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BRIEF REPORT

Education Is Associated With Higher Later Life IQ Scores, but Not With Faster Cognitive Processing Speed

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Recent reports suggest a causal relationship between education and IQ, which has implications for cognitive development and aging—education may improve cognitive reserve. In two longitudinal cohorts, we tested the association between education and lifetime cognitive change. We then tested whether education is linked to improved scores on processing-speed variables such as reaction time, which are associated with both IQ and longevity. Controlling for childhood IQ score, we found that education was positively associated with IQ at ages 79 (Sample 1) and 70 (Sample 2), and more strongly for participants with lower initial IQ scores. Education, however, showed no significant association with processing speed, measured at ages 83 and 70. Increased education may enhance important later life cognitive capacities, but does not appear to improve more fundamental aspects of cognitive processing.

Keywords: cognitive reserve, education, intelligence, Lothian Birth Cohort (LBC), processing speed

Cognitive reserve theory suggests that access to education and other social resources conveys resilience to later life brain lesions, insults, and degeneration (Stern, 2002). Understanding the processes by which education might have these effects is therefore of considerable interest to societies coping with demographic shifts toward old age.

Whereas it is difficult to separate any causal effects of education and initial ability on measures of later ability (Deary & Johnson, 2010), quasi-experimental and cross-sectional evidence now exists suggesting that education raises IQ-type scores (e.g., Brinch & Galloway, 2012; Falch & Sandgren Massih, 2011; Winship & Korenman, 1997), and a number of studies have found a significant association between years of education and mean cognitive scores in old age (though not with altered rates of decline, see Tucker-Drob, Johnson, & Jones, 2009; Zahodne et al., 2011). Together, these studies suggest that education might contribute to the higher cognitive ability scores observed in the better educated elderly. The first objective of the present study is to test whether this is the case. In two samples where intelligence was first measured in childhood, we test the association between education and scores from the same intelligence test taken around 60–70 years later.

A second hypothesis examined here addresses one possible mechanism of the effect of education on intelligence. Whereas maintenance of cognitive capacity is in itself an important factor in successful aging (Deary et al., 2012), clearly other factors are of importance, given the less-than-perfect stability of intelligence differences across the life course. In addition, studies showing that education positively impacts on intelligence-test scores leave unanswered the question of whether this increase is due to attainment of knowledge, development of reasoning skills, or a fundamental change in information-processing capacity. Stelzl, Merz, Ehlers, and Remer (1995) showed effects of education on "fluid," and not only "crystallized," intelligence, indicating that reasoning processes and not simply knowledge were being improved (see also Artman, Cahan, & Avni-Babad, 2006; Gustaffson, 2001). However, Cliffordson and Gustaffson (2008) noted that the evidence for a fluid-increase interpretation is still "weak," and that "further empirical work is needed to clarify the nature of the changes" (p. 151). Furthermore, in a review of 200 studies, Ceci (1991) concluded that the evidence that education improves the efficiency of cognitive processing, as opposed to more specific cognitive skills, was "not compelling" (p. 717).

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The mechanism behind intelligence increases due to education is of particular interest in the light of studies of cognitive reserve in samples of older individuals. Education has been found to be significantly associated with better later life scores on a wide variety of measures; these include neuropsychological tests such as the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975; Christensen et al., 1997; Wilson et al., 2009), as well as a variety of episodic-memory, verbal-memory, reasoning, vocabulary, verbal-fluency, and processing-speed tasks (Batterham, Mackinnon, & Christensen, 2011; Lövdén, Ghisletta, & Lindenberger, 2004; Tucker-Drob et al., 2009; Zahodne et al., 2011). These latter processing-speed tasks are often, however, relatively cognitively complex; they include useful field-of-view, digit–symbol substitution, identical pictures, lexical decision tasks, and sentence verification. No studies to date have examined the effect of education on more basic information-processing tasks such as reaction time (RT) and inspection time (IT), which have been hypothesized to underlie at least some of the important processes involved in producing intelligence differences (Jensen, 2006), and account for the relationship between intelligence and mortality (Deary & Der, 2005).

Recent results have emphasized the link between these simple speed variables and intelligence (Deary, Johnson, & Starr, 2010; Johnson & Deary, 2011). Penke et al. (2012) showed that, not only does white-matter integrity account for a significant fraction of variation in cognitive scores in old age, but that this relationship is completely mediated by processing speed, measured using a latent trait of simple and four-choice RTs and ITs. That is, the effects of brain white-matter integrity were associated with better cognition (the general cognitive ability factor from six varied psychometric tests) through more efficient basic processing speed. In this context, two contrasting expectations can be generated for the present study: If education works via the same mechanisms that underlie the links of neuronal factors such as white matter to cognition, then we should expect education-linked cognitive improvements to be detectable in increased processing-speed differences. If, however, education affects cognition via other routes (for instance, through an increase in knowledge, experiential resources, or reasoning ability), then the education–intelligence link may be found without any improvement in processing speed.

Here, we report data from two rare samples suitable for testing these hypotheses, in which cognitive ability was assessed in individuals at age 11, prior to the start of differential education, and cognitive ability as well as processing-speed measures were taken later in life. Sample 1 is a cohort of older individuals who took a test of general cognitive ability at age 11 and were followed up at ages 79 and 83, the Lothian Birth Cohort, 1921 (Deary, Whiteman, Starr, Whalley, & Fox, 2004). We test the association between education and later life general cognitive ability (which we will abbreviate as IQ), RT, and IT, controlling for age–11 IQ and parental socioeconomic status (SES). We attempt a replication of the findings in a second, larger cohort, again assessed for IQ at age 11, and later assessed at age 70, the Lothian Birth Cohort, 1936 (Deary et al., 2007).

Method

Participants

Sample 1. Participants in Sample 1 were members of the Lothian Birth Cohort, 1921 (LBC1921), most of whom, as schoolchildren in Scotland, had taken the Moray House Test (MHT) No. 12 (Scottish Council for Research in Education, 1933) from the Scottish Mental Survey, 1932 (SMS1932) for the measurement of cognitive ability. Mean age was 10.90 years (SD = .29). Community-dwelling, surviving participants of the SMS1932 who were living in the Edinburgh area of Scotland were recruited and followed up in 1999–2001 (LBC1921 first wave, mean age = 79.06 years, SD = .58, n = 550; 234 men), and again during 2003–2005 (LBC1921 second wave, mean age 83.35, SD = .54, n = 321; 145 men). For a full description of recruitment and testing of the cohort, see Deary, Whiteman et al. (2004), and Deary, Gow, Pattie, and Starr (2011).

Sample 2. Participants in Sample 2 were members of the Lothian Birth Cohort, 1936 (LBC1936), most of whom had been tested at a mean age of 10.94 years (SD = .28) as part of the Scottish Mental Survey, 1947 (SMS1947), using the same IQ test as the SMS1932: the Moray House Test No. 12. A total of 1091 surviving members (548 men) in the Edinburgh area were followed up in 2004–2007 (LBC1936 first wave, mean age 69.53 years, SD = .83). For a full description of this cohort, see Deary et al. (2007, 2011).

All participants in both samples were screened for dementia using the MMSE (Folstein, Folstein, & McHugh, 1975) in the first wave of testing. In Sample 1, the scores of nine participants (1.64%) were below 24, a widely used cutoff for possible dementia. In Sample 2, the scores of 11 participants (1.01%) were lower than 24. Excluding these participants from the analyses did not appreciably change the results we report here.

Measures and Procedure

IQ at age 11 years was measured using the Moray House Test (MHT) No. 12 in the SMS1932 and SMS1947 (Scottish Council for Research in Education, 1933, 1958). This test had a maximum score of 76, and contained 75 items, made up of the following types: 14 on directions, 11 on same–opposites, 10 on word classification, eight on analogies, six practical items, five reasoning items, four on proverbs, four on arithmetic, four spatial items, three on mixed sentences, two on cypher decoding, and four other items; see Deary, Whiteman et al. (2004) for more details and information on scoring. Participants in both samples were administered the same MHT in later life, during the first wave of follow-up. The MHT was validated at the initial childhood test. A sample of 1000 children were also administered the Stanford–Binet test after the SMS1932, which correlated around .8 with the MHT (Scottish Council for Research in Education, 1933). The MHT was validated at follow up in old age, where MHT scores correlated .71 with Raven's Standard Progressive Matrices at age 79 in the LBC1921 (Deary, Whiteman, et al., 2004, p. 134, Table 1), and .62 with a general cognitive ability score derived from six nonverbal Wechsler tests in the LBC1936 (Deary, Johnson, & Starr, 2010, p. 222, Table 1). MHT scores were standardized to a mean of 100 and a SD of 15 for use in the calculations described below.

Table 1
Mean Scores and SD*s for all Measured Variables in Each Sample*

Variable	Sample 1. LBC1921 *n*	*M*	*SD*	Sample 2. LBC1936 *n*	*M*	*SD*
Age at initial test (years)	550	10.90	.29	1078	10.93	.28
Age at Wave 1 (years)	550	79.06	.58	1078	69.49	.83
Age at Wave 2 (years)	321	83.35	.54	—	—	—
Age 11 IQ (MHT score)	493	46.44	12.05	1016	49.04	11.70
Later-life IQ (MHT score)	540	59.23	10.85	1078	64.28	8.64
Education (years)	548	10.92	2.47	1078	10.74	1.13
Simple RT (ms)	318	313	84	1074	276	56
Simple RT *SD* (ms)	318	84	64	1073	62	47
Choice RT (ms)	318	793	145	1073	641	85
Choice RT *SD* (ms)	318	173	48	1073	139	52
IT (correct trials/150)	316	101.47	13.70	1032	112.20	10.97
Age 11 SES	482	2.79	.95	952	2.91	.94

Note. Later life IQ measured at age ~79 in the LBC1921, and at age ~70 in the LBC1936 (LBC = Lothian Birth Cohort). Abbreviations: MHT = Moray House Test (scores out of a maximum of 76); RT = reaction time; IT = inspection time; SES = socioeconomic status.

Years of full-time, formal education were recorded at interview during the first follow-up wave in both samples.

SES of origin was indexed using the participant's father's occupational status when the participant was 11 years old. This was ordered from *I* (professional) to *V* (unskilled), according to the General Register Office Census, 1951 *Classification of Occupations* (General Register Office, 1956). This variable was available for both samples, and was recorded during the first follow-up wave.

Simple and four-choice RTs were measured using a dedicated portable device (described in detail by Deary, Der, & Ford, 2001). Participants responded to a numeric stimulus presented on an LCD screen by pressing the appropriate response key as quickly as possible. Simple RT was assessed in a one-button condition, with eight practice trials and 20 test trials. In the four-choice condition, the subject had to pick the correct response from four available buttons, with eight practice trials and 40 test trials. Mean RT and standard deviation of accurate responses were recorded automatically. RT was measured in the LBC1921 during the second wave (aged ~83 years), and in the LBC1936 during the first wave (aged ~70 years).

Inspection time was also measured in both samples. Participants were asked to judge, as accurately as possible, which was the longer of two vertical lines displayed on a screen. The stimuli were displayed for varying lengths of time—from 6 ms to 200 ms—and the dependent variable was the total number of correct detections out of a possible 150 trials. Participants were informed that their responses were not timed, and accuracy was the only outcome variable measured. See Deary, Simonotto et al. (2004) for a full description of the IT stimuli and procedure. For both samples, IT was measured during the same wave as RT measurement.

Analysis

For both samples, we used hierarchical multiple regression modeling to investigate the associations between years of education and later life IQ scores and speed-of-processing measures, with controls for potentially confounding or mediating variables. The first step of the model controlled for age, because there was some range at testing (e.g., at the tests of RT and IT in old age, the age range was 927 days in Sample 1, and 1346 days in Sample 2), and sex, because of the different educational opportunities for each sex at the time the members of our samples were leaving compulsory schooling (Scottish Council for Research in Education, 1958). The second step added parental SES, to control for the nonrandom availability of education to those from different socioeconomic backgrounds (e.g., Johnson, Brett, & Deary, 2010). The third step added age-11 IQ (adjusted for age in days), to allow us to assess the longitudinal gain in IQ or speed, independent of initial ability. Analysis was restricted to only those participants who had provided the variables necessary for all three steps.

Results

Table 1 shows the full sample sizes and mean scores for each of the variables for both samples. The partial correlation matrix for these variables is given in the Appendix (all correlations controlled for age in days at both times of testing and sex). After controlling for sex and age at time of testing, both simple and choice RT, as well as RT *SD*, were significantly, and for the most part modestly, correlated with both early and later measures of IQ. The significant association between IT and cognitive ability was replicated. Some of these results were reported in Deary et al., (2010), but they are not the principal results in the present report.

Coefficients for the effects of education in each step of the regression models are shown in Table 2, separately for each outcome variable, along with the valid sample size included in each model, as all individuals did not contribute every necessary variable.

Our first hypothesis, that years of education would have a significant positive effect on posteducation IQ while controlling for preexisting IQ, was supported. In the LBC1921, each year of education was associated with a .66-point advantage in IQ (95% confidence interval: .14 to 1.17 points) at age ~79, controlling for age-11 IQ, SES, and age at both times of testing, and sex (Table 2, Step 3). Running the analysis without controlling for age-11 IQ (Table 2, Step 2) resulted in a larger effect of 2.16 points per year. We next added an interaction term to the model to test for nonlinear effects of education on later life IQ for different levels of age-11 IQ. This term was significant ($p < .001$); for individuals

Table 2
Association Between Education and Later Life IQ and Processing Speed in Both Samples

Sample	Measure	Step	*B*	*SE*	*t* value	*p* value
1. LBC1921	IQ points age 79	1	2.491	.274	9.078	<.001
	n = 412	2	2.162	.299	7.232	<.001
		3	.656	.261	2.509	.013
	Simple RT mean (ms)	1	−2.036	2.128	−.957	.340
	n = 267	2	−.305	2.350	−.130	.897
		3	1.460	2.539	.575	.566
	4-choice RT mean (ms)	1	−5.321	3.605	−1.476	.141
	n = 267	2	−4.112	3.998	−1.028	.305
		3	−2.576	4.341	−.593	.553
	Simple RT *SD* (ms)	1	−1.578	1.558	−1.013	.312
	n = 267	2	−.086	1.716	−.052	.959
		3	.998	1.858	.537	.592
	4-choice RT *SD* (ms)	1	−.519	1.151	−.451	.652
	n = 267	2	−1.044	1.276	−.818	.414
		3	−.221	1.381	−.160	.873
	Inspection Time	1	.305	.350	.872	.384
	n = 265	2	.333	.387	.860	.391
		3	−.088	.416	−.211	.833
2. LBC1936	IQ points age 70	1	4.790	.377	12.706	<.001
	n = 901	2	4.511	.398	11.342	<.001
		3	1.424	.338	4.210	<.001
	Simple RT mean (ms)	1	−6.842	1.463	−4.678	<.001
	n = 899	2	−6.418	1.545	−4.153	<.001
		3	−3.327	1.652	−2.014	.044
	4-choice RT mean (ms)	1	−6.913	2.417	−2.859	.004
	n = 898	2	−6.394	2.554	−2.504	.013
		3	1.150	2.686	.428	.669
	Simple RT *SD* (ms)	1	−3.541	1.424	−2.486	.013
	n = 898	2	−2.842	1.504	−1.889	.059
		3	−1.644	1.626	−1.011	.312
	4-choice RT *SD* (ms)	1	−3.578	1.603	−2.231	.026
	n = 898	2	−3.752	1.694	−2.215	.027
		3	−.105	1.811	−.581	.562
	Inspection Time	1	1.059	.330	3.206	.001
	n = 868	2	.933	.349	2.676	.008
		3	.552	.377	1.466	.143

Note. RT = reaction time. In Step 1, models controlled for sex and age (at both time points). In Step 2, models controlled for sex, age, and socioeconomic status (SES). In Step 3, models controlled for sex, age, SES, and age 11 IQ. LBC = Lothian Birth Cohort.

with lower scores on the initial IQ test, education was more strongly associated with higher later life IQ. Including only participants who returned for Wave 2 of the LBC1921, at age ~83, reduced the valid sample size from 412 to 263; an effect of education on later life IQ remained (p = .019), but the added interaction term described above did not reach significance (p = .15).

A similar result was found in the LBC1936, where each year of education was associated with an advantage of 1.42 IQ points (95% CI: .76 to 2.09 points), with the same covariates (combining both samples into one model showed that the association of education with IQ was not significantly larger in the LBC1936 than the LBC1921; an interaction between sample and educational duration was not significant, B = .61, SE = .37, t = 1.64, p = .10). Again, without the inclusion of age 11-IQ in the model (Step 2), the later life IQ advantage was larger: 4.51 IQ points per year of education. There was a significant interaction between age-11 IQ and education ($p < .001$), with lower IQ individuals at age 11 having stronger associations between duration of education and their later life IQ score.

We next tested the second hypothesis, that, controlling for childhood IQ, age at time of testing, and sex, education would be associated with faster processing speed in old age (measured by IT and simple and four-choice RT). As Table 2 shows, whereas significant associations of education with speed were found on several speed measures when age-11 IQ was not controlled, adding this variable to the models in Step 3 reduced all but one of the effect sizes to nonsignificance. The effect of education on simple RT in Sample 2 was the only conventionally significant result (p = .044).

As with the IQ data, interactions were added to the models to test for nonlinear effects. Only one significant effect was found: Education showed a significant interaction with age-11 IQ for simple RT standard deviation in Sample 1 (p = .022). Again, lower initial-IQ participants appeared to have the strongest associations between their simple RT *SD* and education. This interaction was not replicated in the larger Sample 2 (p = .99).

Discussion

In two longitudinal samples, we tested whether the reported positive effects of education on IQ in adolescence (e.g., Brinch & Galloway, 2012; Winship & Korenman, 1997) persist into old age, and whether these effects are reflected in underlying increases in

speed on simple and four-choice RT and IT tasks. The results supported the first hypothesis. Years of education were positively associated with IQ scores (after adjusting for prior IQ) even into later life. In addition, we showed that these effects are nonlinear; that is, education was more strongly associated with the later life IQ scores of individuals with lower IQ scores in childhood. Our second hypothesis was not supported: Associations of education with processing speed (RT or IT) were either small or nonexistent, suggesting that education's effects are possibly limited to specific aspects of intelligence tests, such as knowledge and perhaps reasoning. Education's positive effects on the gaining and deployment of knowledge may not, then, extend to the more basic information-processing tasks that were tested here.

Our estimate of the average IQ increase per year of education in Sample 1 (.66 points) was smaller than that for Sample 2 (1.42 points), but not significantly smaller. Estimates from both samples, however, are smaller than the effect of education reported by previous education-IQ research. For instance, Brinch and Galloway (2012) found an increase of 3.70 IQ points per year of schooling, and other studies have found similar-sized effects (Falch & Sandgren Massih, 2011; Winship & Korenman, 1997). Several factors may account for this discrepancy. Most important, we controlled for age-11 IQ; dropping this variable from the model greatly increases the apparent effect of education on later life IQ; removing this control results in an effect that is around three times larger in both samples (see Table 2). However, as we have argued elsewhere (Deary & Johnson, 2010), given the likelihood that prior cognitive differences contribute to educational outcomes, and given that childhood intelligence and education share some genetic variance (Calvin et al., 2012), it is important to adjust for prior cognitive ability in estimating the association between education and later cognitive ability. In addition, our dataset differs from previous studies culturally, temporally, in the particular IQ test used, and in the age groups at which the follow-up IQ test was administered.

Our finding that education is associated with a greater per-year increase in IQ points for lower ability children replicates and extends into old age a similar finding by Hansen, Heckman, and Mullen (2004), who described education as having "equalizing effects" (p. 79) on cognitive test scores. However, recent reports suggest that individuals who would benefit most from extra education both pre- and postschool are the least likely to be exposed to it (Brand & Xie, 2010; Tucker-Drob, 2012). The results of the present study imply that lower ability individuals who remain longer in full-time education will see the greatest benefits to their IQ scores in old age.

Only one speed measure showed a significant relationship to duration of education: simple RT in Sample 2. However, the effect is only marginally significant, relatively small (one year of education is associated with a 3.5-ms faster RT), and inconsistent with the effects of education on all the other speed measures. There is good reason to regard it as a false positive. The other significant result–the interaction been age-11 IQ and education in the model of education's effects on the simple RT standard deviation in Sample 1–was not replicated in Sample 2. Again, due to this inconsistency, and the incongruity with all the other speed measures, which were not significant, we suggest that this result is spurious. As with the IQ results discussed above, the strength of the relationship between education and speed is much larger when the model does not adjust for age-11 IQ (Table 2, Steps 1 and 2), underlining the importance of controlling for early ability in longitudinal research on cognitive aging.

Results from our analyses of the speed tasks conflict with previous reports supporting both "active" and "passive" cognitive reserve models (Zahodne et al., 2011), as both types of model posit that education in early life will result in improved later life cognitive processing, and result in a higher cognitive starting point from which age-related cognitive decline begins. However, the models differ on the effect of education on the rate of the decline after this point. This contradiction may be due to the heterogeneity of tasks used across those experiments. Previous studies have used tasks such as reasoning, vocabulary, verbal speed, and the Mini-Mental State Examination (Tucker-Drob et al., 2009; Wilson et al., 2009); we might expect those higher level skills to be improved by the training and learning that is essential to education. Indeed, our finding that participants' later life IQ scores were improved by more exposure to education implies that many of these skills would also have had associations with education in our sample. However, education did not appear to be significantly associated with the more basic processes underlying performance on these tasks, as measured by elementary cognitive tasks such as RT and IT.

The present study has some limitations. First, since our earliest measure was at age 11, we may have missed earlier variation in education, as well as any resulting effects on the baseline intelligence measure that would have, in turn, impacted intelligence or speed in later life. By the ages over which compulsory education varies in contemporary Western society (10–15 years), much of the change in biological factors—such as cortical thickness (Shaw et al., 2006), which is associated with increases in general ability (Karama et al., 2011)—have been completed. Whereas it is possible, therefore, that education experienced early in life may increase processing speed, later education may largely be associated with training of specific skills or learning of specific content, and will therefore not generalize to skills such as RT and IT. Only longitudinal studies beginning prior to education will be able to address this important issue. Second, and conversely, duration of education may reflect differences in cognitive ability that, through maturation, appear after age 11. Thus, the increases in later life IQ score may not have been caused by more education; instead, post age-11 increases in intelligence may themselves cause individuals to stay longer in education.

Third, the samples used here are not fully representative of the general population: The community-dwelling follow-up samples were subsets of the full populations tested in 1932 and 1947, and consequently the mean MHT scores of both samples are somewhat higher than those of the populations, with lower standard deviations (Deary et al., 2000). This bias means that we probably underestimate the effect sizes reported here by a small amount. Fourth, in Sample 1, the later life IQ measures were taken approximately four years before the speed measures. The valid sample size for the effect of education on speed, then, is smaller than that for IQ score, due to attrition, meaning the models are not directly comparable. However, analyzing the data from only those who contributed both IQ and speed measures only reduces the interaction between age-11 IQ and years of education to nonsignificance. This is most likely due to the loss of statistical power inherent in reducing the valid sample size from 412 to 263. Nevertheless, the

results from Sample 1, including this interaction, were replicated in Sample 2, a much larger cohort in which all later life measures analyzed here were taken concurrently.

The present results suggest that education has enduring effects on IQ-test performance, even controlling for childhood-IQ score, and that these effects are stronger for those with lower cognitive ability in childhood. However, they also suggest that these effects work via mechanisms—perhaps those involving improvements in specific skills—that are distinct from those generating differences in more fundamental measures of processing speed.

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Appendix

Partial Correlation Matrix for Variables in Both Samples

Variable	1	2	3	4	5	6	7	8	9
Age 11 IQ	—	$.68^{***}$	$.43^{***}$	$-.25^{***}$	$-.12^{***}$	$-.27^{***}$	$-.15^{***}$	$.12^{***}$	$.20^{***}$
Later life IQ	$.66^{***}$	—	$.39^{***}$	$-.33^{***}$	$-.19^{***}$	$-.37^{***}$	$-.20^{***}$	$.25^{***}$	$.20^{***}$
Edu	$.44^{***}$	$.42^{***}$	—	$-.17^{***}$	$-.10^{**}$	$-.11^{***}$	$-.08^{**}$	$.11^{**}$	$.33^{***}$
Simple RT	$-.15^{**}$	$-.26^{***}$	$-.10$	—	$.45^{***}$	$.47^{***}$	$.13^{***}$	$-.16^{***}$	$-.08^{*}$
Simple RT *SD*	$-.16^{**}$	$-.29^{***}$	$-.09$	$.71^{***}$	—	$.19^{***}$	$.06^{*}$	$-.11^{***}$	$-.08^{*}$
Choice RT	$-.14^{*}$	$-.30^{***}$	$-.15^{**}$	$.53^{***}$	$.40^{***}$	—	$.40^{***}$	$-.35^{***}$	$-.06$
Choice RT *SD*	$-.13^{*}$	$-.29^{***}$	$-.11$	$.32^{***}$	$.37^{***}$	$.59^{***}$	—	$-.16^{***}$	$-.02$
IT	$.18^{**}$	$.30^{***}$	$.11^{*}$	$-.26^{***}$	$-.30^{***}$	$-.33^{***}$	$-.33^{***}$	—	$.08^{*}$
Age 11 SES	$.24^{***}$	$.27^{***}$	$.42^{***}$	$-.13^{*}$	$-.14^{*}$	$-.11$	$.00$	$.03$	—

Note. LBC = Lothian Birth Cohort; Edu = years of education; RT = reaction time; IT = inspection time; SES = socioeconomic status. Partial correlations controlled for age at both times of testing and sex. Coefficents below the diagonal = Sample 1 (LBC1921); above the diagonal = Sample 2 (LBC1936). Later life IQ measured at age 79 in the LBC1921, and at age 70 in the LBC1936.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

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