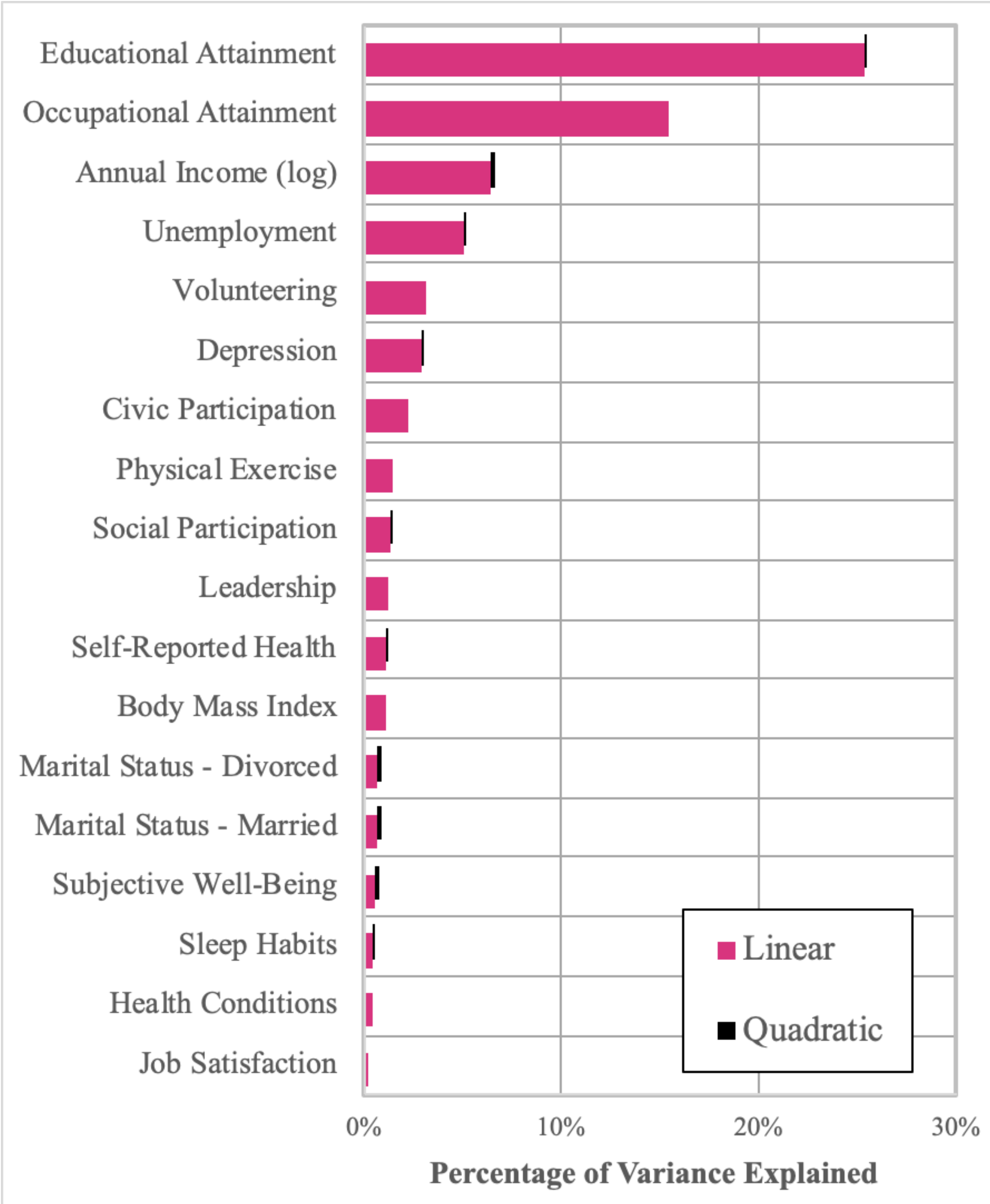


Figure 6. Summary of Linear and Nonlinear Cognitive Ability Effects by Outcome. Red bars represent the percentage of variance explained (R^2) by the linear effect of cognitive ability. In approximately 90% of all models, linear effects indicated that greater GMA is predicted to yield better occupational, educational, health, or social outcomes (194 of 214 models). Offset black bars represent the incremental percentage of variance accounted for by the quadratic effect of cognitive ability.