Journal of Gerontology: SOCIAL SCIENCES
2007, Vol. 62B, No. 6, S404–S414

The Continuing Benefits of Education: Adult Education and Midlife Cognitive Ability in the British 1946 Birth Cohort

Stephani L. Hatch,[1,2] Leon Feinstein,[3] Bruce G. Link,[1]
Michael E. J. Wadsworth,[4] and Marcus Richards[4]

[1]Department of Epidemiology, Mailman School of Public Health, Columbia University, New York.
[2]Department of Psychological Medicine, Institute of Psychiatry, King's College London, United Kingdom.
[3]Centre for Research on the Wider Benefits of Learning, Institute of Education, University of London, United Kingdom.
[4]Medical Research Council National Survey of Health and Development, University College London, United Kingdom.

Objectives. Evidence shows education positively impacts cognitive ability. However, researchers have given little attention to the potential impact of adult education on cognitive ability, still malleable in midlife. The primary study aim was to examine whether there were continuing effects of education over the life course on midlife cognitive ability.

Methods. This study used data from the Medical Research Council National Survey of Health and Development, also known as the British 1946 birth cohort, and multivariate regression to estimate the continuing effects of adult education on multiple measures of midlife cognitive ability.

Results. Educational attainment completed by early adulthood was associated with all measures of cognitive ability in late midlife. The continued effect of education was apparent in the associations between adult education and higher verbal ability, verbal memory, and verbal fluency in late midlife. We found no association between adult education and mental speed and concentration.

Discussion. Associations between adult education and midlife cognitive ability indicate wider benefits of education to health that may be important for social integration, well-being, and the delay of cognitive decline in later life.

FORMAL education has already been identified as a fundamental resource in addressing health and social inequalities (Hatch, 2005; Link & Phelan, 1995; Mirowsky & Ross, 2003). Education and cognition, undoubtedly interrelated, potentially lead individuals to environments or behaviours that protect health. Cognitive function contributes to health inequalities through a variety of indirect pathways (Whalley & Deary, 2001) and provides a foundation for skilled instrumental activities of daily living and goal-directed behaviors. These activities include the learning and retention of information; the understanding of the representation of everyday surroundings and activities, specific task instructions, complex abstract knowledge, calculation of dimensions (e.g., time, age, and quantity); and the organization of attention processes to maintain focus yet enable multitasking. Thus, it is important to consider the potential for wider benefits of adult learning in understanding the impact of education on cognitive functioning in mid-adulthood. Adult education has received far less attention than formal education with respect to its importance to cognitive function, over and above previous educational attainment.

Lower level qualifications, unaccredited courses, and courses taken later in life have limited economic return (Blundell, Dearden, Goodman, & Reed, 1997; Dolton, Makepeace, & Inchley, 1990; Egerton, 2000; McIntosh, Dearden, Myck, & Vignoles, 2002) compared to the benefits of earlier educational participation (Vignoles, Jenkins, Wolf, & Galindo-Rueda, 2003). Adult education in the United Kingdom and United States broadly refers to participation in a range of learning activities taken at any stage after first exit from full-time education that might be accredited or unaccredited; part time or full time; academic, vocational or aimed at developing basic skills (Aldridge & Tuckett, 2007; O'Donnell, 2006; Reder, 2005). In both countries, there are diverse forms of courses taken at work (see, e.g., Heckman, LaLonde, & Smith, 1999; Krueger & Rouse, 1998; LaLonde, 1995; Vignoles, Galindo-Rueda, & Feinstein, 2004), in basic skills courses (i.e., to enhance literacy or numeracy; Sticht, 2002; Torgerson, Porthouse, & Brooks, 2005), and in mature participation in higher education and in family and community learning programs.

Adult education courses are sometimes taken as leisure or, in economic terms, as consumption rather than investment. However, there is evidence that the wider, noneconomic returns to accredited and unaccredited adult learning may be quite high (Behrman & Stacey, 1997; Feinstein & Hammond, 2004; Schuller, Preston, Hammond, Brassett-Grundy, & Bynner, 2004) and that unaccredited courses may provide steppingstones for many who would otherwise not engage in learning (Sabates, Feinstein, & Skaliotis, 2007). Evidence on the benefits of unaccredited and accredited educational participation in later life has highlighted the potential contribution of adult learning to important policy outcomes in the United States and United Kingdom, such as health (Sabates & Feinstein, 2006), well-being (Feinstein & Hammond, 2004), and social cohesion (Fujita-Starck, 1996; Preston, Feinstein, & Anderson, 2005).

The primary aim of our study was therefore to examine whether there were continuing effects of education over the life course on cognitive ability, specifically as it relates to the relationship between adult education by 43 years and cognitive ability at 53 years, controlling for educational attainment earlier in the life course and key sociodemographic factors. A secondary aim was to describe key explanatory factors that characterize selection into adult education participation based on different typologies of adult learners identified in previous research (Boshier, 1991; Houle, 1961; Morstain & Smart, 1977).

Cognition and Educational Attainment

Although there is little doubt that cognitive ability plays a role in determining educational attainment, a variety of evidence has suggested that schooling per se has an important effect on cognitive performance (Alwin & McCammon, 2001; Neisser et al. 1996; Rutter, 1985). Ceci (1996) summarized this evidence based on effects of timing of schooling (e.g., years completed, early or delayed entry, interruption, and early termination), regional effects of schooling (allowing for selective migration), and intergenerational effects. In the British 1946 birth cohort, educational attainment was positively associated with cognitive ability in later adulthood independently of childhood cognition (Richards & Sacker, 2003). These independent associations between educational attainment by early adulthood and midlife cognitive ability were particularly strong for verbal ability and verbal memory. However, researchers have not investigated quantitatively in large samples the question of whether adult education can continue to benefit cognition, in spite of the evidence that cognitive ability is still malleable at this phase of the life course (Arbuckle, Maag, Pushkar, & Chaikelson, 1998; Rabbitt, 1993; Schaie, 1996).

Aims

The primary aim of this analysis was to test the effects of adult education on midlife cognitive ability, controlling for prior cognitive ability and key determinants of adult education. Given the availability of multiple cognitive measures in this cohort, we tested whether any association between adult education and midlife cognitive ability was generalized across all measures or specific to any one measure. An analysis of over 450 high-quality data sets of mental ability test scores by Carroll (1993) revealed eight second-order factors: Crystallized Ability, Fluid Ability, General Memory & Learning, Broad Visual Perception, Broad Auditory Perception, Broad Retrieval Ability, Broad Cognitive Speediness, and Processing Speed (reaction time decision speed). Tests used in the present study (see “Methods”) were the National Adult Reading Test (NART) and tests of verbal memory, verbal fluency, and timed letter search, corresponding, respectively, to Crystallized Ability, General Memory & Learning, Broad Retrieval Ability, and Broad Visual Perception/Broad Cognitive Speediness. Based on evidence of strong education gradients in crystallized ability and memory and retrieval, but not in visual perception or speediness (Gallacher et al., 1999, Richards & Sacker, 2003; Richards, Shipley, Fuhrer, & Wadsworth, 2004), our principal hypothesis was that adult education would be specifically associated with the verbal-based measures: NART, verbal memory, and verbal fluency. We also posited that adult education would not be related to speed and concentration as measured by the timed letter-search tasks. All associations were hypothesized to be present independently of general cognitive ability prior to adult education, formal education, and social class attainment.

A secondary aim was to describe key explanatory factors that impact the likelihood of adult education participation. Participation varies by a range of factors including age (Sargant & Aldridge, 2002), gender (Aldridge & Tuckett, 2007), early life context (Conlon, 2005; Gorard, Rees, Fevre, & Welland, 2001), and current employment status and occupational social class (Hillage, Uden, Aldridge, & Eccles, 2000).

Methods

Sample

The Medical Research Council National Survey of Health and Development (NSHD), also known as the British 1946 birth cohort, presented a unique opportunity to examine whether there is an association between adult education and midlife cognitive ability. The MRC NSHD initially consisted of 5,362 children of nonmanual and agricultural workers and a random sample of 1 in 4 manual workers selected from all single and legitimate births that occurred in England, Scotland, and Wales during 1 week in March 1946. The cohort has been studied on 21 occasions between birth and age 53 years, when information about demographic and socioeconomic factors and cognitive function was obtained by interview and examination. This occurred most recently in 1999 at age 53 when the sample size was 3,035 based on loss to follow-up from the exclusion of deaths, persons living abroad or untraced, and permanent refusals (Wadsworth et al., 2003). Further details of the sampling frame and data collection appear in Wadsworth and colleagues (2003). We based the current study on data collected when the cohort members were 8, 26, 36, 43, and 53 years of age. The descriptive analysis refers to the 1,934 cohort members with complete data on all variables of interest for this analysis.

Measures

Cognitive outcomes at 53 years.—At age 53 years, survey members took the NART (Nelson & Willison, 1991). This pronunciation test presents 50 irregular words of increasing difficulty, chosen to violate conventional grapheme–phoneme correspondence rules. The following are examples of words in the beginning, middle, and end of the test: 1. *CHORD* . . . 20. *ASSIGNATE* . . . 33. *DRACHM* . . . 50. *CAMPANILE*. To pronounce the words correctly, the respondent must recognize them in their written form rather than rely on intelligent guesswork. Thus, it is effectively a test of knowledge acquisition, although it correlates with full-scale IQ (Crawford, Stewart, Parker, Besson, & DeLacey, 1989).

At the same age, survey members took three other cognitive tests: verbal memory, verbal fluency, and timed letter search. Verbal memory was assessed by a 15-item word-learning task devised by the NSHD. After cohort members viewed all 15 words for 2 s, they wrote down as many of the words as possible. Total number of words correctly recalled over three identical trials were summed to provide an overall score for short-term verbal memory (maximum score = 45). Verbal fluency was assessed by asking participants to name as many animals as possible in 1 min. Timed letter search, which measures speed and concentration, required participants to cross out the letters *P* and *W*, randomly embedded within a page of other letters, as quickly and accurately as possible within 1 min. The score was the total number of letters searched (maximum score = 600).

Prior cognitive ability.—At age 8 years, children took four tests devised by the U.K. National Foundation for Educational Research (Pigeon, 1964): reading comprehension (selecting appropriate words to complete 35 sentences), word reading (ability to read and pronounce 50 words), vocabulary (ability to explain the meaning of 50 words), and picture intelligence (60-item nonverbal reasoning test; $\alpha = .85$). At age 26 years, survey members retook the Watts-Vernon Reading Test, with an additional 10 items of increased difficulty to avoid a ceiling effect (Rodgers, 1986).

Formal educational attainment.—The highest educational or training qualification achieved by 26 years was classified according to the Burnham scale (Department of Education and Science, 1972) and grouped into the following: no qualification, below ordinary secondary qualifications, ordinary secondary qualifications (O levels or their training equivalents; e.g., U.S. high school diploma), advanced secondary education (A levels or their equivalents; e.g., U.S. advanced placement courses), or higher education (university degree level or equivalent).

Adult education and training.—At 36 years survey members were asked if they had any training or retraining courses, had any evening classes in their spare time, or had obtained any higher or further education in the past 5 years. At 43 years they were asked if they had undertaken any educational or work-related training courses, or taken any examinations since their previous interview. At both ages, there was the possibility to obtain additional qualifications at both O and A levels in subject areas not undertaken by age 26 years. For the purpose of this study, we grouped adult education into 4 categories: 0 = no adult education at 36 or 43 years; 1 = some education but with no resulting qualification; 2 = some education, with a resulting qualification up to O level or equivalent; 3 = some education, with a resulting qualification of at least A level or equivalent. Based on the evidence suggesting that formal education promotes cognitive development, we anticipated similar cognitive gains from adult education, whether undertaken in leisure or in association with occupational training.

Adult occupational social class mobility.—Although the influence of social class on cognitive ability, net of educational attainment, is weak (Lee, Kawachi, Berkman, & Grodstein, 2003; Richards & Sacker, 2003), researchers know little about the effects of adult social mobility, one of the benefits of adult education, particularly job-related training, on cognitive ability. Thus, we examined the potential confounding effect of social class mobility from early to mid-adulthood, rather than social class at discrete time points, on associations between adult education and cognition. Additionally, higher social status can result in exposure to other resources that may enhance cognitive ability.

Current or previous occupational social class at ages 26 and 53 years was classified as nonmanual (professional, managerial, and intermediate) and manual (skilled manual, semiskilled manual, and unskilled) according to the Registrar General (Office of Population Censuses and Surveys, 1970). We then grouped survey members into four discrete categories: long-term manual (i.e., manual social class at both ages), upwardly mobile (i.e., manual at 26 years to nonmanual at 53 years), downwardly mobile (i.e., nonmanual at 26 years to manual at 53 years), and long-term nonmanual (i.e., nonmanual at both ages).

Statistical Analysis

To address the primary aim of this analysis, we selected across all of the factors, resulting in 1,101 of the 3,035 cohort members interviewed at 53 years having missing data for at least one variable. This resulted in a subsample of 1,934 based on those with complete data. To address the issue of missing data, we compared the models estimated by using ordinary least squares regression with listwise deletion of missing data with models estimated by using a full information maximum likelihood (FIML) approach that was based on all of the observed data and accounted for missing values in parameter estimates. FIML estimates are preferable to the listwise deletion approach because they tend to show less biased estimates and more reliable estimates even when the data are missing due to a wide range of conditions (Arbuckle, 1996). In Model 1, we partially adjusted for gender, cognitive ability at 8 years, and educational attainment by 26 years. In Model 2, we made further adjustments for cognitive ability at 26 years. Model 3 adjusted for adult education. Finally, we added adult occupational social class mobility in Model 4, the fully adjusted model. We tested all models for each of the four measures of cognitive ability at 53 years in midlife: verbal ability, verbal memory, verbal fluency, and speed and concentration. The Adult Education × Gender interaction term was not significant at the 5% level. Therefore, we tested associations on the total sample, men and women combined. Because the broader substantive findings were similar when we compared the listwise deletion and FIML approaches, the multivariate results presented here were assessed in the FIML analyses conducted using Mplus version 4.2 (Muthén & Muthén, 1998/2006).

To address the secondary aim, we used binomial logistic regression to examine demographic variation in adult education participation. We estimated the odds ratios (ORs; relative odds) of participating in adult education by gender (female was the reference), each of the four levels of educational attainment by 26 years, and occupational social class (manual was the reference) for father during childhood and occupational social class in adulthood at three time points: 26 years, 36 years, and 43 years. We entered binary variables for each variable. In addition, we provide the means for each test of cognitive ability by adult education, as well as by gender, formal educational attainment, and adult occupational social class mobility.

Results

Bivariate Associations Between Adult Education and Cognitive Outcomes

Table 1 shows the means and standard deviations and corresponding *F* tests for all of the cognitive outcomes at 53

Table 1. Summary Statistics for All Measures of Cognitive Ability at 53 Years by Adult Education by Mid-Adulthood

Formal Education by 26 Years	AE	*n*	Verbal Ability	Verbal Memory	Verbal Fluency	Speed and Concentration
No qualifications	None	348	26.59 (9.04)	20.39 (5.20)	21.35 (6.36)	267.58 (75.85)
	AE, no qualifications	114	28.63 (8.61)	21.54 (5.56)	21.85 (6.22)	277.05 (71.85)
	Qualifications up to O level	142	29.26 (8.49)	21.09 (5.08)	21.92 (6.35)	254.25 (67.17)
	Qualifications beyond O level	25	28.84 (8.25)	21.68 (5.28)	22.72 (4.32)	265.44 (67.95)
Vocational only	None	72	31.06 (8.50)	22.02 (4.94)	21.96 (6.99)	269.07 (64.58)
	AE, no qualifications	38	30.17 (5.93)	20.80 (5.85)	21.90 (4.96)	262.80 (65.58)
	Qualifications up to O level	12	32.00 (7.90)	22.37 (5.44)	22.68 (5.39)	262.24 (69.67)
	Qualifications beyond O level	152	31.33 (9.42)	22.42 (5.95)	23.00 (4.88)	273.25 (56.11)
O level	None	173	34.57 (7.57)	24.47 (5.87)	23.93 (6.73)	284.99 (74.40)
	AE, no qualifications	108	37.15 (6.24)	26.99 (4.89)	24.56 (5.75)	274.06 (66.46)
	Qualifications up to O level	93	36.45 (7.68)	26.41 (5.78)	23.84 (6.83)	287.24 (68.18)
	Qualifications beyond O level	38	40.58 (5.64)	28.44 (5.53)	25.95 (5.78)	296.50 (76.15)
A level	None	152	37.18 (7.17)	25.95 (5.84)	25.48 (5.97)	285.72 (72.93)
	AE, no qualifications	171	39.77 (6.30)	26.19 (5.53)	26.05 (7.10)	289.81 (73.50)
	Qualifications up to O level	126	39.38 (6.87)	26.06 (5.60)	25.76 (7.02)	280.71 (73.60)
	Qualifications beyond O level	98	39.23 (7.04)	27.26 (6.16)	25.71 (6.49)	273.11 (70.72)
Higher	None	43	42.79 (7.23)	27.09 (6.80)	26.05 (6.96)	300.56 (90.19)
	AE, no qualifications	82	43.80 (4.93)	28.33 (4.94)	27.54 (7.88)	307.67 (97.04)
	Qualifications up to O level	40	42.88 (7.43)	29.23 (4.60)	28.27 (6.42)	289.30 (63.30)
	Qualifications beyond O level	29	42.62 (8.99)	29.45 (4.42)	26.83 (8.03)	312.45 (80.68)
			$F = 47.49$, $p < .001$	$F = 31.59$, $p < .001$	$F = 10.51$, $p < .001$	$F = 2.42$, $p = .06$

Note: Data are means (*SD*) unless otherwise noted. Ranges are as follows: verbal ability (2–50), verbal memory (5–41), verbal fluency (1–62), speed and concentration (88–590). AE = adult education; O level = ordinary secondary education; A level = advanced secondary education.

years by each adult education category and stratified by the level of educational attainment by 26 years. With few exceptions, adult education consistently contributed to an increase in the mean score on cognitive ability outcomes at all levels of previous educational attainment. However, these associations were not linear with respect to level of adult education; obtaining qualifications as a result of adult education did not necessarily result in correspondingly higher mean scores. Those with any formal educational qualifications by 26 years were more likely to have undertaken adult education than those with no formal educational qualifications by this age ($p < .001$). The benefits of continuing educational attainment beyond 26 years were seen across groups. Finally, tests for interaction between educational attainment by 26 years and adult education were not significant at the 10% level.

Education and Verbal Ability With Adjustment for Confounders

Table 2 shows FIML estimates representing mean differences in the verbal ability score (NART) per level increase in formal educational attainment by 26 years, controlling for gender and cognition at 8 years (Model 1). In comparison to those had no qualifications by 26 years, there was an approximate 2.5-point increase in the NART score for those who obtained vocational qualifications, a 5-point increase in the NART score for those who reported obtaining Ordinary O-level qualifications, a 6.6-point increase in the NART score for those who received qualifications at the O level, and a 8.2-point increase in the NART score for those who achieved higher education qualifications.

In Model 2, educational attainment continued to have a strong impact on verbal ability at 53 years, but the addition of cognition at 26 years clearly partially attenuated the association with coefficients being reduced by at least half. Model 3 shows that adult education, with or without qualifications, resulted in a 1- to 1.4-point increase in the NART score over and above cognition at 8 and 26 years and educational attainment by 26 years. With further adjustment for social mobility in the fully adjusted model (Model 4), the influence of education was attenuated at all levels, with the association between obtaining vocational qualifications by 26 years and verbal ability no longer being significant at the 5% level. All levels of formal educational attainment by age 26 years showed a significant linear trend with verbal ability ($p < .001$), and each level of educational attainment except vocational-only qualifications was strongly associated with verbal ability in comparison to no educational qualifications.

Coefficients for social class mobility indicated significantly higher verbal ability scores for those upwardly mobile and those stably positioned in nonmanual occupational social class in comparison to those stably positioned in manual occupational social class. Even those who experienced downward mobile had significantly different NART scores in comparison to those stably in manual class. In addition, all categories of adult education were more frequent in those who were upwardly mobile or stably in nonmanual social class than in those who were downwardly mobile or stably in manual class ($p < .001$; data not shown).

Education and Verbal Memory With Adjustment for Confounders

For verbal memory in Table 3, Model 1 shows an approximately 3.4-point increase for those who achieved qualifications at the O level by 26 years, a 4-point increase for those who achieved A-level qualifications, and a 5.4-point increase among those who achieved higher education qualifications in

Table 2. Full Information Maximum Likelihood Estimates (Regression Coefficients and 95% Confidence Intervals) for Verbal Ability at 53 Years

Study Variable	Model 1	Model 2	Model 3	Model 4
Gender (female = 1)	0.08 (−0.44, 0.59)	0.25 (−0.22, 0.71)	0.32 (−0.15, 0.78)	−0.08 (−0.57, 0.41)
Cognition at 8 years (per point increase)	0.17 (0.16, 0.18)***	0.10 (0.08, 0.11)***	0.10 (0.08, 0.11)***	0.09 (0.08, 0.10)***
Formal education by 26 years[a]				
Vocational only	2.46 (1.43, 3.49)***	1.30 (0.37, 2.24)**	1.22 (0.28, 2.15)**	0.94 (0.01, 1.87)
Ordinary (O level)	5.02 (4.27, 5.78)***	2.60 (1.89, 3.31)***	2.46 (1.76, 3.17)***	1.95 (1.22, 2.68)***
Advanced (A level)	6.60 (5.86, 7.33)***	3.40 (2.69, 4.11)***	3.14 (2.42, 3.86)***	2.60 (1.86, 3.34)***
Higher	8.21 (7.15, 9.28)***	3.83 (2.81, 4.85)***	3.57 (2.55, 4.60)***	2.75 (1.68, 3.82)***
Cognition at 26 years (per point increase)		0.56 (0.51, 0.60)***	0.55 (0.50, 0.59)***	0.53 (0.49, 0.58)***
Adult education[b]				
No qualifications			1.36 (0.74, 1.97)***	1.17 (0.55, 1.79)***
Qualifications up to O level			1.01 (0.38, 1.64)**	0.87 (0.25, 1.50)**
Qualifications beyond O level			1.13 (0.29, 1.97)**	0.96 (0.12, 1.79)*
Occupational social class mobility[c]				
M → NM				1.40 (0.56, 2.25)***
NM → M				1.16 (0.16, 2.14)**
NM → NM				2.10 (1.36, 2.85)***
R^2	.497	.587	.590	.595

Notes: O level = ordinary secondary education; A level = advanced secondary education; M = manual; NM = nonmanual.
[a]No formal education qualifications is the reference group.
[b]No adult education is the reference group.
[c]M → M is the reference group.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

comparison to those with no qualifications. There was no significant association between having vocational-only qualifications by 26 years and verbal memory at 53 years. Adjusting for cognitive ability at 26 years reduced the effect size of educational attainment by 26 years, but the associations remained strong. In Model 3, adult education at all levels had an independent effect on verbal memory in comparison to those who reported no adult education, over and above earlier

Table 3. Full Information Maximum Likelihood Estimates (Regression Coefficients and 95% Confidence Intervals) for Verbal Memory at 53 Years

Study Variable	Model 1	Model 2	Model 3	Model 4
Gender (female = 1)	2.12 (1.72, 2.51)***	2.19 (1.81, 2.57)***	2.24 (1.86, 2.62)***	1.97 (1.57, 2.37)***
Cognition at 8 years (per point increase)	0.07 (0.06, 0.08)***	0.03 (0.02, 0.04)***	0.03 (0.02, 0.04)***	0.03 (0.02, 0.04)***
Formal education by 26 years[a]				
Vocational only	0.62 (−0.17, 1.41)	0.01 (−0.76, 0.77)	−0.07 (−0.83, 0.70)	−0.26 (−1.03, 0.50)
O level	3.43 (2.85, 4.02)***	2.18 (1.60, 2.76)***	2.07 (1.49, 2.65)***	1.69 (1.09, 2.29)***
A level	4.01 (3.44, 4.58)***	2.38 (1.79, 2.96)***	2.14 (1.55, 2.73)***	1.74 (1.13, 2.35)***
Higher	5.35 (4.52, 6.18)***	3.14 (2.30, 3.98)***	2.93 (2.09, 3.78)***	2.33 (1.44, 3.21)***
Cognition at 26 years (per point increase)		0.28 (0.24, 0.31)***	0.27 (0.23, 0.31)***	0.26 (0.22, 0.29)***
Adult education[b]				
No qualifications			0.98 (0.47, 1.48)***	0.83 (0.33, 1.34)***
Qualifications up to O level			0.81 (0.30, 1.31)**	0.71 (0.20, 1.22)**
Qualifications beyond O level			1.22 (0.54, 1.91)***	1.09 (0.41, 1.77)**
Occupational social class mobility[c]				
M → NM				0.96 (0.26, 1.65)***
NM → M				0.73 (−0.07, 1.54)
NM → NM				1.51 (0.89, 2.13)***
R^2	.294	.349	.353	.362

Notes: O level = ordinary secondary education; A level = advanced secondary education; M = manual; NM = nonmanual.
[a]No formal education qualifications is the reference group.
[b]No adult education is the reference group.
[c]M → M is the reference group.
$^{**}p < .01$; $^{***}p < .001$.

Table 4. Full Information Maximum Likelihood Estimates (Regression Coefficients and 95% Confidence Intervals) for Verbal Fluency at 53 Years

Study Variable	Model 1	Model 2	Model 3	Model 4
Gender (female = 1)	−0.23 (−0.71, 0.25)	−0.18 (−0.66, 0.29)	−0.16 (−0.63, 0.32)	−0.12 (−0.62, 0.39)
Cognition at 8 years (per point increase)	0.06 (0.05, 0.07)***	0.03 (0.02, 0.04)***	0.03 (0.02, 0.04)***	0.03 (0.02, 0.04)***
Formal education by 26 years[a]				
Vocational only	0.43 (−0.55, 1.40)	−0.09 (−1.05, 0.87)	−0.14 (−1.10, 0.83)	−0.13 (−1.10, 0.84)
O level	1.69 (0.97, 2.41)***	0.64 (−0.10, 1.37)	0.56 (−0.17, 1.30)	0.62 (−0.14, 1.39)
A level	2.64 (1.94, 3.34)***	1.27 (0.53, 2.00)***	1.14 (0.39, 1.88)**	1.20 (0.42, 1.98)**
Higher	3.02 (2.00, 4.04)***	1.18 (0.12, 2.24)*	1.04 (−0.03, 2.10)	1.18 (0.05, 2.30)*
Cognition at 26 years (per point increase)		0.23 (0.18, 0.28)***	0.23 (0.18, 0.27)***	0.23 (0.18, 0.27)***
Adult education[b]				
No qualifications			0.72 (0.09, 1.35)*	0.72 (0.08, 1.35)*
Qualifications up to O level			0.35 (−0.28, 0.99)	0.34 (−0.30, 0.98)
Qualifications beyond O level			0.38 (−0.47, 1.24)	0.38 (−0.48, 1.23)
Occupational social class mobility[c]				
M → NM				0.45 (−0.43, 1.33)
NM → M				−0.11 (−1.13, 0.92)
NM → NM				−0.04 (−0.83, 0.75)
R^2	.123	.149	.149	.149

Notes: O level = ordinary secondary education; A level = advanced secondary education; M = manual; NM = nonmanual.
[a]No formal education qualifications is the reference group.
[b]No adult education is the reference group.
[c]M → M is the reference group.
*$p < .05$; **$p < .01$; ***$p < .001$.

education attainment and cognitive ability. However, the regression coefficients showed a nonordered (or monotonic) association between level of adult education and verbal memory, a fact that was confirmed by a test for trend (p for trend = .09).

Model 4 shows the fully adjusted model for verbal memory at age 53 years. Although the estimates were reduced with the introduction of social mobility, the independent effects of educational attainment by 26 years increased with each level, and the impact of participating in any adult education was apparent with or without obtaining qualifications. Coefficients for social class mobility indicated significantly higher verbal memory scores for those upwardly mobile and those stably positioned in nonmanual occupational social class in comparison to those stably positioned in manual occupational social class. In contrast to scores of verbal ability, verbal memory scores of those downwardly mobile were not significantly different from those of persons stably in manual class.

Education and Verbal Fluency With Adjustment for Confounders

Table 4 shows the partially and fully adjusted models for verbal fluency at 53 years. In comparison to those with no educational qualifications by 26 years in Model 1, educational qualifications above the vocational level by 26 years resulted in an approximately 1.7-point increase in the verbal fluency score for those who achieved O-level qualifications, a higher increase (2.6 points) for those with qualifications at the A level and a continued increase (with a slightly higher 3.0-point increase) for those with higher education qualifications. The introduction of cognitive ability at 26 years in Model 2 attenuated the significant association between having O-level qualifications and verbal fluency in comparison to having no educational qualifications by 26 years.

With adjustment for adult education in Model 3, having A-level qualifications by 26 years and having adult education with no qualifications were associated with verbal fluency. In the fully adjusted model (Model 4), unlike verbal ability and verbal memory, there was no significant relationship between social mobility and verbal fluency. However, having A-level qualifications by 26 years and having adult education with no qualifications continued to have an influence on verbal fluency scores. In addition, the marginally significant relationship between higher educational qualifications by 26 years and verbal fluency in Model 3 became significant at the 5% level in the fully adjusted model.

Education and Speed and Concentration With Adjustment for Confounders

Table 5 shows the results for speed and concentration at 53 years. We found an increase in the speed and concentration score with each level of educational qualification by 26 years at the O level or above in comparison to having no qualifications in Model 1, controlling for gender and cognitive ability at 8 years. In Model 2, there was no association between having qualifications at the O level or below and speed and concentration. We should note that cognition at 26 years was not associated with speed and concentration at the 5% level. In Model 3, the effects of having qualifications at the A level and higher education continued, whereas adult education had no added benefits for verbal speed and concentration. Finally, in the fully adjusted model, cognitive abilities at 8 and 26 years

Table 5. Full Information Maximum Likelihood Estimates (Regression Coefficients and 95% Confidence Intervals) for Speed and Concentration at 53 Years

Study Variable	Model 1	Model 2	Model 3	Model 4
Gender (female = 1)	19.18 (13.72, 24.63)***	19.34 (13.72, 24.63)***	18.97 (13.49, 24.45)***	15.38 (9.57, 21.18)***
Cognition at 8 years (per point increase)	0.23 (0.11, 0.36)***	0.15 (0.11, 0.36)*	0.16 (0.01, 0.30)*	0.13 (−0.02, 0.28)
Formal education by 26 years[a]				
Vocational only	0.45 (−10.54, 11.43)	−0.36 (−11.39, 10.67)	−0.34 (−11.37, 10.69)	−2.27 (−13.35, 8.81)
O level	9.25 (1.13, 17.37)*	7.60 (−0.84, 16.04)	7.38 (−1.08, 15.83)	2.86 (−5.89, 11.61)
A level	14.74 (6.81, 22.66)***	12.54 (4.07, 21.02)**	12.20 (3.61, 20.80)**	7.47 (−1.43, 16.38)
Higher	30.01 (18.48, 41.54)***	27.16 (14.96, 39.35)***	26.39 (14.11, 38.66)***	18.37 (5.51, 31.23)**
Cognition at 26 years (per point increase)		0.48 (−0.06, 1.01)	0.50 (−0.04, 1.03)	0.34 (−0.20, 0.89)
Adult education[b]				
No qualifications			1.87 (−5.45, 9.18)	0.62 (−6.73, 7.97)
Qualifications up to O level			−4.75 (−12.11, 2.61)	−5.33 (−12.70, 2.04)
Qualifications beyond O level			−0.14 (−10.02, 9.74)	−1.19 (−11.07, 8.70)
Occupational social class mobility[c]				
M → NM				0.16 (−10.02, 10.33)
NM → M				9.83 (−2.04, 21.70)
NM → NM				15.81 (6.72, 24.89)***
R^2	.049	.051	.052	.057

Notes: O level = ordinary secondary education; A level = advanced secondary education; M = manual; NM = nonmanual.
[a]No formal education qualifications is the reference group.
[b]No adult education is the reference group.
[c]M → M is the reference group.
*$p < .05$; **$p < .01$; ***$p < .001$.

were not associated with speed and concentration at 53 years. In contrast, having higher education qualifications resulted in an 18-point increase in the speed and concentration score in comparison to having achieved no qualifications by 26 years. Finally, having occupied nonmanual occupational social class positions throughout adulthood had a significant benefit on speed and concentration at 53 years in comparison to having been stably manual social class.

We repeated the analysis with prior cognitive ability trajectories to determine whether relative trajectory placement, rather than continuous scores at each time point, attenuated the relationship between adult education and midlife cognitive ability (data not shown). Trajectories represented movement in quartile placements from 8 to 26 years, resulting in four categories (low-low, low-high, high-low, and high-high) compared to a mid-range reference group. There was no substantial change in the findings as a result of this additional analysis.

Likelihood of Participating in Adult Education

Finally, to understand selection into continuing education, we assessed the relative odds of participating in adult education with bivariate logistic regression models (data not shown). Men had a 37% greater likelihood of participating in adult education ($p < .001$). The odds of engaging in adult education increased with greater educational qualifications by 26 years, with those with advanced and higher level qualifications being approximately 3 and 3.9 times, respectively, more likely to participate in adult education in comparison to those having no qualifications ($p < .001$). Those whose fathers were nonmanual occupational social class during childhood were 1.6 times more likely to take part in adult education ($p < .01$) than those whose fathers were classified as manual social class. Being nonmanual occupational social class at ages 26 (OR = 2.26), 36 (OR = 2.25), and 43 (OR = 3.02) years increased the likelihood of participating in adult education in comparison to being manual occupational social class ($p < .001$, respectively). Finally, higher cognitive abilities at 8 and 26 years increased the odds of participation in adult education (ORs = 1.01 and 1.04, respectively; $p < .001$) independently of social class throughout adulthood.

Discussion

In this study, based on a longitudinal national population-based sample, the primary aim was to examine whether there were continuing effects of education over the life course on cognitive ability in midlife with specific attention to the relationship between adult education by 43 years and cognitive ability at 53 years. The secondary aim was to characterize selection into adult education, defined largely in terms of occupational training, but also including attendance at evening courses. Regarding the first aim, independent of cognitive ability, we found that educational attainment completed by early adulthood had a strong association with higher verbal ability and verbal memory in late midlife at almost all qualification levels and with verbal fluency (animal naming) and mental speed and concentration (timed letter search) at the two highest qualification levels. The continued effects of education were apparent in the associations between adult education at all levels and higher verbal ability and verbal memory, as well as verbal fluency at the level of participation without qualifications in late midlife. We found no association between adult education and mental speed and concentration. The adult education and midlife cognitive ability associations were independent of prior cognitive ability, formal educational attainment, and adult social class attainment and mobility. In terms of the second aim, we showed that men from nonmanual occupational social class of origin and in adulthood and having greater formal educational attainment by 26 years had an increased likelihood of participating in adult education.

The continued effects of education through participation in adult education, a small but valuable intervention, appeared to confer a modest benefit to verbal ability, memory, and fluency in the fully adjusted models, as expected. Our principal hypothesis, that adult education would be independently associated with higher verbal-based measures of cognitive ability in midlife was, therefore, confirmed through significant associations with verbal ability and verbal memory, although only partially confirmed through its relationship to verbal fluency in the fully adjusted models. Our findings supported our secondary hypothesis by showing that adult education was not related to speed and concentration, representing time and visual search tasks, consistent with the weak association between formal education and this measure (Richards & Sacker, 2003). Our findings were also consistent with those of the Seattle Longitudinal Aging Study, which showed verbal memory to improve over the adult life course, peaking at around age 60 years (Schaie, 1996). In contrast, perceptual speed, which in part underlies the letter search task, showed a systematic decline from a peak in early adulthood.

Controlling for prior cognitive ability at two time points reduced the likelihood of reverse causality. Additionally, we adjusted for mobility between manual and nonmanual social class from ages 26 to 53 years to decrease the possibility that adult education leading to occupational advancement was a confounding factor. We should note, however, that regressing adult cognitive ability on educational attainment and another measure of cognitive ability is noninformative if the correlation between these variables is due to a common cause, such as genetic potential (Dickens & Flynn, 2001). Nevertheless, we argue that our results represent an association between adult education and midlife cognitive ability.

It is interesting to note that adult education without qualifications was associated with higher verbal ability and fluency scores than was adult education leading to a qualification. Given that adult education was more likely to have been undertaken by those with formal qualifications by 26 years, it may be that further qualifications achieved through adult education bestow no extra benefit to verbal fluency beyond that conferred during the school years. For verbal ability, obtaining qualifications through adult education courses confers less benefit than undertaking adult education without qualifications. In contrast, the greatest benefit for verbal memory at 53 years came from completing adult education with qualifications beyond the O level.

In addition to these main findings, the pattern of associations between social mobility and verbal memory is worthy of comment. As expected, those in manual occupational social class at ages 26 and 53 years, and those in nonmanual social class at both these ages, had, respectively, the lowest and highest mean NART scores in the sample. In the fully adjusted model, upward mobility (manual to nonmanual) was associated with an increase in verbal memory score of almost equal magnitude to that of those consistently in nonmanual class. As would be expected, being upwardly mobile resulted in higher verbal ability scores than being stably manual and relatively better scores than being downwardly mobile, but less than being stably nonmanual social class. We did not observe these associations for verbal fluency and speed and concentration.

These findings, along with the independent association of adult education and midlife cognitive ability, corroborate evidence that cognitive ability is capable of modification over the adult life course. Other longitudinal studies have also shown fluctuations in cognitive test performance, in adulthood (Arbuckle et al., 1998; Rabbitt, 1993; Schaie, 1996) as well as in childhood (Caspi, Harkness, Moffitt, & Silva, 1996; Feinstein & Bynner, 2004). Corroborating evidence for such modifiability of cognitive ability comes from a range of sources. The "Flynn effect" (Flynn, 1987, 1999) refers to secular IQ rises in Western countries that cannot be accounted for by changes in the gene pool, although these may be partly based on improvements in nontransferable skills through increased familiarity with test materials and conventions (Neisser, 1998). However, there are within-family variations in IQ, such as its inverse association with birth order (Zajonc & Bargh, 1980), as well as environmental influences on IQ beyond the family, such as the effect of neighborhood (Blau, 1981). This evidence was supported by adoption studies that demonstrated substantial gains in IQ in high-risk children removed to more advantaged homes (Duyme, Dumaret, & Tomkiewicz, 1999; Rutter, 1998; Schiff & Lewontin, 1986). Finally, cognitive function can be changed through early learning and school readiness interventions (Caspi et al., 1996; Ramey & Ramey, 2004).

We should note two possible limitations of the present study. First, there are important distinctions to make in assessing the benefits of adult learning that extend beyond the broad and inclusive measure of adult education available in these data. Adult learning experiences vary in terms of the availability of accreditation, the level of accreditation, the curriculum (e.g., academic or vocational), the mode of learning (e.g., classroom or distance learning), the location (e.g., community center, workplace), and duration (e.g., occasional evening study for one term, full-time higher education degree over several years; Feinstein & Hammond, 2004; Vignoles et al., 2003). Nonetheless, it is important to note that these data allow for the differentiation between adult education participants and nonparticipants, as well as between accredited and unaccredited courses. The measure is broader than we would have preferred; however, few longitudinal, large-sample data sets include these types of detailed measures, and even fewer also contain measures of prior and subsequent cognitive development over the life course. Although more detailed measurement would help to differentiate the which aspects of adult education may have an impact cognitive ability, our primary aim of discovering whether there was an independent association between participation in adult education on midlife cognitive ability, independent of prior cognitive ability, was possible with our inclusive adult education measure. Second, our results may have been influenced by selection bias. Adults with higher prior cognitive ability may be on life paths of greater cognitive skill development (i.e., less decline in functioning and/or more cognitively challenging activities) and more likely to engage in adult learning. Although we have no reason to conclude that the selection bias was substantial in this study (i.e., we found benefits of adult education at all levels of formal education by 26 years and at every level of the cognitive ability trajectory from 8 to 26 years), the statistical associations may represent, in part, this underlying factor rather than an association that was solely due to the benefits of adult education.

With these limitations in mind, how should one interpret the association between adult education and midlife cognitive function? Verbal ability, as indexed in this study by the NART, is sometimes referred to as *crystallized intelligence*, a term originally coined by Horn and Cattell (1966) and defined by Carroll (1993, p. 599) as "a type of broad mental ability that develops through the 'investment' of general intelligence into learning through education and experience." Although this definition implies that those of high general intelligence are likely to seek (invest in) education and other enriching experiences, our findings strongly suggest that the reverse causal pathway (i.e., that these experiences also augment cognitive ability) is equally likely. This applies (a) to verbal ability as measured by the NART, which by design depends on the acquisition of information, and also (b) to memory, with possible implications for the reduction of dementia risk in old age (Gauthier et al., 2006). The positive influence of adult education on verbal ability may also reflect improvement in literacy, with important consequences for skilled daily function, employment retention, and career progression (Bynner, 2004).

The association between adult education and cognitive ability also has important public health implications. Unlike in formal schooling, which is compulsory to age 16 years in the United States and United Kingdom, individuals potentially have more agency in choosing to take up adult education, whether driven by economic need, by career considerations, or by a love of learning. The structure of the U.K. educational system below the higher education level may allow for more opportunities to obtain a variety of accepted qualifications at any age. For example, instead of a single high school diploma or qualification for completion of minimum schooling, U.K. students take examinations for the General Certificate in Secondary Education or O levels. Each subject has a separate exam, with students taking exams in as many as 12 subjects. Individuals seeking entrance into higher education will then go on to take advanced-level exams (Department for Education and Skills, 2007). However, despite the U.K. system including more opportunity for concentration in specific subjects, there is no evidence to suggest the benefits of adult education are less in the United States.

Therefore, the characteristics that increase the likelihood of participation in adult education, or at least reduce the barriers to access, are particularly important to note. Our results indicated that participation was more likely for those with formal educational qualifications and higher social class positions, results that are broadly consistent with those of Gorard and colleagues (2001). Ideally, policies and programs should be directed toward increasing adult education in midlife and later life among those educationally and economically disadvantaged, and they should emphasize personal development goals in addition to accredited learning (Aldridge & Tuckett, 2005).

The benefits of adult education for cognitive ability in late midlife, although modest, have implications beyond increasing a skilled labor market and may help to delay cognitive decline, with potentially important benefits for independence, social integration, and well-being in later life (Panza et al., 2005). Verbal ability, a proxy for cognitive "reserve" (Richards & Deary, 2004), may protect against the clinical expression of disease (e.g., from neurodegenerative processes underlying Alzheimer's disease). Unlike other measures of cognitive functions, it is relatively resistant to age- or morbidity-associated decline. In contrast, impairment in learning and memory (word-list task) is arguably the most pathonemonic of all neuropsychological findings for Alzheimer's disease, a disorder that is associated with severe loss of independence and quality of life, whereas verbal fluency (animal naming) and visual perception and cognitive speediness (timed letter search) reflect different aspects of skilled daily functioning. The positive association between education and a wider range of health and functioning is well known (Mirowsky & Ross, 2003). It will, therefore, be important for further research to examine whether similar health benefits are gained or continued through adult education.

Acknowledgments

Funding for Marcus Richards and Michael E. J. Wadsworth was provided by the United Kingdom Medical Research Council.

Stephani L. Hatch assisted in planning the study and performed the majority of the data analysis and writing of the article. Leon Feinstein assisted in planning the study and contributed to writing and revising the article. Bruce G. Link assisted in planning the data analysis and contributed to revising the article. Michael E. J. Wadsworth contributed to revising the article. Marcus Richards assisted in planning the study and analyzing the data, as well as writing and revising the article.

Correspondence

Address correspondence to Stephani L. Hatch, Department of Psychological Medicine, Institute of Psychiatry, King's College London, Weston Education Centre, 10 Cutcombe Road, London SE5 9RJ UK. E-mail: Stephani.hatch@iop.kcl.ac.uk

References

Aldridge, F., & Tuckett, A. (2005). *Better news this time? The NIACE survey on adult participation in learning 2005*. Leicester, England: National Institute of Adult Continuing Education.

Aldridge, F., & Tuckett, A. (2007). *Green shoots? The NIACE survey on adult participation in learning 2006*. Leicester, England: National Institute of Adult Continuing Education.

Alwin, D. F., & McCammon, R. J. (2001). Aging, cohorts, and verbal ability. *Journal of Gerontology: Social Sciences, 56B*, S151–S161.

Arbuckle, J. L. (1996). Full information estimation in the presence of incomplete data. In G. A. Marcoulides & R. E. Schumacker (Eds.), *Advanced structural equation modeling: Issues and techniques* (pp. 243–277). Hillsdale, NJ: Erlbaum.

Arbuckle, T. A., Maag, U., Pushkar, D., & Chaikelson, J. S. (1998). Individual differences in trajectory of intellectual development over 45 years of adulthood. *Psychology and Aging, 13*, 663–675.

Behrman J. R., & Stacey, N. (Eds.). (1997). *The social benefits of education*. Ann Arbor: University of Michigan Press.

Blau, Z. (1981). *Black children/white children: Competence, socialization, and social structure*. New York: Free Press.

Blundell, R., Dearden, L., Goodman, A., & Reed, H. (1997). *Higher education, employment and earnings in Britain* (Report R52). London, England: The Institute for Fiscal Studies.

Boshier, R. W. (1991). Psychometric properties of the Education Participation Scale. *Adult Education Quarterly, 41*, 150–167.

Bynner, J. (2004). Literacy, numeracy and employability: Evidence from the British birth cohort studies. *Literacy & Numeracy Studies, 13*, 31–48.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor analytic studies.* Cambridge, England: Cambridge University Press.

Caspi, A., Harkness, A. R., Moffitt, T., & Silva, P. (1996). Intellectual performance: Continuity and change. In P. A. Silva & W. R. Stanton (Eds.), *From child to adult: The Dunedin Multidisciplinary Health and Development Study* (pp. 59–74). Auckland, New Zealand: Oxford University Press.

Ceci, S. (1996). *On intelligence*. Cambridge, MA: Harvard University Press.

Conlon, G. (2005). The determinants of undertaking academic and vocational qualifications in the United Kingdom. *Education Economics, 13*, 299–313.

Crawford, J. R., Stewart, L. E., Parker, D. M., Besson, J. A. O., & DeLacey, G. (1989). Prediction of WAIS IQ with the National Adult Reading Test: Cross-validation and extension. *British Journal of Clinical Psychology, 28*, 267–273.

Department of Education and Science. (1972). *Burnham further education committee grading courses.* London: HMSO.

Department for Education and Skills. (2007). http://www.dfes.gov.uk/qualifications/.

Dickens, W. T., & Flynn, J. R. (2001). Heritability estimates versus large environmental effects: The IQ paradox resolved. *Psychological Review, 108*, 346–369.

Dolton, P. J., Makepeace, G. H., & Inchley, G. D. (1990). *The early careers of 1980 graduates: Earnings, earnings differentials and postgraduate study* (Employment Department Research Paper No. 78). London: HMSO.

Duyme, M., Dumaret, A. C., & Tomkiewicz, S. (1999). How can we boost IQs of "dull children"? A late adoption study. *Proceedings of the National Academy of Sciences, USA, 96*, 8790–8794.

Egerton, Muriel (2000). 'Pay differentials between early and mature graduate men: the role of state employment' *Journal of Education and Work, 13*, 289–306.

Feinstein, L., & Bynner, J. (2004). The importance of cognitive development in middle childhood for adulthood socioeconomic status, mental health, and problem behaviour. *Child Development, 75*, 1329–1339.

Feinstein, L., & Hammond, C. (2004). The contribution of adult learning to health and social capital. *Oxford Review of Education, 30*, 199–221.

Flynn, J. R. (1987). Massive IQ gains in 14 nations: What IQ tests really measure. *Psychological Bulletin, 101*, 171–191.

Flynn, J. R. (1999). Searching for justice: The discovery of IQ gains over time. *American Psychologist, 54*, 5–20.

Fujita-Starck, P. J. (1996). Motivations and characteristics of adult students: Factor stability and construct validity of the Educational Participation Scale. *Adult Education Quarterly, 1*, 29–40.

Gallacher, J., Elwood, P., Hopkinson, C., Rabbitt, P., Stollery, B., Sweetnam, P., et al. (1999). Cognitive function in the Caerphilly Study: Associations with age, social class, education and mood. *European Journal of Epidemiology, 15*, 161–169.

Gauthier, S., Reisberg, B., Zaudig, M., Petersen, R. C., Ritchie, K., Broich, K., et al. (2006). Mild cognitive impairment. *Lancet, 367*, 1262–1270.

Gorard, S., Rees, G., Fevre, R., & Welland, T. (2001). Lifelong learning trajectories: Some voices of those 'in transit.' *International Journal of Lifelong Education, 20*, 169–187.

Hatch, S. (2005). Conceptualizing and identifying cumulative adversity and protective resources: Implications for understanding health inequalities. *Journal of Gerontology: Social Sciences, 60B*, S130–S134.

Heckman, J., LaLonde, R., & Smith, J. (1999). The economics and econometrics of active labour market programs. In O. Ashenfelter & R. LaLonde (Eds.), *Handbook of labour economics* (pp. 1865–2097). Amsterdam, The Netherlands: North Holland.

Hillage, J., Uden, T., Aldridge, F., & Eccles, J. (2000). *Adult learning in England: A review.* Brighton: Institute for Employment Studies; and Leicester: National Institute of Adult Continuing Education.

Horn, J. L., & Cattell, R. B. (1966). Refinement and test of the theory of fluid and crystallized general intelligences. *Journal of Educational Psychology, 57*, 253–270.

Houle, C. O. (1961). *The inquiring mind: A study of the adult who continues to learn.* Madison: University of Wisconsin Press.

Krueger, A., & Rouse, C. (1998). The effect of workplace education on earnings, turnover, and job performance. *Journal of Labor Economics, 16*, 61–94.

LaLonde, R. (1995). The promise of public sponsored training programs. *Journal of Economic Perspectives, 9*, 149–168.

Lee, S., Kawachi, I., Berkman, L. F., & Grodstein, F. (2003). Education, other socioeconomic indicators, and cognitive function. *American Journal of Epidemiology, 157*, 712–720.

Link, B. G., & Phelan, J. C. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior, 36*(Special Issue), 80–94.

McIntosh, S., Dearden, L., Myck, M., & Vignoles, A. (2002). The returns to academic and vocational qualifications in Britain. *Bulletin of Economic Research, 54*, 249–274.

Mirowsky, J., & Ross, C. E. (2003). *Education, social status, and health.* New York: Aldine de Gruyter.

Morstain, B., & Smart, J. (1977). A motivational typology of adult learners. *Journal of Higher Education, 48*, 665–679.

Muthén, L. K., & Muthén, B. O. (1998/2006). *Mplus user's guide* (3rd ed.). Los Angeles, CA: Authors.

Neisser, U. (1998). *The rising curve: Long-term gains in IQ and related measures.* Washington, DC: American Psychological Association.

Neisser, U., Boodoo, G., Bouchard, T. J., Boykin, A. W., Brody, N., Ceci, S. J., et al. (1996). Intelligence: Knowns and unknowns. *American Psychologist, 51*, 77–101.

Nelson, H. E., & Willison, J. R. (1991). *National Adult Reading Test (NART)* (2nd ed.). Windsor, UK: National Foundation for Educational Research.

O'Donnell, K. (2006). *Adult education participation in 2004–05* (NCES 2006-077). Washington, DC: National Center for Education Statistics.

Office of Population Censuses and Surveys. (1970). *Classification of occupations.* London: HMSO.

Panza, F., D'Introno, A., Colaciocco, A. M., Capurso, C., Del Parigi, A., Caselli, R. J., et al. (2005). Current epidemiology of mild cognitive impairment and other predementia syndromes. *American Journal of Psychiatry, 13*, 633–644.

Pigeon, D. A. (1964). Tests used in the 1954 and 1957 surveys. In J. W. B. Douglas (Ed.), *The home and the school* (pp. 129–132). London: MacGibbon & Kee.

Preston, J., Feinstein, L., & Anderson, T. M. (2005). Can adult education change extremist attitudes? Research on the wider benefits of learning. *London Review of Education, 3*(Special Issue), 289–310.

Rabbitt, P. (1993). Does it all go together when it goes? *Quarterly Journal of Experimental Psychology, 46*, 385–433.

Ramey, C. T., & Ramey, S. L. (2004). Early learning and school readiness: Can early intervention make a difference? *Merrill-Palmer Quarterly Journal of Developmental Psychology, 50*, 471–491.

Reder, S. (2005, February). *Literacy and the life-course* (Reflect Issue 2). London: Institute of Education.

Richards, M., & Deary I. J. (2005). Cognitive reserve: a model for cognitive aging and development? *Annals of Neurology, 58*, 617–622.

Richards, M., & Sacker A. (2003). Lifetime antecedents of cognitive reserve. *Journal of Clinical and Experimental Neuropsychology, 25*, 614–624.

Richards, M., Shipley, B., Fuhrer, R., & Wadsworth, M. E. J. (2004). Childhood cognitive ability and cognitive decline in midlife: longitudinal birth cohort study. *British Medical Journal, 328*, 552–554.

Rodgers, B. (1986). Change in the reading attainment of adults: A longitudinal study. *British Journal of Developmental Psychology, 4*, 1–17.

Rutter, M. (1985). Family and school influences on cognitive development. *Journal of Child Psychology and Psychiatry, 26*, 683–704.

Rutter, M. (1998). Developmental catch-up, and deficit following adoption after severe global early privation. *Journal of Child Psychology and Child Psychiatry, 39*, 465–476.

Sabates, R., & Feinstein, L. (2006). The role of education in the uptake of preventative health care: The case of cervical screening in Britain. *Social Science & Medicine, 62*, 2998–3010.

Sabates, R., Feinstein, L., & Skaliotis, E. (2007). *Determination and pathways of progression to level 2 qualifications: Evidence from the*

NCDS and BHPS (Centre for Research on the Wider Benefits of Learning Research Report No. 22). London: Institute of Education.

Sargant, N., & Aldridge, F. (2002). *Adult learning and social division: A persistent pattern.* Leicester, England: National Institute of Adult Continuing Education.

Schaie, K. W. (1996). The course of adult intellectual development. *American Psychologist, 49*, 304–313.

Schiff, M., & Lewontin, R. (1986). *Education and class: The irrelevance of IQ genetic studies.* Oxford, England: Clarendon Press.

Schuller, T., Preston, J., Hammond, C., Brassett-Grundy, A., & Bynner, J. (2004). *The benefits of learning: The impact of education on health, family life and social capital.* London: Routledge Falmer.

Sticht, T. (2002). The rise of the adult education and literacy system in the United States: 1600–2000. In J. Comings, B. Garner, & C. Smith (Eds.), *The annual review of adult learning and literacy* (pp. 10–43). San Francisco: Jossey-Bass.

Torgerson, C., Porthouse, J., & Brooks, G. (2005). A systematic review of controlled trials evaluating interventions in adult literacy and numeracy. *Journal of Research in Reading, 28*, 87–107.

Vignoles, A, Galindo-Rueda, F., & Feinstein, L. (2004). The labour market impact of adult education and training: A cohort analysis. *Scottish Journal of Political Economy, 51*, 266–280.

Vignoles, A., Jenkins, A., Wolf, A., & Galindo-Rueda, F. (2003). The determinants and labour market effects of lifelong learning. *Applied Economics, 35*, 1711–1721.

Wadsworth, M. E. J., Butterworth, S. L., Hardy, R., Kuh, D., Richards, M., Langenberg, C., et al. (2003). The life course design: An example of benefits and problems associated with study longevity. *Social Science & Medicine, 57*, 2193–2205.

Whalley, L. J., & Deary, I. J. (2001). Longitudinal cohort study of childhood IQ and survival up to age 76. *British Medical Journal, 322*, 1–5.

Zajonc, R., & Bargh, J. (1980). The confluence model: Parameter estimation for six divergent data sets on family factors and intelligence. *Intelligence, 4*, 349–361.

Received January 29, 2007
Accepted July 21, 2007
Decision Editor: Kenneth F. Ferraro, PhD