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Childhood general cognitive ability predicts leadership role occupancy across life: Evidence from 17,000 cohort study participants

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ABSTRACT

Research in the leadership literature has not yet identified links between childhood general cognitive ability and leadership potential in adulthood. We tested whether early cognitive ability contributed to leadership role occupancy across four decades in a sample of 17,000 working individuals from two representative British cohorts. On average a 1 standard deviation increase in cognitive ability predicted a 6.2 percentage point higher probability of leadership role occupancy. In Study 1, adjusted models showed that 37.3% of high cognitive ability children (+1 SD) occupied leadership positions compared to 25.4% of low cognitive ability (−1 SD) children and this gap was even more pronounced in Study 2 (27.8% vs. 15.1%). Cognitive ability showed a graded association with the number of employees supervised in both studies and educational attainment partially explained the cognitive ability–leadership association. The results suggest that early individual differences in childhood general cognitive ability may profoundly shape trajectories of leadership across working life.

Introduction

Leadership roles are complex and require sophisticated information gathering and processing skills as well as strong planning and creative problem solving abilities. For these reasons key leadership models (e.g. DeRue, Nahrgang, Wellman, & Humphrey, 2011; Mumford, Campion, & Morgeson, 2007; Mumford, Zaccaro, Harding, Jacobs, & Fleishman, 2000) consider general cognitive ability to be a critical element underlying leadership competency. Employees also view intelligence as a prototypical attribute of leaders (Epitropaki & Martin, 2004; Lord, Foti, & De Vader, 1984). Yet, the evidence base for the association between general cognitive ability and leadership has relied primarily on findings from cross-sectional data (e.g. Judge, Colbert, & Ilies, , 2004; Mann, 1959) which have not been supported by recent longitudinal studies (Li, Arvey, & Song, 2011; Reichard et al., 2011). Given that high cognitive ability is considered to be a key element of leadership both in leadership models and by employees, the goal of this study is to test whether an association exists between early life general cognitive ability and leadership prospects across working life.

Although leadership development occurs continuously throughout the lifespan (e.g. Avolio, Walumbwa, & Weber, 2009; Day, 2011), we propose that the foundations of leadership may be laid early in life. Individual differences in general cognitive ability are formed primarily in the first decade of life, are highly stable, and prospectively predict a range of key life outcomes including criminal behavior, health, and success in finding and keeping work (e.g. Daly, Delaney, Egan, & Baumeister, 2015; Heckman, 2006; Heckman, Stixrud, & Urzua, 2006). There is also extensive evidence demonstrating that general cognitive ability predicts important facets of

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occupational success including job performance (Schmidt & Hunter, 2000), mobility in the job hierarchy and remuneration (Dreher & Bretz, 1991; Judge, Higgins, Thoresen, & Barrick, 1999; Salgado & Anderson, 2002; Schmidt & Hunter, 1998). However, research in the leadership literature has not yet linked childhood cognitive ability to leadership in adulthood, though there are strong theoretical reasons to suspect that intelligence may be an important precursor of leader emergence. The focus of this special issue is on leader cognition and we suggest that general cognitive abilities provide the cognitive architecture to support key types of thinking needed for leadership roles.

For instance, higher-level general cognitive abilities including verbal comprehension, working memory, reasoning and processing speed (Wechsler, 2008) may enable employees to generate valued solutions to problems within organizations (Mumford et al., 2000). When tackling difficult, ill-defined, or novel problems employees with higher levels of cognitive ability may be particularly effective in collecting and processing the quantitative and verbal information needed to identify a solution (Lau & Pavett, 1980; Mumford et al., 2007). Such individuals may be capable of holding several key pieces of information gathered from organizational systems in memory, mentally integrating this information, and reasoning through competing options to identify a workable solution. Finally, employees with strong cognitive abilities may work through this problem solving process quickly in the face of competing demands and time pressure. It is likely that such employees who are adept at solving crucial institutional problems may be particularly likely to be promoted to leadership roles.

In this study, we therefore suggest that leadership will tend to follow from general cognitive abilities. Specifically, we propose that early life general cognitive ability will play a formative role in shaping a key aspect of leadership — leadership role occupancy. We test whether childhood cognitive ability distinguishes leaders from other employees and identify the magnitude of this association using data from almost 17,000 participants from two large-scale prospective cohort studies from Great Britain. Both cohorts include high-quality measures of childhood general cognitive ability, other important predictors of occupational success such as socioeconomic status and self-control (Daly et al., 2015), and measures of leadership role occupancy at multiple time-points across adult working life.

General cognitive ability and leadership

Leadership and individual differences research saw a decline and subsequent resurgence during the 20th century. Stogdill's (1948) and Mann's (1959) reviews of the literature were viewed as providing little support for the idea that stable individual differences shape the emergence of leaders and leadership behaviors across contexts (Antonakis, Day, & Schyns, 2012). This led to the establishment of a behavioral perspective in leadership research focused on understanding leader behavior in many domains including task processes, relational dynamics, and change-orientated behaviors (DeRue et al., 2011).

Trait-based theories did not re-emerge as a focus of leadership research until the 1980s when reanalyses of prior studies found stronger evidence for cross-situational consistency in leadership emergence and perceptions than previously identified (e.g. Kenny & Zaccaro, 1983; Zaccaro, 2007). Lord, De Vader, and Alliger (1986) conducted a meta-analytic review of the studies examined initially by Mann (1959) and identified intelligence as a key characteristic that was positively correlated with perceptions of good leaders ($r = 0.50$). This research provided empirical support for a leader trait perspective and general cognitive ability as a potential determinant of leadership emergence and effectiveness.

As described above, there is a clear match between the comprehension, memory, processing, and reasoning skills that characterize general cognitive ability and the leadership skills needed to assimilate information and solve complex problems in modern organizations. Intelligence may also allow leaders to tackle other key cognitive job demands of contemporary organizations. For instance, high levels of cognitive ability may enable leaders to generate creative ideas and strategic plans in competitive and rapidly changing organizational environments (Mumford & Connelly, 1991; Mumford, Connelly, & Gaddis, 2003; Mumford et al., 2000). Creative leaders who advance original and useful ideas for the development of products, organizational processes, and employee skills are valuable to organizations particularly in uncertain economic times characterized by technological change (e.g. Reiter-Palmon & Illies, 2004). Although initial studies found little overlap between cognitive ability and creativity ($r = 0.17$; Kim, 2005), emerging evidence points to a potential strong contribution of general cognitive ability to several aspects of creative thinking. For instance, intelligence has been shown to positively predict divergent thinking ($r = 0.34$; Benedek, Jauk, Sommer, Arendasy, & Neunauer, 2014) and to facilitate the generation of creative metaphors ($\beta = 0.49$; Silvia & Beaty, 2012) and original ideas ($\beta = 0.51$; Benedek, Franz, Heene, & Neubauer, 2012). It is possible that creativity may act as a pathway between general cognitive ability and leadership. If employees with high levels of cognitive ability are more creative in their behavior and generate valuable solutions to organizational problems they may be considered to have strong leadership potential.

Employees with high levels of cognitive ability may also be considered suitable for leadership opportunities because of their ability to draw on information from multiple sources in order to generate plans and make strategic decisions. For instance, forming business strategies in order to achieve longer-term strategic objectives involves the accumulation, comprehension, and integration of an abundance of relevant information (Li et al., 2011). Such planning also involves the comparison of multiple alternatives and the anticipation of potential consequences which together pose substantial demands on cognitive abilities. Leaders must also make strategic decisions whilst dealing adaptively with complexity and information ambiguity within restrictions imposed by time, resources, system demands, and differing goals and conflicting problems (Mumford et al., 2000). Moreover, they must do this whilst monitoring numerous operations and employees which further taxes cognitive abilities. Thus, there are many theoretical reasons to expect those endowed with high levels of cognitive ability to be identified and selected as emergent leaders.

It is therefore potentially unsurprising that an empirical association between cognitive ability and leadership has been comprehensively documented in the literature (Judge et al., 2004; Kickul & Neuman, 2000; Lord et al., 1986; Mumford et al.,

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2007). However, the magnitude and robustness of this relationship remains unclear. A meta-analytic review of 151 studies identified a relatively weak cross-sectional association between intelligence test scores and leadership emergence and effectiveness (corrected and adjusted for restriction of range, r = 0.25 and 0.33 respectively) (Judge et al., 2004). These estimates are a degree smaller than those identified in the Lord et al. (1986) meta-analysis (r = 0.50), potentially because of the broader scope of the more recent meta-analysis. In addition, a smaller portion of the studies included in the Judge et al. (2004) meta-analysis relied on perceptual measures of intelligence and leadership which could inflate correlations due to common method bias or attitudes of the rater towards the leader (Podsakoff, MacKenzie, Jeong-Yeon, & Podsakoff, 2003). It is possible that the true relationship between general cognitive ability and leadership may be weaker again because the majority of the research reviewed by Judge et al. (2004) relied chiefly on cross-sectional data.

Indeed, longitudinal analysis of this relationship is comparatively rare and few studies have examined the association between cognitive ability and leadership over time horizons of several years or longer. In one of the few examples of such research, Reichard and colleagues used data from the Fullerton Longitudinal Study (N = 130) to show that cognitive ability at age 17 had little or no relationship with leader emergence or transformational leadership assessed at age 29 (Reichard et al., 2011). Similarly, Li et al. (2011) found that adolescent cognitive ability was unrelated to leadership role occupancy and advancement in a larger sample drawn from the U.S. National Longitudinal Survey of Youth 1979 (N = 1,747). In supplementary analyses the authors did identify a weak positive association between cognitive ability and leadership role occupancy which was rendered non-significant when self-esteem was included in the regression model.

Although both of these studies failed to identify a robust association between general cognitive ability and leadership they offer two clear methodological advancements on existing research in this area. Firstly, by implementing a long run prospective design where cognitive ability was measured in youth these studies avoid inadvertently estimating the impact of 'third variables' such as poor physical or mental health that could affect both cognitive ability and leadership in adulthood and inflate cross-sectional estimates of the association. Secondly, these studies avoid the potential for endogeneity or reverse causality. Changes in occupational status have been shown to influence largely stable individual difference characteristics (Boyce, Wood, Daly, & Sedikides, 2015). Similarly, cognitive skills may be enhanced by career advancement, for instance, through the provision of training programmes (Carter, 2002).

In the current study we avoid this possibility by employing a longitudinal research design where cognitive ability is measured prior to labour force entry in two large samples with extensive periods of follow up. We propose that general cognitive ability is likely to contribute to leadership based on existing meta-analytic evidence (e.g. Judge et al., 2004; Lord et al., 1986) and prospective studies that have shown cognitive ability to positively influence academic success, earnings, and career advancement (Dreher & Bretz 1991; Salgado & Anderson, 2002; Schmidt & Hunter, 1998; Wilk, Desmarais, & Sackett, 1995). For instance, several studies have shown high general cognitive ability individuals earn higher incomes and enter higher prestige jobs earlier in their careers, and accumulate gains at a faster pace than their low ability peers (Judge, Klinger, & Simon, 2010; Judge et al., 1999; Murray, 1998).

It is a natural progression to expect that cognitive ability is also closely related to leadership role occupancy. Based on this research, we put forward the following hypothesis:

Hypothesis 1. Childhood general cognitive ability will be positively related to a) leadership role occupancy, and b) occupying leadership roles with greater responsibility as gauged by supervising a larger number of employees.

Education as a pathway between cognitive ability and leadership

General cognitive ability is a powerful determinant of academic performance, which in turn may shape future leadership prospects. Psychometric tests scores capturing general cognitive ability have been shown to explain a quarter of the variance in academic achievement scores and academic attainment levels (Deary, Strand, Smith, & Fernandes, 2007; Mackintosh, 1998; Rohde & Thompson, 2007). Those with higher levels of cognitive ability are far less likely than others to drop out of education early (Foley, Gallipoli, & Green, 2009), and are more likely to progress to and perform well in third-level education (Bosma, van Boxtel, Kempen, van Eijk, & Jolles, 2007; Richardson, Abraham, & Bond, 2012). Success in education is an important foundation for career success including greater earnings and occupational prestige (Cohn & Addison, 1998). Causal estimates of the financial returns to education from studies examining policy changes such as the raising of the school leaving age (e.g. Card, 1999) have shown these returns to be significant and large in magnitude.

Achieving higher pay and rising within the ranks of corporate management are also closely related to educational attainment, possessing a high quality graduate degree and holding a qualification from a prestigious or leading institution or program (Judge, Cable, Boudreau, & Bretz, 1995; Useem & Karabel, 1986). Students with high levels of cognitive ability are likely to be particularly effective in gaining places on prominent programs, learning course materials and accumulating career relevant knowledge during educational training (Richardson et al., 2012). These students may subsequently demonstrate higher levels of job knowledge and performance (e.g. Hunter, 1986) and move quickly into leadership positions. Based on existing evidence, we therefore expect that by achieving strong academic qualifications high cognitive ability children will experience rapid trajectories of career progression (e.g. Cheng & Furnham, 2012) culminating in the attainment of leadership roles. Specifically, we suggest the following hypothesis:

Hypothesis 2. The contribution of childhood general cognitive ability to leadership role occupancy and attaining high responsibility leadership positions will be explained, at least in part, by educational attainment.

Gender, cognitive ability, and leadership

The concept of the "glass ceiling" has been used since the 1980s to describe the unseen, yet seemingly unbreakable barrier that impedes the progress of women and minorities up the management hierarchy (Morrison & von Glinow, 1990). Although the proportion of women in leadership positions has grown in recent decades, females are still under-represented in leadership roles (Schuh et al., 2014). In the US, women make up 47% of the workforce, but account for only 14.6% of top management positions and 18.5% of the seats in Congress (Warner, 2014). Similarly, in the UK, women hold just 14% of top management jobs and occupy only 22% of parliamentary positions (Hausmann, Tyson, & Zahidi, 2010). Moreover, worldwide, the division of gender in the management hierarchy is highly imbalanced such that men occupy the most powerful positions and women tend to hold lower and middle managerial ranks (Vinnicombe, 2000). Women also tend to receive lower salaries than their male counterparts for equivalent work (Blau & Kahn, 2000) and the positions women occupy have been found to have less scope for career progression and less opportunity for material rewards such as stock options and bonuses (e.g. Haslam & Ryan, 2008; Jacobs, 1992).

In the present study, we examine the effect of gender on leadership role occupancy and its potential to moderate the relationship between cognitive ability and leadership role occupancy. In line with the well documented association between gender and leadership outlined above we expect females will be less likely than males to occupy leadership roles and to attain high responsibility leadership roles. Moreover, we expect that general cognitive ability will have weaker associations with leadership for females than males. Females face more barriers than males to fully capitalize on their cognitive capabilities in the workplace centrally because of gender biases and the restrictions associated with social roles (Li et al., 2011). For instance, cultural and social norms whereby women have greater domestic responsibilities could stifle the potential of women to maximally apply their cognitive skills for career advantage (Bianchi, Milkie, Sayer, & Robinson, 2000). Furthermore, cultural and social norms may encourage discriminatory practices whereby the cognitive capabilities of women are not fully recognized and rewarded through leadership positions (Growe & Montgomery, 2000). More subtle gender biases could affect the degree to which females are chosen as allies or are closely mentored again inhibiting their ability to draw on their cognitive abilities to ascend to more senior positions of authority (Jacobs, 1992). Based on the above observations we predict the following:

Hypothesis 3. Females will be less likely than males to a) occupy leadership positions, or to b) attain high responsibility leadership positions.

Hypothesis 4. Gender will moderate the association between cognitive ability and occupying leadership roles, such that the link between cognitive ability and leadership outcomes will be weaker for females.

Study 1

Method

Participants & procedure

Participants were from the British Cohort Study (BCS), a nationally representative cohort of 17,000 people born in England, Scotland, and Wales from the 5th to 11th of April 1970. The BCS contains detailed information on the cohort members' background characteristics and childhood cognitive ability at age 10 and information about their leadership role occupancy at ages 26, 30, 34,

Table 1
Characteristics of participants from the British Cohort Study, divided into columns for each available wave of employment data (age 26, 30, 34, 38, 42).

Age	26	30	34	38	42	26–42
N	3643	3743	3419	3119	3294	6284
Employees %	83%	70%	63%	59%	60%	71.5%
(N)	(3014)	(2612)	(2165)	(1849)	(1991)	
Leadership role %	17%	30%	37%	41%	40%	29.5%
(N)	(629)	(1131)	(1254)	(1270)	(1303)	
Cognitive ability[a]	79.2	78.2	78.3	79.1	78.7	77.91
(SD)	(13.5)	(14.1)	(13.8)	(13.6)	(13.6)	(13.93)
Self-control[b]	33.0	32.3	32.4	32.9	32.5	32.14
(SD)	(9.2)	(9.6)	(9.4)	(9.3)	(9.4)	(9.58)
Female	52.9%	48.7%	50.0%	51.1%	50.7%	50.7%
SES I[c]	7.7%	7.5%	7.3%	7.5%	7.0%	7.0%
SES II[c]	26.2%	24.8%	24.7%	25.7%	25.3%	24.6%
SES III[c]	52.9%	54.0%	54.1%	53.1%	53.0%	53.9%
SES IV[c]	10.7%	10.7%	11.0%	11.0%	12.0%	11.6%
SES V[c]	2.4%	3.0%	2.9%	2.7%	2.7%	2.9%

[a] Unstandardized cognitive ability scores ranging from 23 to 125.
[b] Unstandardized self-control scores ranging from 1.45 to 47.
[c] Social class is derived from the occupation of the child's father, where I = professional occupations and V = unskilled workers.

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38 and 42. Our sample was restricted to those who were in full-time employment and excluded those in non-managerial foreman/supervisory roles that were typically in manual/low skill occupations and associated with lower pay than our core leadership role occupancy variable. After retaining only observations with complete data on the main study variables (cognitive ability, leadership role occupancy, gender, socioeconomic status at birth, and self-control) there were 6284 participants with data for at least one wave of follow-up in adulthood. The sample was 51% female across the waves and participants had a broad range of socioeconomic backgrounds as shown in Table 1.

Measures

Leadership role occupancy. In this study we aimed to uncover the type of individual who emerges as a leader and therefore use leadership role occupancy as our main outcome measure. We did not seek to identify if cognitive ability contributes to leadership performance, style, or how leaders are perceived. For this reason, participants were not pre-selected based on specific leadership characteristics, experience, or abilities. Rather, we examined a national cohort of children and assessed whether these individuals went on to hold a position with leadership functions later in life. In line with prior research from a leadership role occupancy perspective (e.g. Arvey, Rotundo, Johnson, Zhang, & McGue, 2006; Arvey, Zhang, Avolio, & Krueger, 2007; Avolio et al., 2009; De Neve, Mikhaylov, Dawes, Christakis, & Fowler, 2013; Li et al., 2011; Reichard et al., 2011) we consider leadership emergence is an initial step in the process of becoming an effective leader and that those who hold such roles lead as a result of the status of the position they occupy (Bass, 1990; Ilies, Gerhardt, & Le, 2004).

Prior studies have employed a “bio-history” methodology to elicit information about the leadership positions an individual has held (e.g. Arvey et al., 2006; Judge, Bono, Ilies, & Gerhardt, 2002; Mumford, O'Conner, Clifton, Connelly, & Zaccaro, 1993). To capture leadership experience participants have been asked to recall the number of specific leadership positions they have held including whether they have captained sports teams or held formal officer roles in clubs or organizations or acted as class leaders in high school (Day, Sin, & Chen, 2004, Mumford et al., 1993; Stricker & Rock, 1998). Our leadership role occupancy variable was a binary indicator of whether the cohort member was an employee or a manager at the time of being interviewed. As such this measure has the advantage of not relying on participants to accurately recollect their leadership positions across a broad time horizon.

Participants were asked “Do you have any managerial duties, or are you supervising any other employees?” at ages 30, 34, 38 and 42. At age 26 we used a measure of current employment status which was elicited using different phrasing but was essentially similar. We constructed a binary variable where those with managerial duties were considered ‘leaders’ and those who did not supervise or manage others considered ‘followers’. On average 29.5% of participants were classified as leaders across the five waves examined. The proportion of leaders ranged from 17% at age 26 to 41% at age 38, as shown in Table 1.

To examine the convergent and predictive validity of our leadership role occupancy variable we drew upon two sources of evidence: a set of indicators of workplace responsibility and a measure of household income, all examined when the cohort members were 42 years. Occupying a leadership position correlated positively with responsibility for work decisions ($r = 0.35$, $p < 0.01$) and deciding work hours ($r = 0.28$, $p < 0.01$), and negatively with whether the participant was closely supervised at work ($r = -0.24$, $p < 0.01$). Those in leadership roles had substantially higher income levels ($r = 0.32$, $p < 0.01$), providing evidence of the predictive validity of our leadership measure. These correlations and validation metrics are of a similar, and in some cases greater, magnitude to those shown in previous studies (Li et al., 2011). Taken together, our validation analyses suggest that the leadership role occupancy variable employed in this study demonstrates sufficient convergent and predictive validity.

High responsibility leadership role occupancy. At age 30, 34 and 38 participants were specifically asked whether they had managerial duties and if so whether they supervised more or less than 25 people. We assumed that supervising a greater number of employees was likely to be indicative of higher level leadership on average. To contrast ‘followers’ with low and high level ‘leaders’ we constructed a variable where employees without managerial or supervisory duties were coded as 0 (72% of the sample on average across the three age groups), managers supervising 1–24 employees were coded as 1 (9% of sample on average), and where those occupying a management position involving the supervision of at least 25 employees were coded as 2 (19% of the sample on average).

Childhood general cognitive ability. General cognitive ability was measured at age 10 using the British Ability Scales (BAS). The BAS has been shown to have high levels of convergent validity and scores on this measure align closely with those derived from other measures of general cognitive ability including the Wechsler Intelligence Scale for Children and the Stanford–Binet Intelligence Test. The BAS is comprised of two verbal (word definitions, word similarities) and two non-verbal (digit-span, matrices) subscales (Elliott, Murray, & Pearson, 1978). For the word definitions test the participating child was asked to indicate the meaning of 37 words. For the word similarity test the child was presented with 42 three-word lists (e.g. orange, banana, strawberry) and asked to name a word consistent with the theme. The recall of digits test consisted of 34 series of digits. Each digit list was read aloud at half-second intervals after and the child was tasked with repeating the digits. Finally, for the matrices test the child was presented with 28 incomplete patterns and asked to fill in a missing section of the pattern.

We summed correct responses for each subscale and then standardized these four variables to have a mean of 0 and standard deviation of 1. Finally, we summed these four standardized variables (Cronbach's alpha = 0.75), and standardized the resulting variable to create our main independent variable.

Covariates. Our main covariates were gender, socio-economic status and childhood self-control. Socio-economic status (SES) was derived from the father's occupation in 1970 when the participant was born (ranging from I = professional occupations and V = unskilled workers). Individual differences in childhood self-control correlate positively with cognitive ability (e.g. Duckworth & Seligman, 2005) and have been positively linked to later life occupational success and (e.g. Daly et al., 2015; Moffitt et al., 2011). We therefore adjusted for self-control scores derived from 11 teacher-rated items from the 'inattentive' subscale of the 53-item Child Developmental Behaviors questionnaire, taken when the child was 10 years old (see Daly et al., 2015 for a full discussion of the self-control measures in Study 1 and 2).

In order to test whether education explained the link between cognitive ability and leadership we used measures of educational attainment taken at 30, 34, 38 and 42 which elicited the highest academic or vocational qualification attained by the cohort member. This measure was chiefly indexed by National Vocational Qualification (NVQ) rankings which capture the spectrum of academic achievement from basic second level or vocational qualifications (NVQ 1) to postgraduate degrees (NVQ 5). Those who did not attain formal qualifications were coded as 0 producing a variable ranging from 0 to 5 (0 = no qualifications, 1 = NVQ 1, 2 = NVQ 2, 3 = NVQ 3, 4 = NVQ 4, 5 = NVQ 5).

Statistical methods

We specified a random intercepts multilevel model (Model 1) to estimate the association between cognitive ability and the probability of leadership role occupancy (LRO) (coded as 1) versus a non-leader employee (coded as 0) across ages 26, 30, 34, 38 and 42. The model accounted for repeated observations on each individual (i) across waves as the sample age (t). Age was the sole level-1 covariate and the level-2 person-level variables cognitive ability and the study control variables (i.e. gender, socioeconomic status, self-control) were added to the intercept equation.

A supplemental analysis tested whether this relationship was robust to adjustment for the type of industry the participant worked in. To investigate whether these associations were explained by educational attainment, we included a model with a measure of education as indexed by NVQ rankings (Model 2). We also specified an interaction model to investigate whether the relationship between childhood cognitive ability and adult leadership was different for males and females (Model 3). In line with standard practice, we included the interaction terms as well as the independent main effects of the constituent variables in the latter model (Aiken & West, 1991). All models controlled for gender, parental social class and childhood self-control.

The formal specification of each of the core models is detailed below:

Model 1:

Level 1: $\text{LRO Age } (26/30/34/38/42)_{ti} = \beta_{0i} + \beta_{1i}(\text{Age}_{ti}) + \varepsilon_{ti}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Childhood Cognitive Ability}_i) + \gamma_{02}(\text{Controls}_i) + \mu_{0i}$

Model 2:

Level 1: $\text{LRO Age } (26/30/34/38/42)_{ti} = \beta_{0i} + \beta_{1i}(\text{Age}_{ti}) + \varepsilon_{ti}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Childhood Cognitive Ability}_i) + \gamma_{02}(\text{Controls}_i) + \gamma_{03}(\text{Education}_i) + \mu_{0i}$

Model 3:

Level 1: $\text{LRO Age } (26/30/34/38/42)_{ti} = \beta_{0i} + \beta_{1i}(\text{Age}_{ti}) + \varepsilon_{ti}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Childhood Cognitive Ability}_i) + \gamma_{02}(\text{Controls}_i) + \gamma_{03}(\text{Female}_i * \text{Childhood Cognitive Ability}_i) + \mu_{0i}$

To examine whether the relationship between cognitive ability and leadership role occupancy varied over time we examined each individual wave separately (age 26, 30, 34, 38 and 42) using Probit models and computed marginal effects using the 'margins' command in Stata to estimate percentage point changes (Long & Freese, 2014).

Finally, we ran a multilevel model using the specifications in Models 1–3 to predict high responsibility leadership at ages 30, 34 and 38 (where 0 = no employees supervised, 1 = 1–24 employees supervised, and 2 = 25+ supervised).

Results

Descriptive statistics

Table 1 and Fig. 1 show descriptive statistics for the sample. As might be expected, the percentage of cohort members who were classified as occupying a leadership role rose over time — from 17% at age 26 to a peak of 41% at age 38. There were large gender differences in leadership role occupancy; by age 42 only 29% of females held leadership positions compared to 50% of males. Fig. 1A illustrates the relatively stable association between cognitive ability and leadership from age 30 with both low (−1 SD and below; 16% of sample) and high ability (+1 SD and above; 17% of sample) contributing to leadership role occupancy. Fig. 1B shows large differences by gender and cognitive ability; by age 42 there was a gap of 17 percentage points between men and women of high cognitive ability occupying positions of leadership (61% of men vs. 44% of women) and a gap of 15 percentage points between men and women of low cognitive ability (29% of men vs. 14% of women). The sample remained relatively consistent over time in terms of cognitive ability levels, gender, socio-economic status, and self-control scores, suggesting that selective attrition on the basis of these characteristics was unlikely.

Table 2 shows a correlation matrix for key variables. Cognitive ability correlated positively with leadership role occupancy ($r = 0.22$, $p < 0.01$) and higher educational attainment ($r = 0.43$, $p < 0.01$), and those with higher cognitive ability had higher parental socio-economic status as indicated by a negative correlation with the social class variable ($r = -0.29$, $p < 0.01$).

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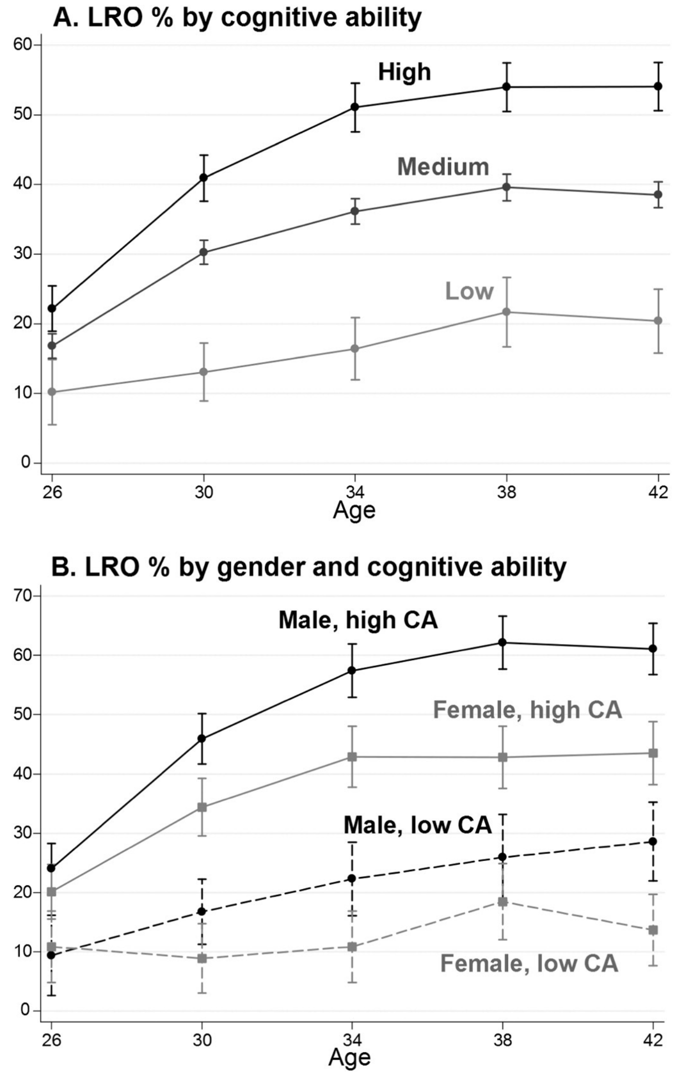

Fig. 1. Descriptive statistics showing leadership role occupancy (LRO) with 95% CIs over time in the British Cohort Study by (A) levels of childhood cognitive ability (CA) and (B) levels of childhood cognitive ability and gender. High cognitive ability is classified as scoring 1 SD or more above the standardized mean (17% of sample) and low cognitive ability is those scoring 1 SD or more below the standardized mean (16% of sample).

Leadership role occupancy

Our main regression results for Study 1 are described in Table 3 (multilevel models) and Table 4 (individual study wave models). In Table 3 and in line with our hypothesis that childhood cognitive ability would predict future leadership role occupancy, we found that a 1 SD increase in childhood cognitive ability predicted an average of 5.9 percentage point higher probability of leadership role occupancy over between age 26 and 42 ($b = 0.059$, $SE = 0.006$, $p < 0.01$). This analysis indicates that a predicted 25.4% of those

Table 2
Correlation matrix for key variables in the British Cohort Study (N = 6,298).

	Cognitive ability	Female	SES[a]	Education[b]
Female	−0.05**	1		
SES[a]	−0.29**	−0.01	1	
Education[b]	0.43**	0.01	−0.28**	1
LRO[c]	0.22**	−0.15**	−0.14**	0.27**

[a] SES = social class at birth derived from the occupation of the child's father, where I = professional occupations and V = unskilled workers.
[b] Highest educational attainment to date as indexed using the average NVQ ranking (from 0 = no qualifications, to 5 = NVQ 5) between ages 26 and 42 years.
[c] LRO = leadership role occupancy takes the average from age 26 to 42 years.
** Statistically significant at $p < 0.01$.

Table 3
Childhood cognitive ability predicting leadership role occupancy at ages 26, 30, 34, 38 and 42 in multilevel models in the British Cohort Study before and after adjustment for educational attainment.

Age	26–42	26–42	26–42
Observations	17,218	17,054	17,218
N	6284	6241	6284
Cognitive ability[a]	0.059**	0.037**	0.068**
	(0.006)	(0.006)	(0.008)
Female	−0.133**	−0.132**	−0.130**
	(0.010)	(0.010)	(0.010)
Age	0.014**	0.013**	0.014**
	(0.001)	(0.001)	(0.001)
Education[b]		0.053**	
		(0.004)	
CA * Female			−0.017
			(0.009)

Regressions are adjusted for childhood self-control and parental socio-economic status.
Robust standard errors in parentheses.
[a] Cognitive ability is standardized.
[b] Highest educational attainment to date as indexed using NVQ rankings ranging from 0 (no qualifications) to 5 (NVQ 5).
** $p < 0.01$.

with cognitive ability levels 1 SD below the average were classified as leaders across the study waves. In contrast, 37.3% of those with high levels of general cognitive ability (+1 SD) occupied a leadership position in this study.

Our analysis of each study wave confirmed that childhood cognitive ability predicted a significantly higher probability of leadership role occupancy across each of the five time points observed (see Table 4). Specifically, a 1 SD increase in cognitive ability predicted a 3 percentage point higher probability of being a manager at age 26 ($b = 0.030$, $SE = 0.008$, $p < 0.01$) and 6.3 points at age 30 ($b = 0.063$, $SE = 0.009$, $p < 0.01$). This rapid growth in the role of cognitive ability appeared to subsequently stabilize and was found to be 6.8 points at age 34 ($b = 0.068$, $SE = 0.009$, $p < 0.01$), 6.6 points at age 38 ($b = 0.066$, $SE = 0.010$, $p < 0.01$) and 7.5 points at age 42 ($b = 0.075$, $SE = 0.010$, $p < 0.01$). Taken together the wave analyses results appear to show a trend whereby the contribution of cognitive ability to leadership role occupancy increased quickly and then this increase slowed markedly.

Education and leadership role occupancy

As anticipated, childhood cognitive ability was strongly related to educational attainment. A 1 SD increase in cognitive ability was associated with a 0.6 unit increase ($b = 0.599$, $SE = 0.014$, $p < 0.001$) in educational attainment (ranging from 0 = none to 5 = NVQ 5). Average cognitive ability scores across NVQ rankings ranged from 70.2 ($SD = 13.0$) for those of no educational attainment (the lowest) to 89.5 ($SD = 11.4$) for NVQ level 5 (the highest), a difference of 1.4 SD. Education was found to partially explain the association between cognitive ability and leadership. In our multilevel model the strength of this association decreased by 37% after controlling for educational attainment ($b = 0.037$, $SE = 0.006$, $p < 0.1$), as shown in Table 3. Our analysis of the five individual study waves showed that controlling for education had a relatively consistent impact on the link between cognitive ability and leadership occupancy (see Table 4). On average adjusting for education decreased the role of cognitive ability by 36% across the five time points, verifying that higher educational attainment appears to be a pathway through which childhood cognitive ability enhances leadership prospects.

Table 4
Childhood cognitive ability predicting leadership role occupancy at ages 26, 30, 34, 38 and 42 in the British Cohort Study.

Age	26	26	30	30	34	34	38	38	42	42
N	3643	3479	3743	3743	3419	3419	3119	3119	3294	3294
Cognitive ability[a]	0.030**	0.024**	0.063**	0.033**	0.068**	0.039**	0.066**	0.042**	0.075**	0.052**
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Female	0.002	0.001	−0.106**	−0.100**	−0.158**	−0.149**	−0.197**	−0.192**	−0.196**	−0.195**
	(0.013)	(0.013)	(0.015)	(0.014)	(0.015)	(0.015)	(0.016)	(0.016)	(0.016)	(0.015)
Education[b]		0.009		0.070**		0.070**		0.064**		0.058**
		(0.005)		(0.006)		(0.006)		(0.007)		(0.006)

Regressions contain Probit marginal effect coefficients and are adjusted for childhood self-control and parental socio-economic status.
Standard errors in parentheses.
[a] Cognitive ability is standardized.
[b] Highest educational attainment to date, indexed using NVQ rankings ranging from 0 (no qualifications) to 5 (NVQ 5).
** $p < 0.01$.

Gender and leadership role occupancy

As anticipated, females were less likely to occupy a leadership role ($b = -0.133$, $SE = 0.010$, $p < 0.01$), as shown in Table 3. Across all available data females were 13.3 percentage points less likely on average to hold a leadership position (see Table 4). The individual wave analyses showed that the gender discrepancy in leadership appeared to increase over time and was almost 20 percentage points by age 42.

To test whether cognitive ability was differentially associated with leadership for males and females we examined the interaction between cognitive ability and female gender. This interaction was not statistically significant ($b = -0.017$, $SE = 0.009$, $p = 0.07$). However, there was a marginal trend indicating that the role of childhood cognitive ability in shaping leadership prospects may differ between males and females in this study.

High responsibility leadership role occupancy

Average cognitive ability scores across ages 30, 34 and 38 were 76.2 ($SD = 14.0$) for employees compared to 79.4 ($SD = 12.5$) for those managing 1−24 employees and 83.3 ($SD = 12.6$) for those managing 25+ employees. The difference in cognitive ability between non-supervisors and those managing 1–24 employees and was approximately 0.25 SD which grew to 0.5 SD when non-supervisors were compared to those managing 25 or more employees. In multilevel analysis using a sample of 5049 cohort members (see Table 5), we found that a 1 SD increase in childhood cognitive ability was strongly positively associated with higher leadership status ($b = 0.105$, $SE = 0.012$, $p < 0.01$). Taken together, our analyses provide some support for a graded positive association between cognitive ability leadership responsibility as gauged by the number of employees supervised.

As in the analysis of leadership role occupancy, we found that controlling for education reduced the influence of cognitive ability on high responsibility leadership by 38% ($b = 0.065$, $SE = 0.012$, $p < 0.01$). This analysis suggests that educational attainment plays a consistent role in explaining why childhood cognitive ability shapes both leadership role occupancy and the attainment of high responsibility leadership positions.

Females were much less likely on average to occupy a high leadership role ($b = -0.268$, $SE = 0.022$, $p < 0.01$), as in the main analysis, and there was a small but statistically significant negative interaction between the female gender and cognitive ability ($b = -0.047$, $SE = 0.020$, $p < 0.05$). These results support our predictions that higher cognitive ability would be associated with higher level leadership as defined by managing a greater number of employees and that this link would be weaker amongst females.

Adjustment for industry type

As a final robustness test, we examined whether the association between cognitive ability and leadership was affected by differences in the number of employees supervised across industries. To do this we adjusted for industry type which was only available at age 34 in the BCS. Specifically, we reran our model of the association between cognitive ability and leadership role occupancy at age 34 (see Table 4, column 5) and included 13 industry categories (Agriculture/Fishing, Mining/Quarrying, Manufacturing, Electricity/Gas, Construction, Wholesale/Retail Trade, Hotel/Restaurant, Transport, Financial Activities, Property Activities, Public Administration, Education, Health & Social Work). The addition of industry dummy variables increased the cognitive ability coefficient from 6.8 percentage points ($N = 3{,}419$; $b = 0.068$, $SE = 0.009$, $p < 0.01$) to 6.9 points ($N = 3{,}382$; $b = 0.069$, $SE = 0.009$, $p < 0.01$). We interpret this as evidence that the link between cognitive ability and leadership was not affected by the industry cohort members were employed in.

Table 5
Childhood cognitive ability predicting leadership role occupancy (coded as 0 = employee, 1 = manager of 1–24 employees, 2 = manager of 25+ employees) at ages 30, 34 and 38 in multilevel models in the British Cohort Study.

Age	30/34/38	30/34/38	30/34/38
Observations	9078	9077	9077
N	5049	5048	5048
Cognitive ability[a]	0.105**	0.065**	0.127**
	(0.012)	(0.012)	(0.016)
Female	−0.268**	−0.257**	−0.261**
	(0.022)	(0.021)	(0.021)
Age	0.000	−0.003	−0.000
	(0.002)	(0.002)	(0.002)
Education[b]		0.102**	
		(0.008)	
Female * CA			−0.047*
			(0.020)

Regressions are adjusted for self-control and parental socio-economic status.
Robust standard errors in parentheses.
[a] Cognitive ability is standardized.
[b] Highest educational attainment to date, indexed using NVQ rankings ranging from 0 (no qualifications) to 5 (NVQ 5).
* $p < 0.05$.
** $p < 0.01$.

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Study 2

Method

Participants & procedure

Participants were from the National Child Development Study (NCDS) in Britain, a longitudinal study following almost 18,000 people born in Britain in a week in March 1958. The NCDS contains detailed information on the cohort members' childhood characteristics and background and comprehensive labour force activity data. As well as benefiting from a low attrition rate, Hawkes and Plewis (2006) show that those who did leave the survey did not differ significantly from the rest of the sample on the basis of observable socioeconomic characteristics. Only those who were in full-time employment were included in the sample and we removed those in non-managerial foreman and supervisory roles from our analyses as in Study 1. Such roles were typically in manual or low skill occupations and were linked with lower pay than our main leadership role occupancy variable. After retaining only observations with complete data on our the main study variables (gender, childhood cognitive ability, leadership role occupancy, social class at birth, and childhood self-control), 10,382 participants provided data for at least one wave of follow-up in adulthood. The sample was 51% female on average across the four waves surveyed and participants had a broad range of socioeconomic backgrounds, as outlined in Table 6.

Measures

Leadership role occupancy. As in Study 1, our outcome measure was a binary variable measuring whether the cohort member was a manager or an employee without managerial duties at the time of being interviewed. At age 23 and 33 participants were asked about their current employment status and at age 42 and 50 were asked "Do you have any managerial duties, or are you supervising any other employees?". We utilized these items to construct a binary variable where those with managerial duties were considered 'leaders' and employees who did not supervise others or have managerial duties were considered 'followers'.

To examine the convergent and predictive validity of our main leadership role occupancy variable we used two sources of evidence similar to those used in Study 1: a set of indicators of supervisory abilities and experience (examined when the cohort members were aged 33) and a measure of household income (examined at age 50). Leadership role occupancy correlated positively with self-rated supervision ability ($r = 0.22$, $p < 0.01$) and a self-rated assessment of whether the cohort member's supervising skill improved over the last 10 years ($r = 0.22$, $p < 0.01$). Those in leadership roles had substantially higher total gross pay levels compared to employees ($r = 0.22$, $p < 0.01$), providing evidence of the predictive validity of our leadership measure. Taken together, this evidence suggests reasonable convergent and predictive validity of the main leadership role occupancy variable utilized in this study.

High responsibility leadership role occupancy. As in Study 1, we conducted additional analyses to test high level leadership using leadership measures elicited from the cohort members at age 33, 42 and 50. We again used a three-category measure of high responsibility leadership which grouped managers supervising more than 25 people into a high level 'leaders' group (coded as 2, 18% of sample across the three ages), those who supervised 1–24 people (coded as 1, 7% of sample) and a 'followers' group consisting of employees without supervisory duties (coded as 0, 75% of sample).

Childhood general cognitive ability. General cognitive ability was assessed at age 11 using an 80-item general ability test developed by the National Foundation for Educational Research in England and Wales (Pigeon, 1964). This test had high levels of convergent validity with a contemporaneous IQ test ($r = 0.93$) used for secondary school selection (Pigeon, 1964). The test consisted of 40 verbal and 40

Table 6
Characteristics of participants from the National Child Development Study, divided into columns for each available wave of employment data (age 23, 33, 42, 50).

Age	23	33	42	50	23–50
N	6013	7467	5411	4758	10,382
Employees	95%	84%	64%	63%	80.3%
(N)	(5701)	(6260)	(3481)	(2990)	
Leadership Role	5%	16%	36%	37%	20.7%
(N)	(312)	(1207)	(1930)	(1768)	
Cognitive ability[a]	42.7	45.0	45.6	46.7	44.0
(SD)	(15.6)	(15.4)	(15.3)	(14.9)	(15.7)
Self-control[b]	11.6	11.8	11.8	11.9	11.7
(SD)	(2.0)	(1.9)	(1.8)	(1.7)	(1.9)
Female	51.7%	51.9%	50.6%	52%	50.3%
SES I[c]	3.7%	4.6%	4.4%	4.4%	4.3%
SES II[c]	10.8%	13.2%	13.4%	14.1%	12.8%
SES III[c]	62.5%	61.9%	61.8%	62.0%	61.6%
SES IV[c]	13.3%	12.2%	12.1%	11.7%	12.3%
SES V[c]	9.7%	8.1%	8.3%	7.8%	9.0%

[a] Unstandardized cognitive ability scores ranging from 0 to 79.
[b] Unstandardized self-control levels ranging from 1 to 13; higher scores indicate better self-control.
[c] Social class is derived from the occupation of the child's father, where I = professional occupations and V = unskilled workers.

non-verbal items which were administered to students individually by teachers. For the verbal (non-verbal) items the child was presented with an example set of related words (shapes) and then given a set of words (shapes) with one missing. The child then had to select the missing item from a list of alternatives. Each correct answer was awarded one point for a maximum possible score of 80. We standardized this variable to have a mean of 0 and a standard deviation of 1 to create our main independent variable.

Covariates. As in Study 1, our main covariates were gender, social class at birth, and self-control. Social class was derived from the father's occupation in 1958 (ranging from I = professional occupations to V = unskilled workers). Our self-control measure was based on teacher-ratings taken when the child was aged 11 using a 13-item scale from the British Social Adjustment Guide (Stott, 1969) which gauged "impulsive acting out without regard for consequences". If participants did not have data at age 11, we used the same measure elicited at age 7 in order to maximize sample size. As in Study 1, we included measures of educational attainment (highest academic or vocational qualification) indexed by National Vocational Qualifications at age 23, 33 and 50 (ranging from 0 = no qualifications, to 5 = NVQ 5) in order to examine whether the relationship between cognitive ability and leadership was explained by education.

Statistical methods

As in Study 1 we specified a random intercepts model (Model 4) to estimate the association between childhood cognitive ability and leadership role occupancy (LRO) from age 23 to 50, with supplemental analysis to test whether this relationship was robust to adjustment for industry type at age 50. Our outcome measure was whether the cohort member was a follower (coded as 0) or a leader (coded as 1). All analyses included controls for gender, childhood socioeconomic status, and self-control. We investigated whether the contribution of cognitive ability to attaining a leadership position was explained by educational attainment (Model 5) and specified an interaction model to examine whether the contribution of cognitive ability differed by gender (Model 6).

Model 4:

Level 1: $\text{LRO Age } (23/33/42/50)_{ti} = \beta_{0i} + \beta_{1i}(\text{Age}_{ti}) + \varepsilon_{ti}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Childhood Cognitive Ability}_i) + \gamma_{02}(\text{Controls}_i) + \mu_{0i}$

Model 5:

Level 1: $\text{LRO Age } (26/30/34/38/42)_{ti} = \beta_{0i} + \beta_{1i}(\text{Age}_{ti}) + \varepsilon_{ti}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Childhood Cognitive Ability}_i) + \gamma_{02}(\text{Controls}_i) + \gamma_{03}(\text{Education}_i) + \mu_{0i}$

Model 6:

Level 1: $\text{LRO Age } (26/30/34/38/42)_{ti} = \beta_{0i} + \beta_{1i}(\text{Age}_{ti}) + \varepsilon_{ti}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(\text{Childhood Cognitive Ability}_i) + \gamma_{02}(\text{Controls}_i) + \gamma_{03}(\text{Female}_i * \text{Childhood Cognitive Ability}_i) + \mu_{0i}$

As in Study 1, we also estimated the relationship between cognitive ability and leadership role occupancy separately at each individual wave (age 23, 33, 42 and 50) using Probit models and computed marginal effects.

Lastly, we ran multilevel models using the specifications in Models 4–6 to estimate the role of cognitive ability and gender in predicting high responsibility leadership at age 33, 42 and 50 (coded so that 0 = no employees supervised, 1 = 1–24 employees supervised, and 2 = 25+ supervised).

Results

Descriptive statistics

Table 6 and Fig. 2 show descriptive statistics for Study 2. The proportion of the sample who were managers rose from 5% at age 23 to a peak of 37% at age 50. There were significant gender differences in terms of leadership role occupancy; by age 50 only 28% of women were managers compared to 47% of men. On average across the four study waves females were 14.4 percentage points less likely to be leaders than males. Fig. 2A shows a particularly strong association between both high (+1 SD and above; 17% of sample) and low (−1 SD and below; 19% of sample) cognitive ability and leadership from age 42 onwards. Fig. 2B shows differences by gender and cognitive ability; by age 42 there was a gap of 33 percentage points between men and women of high cognitive ability occupying positions of leadership (68% of men vs. 35% of women) and a gap of 6 percentage points between men and women of low cognitive ability (17% of men vs. 11% of women).

Although the sample composition did not change significantly over time on the basis of gender, socioeconomic status or childhood cognitive ability or self-control scores, the usable sample size decreased across the study to a greater extent than in Study 1 (21% vs. 10% decrease from first to final wave).

Table 7 shows a correlation matrix for key variables. The results are similar to those in Study 1. Over ages 23–50, cognitive ability correlated positively with higher leadership role occupancy ($r = 0.23$, $p < 0.01$) and educational attainment ($r = 0.53$, $p < 0.01$), and negatively with lower parental socio-economic status ($r = -0.28$, $p < 0.01$).

Leadership role occupancy

Our main regression results for Study 2 are described in Table 8 (multilevel models) and Table 9 (wave models). In line with our hypothesis that childhood cognitive ability would predict future leadership role occupancy, we found that a 1 SD increase in childhood

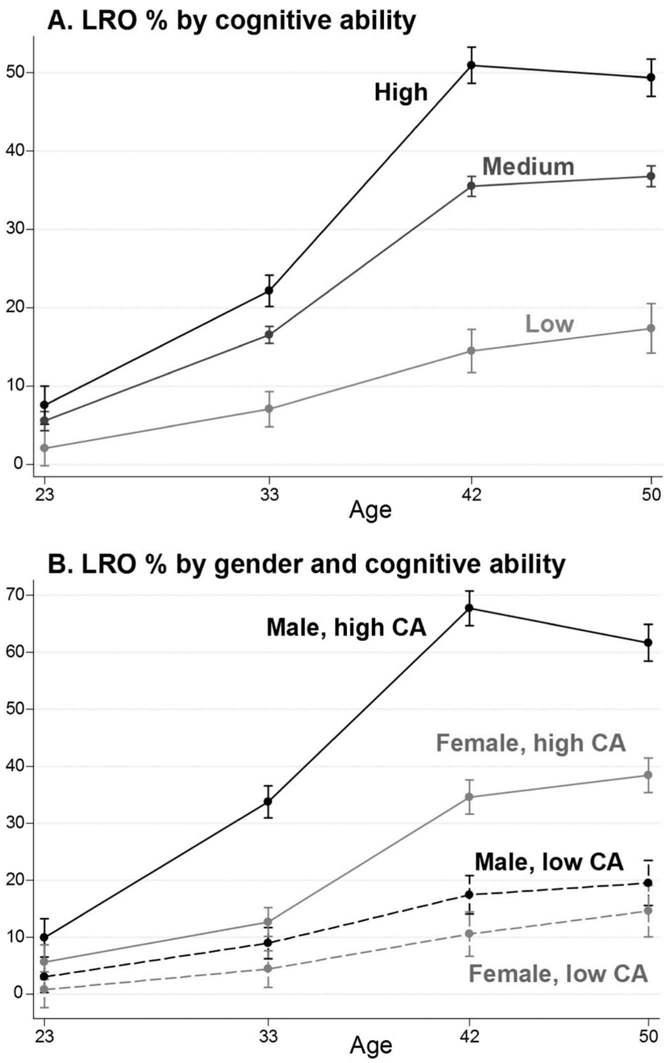

Fig. 2. Descriptive statistics showing leadership role occupancy (LRO) with 95% CIs in the National Cohort Development Study by (A) levels of childhood cognitive ability (CA) and (B) levels of childhood cognitive ability and gender. High cognitive ability is classified as scoring 1 SD or more above the standardized mean (17% of sample) and low cognitive ability is those scoring 1 SD or more below the standardized mean (19% of sample).

cognitive ability predicted an average of 6.3 percentage point higher probability of leadership role occupancy over age 23–50 ($b = 0.063$, $SE = 0.003$, $p < 0.01$). The multilevel results indicate that on average those with high levels of cognitive ability were almost twice as likely to occupy leadership positions (+1 SD; 27.8% leaders) than those with lower levels of general cognitive ability (−1 SD; 15.1% leaders).

Our individual wave analyses showed that cognitive ability was associated with a higher probability of leadership role occupancy across each of the four time points examined (see Table 9). The contribution of cognitive ability to leadership grew rapidly from youth

Table 7
Correlation matrix for key variables in the National Child Development Study (N = 10,382).

	Cognitive ability	Female	SES[a]	Education[b]
Female	0.08**	1		
SES[a]	−0.28**	−0.00	1	
Education[b]	0.53**	−0.05	−0.28**	1
LRO[c]	0.23**	−0.18**	−0.15**	0.31**

[a] SES = social class at birth derived from the occupation of the child's father, where I = professional occupations and V = unskilled workers.
[b] Highest educational attainment to date as indexed using the average NVQ ranking (from 0 = none, to 5 = NVQ 5) between ages 23 and 50 years.
[c] LRO = leadership role occupancy and takes the average from age 23 to 50 years.
** Statistically significant at $p < 0.01$.

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Table 8
Childhood cognitive ability predicting leadership role occupancy at ages 23, 33, 42 and 50 in multilevel models in the National Child Development Study.

Age	23–50	23–50	23–50
Observations	23,649	20,877	23,649
N	10,382	9097	10,382
Cognitive ability[a]	0.063**	0.035**	0.094**
	(0.003)	(0.004)	(0.005)
Female	−0.152**	−0.141**	−0.144**
	(0.006)	(0.007)	(0.006)
Age	0.012**	0.011**	0.012**
	(0.000)	(0.000)	(0.000)
Education[b]		0.047**	
		(0.003)	
CA * Female			−0.062**
			(0.006)

Regressions are adjusted for childhood self-control and parental social class.
Robust standard errors in parentheses.
[a] Cognitive ability is standardized.
[b] Highest educational attainment to date as indexed using NVQ rankings ranging from 0 (no qualifications) to 5 (NVQ 5).
** $p < 0.01$.

to midlife. Specifically, a 1 SD increase in cognitive ability predicted a 1.6 percentage point higher probability of being a manager at age 23 ($b = 0.016$, $SE = 0.003$, $p < 0.01$), which rose to 5.2 points at age 33 ($b = 0.052$, $SE = 0.005$, $p < 0.01$), and rose again to 11.3 points at age 42 ($b = 0.113$, $SE = 0.007$, $p < 0.01$). As in Study 1, the contribution of cognitive ability to leadership appeared to level off after age 40 and was 9.3 points at age 50 ($b = 0.093$, $SE = 0.008$, $p < 0.01$). The individual wave analyses indicate that cognitive ability becomes an increasingly important predictor of leadership role occupancy from ages 23 to 42, at which point the contribution stabilized.

Education and leadership role occupancy

As in Study 1, childhood general cognitive ability was closely related to educational attainment as gauged by NVQ rankings. A 1 SD increase in cognitive ability was associated with a 0.8 unit increase ($b = 0.753$, $SE = 0.013$, $p < 0.001$) in educational attainment (ranging from 0 = none to 5 = NVQ 5). Average cognitive ability scores across NVQ rankings ranged from 30.2 ($SD = 13.9$) for those of no educational attainment (the lowest) to 58.4 ($SD = 10.4$) for NVQ level 5 (the highest), a difference of 1.9 SD. As in Study 1, children with higher levels of cognitive ability appeared to be more likely to become leaders partly because they achieved higher levels of educational qualifications. Including education in the multilevel model reduced the contribution of cognitive ability to leadership from 6.3 ($b = 0.063$, $SE = 0.003$, $p < 0.01$) to 3.5 percentage points ($b = 0.034$, $SE = 0.004$, $p < 0.01$), a decrease of 44% (see Table 8).

Our analysis of individual waves showed that controlling for education diminished the cognitive ability coefficients by 40% on average across the four time points (see Table 9). The role of educational attainment in explaining the association between general cognitive ability and leadership appeared to increase across survey waves. Whilst educational qualifications explained just 25% of the cognitive ability–leadership association at age 23, this rose to 54% by age 50. Because there were notable drops in sample size when controlling for education at ages 23 and 42, we conducted additional analysis to determine whether the change in the cognitive

Table 9
Childhood cognitive ability predicting leadership role occupancy at ages 23, 33, 42 and 50 in the National Child Development Study before and after adjustment for educational attainment.

Age	23	23	33	33	42	42	50	50
N	6013	4387	7467	7294	5411	4438	4758	4758
Cognitive ability[a]	0.016**	0.012**	0.052**	0.034**	0.113**	0.062**	0.093**	0.043**
	(0.003)	(0.004)	(0.005)	(0.005)	(0.007)	(0.008)	(0.008)	(0.008)
Female	−0.036**	−0.037**	−0.134**	−0.125**	−0.233**	−0.207**	−0.195**	−0.177**
	(0.006)	(0.007)	(0.008)	(0.008)	(0.011)	(0.012)	(0.013)	(0.013)
Education[b]		0.006*		0.024**		0.086**		0.088**
		(0.003)		(0.003)		(0.005)		(0.005)

Regressions contain Probit marginal effect coefficients and are adjusted for childhood self-control and parental socio-economic status.
Standard errors in parentheses.
[a] Cognitive ability is standardized.
[b] Highest educational attainment to date as indexed using NVQ rankings ranging from 0 (no qualifications) to 5 (NVQ 5).
* $p < 0.05$.
** $p < 0.01$.

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ability coefficient was affected by changes in the composition of the sample. This was not the case; restricting the analysis to those with education data produces estimates almost identical to the main analysis.

Gender and leadership role occupancy

The multilevel analysis showed that females were 15.2 percentage points (b = −0.152, SE = 0.006, $p < 0.01$) less likely than men to occupy positions of leadership on average (see Table 8). Females were also less likely to hold leadership positions across each of the individual wave analyses, as detailed in Table 9. As in Study 1, the gender gap in leadership role occupancy appeared to grow over time, widening to almost 20 percentage points by the final period of observation at age 50.

In Table 8 the interaction term of cognitive ability and female gender was highly negatively significant (b = −0.062, SE = 0.006, $p < 0.01$), indicating that childhood cognitive ability was more weakly related to leadership in females than in males. This result was in contrast to Study 1 where we did not find statistically significant evidence that general cognitive ability was differentially related to holding a leadership position for males and females.

High responsibility leadership role occupancy

Average cognitive ability scores across ages 33, 42 and 50 were 43.6 (SD = 15.4) for employees compared to 48.1 (SD = 13.9) for those managing 1–24 employees and 51.4 (SD = 13.3) for those managing 25+ employees. As in Study 1, the difference in cognitive ability between employees and those managing 25 or more employees was approximately 0.5 standard deviations. In regression analysis using a sample of 9038 cohort members (see Table 10), we found that a 1 SD increase in childhood cognitive ability was positively associated with higher leadership status (b = 0.145, SE = 0.008, $p < 0.01$) as gauged by the supervision of a greater number of employees. In line with the main analysis of leadership occupancy, controlling for education reduced the cognitive ability coefficient markedly (b = 0.070, SE = 0.009, $p < 0.01$), explaining 52% of the link between cognitive ability and high responsibility leadership. These analyses provide further support for a graded positive association between general cognitive ability and the number of employees supervised and for educational attainment as an explanatory pathway through which this link occurs.

As predicted, females were less likely occupy high level leadership positions (b = −0.360, SE = 0.014, $p < 0.01$). There was a significant negative interaction between the female gender and cognitive ability (b = −0.152, SE = 0.013, $p < 0.01$). This interaction was more pronounced than in Study 1 and indicated that for females cognitive ability was less closely associated with managing a greater number of employees.

Adjustment for industry type

Our final test examined whether the link between cognitive ability and leadership was independent of the industry cohort members were employed in. We reran our age 50 wave analysis (Table 9, column 5) adding dummy variables for 16 industry categories (Agriculture/Fishing, Mining/Quarrying, Manufacturing, Electricity/Gas, Construction, Wholesale/Retail Trade, Hotel/Restaurant, Transport, Financial Intermediation, Real Estate/Renting/Business, Public Admin, Education, Health & Social Work, Community/Social/Personal Service, Households Employing Staff, Extra-Territorial Organisation and Bodies). The addition of industry controls decreased the cognitive ability coefficient from 9.3 percentage points (N = 4,758; b = 0.093, SE = 0.008, $p < 0.01$) to 9 points

Table 10
Childhood cognitive ability predicting leadership role occupancy (coded as 0 = employee, 1 = manager of 1–24 employees, 2 = manager of 25+ employees) at ages 33, 42 and 50 in multilevel models in the National Child Development Study.

Age	33/42/50	33/42/50	33/42/50
Observations	16,849	11,254	11,254
N	9038	8245	8245
Cognitive ability[a]	0.145**	0.070**	0.120**
	(0.008)	(0.009)	(0.011)
Female	−0.360**	−0.291**	−.338**
	(0.014)	(0.015)	(0.014)
Age	0.011**	0.007**	0.011**
	(0.001)	(0.001)	(0.001)
Education[b]		0.068**	
		(0.006)	
Female * CA			−0.152**
			(0.013)

Regressions are adjusted for self-control and parental socio-economic status.
Robust standard errors in parentheses.
[a] Cognitive ability is standardized.
[b] Highest educational attainment to date, indexed using NVQ rankings ranging from 0 (no qualifications) to 5 (NVQ 5).
* $p < 0.05$.
** $p < 0.01$.

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($N = 4,656$; $b = 0.09$, $SE = 0.008$, $p < 0.01$). As in Study 1, we take these results as evidence that the link between higher cognitive ability and leadership is unlikely to be explained by the industry cohort members were employed in.

Discussion

This is the first study to identify a close link between individual differences in childhood cognitive abilities and leadership prospects throughout working life. Prior research examining the association between leadership and general cognitive ability has relied predominantly on cross-sectional data or short periods of follow-up (e.g. Judge et al., 2004). It has therefore been difficult to infer whether a robust relationship exists between cognitive capabilities and leadership, as most studies have provided only a snap-shot of this association at one time point. The few longitudinal studies available have found little association between general cognitive ability and leadership emergence and effectiveness, sparking some debate as to whether cognitive abilities truly influence the developmental trajectories of leadership (Day & Sin, 2011; Gottfried et al., 2011; Li et al., 2011). The present study sheds new light on this debate. Using prospectively collected data from almost 17,000 participants from two unique large-scale birth cohort studies we show that childhood general cognitive ability is strongly associated with leadership role occupancy over four decades.

General cognitive ability and leadership role occupancy

In support of our primary hypothesis, the results of the current study suggest that general cognitive ability influences leadership role occupancy. Children with high levels of cognitive ability were more likely than others to go on to occupy leadership positions at each of the nine time-points examined across the two birth cohort samples. Averaged across the two cohorts a one standard deviation increase in general cognitive ability was linked to a 6.2 percentage point higher rate of leadership role occupancy. This effect is large and meaningful in magnitude. Our adjusted models showed that in the BCS cohort 37.3% of high cognitive ability children (+1 SD) occupied leadership positions compared to 25.4% of low cognitive ability (−1 SD) children and this gap was larger again in the NCDS cohort (27.8% vs. 15.1%). The results also provided consistent evidence that childhood cognitive ability may impact substantially on high responsibility leadership role occupancy in both cohorts. It appears that the predisposition towards effective reasoning and problem solving in childhood continues into adulthood and acts to foster leadership potential including the ability to supervise and manage large numbers of subordinates.

Our findings contrast sharply with prior prospective studies which found that general cognitive ability contributed little to leader emergence or to leadership role occupancy and advancement (Li et al., 2011; Reichard et al., 2011). There are several possible explanations for this discrepancy. Firstly, we utilized a combined sample of almost seventeen thousand participants which is several times larger than that employed in previous work. This may allow greater sensitivity to identify the influence of general cognitive ability on leadership, particularly early in life when the prevalence of leadership role occupancy is low. Secondly, in the current study the strongest impact of cognitive ability on leadership was in midlife, specifically at 42 years in both cohorts. Prior research has not followed participants from childhood into the fourth decade of life, potentially explaining why these linkages have not been identified.

The examination of the link between cognitive ability and leadership role occupancy reported in the Fullerton Longitudinal Study (Reichard et al., 2011) illustrates how both sample size and length of follow-up may explain why our study has found evidence for this association where other studies failed to do so. In the Fullerton study a sample of 106 participants was followed up from age 17 to age 29 years. The cognitive ability measures employed in the Fullerton study and the current study show substantial overlap (e.g. Elliott et al., 1978; Wechsler, 2008) and general cognitive ability was correlated with leadership role occupancy prior to age 30 to a similar degree in both studies ($r = 0.15$ across waves in the Fullerton Study and $r = 0.1$ at ages 23 and 26 in the current study). However, the much larger sample size in the current study meant that the contribution of general cognitive ability to leadership role occupancy prior to age 30 could be precisely identified. Furthermore, the strength of the link between childhood cognitive ability and holding a leadership position increased substantially, perhaps 3-fold, after age 30 in the current study. Our findings suggest that if the Fullerton Study participants were observed beyond the initial stages of their careers, a clearer link between cognitive ability and leadership role occupancy may have been evident.

By examining repeated observations on the same individuals over time, our findings yield some insight into how cognitive abilities may affect trajectories of leadership emergence over the lifespan. Although the strength of general cognitive ability in predicting leadership role occupancy was weak initially (e.g. a 1 SD increase in cognitive ability predicted a 1.5 percentage point increase in leadership occupancy at age 23 in the NCDS) it strengthened quickly from early adulthood to midlife. By age 42 a 1 SD increase in general cognitive ability was linked to a 7 point increase in leadership role occupancy in the BCS cohort and a 10.8 point increase in the NCDS cohort. It might be the case that general cognitive ability and the associated reasoning capabilities and proficiency in abstract thought hasten leadership development over time. High cognitive ability workers may accumulate competencies and expertise more efficiently and effectively than others and subsequently secure leadership positions at a relatively early career stage. In the current study, this appeared to be true for leadership roles generally and for high responsibility leadership roles with broader supervisory scope.

Pathways to leadership

Our results provide some insight into the potential mechanisms whereby cognitive ability may contribute to leadership. In support of our hypothesis, we found that educational attainment acts as an important pathway through which general cognitive ability contributes to leadership role occupancy. Cognitive ability was positively associated with higher educational attainment ($r = 0.43$, $p < 0.01$ in BCS, $r = 0.53$, $p < 0.01$ in NCDS) and including measures of educational attainment in our analyses reduced the average contribution of cognitive ability to leadership roles by over a third. These findings indicate that children with high levels of cognitive

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ability benefited more from educational opportunities via increased attainment and/or deeper educational engagement. Whilst in education students may have refined the higher-order thinking skills needed for effective leadership such as causal analysis (Hester et al., 2012) and forecasting (Shipman, Byrne, & Mumford, 2010), essentially becoming more successful problem-solvers and more creative thinkers (e.g. Vincent, Decker, & Mumford, 2002; Zaccaro, Mumford, Connelly, Marks, & Gilbert, 2000). In the current study, the greater attainment and skill development associated with high levels of education appeared to be recognized by employers and partially explained why such children went on to leadership roles.

However, the vast majority of the association between childhood cognitive abilities and leadership was not explained by formal educational qualifications. There are other unexamined pathways that could explain the trends observed in the present study. For instance, cognitive ability contributes positively to mental and physical health which could facilitate career advancement (e.g. Deary, Weiss, & Batty, 2010). Early cognitive capabilities could shape later psychological factors including adult personality and goal orientation (Day & Sin, 2011) which may influence leadership development. Finally, cognitive ability may contribute to engagement with professional development training that was not captured by the formal educational qualifications assessed in the current study. These potential channels have important implications for the science and practice of leadership research and should be investigated in future studies.

Gender, cognitive capabilities, and leadership

As anticipated, females were far less likely than males to occupy leadership positions or to supervise large numbers of employees. This gender difference was marginally smaller in the more recent 1970 BCS cohort sample (13.3 percentage points for leadership role occupancy across ages 26–42) than in the 1958 NCDS cohort (15.2 percentage points across ages 23–50) probably reflecting the documented reduction in the gender gap in leadership in recent years (e.g. Powell & Graves, 2003). We also predicted that cognitive abilities would have a greater influence on leadership prospects for males than females. In support of this idea, we found evidence that general cognitive abilities tended to contribute more to leadership role occupancy for males. This was true in the earlier NCDS but not the more recent BCS sample, a finding which could potentially be attributed to a reduction in discrimination between equally skilled men and women over time. There was also some evidence for this positive trend in our examination of high responsibility roles. Whilst the contribution of cognitive ability to such leadership positions was more pronounced amongst males than females in the NCDS, this trend was much weaker in the more recent BCS cohort. Thus our prediction that the impact of cognitive ability on leadership role occupancy would be less-pronounced in females than in males was partly supported.

Given there was some inconsistency in the tendency for gender to moderate the link between cognitive ability and leadership we suggest further research is needed prior to placing substantial weight on these findings. It should be noted, however, that in all instances where cognitive abilities were found to be weighted more heavily for one sex in leadership role occupancy analyses, the additional weighting was in favour of males. These findings provide initial evidence that, in addition to the gender gap in leadership, cognitive abilities may promote leadership role occupancy and supervisory responsibilities to a greater extent for males than females.

Strengths, limitations and implications

The core strength of this study is its extensive longitudinal design. Individual differences in childhood cognitive ability were assessed at around age 10 and leadership role occupancy was gauged over several time-points up to forty years after these initial measures were taken. Thus, we were able to extend prior research and provide a comprehensive account of the potential impact early life cognitive abilities on leadership emergence during the early and mid-career stages.

Moreover, our findings replicate across two independent birth cohorts; the 1970 British Cohort Study and the 1958 National Childhood Development Study. Unlike much of leadership research which relies on convenience or industry specific samples these datasets are representative of the population of Great Britain allowing the influence of cognitive abilities on leadership roles to be aggregated across a diverse range of occupations. Furthermore, using two cohorts allowed us to uncover evidence of strong stability in the size of the effect of general cognitive ability on leadership role occupancy across cohorts suggesting these results are unlikely to be cohort specific as the initial period of data collection differed by over a decade between these two studies.

Some limitations of the study must be acknowledged. Our primary measure of leadership role occupancy simply divides our sample between 'leaders'; those with management duties and supervisory obligations and 'followers'; those without such duties. A continuous measure which gauged the spectrum of leadership responsibility would have reduced measurement error and allowed a clearer 'dose–response' relationship with childhood cognitive ability to be estimated (De Neve et al., 2013; Li et al., 2011). Whilst the present study does not assess the full gradient of responsibility of leadership positions, we complemented our primary outcome measure with a high responsibility leadership variable indexed by the supervision of 25 or more employees. Our analyses showed that general cognitive ability demonstrated a similar pattern of relationships with both leadership role occupancy and this high responsibility leadership variables.

Our measures of leadership are further limited in that they do not assess important aspects of leadership style (e.g. transformative, transactional) and effectiveness that have been examined extensively in the leadership literature. We therefore cannot identify whether cognitive abilities influence the developmental trajectory of leader effectiveness to the same degree as leadership emergence and ascendance to high responsibility roles. Furthermore, although we can identify those who go on to occupy leadership roles we do not know if these individuals are perceived as leaders or the types of leadership work duties they perform. These remains important potential areas for future lifespan leadership research. A final potential limitation with our leadership role occupancy measure is that we identify leaders based on supervisory responsibilities and these duties vary substantially across industries. A spurious association between cognitive ability and leadership role occupancy could therefore be generated if intelligent children select into industries where supervision is more common. However, we were able to adjust for common industry types in both studies and these analyses indicated that the close link between cognitive ability and leadership is not due to differences in typical supervisory responsibilities across industries.

A final limitation of this research was that the participants in both cohort studies examined were predominantly white which limits the generalizability of our research to other ethnic groups. We also did not observe participants into their late (post age 50 years) career stages. However, promotion to leadership positions generally tends to occur in the early and middle career stages (Li et al., 2011) as evidenced by the plateau in the percentage of individuals occupying leadership roles we observed after the age of 40 in the NCDS sample. Our estimates of the association between general cognitive ability and leadership also appeared to be relatively stable after age 40 suggesting that examining workers further along in the adult lifespan may not produce substantially different results.

In summary, the findings we report here highlight the role of early childhood general cognitive ability in shaping who occupies leadership roles over the lifespan. Two cohorts from different eras support the notion that childhood general cognitive ability fosters the attainment of leadership positions including roles with greater supervisory responsibilities. Contemporary leaders are faced with a broad set of cognitively complex tasks and organizational structures. They are expected to assimilate detailed information, make informed decisions and develop competitive strategies under time pressure. It is perhaps unsurprising that those with high levels of cognitive ability appear to thrive and go on to occupy leadership positions in the cognitively demanding environments that characterize modern organizations. Spanning four decades, our findings provide robust evidence that high levels of childhood general cognitive ability are a key precursor of leader emergence and are consistently predictive of leadership role occupancy throughout working life.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.leaqua.2015.03.006.

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