



## Cognition and Neurosciences

# Intelligence as a predictor of social mobility in Estonia

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The purpose of this study was to explore how individual and environmental predictors of intergenerational social mobility intersect in rarely studied post-communist developing society of Estonia. We used a contemporary cross-sectional dataset ( $n = 759$ ) to assess the influence of cognitive ability and parental socioeconomic status to the participants' educational and occupational attainment. Our results indicated that cognitive ability and one's own educational level mediated the association of parental socioeconomic status with one's own occupational success. Analysis of separate components of cognitive ability indicated that verbal ability had the highest influence on occupational status. We concluded that both individual-level and environmental factors have a predictive effect on educational and occupational attainment.

**Key words:** Social mobility, status attainment, education, cognitive ability, socioeconomic status, WAIS-III, Estonia.

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### INTRODUCTION

Intergenerational, or social, mobility, is defined as movement between different social classes and it is examined by comparing people's current circumstances with those from which they originate (Breen & Jonsson, 2007). Identifying predictors of such mobility is important to understand not only the factors contributing to individuals' own success (Strenze, 2006), but also wider societal phenomena such as economic growth (Beller & Hout, 2006), inequality (Breen & Luijkx, 2004), and educational systems (Johnson, Brett & Deary, 2010a; Saar, 2010). Both individual-level factors such as intelligence, personality traits or effort as well as arguably more environmental factors such as parental education, social position, economic situation, and industrialization have been implicated in social mobility (Breen & Goldthorpe, 1999, 2002; Deary, Taylor, Hart *et al.*, 2005; Erikson & Goldthorpe, 1993; Johnson, Brett & Deary, 2010b; Johnson, Brett & Deary, 2010a; Nettle, 2003; Saunders, 1997, 2002; von Stumm, Gale, Batty & Deary, 2009). But which of these play comparatively larger roles?

Several studies have concluded that intelligence is a better predictor of social mobility than parental socioeconomic status (Deary, *et al.*, 2005; Erikson, 2016; Herrnstein & Murray, 1994; Johnson *et al.*, 2010b; Nettle, 2003; Sorjonen, Hemmingsson, Lundin & Melin, 2011). Much of the discussion has focused on the "Bell curve studies" (Herrnstein & Murray, 1994), which concluded that intelligence is the main predictor of success and status attainment, leaving parental status of origin to play only a partial role, at least in the US society. Later studies on other samples have found similar results. For example, Nettle (2003) showed that general cognitive ability was the main predictor of social mobility as well as occupational attainment in the UK, and these results were in accordance with previous British studies conducted by Saunders (1997, 2002). Using data from the Scottish Mental Survey, Deary *et al.* (2005) found that childhood intelligence strongly predicted the occupation attained by midlife. In a meta-analysis, Strenze

(2007) concluded that cognitive ability is slightly more strongly associated with occupational attainment than other factors such as education or parental background, although the association of these with occupational attainment was rather similar.

However, rather than pitting educational level and cognitive abilities against each other, Johnson *et al.* (2010b) suggested that educational attainment may have a pivotal role through which individuals with higher cognitive ability can be upwardly mobile. Parental social class, in contrast, may restrain the otherwise meritocratic movement between classes. It is also possible that mental ability makes a contribution to social class attainment independently of educational attainment so that individuals with higher mental ability manage to make use of that ability to work their way up to positions of status, even when educational attainment is blocked (Johnson *et al.*, 2010a).

The individual differences (such as intelligence, educational attainment, and personality) that may influence social mobility have a largely overlapping genetic basis (Marioni, Davies, Hayward *et al.*, 2014; Möttus, Realo, Vainik, Allik & Esko, 2017b). This suggests that the same genetic variants may contribute not only to those but also to socioeconomic success (pleiotropy) or these individual differences may mediate the genetic influences on socioeconomic success. If so, direct causal associations between cognitive ability, education and other markers of social class may be less likely – the associations may be genetically confounded.

Although much of the earlier research has studied intelligence/cognitive ability as a unidimensional construct, Epstein and Winship (2006) suggested that a multidimensional model of intelligence provides a better understanding of the relationships with social status and it might do so in social mobility as well. They hypothesized that not all areas of cognitive ability predict educational and socioeconomic attainment equally. Their research showed that the unidimensional model fits poorly and different dimensions of mental ability correlated differently with various aspects of social mobility and success. More specifically,

they found that quantitative and verbal ability were the most important predictors of educational attainment, but appeared to have no direct effect on economic success. They propose that these factors may affect economic success indirectly through educational attainment. Indeed, it has also been found that some components of intelligence (e.g., language skills, executive functions, and memory) may be more sensitive to the effect of parental background than others (Farah, Shera, Savage *et al.*, 2006; Noble, Norman & Farah, 2005). Asbury, Wachs and Plomin (2005) studied the genotype-environment interactions on cognitive ability and concluded that the environmental influences emerged for verbal ability but not for nonverbal ability. Therefore, there is a possibility that the different aspects of cognitive ability may contribute differently to social mobility and are disproportionately affected by different environmental or individual factors (Asbury *et al.*, 2005; Farah *et al.*, 2006).

The importance of environmental factors (e.g., parental socioeconomic status) has been highlighted by findings which show that individuals with lower social class of origin have to display more merit than individuals from higher class background to be upwardly mobile (Breen & Goldthorpe, 1999, 2001), although more recent genetic studies analyzing environmental factors have found contradictory results. A meta-analysis by Tucker-Drob and Bates (2016) indicated that the effects of genetic and environmental factors may be dependent on the (parental) socioeconomic status itself: there was support for the socioeconomic status moderating the extent to which genetic influences manifested in observable intelligence in the US, but this was not the case everywhere. Data from Western Europe and Australia did not confirm the lower heritability of intelligence in families with low socioeconomic status, which indicates that the society and its policies may contribute to the development of intelligence.

Evidence for genetic overlap between different psychological and social phenomena (Marioni *et al.*, 2014; Mõttus, Marioni & Deary, 2017a; Mõttus *et al.*, 2017b) also suggests that intrinsic and presumably more environmental factors may intersect in how they relate to social mobility. Damian, Su, Shanahan, Trautwein and Roberts (2015) indicated that previous work on social mobility and attainment has somewhat avoided the integrative research between the individual-based and environmental approaches. They proposed different scenarios for possible interplays between individual and environmental factors: (1) personality characteristics and intelligence may predict attainment independently of parental socioeconomic level (no interaction); (2) personality characteristics and intelligence are stronger predictors of attainment at lower levels of parental socioeconomic status (compensation); or (3) personality characteristics and intelligence are stronger predictors of attainment at higher levels of parental socioeconomic status (accumulated advantage). In a large US dataset, the results showed that intelligence may compensate for background disadvantage in several ways and these effects remained statistically significant when controlling for personality traits. The authors suggested that personality traits may help compensate the disadvantages of parental background, but only to a relatively small extent, whereas intelligence showed a full “catch-up” effect. All in all, they argued that more complex combinations of different factors may contribute to social attainment and to the probability of being socially mobile.

According to previous research, there is little doubt that the economic situation (Beller & Hout, 2006), educational system and other institutions, as well as stratification of income (Johnson, Deary & Iacono, 2009) and societal openness (Breen & Luijkx, 2004) in the particular country are also part of the social mobility trends. Nevertheless, most studies have mainly analyzed data from western societies, so their findings may not necessarily be applicable everywhere. Studies of different samples and locations are needed to further explain the possible interplay that predicts the mobility (Hanscombe, Trzaskowski, Haworth, Davis, Dale & Plomin, 2012).

One of such non-traditional locations may be Estonia, a former socialist society that has gone through many structural changes in the last decades and has been relatively successful in becoming a functional market society (Saar, 2010; Titma, Roots & Soidla, 2010). Previous studies have found contradictory results about the changes of social mobility concerning the transition from early socialist to post-socialist regimes (Gerber & Hout, 2004; Mach, 2004; Róbert & Bukodi, 2004). One of the reasons of these differences may be the transition model that governments have followed. In many post-socialist countries the state control over the economy loosened, which led to the rise in private ownership. Most of the countries followed a gradual strategy of this transition, whereas Estonia was unique in its abrupt shift to low state intervention and a liberal transition model (Saar, 2010).

Strenze (2006) has compared data from Estonia and the United States to establish the correlates of success and status attainment. As expected, both parental social status and cognitive ability had positive associations with success. Additionally, Strenze (2006) found that mental ability was a greater predictor of success in America, compared to Estonia. It is possible that these differences may have been associated with stability in social environment: stable and open social environment in America may provide better conditions for people to fully use their intellectual capabilities (see Herrnstein & Murray, 1994). Strenze proposed that if the society matures and becomes more stable, the advantage of being intelligent would grow in Estonia.

Although many researches have established different individual as well as arguably more environmental predictors of social mobility, the interplay of intelligence, education and socioeconomic status is still poorly understood and needs to be studied further (Deary & Johnson, 2010; Marioni *et al.*, 2014; Sorjonen, Hemmingsson, Deary & Melin, 2015). The aim of this study is to analyze the mechanisms of intergenerational social mobility by establishing the associations between parental background, education, and cognitive abilities in Estonia. We explore whether the same patterns of associations between education, intelligence and socioeconomic status apply in the more extensively studied western populations as well as in post-soviet Estonia. According to the previous findings we hypothesize that both parental socioeconomic background and individual factors influence the personal attainment. Based on Strenze's (2006) research in Estonia, it is expected that intelligence may be the most important predictor of educational or occupational attainment. We also analyze the effect of different components of cognitive ability and hypothesize verbal skills, compared to others, may have a more important part in these interactions, as indicated by previous studies (Asbury *et al.*, 2005; Farah *et al.*, 2006).

## METHOD

### Participants

The study was based on data from the adaptation project for the Estonian version of the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997; Estonian version – Wechsler, 2011). The project was carried out in association with the Department of Psychology of the University of Tartu. The data was collected during 2012–2017 by clinical psychologists. Ethical approval was granted by the Ethic Review Committee on Human Research, University of Tartu, Estonia.

The composition of the sample ( $N = 759$ ; 44.1% male, 55.9% female; age 16–89) was renewed during the data collection and was based on the 2014 Estonian census data, stratified by age, sex and educational level.

### Measures

**Education and occupation.** Socioeconomic status was operationalized as parents' educational attainment. The participants' and their parents' education was coded into five categories: (1) primary and basic education; (2) vocational education; (3) specialized secondary education; (4) general secondary education; and (5) higher education. If parents' educational levels differed, the higher level was used, according to the dominance principle proposed by Erikson, 1984.

Occupations were available for 571 participants, because part of the sample consisted of students without an occupation. The occupations were coded according to the International Standard Classification of Occupations (ISCO-08). A three digit code of ISCO-08 was recoded into a modified version of the Erikson–Goldthorpe scheme (Erikson & Goldthorpe, 1993), which is widely used in social mobility studies. We used the similar country-specific modifications as previous sociological studies in Estonia have used (e.g., Saar, 2010; Titma, Tuma & Roosma, 2003), to correspond better with the Estonian occupational distribution and sample characteristics (some of the occupations specified in the Erikson–Goldthorpe scheme were too sparsely populated in our data). The original Erikson–Goldthorpe version and the modified classification for our study are shown in Table 1.

**Cognitive ability.** Cognitive ability was measured using the Estonian version of WAIS-III (Wechsler, 2011), which is one of the most widely used intelligence test in the world. Participants were administered all the 14 subtests. The scale has been adapted to Estonian language and culture, but as the test norms are still in development, it is not possible to calculate the Full-Scale IQ or index scores (Verbal Comprehension Index, Perceptual Organization Index, Working Memory Index, and Processing Speed Index). Thus, we applied factor analysis to all the subtests to obtain a general intelligence ( $g$ ) score and to different combinations of subtests to obtain equivalents for index scores. The verbal ability component consisted of the subtests Vocabulary, Similarities, Information and Comprehension; the perceptual component was calculated with scores of Picture Completion, Matrix Reasoning, and Block Design; the working memory component was calculated with scores of Arithmetic, Digit Span,

and Letter-Number Sequencing; the processing speed component was calculated with scores of Symbol-Digit Coding and Symbol Search. The obtained scores in data analysis representation were converted to IQ-type scores with a mean 100 and a standard deviation of 15.

### Data analysis

Regression analyses were performed to predict the effect of parental education and the participant's own cognitive ability to attained educational level. Taking the hierarchical regression approach, we added the independent variables separately to see possible mediating effects between them. Then we performed similar regression analyses using the participant's occupational status as the dependent variable and parental education and the participant's own cognitive ability stepwise as independent variables, followed by adding the participant's own educational level to the model. Finally, we then reran these analyses using index scores for different cognitive domains instead of general cognitive ability. We used the Sobel test to determine the significance of the mediating effects (Sobel, 1982).

## RESULTS

### Descriptive data

Correlations among the measured variables are shown in Table 2, with variables correlated in the expected direction. The mothers' and fathers' education is highly correlated ( $r = 0.654$ ;  $p < 0.001$ ), indicating assortative mating for education. Correlations are relatively low between the highest parental education and the participants' own education ( $r = 0.073$ ;  $p < 0.05$ ) and occupational attainment ( $r = 0.111$ ;  $p < 0.05$ ). Parental education correlates more strongly with the participants' cognitive ability ( $r = 0.523$ ;  $p < 0.001$ ). When analyzed separately, the participants' cognitive ability is substantially correlated with mothers' education ( $r = 0.520$ ;  $p < 0.001$ ) as well as fathers' education ( $r = 0.459$ ;  $p < 0.001$ ). As expected, the participants' occupation is moderately related to participants' cognitive ability ( $r = 0.254$ ;  $p < 0.001$ ) and the strongest relationship is between the participants' own occupation and education ( $r = 0.537$ ;  $p < 0.001$ ).

Analyzing the components of cognitive ability separately, the verbal ability component had the highest correlations with the participant's educational and occupational status, but the lowest correlation with parental education ( $r = 0.294$ ,  $p < 0.001$ ). The highest correlation with parental education appeared with the perceptual abilities component ( $r = 0.488$ ,  $p < 0.001$ ).

Table 1. The Erikson–Goldthorpe class schema: original and modified versions

Original version	Modified version
I. Upper service class; senior civil servants, higher managerial, higher-grade professionals (also self-employed).	I. Upper service class; senior civil servants, higher managerial, higher-grade professionals (also self-employed).
II. Lower service class; middle-level administrators, and officials, lower managerial, lower-grade professionals.	II. Lower service class; middle-level administrators, and officials, lower managerial, lower-grade professionals.
III. Routine non-manual employees, clerks.	III. Routine non-manual employees, clerks.
IVab. Self-employed and employers in non-agricultural businesses.	IV. Agricultural skilled workers
IVcd. Farmers and smallholders, including self-employed fishermen.	
VI. Skilled manual workers.	V. Skilled manual workers, non-agricultural
VII. Semi- and unskilled manual workers including unqualified sales personnel.	VI. Unskilled manual workers

Table 2. Correlations among the variables assessed in the study

	1	2	3	4	5	6	7	8	Mean (SD)
1. Cognitive ability IQ									100.15 (14.44) N = 751
2. Participant education	0.214** N = 751								2.92 (1.506) N = 759
3. Participant occupation	0.254** N = 565	0.537** N = 571							2.45 (0.626) N = 571
4. Highest parental education	0.523** N = 723	0.073* N = 731	0.111* N = 556						3.11 (1.598) N = 731
5. Verbal component	0.737** N = 751	0.459** N = 756	0.393* N = 569	0.294** N = 728					100.00 (14.15) N = 756
6. Perceptual component	0.927** N = 751	0.115** N = 759	0.166** N = 571	0.488** N = 731	0.537** N = 756				100.00 (13.95) N = 759
7. Memory component	0.803** N = 751	0.168** N = 757	0.215** N = 569	0.442 N = 729	0.540** N = 754	0.661** N = 757			100.00 (13.49) N = 757
8. Speed component	0.806** N = 751	0.033 N = 757	0.148** N = 570	0.480** N = 729	0.383** N = 754	0.746** N = 757	0.608** N = 755		100.00 (14.99) N = 757

Note: \* $p < 0.05$ ; \*\* $p = 0.01$  (two-tailed).

#### Predictors of participants' educational attainment and occupational social status

First, we tested the predictive effect of parental education for the participants' own educational level and occupational class, controlling for age and gender (model 1 in Table 3 and Table 4). The results of the regression indicated that the parental education significantly predicted the educational level ( $F(3, 727) = 35.42, p < 0.001; R^2 = 0.1275$ ) and occupational status ( $F(3, 552) = 17.02, p < 0.001; R^2 = 0.0847$ ). In Model 2 we used the participants' cognitive ability as a predictor for educational and occupational attainment but did not include the parental education. The results showed that, when analyzed separately, the predictive effect of cognitive ability is stronger than that of parental education (Table 3 and Table 4). The predictive power of the regression model with cognitive ability is slightly better for both educational level ( $F(3, 747) = 92.46, p < 0.001; R^2 = 0.2708$ ) and occupational status ( $F(3, 561) = 52.29, p < 0.001; R^2 = 0.2185$ ). In model 3 we included both, the parental education and cognitive ability as predictor variables for educational and occupational attainment. Models that include both the parental education and cognitive ability account for 22%–30% of variance in status attainment. This predictive power is comparable to models with only cognitive ability, which account for 22%–27% of educational and occupational

attainment. When adding the cognitive ability to predictor variables as well as the parental education, the coefficient of parental education attenuates for both outcomes. The results of the Sobel test indicated that cognitive ability was a significant mediator between parental education and participant education ( $Z = 2.4403, SE = 0.0524, p < 0.05$ ; standardized indirect effect  $ab_{es} = 0.13$ ) as well as between parental education and participant occupational status ( $Z = 5.5831, SE = 0.0203, p < 0.001; ab_{es} = 0.11$ ).

In model 4 we added an interaction between parental education and intelligence (Table 3 and Table 4). This interaction did not add any remarkable additional value or predictive power to the analysis, which indicates that the level of parental education does not influence the effect of cognitive abilities on educational or occupational attainment, or the other way around.

To further specify how different variables contribute to the participant's occupational attainment, we included the participants' own education (Table 5, model 1) and different components of cognitive ability (Table 5, model 2) in addition to parental education and the participants' own general intelligence. The predictive power for occupational level was expectedly higher compared to models without the participants' own educational level. The results showed that adding the participants' own educational level attenuates the predictive effects of parental

Table 3. Regression analysis summary for predicting participant's educational level

	Model 1	Model 2	Model 3	Model 4
Participant age	0.018***	0.027***	0.031***	0.031***
Participant sex	0.205**	0.209**	0.230***	0.231***
Parental education	0.322***	–	0.201***	0.201***
Participant cognitive ability $g$	–	0.580***	0.530***	0.526***
Parental education $\times g$				–0.076*
$N$	728	748	719	718
$R^2$ (adjusted $R^2$ )	0.1275 (0.1239)	0.2708 (0.2678)	0.2950 (0.2910)	0.2998 (0.2949)
$\Delta R^2$		0.1433	0.0242	0.0048

Note: Unstandardized regression coefficients. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

Table 4. Regression analysis summary for predicting participant's occupational status

Predictor variables	Dependent variable: Occupational status			
	Model 1	Model 2	Model 3	Model 4
Participant age	0.007**	0.017***	0.020***	0.020***
Participant sex	0.468***	0.522***	0.510***	0.511***
Parental education	0.227***	–	0.140**	0.141**
Participant cognitive ability <i>g</i>	–	0.506***	0.470***	0.473***
Parental education × <i>g</i>				0.022
<i>N</i>	553	562	546	545
<i>R</i> <sup>2</sup> (adjusted <i>R</i> <sup>2</sup> )	0.0846 (0.0797)	0.2185 (0.2143)	0.2231 (0.2174)	0.2235 (0.2164)
$\Delta R^2$		0.1338	0.0046	0.0004

Note: Unstandardized regression coefficients. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

education to an insignificant level. The attenuating effect appears with cognitive ability as well, although it still remains as significant for predicting the occupational attainment. This suggests that one's own education may mediate the effects of parental education and cognitive ability on social status attainment. The Sobel test confirmed that participant education has a significant mediating effect between cognitive ability and occupational status ( $Z = 8.1989$ ,  $SE = 0.0302$ ,  $p < 0.001$ ;  $ab_{es} = 0.25$ ) and significant mediating effect between parental education and occupational status ( $Z = 6.003$ ,  $SE = 0.0229$ ,  $p < 0.001$ ;  $ab_{es} = 0.14$ ).

When analyzing different separate components of intelligence as predictors to occupational attainment, the verbal ability stood out as a significant contributor. Processing speed, perceptual organization ability and working memory did not have a significant effect on occupational attainment in a multivariate model alongside verbal ability and other highly correlated variables. The predictive power with separate cognitive domains is similar with the model that included the general *g*, explaining 35% of the variance ( $F(8, 542) = 36.15$ ,  $p < 0.001$ ;  $R^2 = 0.3479$ ).

Table 5. Summary of regression analysis for predicting participant occupational status adding own education and different components of *g* as predictor variables

Predictor variables	Dependent variable: occupational status	
	Model 1	Model 2
Participant age	0.009***	0.007*
Participant sex	0.373***	0.358***
Parental education	0.054	0.043
Participant cognitive ability <i>g</i>	0.229***	
Participant education	0.427***	0.412***
Different components of <i>g</i>		
Verbal component		0.158**
Perceptual component		0.018
Working memory		0.025
Processing speed		0.063
<i>N</i>	545	543
<i>R</i> <sup>2</sup>	0.3421 (0.3360)	0.3479 (0.3383)
$\Delta R^2$		0.0058

Note: Unstandardized regression coefficients. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

As the variables in the model were highly correlated, we tested for multicollinearity by inspecting the variance inflation factors (VIF). The VIF were in the range of 1.16–3.78, which can be considered low multicollinearity (Hair, Black, Babin & Anderson, 2010).

We also analyzed the effect of cognitive domains separately in four models with parental education and the participants' own education predicting the participants' occupational attainment alongside a specific cognitive domain. This may be useful for future comparisons, if the data is available for some specific cognitive abilities. By a very small margin, the model with verbal ability explained most of the variance ( $F(8, 542) = 36.15$ ,  $p < 0.001$ ;  $R^2 = 0.3383$ ). The other three models explained about 32% of the variance (for the perceptual component model,  $F(5, 550) = 53.56$ ,  $p < 0.001$ ,  $R^2 = 0.3214$ ; for the working memory component model,  $F(5, 548) = 53.54$ ,  $p < 0.001$ ;  $R^2 = 0.3220$ ; for the speed component model,  $F(5, 549) = 53.69$ ,  $p < 0.001$ ;  $R^2 = 0.3223$ ). These separate regression analyses confirmed that the verbal component had the strongest predictive effect ( $B = 0.210$ ,  $p < 0.001$ ), followed by working memory component ( $B = 0.172$ ,  $p < 0.001$ ), speed component ( $B = 0.169$ ,  $p < 0.001$ ), and perceptual component ( $B = 0.163$ ,  $p < 0.001$ ); however, we note that the difference effect sizes are small. Similar to the model with all components added simultaneously, the association with parental education was insignificant in every separate model, whereas the effect of the participants' own education was significant (standardized *B* coefficients were in the range of 0.412–0.490).

## DISCUSSION

In this study we used a contemporary cross-sectional dataset from Estonia to explore how different predictors of social mobility intersect in a rarely studied post-communist developing society. We found that both individual-level factors and more environmental factors have a predictive effect on educational and occupational attainment. Our results indicated that cognitive ability and one's own educational level mediated the association of parental socioeconomic status with one's own occupational success.

First, we tested the predictive effect of parental education and cognitive ability for participants' own educational level and occupational class, controlling for age and gender. Our results

showed that when tested separately, both predictors (parental education and intelligence) significantly predicted the educational level as well as occupational status. Parental educational background accounted for about 13% of the variance in children's educational attainment and 8% of the variance in occupational attainment. Cognitive ability alone accounted for more of the variance – for 27% and 22%, respectively. Similarly to previous studies (i.e., Strenze, 2007) the predictive power of cognitive ability for educational attainment was larger than that of occupational attainment. Together, parental education and cognitive ability accounted for around one-fifth of the variance in educational attainment and one-third of the occupational attainment. Interestingly, it appeared that when parental education and intelligence were added simultaneously to the analysis, then the predictive effect of parental education attenuated by 37–38% for both outcomes but did not disappear completely. This may show that approximately 40% of the parental background association is mediated through cognitive ability for both variables. These results confirm that individual and environmental factors influence educational attainment. For example, Erikson (2016) found similar results in the Swedish sample, when he investigated the effects of family background and cognitive ability on educational attainment. Erikson concluded, that around 16%–19% of the variance in education is accounted for by the social origin factors and around 25% is accounted for by cognitive ability. Our results show that in Estonia the contribution of parental background may be somewhat lower than in the Swedish sample, which may be indicative of a more intelligence-based social mobility.

We also included the participants' own education in addition to parental education and the participants' own cognitive ability to the analysis. Similar to earlier studies we found that mental ability and educational attainment had a strong association with occupational status attainment (Deary *et al.*, 2005; Herrnstein & Murray, 1994; Strenze, 2007). The results showed that adding one's own educational level to the predictor variables attenuated the effects of parental education and one's own cognitive ability as predictors of participant occupational status, indicating that participant's own education may be a mediator between parental education/cognitive ability and the occupational attainment, which has been reported in earlier studies as well (Breen & Goldthorpe, 2001; Deary *et al.*, 2005; Nettle, 2003). The study by Johnson *et al.* (2010b) even concluded that social class of origin predicted educational attainment and educational attainment fully mediated the associations between social class of origin and social class attainment. Cognitive ability predicted both educational and social class attainment, and educational attainment contributed directly to class mobility as well (Johnson *et al.*, 2010b).

In Estonia, parental social status may be even less important for success than in, say, Scotland (Deary *et al.*, 2005). Deary concluded that the childhood intelligence accounted for 23.2% and parental social class for 17.6% of the total variance in social status attainment in midlife, but in our sample the parental status significance diminished, when one's own educational level was included. Our results showed that the influence of parental social status to participant occupational attainment is probably mostly mediated through participant education. This finding may be related to the fact that Estonia was part of the Soviet society and

most of the parents of our data acquired education in that period. Titma *et al.* (2003) studied the social mobility in different areas of Soviet society and found similarly that the occupation in the final years of the regime was highly influenced by education. Although they doubt that this indicates meritocracy. In the Soviet system the educational and occupational paths were in most parts assigned by state ministries and command economy, so the social reproduction was limited and mobility was probably more influenced by the Soviet system than actual free movement between classes (cf Titma *et al.*, 2003). This may have implications for our results as well, as Estonia did not have an open labor market like many western democracies until the Soviet Union collapsed in 1991, thus the pre-existing social class structure was less apparent and the influence of parental class was low.

On the other hand, the possible mediating effect of cognitive ability and educational level between parental background and offspring attainment may reflect genetic confounds. This interpretation is in accordance with the confirmed assumptions that social mobility and occupational attainment may be influenced by shared genetic predispositions. For example, it has been established there is high gene correlation with educational attainment and personality traits (Mõttus *et al.*, 2017b) and strong genetic correlation between intelligence and education (Calvin *et al.*, 2012; Marioni *et al.*, 2014), even up to near-complete overlap in genetic contributions to intelligence and education (Marioni *et al.*, 2014). Similarly to previous studies (Breen & Goldthorpe, 2001; Deary *et al.*, 2005; Nettle, 2003), parental educational level as an indicator of social class and participants' cognitive ability was correlated at  $r = 0.51$ . Although our study did not allow to further analyze these aspects, this association may indicate the interplay of genetic influences to intelligence and environmental factors, provided by family. This in turn suggests that there definitely is no single most important factor that predicts the social mobility or specific status attainment, but it should be associated with various mediators, which are probably forming different interplays, depending on the sample, its geographical setting, point of time, educational and social systems, etc.

We also tested for an interaction between socioeconomic status (parental education) and cognitive ability, something that has been suggested in previous research (Damian *et al.*, 2015). Adding this interaction to the multiple regression did not show any remarkable additional predictive power to the analysis, which indicates that the level of parental education does not influence the effect of cognitive ability to educational or occupational attainment, or the other way around. In other words, we found confirmation of the independent effect hypothesis, and no confirmation of the compensation or accumulated advantages (Matthew effect) hypothesis. Damian *et al.* (2015) concluded, that with the US data the intelligence showed evidence of resource substitution, which can be interpreted as cognitive ability making up for the lack of supporting socioeconomic background and contributing even more to social mobility and leading one to a higher attainment than expected by parental status. Of course, Damian *et al.* (2015) had substantially more statistical power to detect such interactions, and the effects were small indeed.

To further define whether different components of cognitive ability affect social mobility differently, we distinguished between

separate cognitive abilities in their prediction of the participants' occupational status. The results confirmed that verbal ability significantly predicted occupational status and its predictive strength is comparable with that of general intelligence. This is partly expected because previous research has also shown that verbal abilities are among the strongest predictors of academic achievement (Mather & Wendling, 2005; Roth, Becker, Romeyke, Schäfer, Domnick & Spinath, 2015), which may then bleed into occupational attainment as well. Previous studies have indicated that gene  $\times$  environment interaction may be different on verbal and non-verbal abilities and socioeconomic status may influence various areas of neurocognition differently (Farah *et al.*, 2006). It has been proposed that a higher social position of the family leads to more stimulating, demanding resources and environments that support the development of verbal abilities (Bradley, Corwyn, McAdoo & García Coll, 2001; Hauser & Huang, 1997). Nevertheless, our correlational results did not indicate the stronger relationship between parental status and verbal abilities – other components of measured cognitive abilities had actually stronger correlations than verbal component. One explanation of this pattern may be the classification system of occupations itself. It may be assumed that the higher positions in Erikson–Goldthorpe classification may require dominantly verbal skills. This hypothesis needs to be studied further to confirm the effect of different abilities on attainment.

One of the limitations of this study is the comparably young age at the lowest age-point of our sample. This means that part of the sample reported their educational level and occupation at an age when educational level and careers would still be developing and would probably be more reliably estimated by midlife (Breen & Goldthorpe, 2001; Deary *et al.*, 2005; Nettle, 2003; Strenze, 2007). To further study the effect of age, we conducted all the data analysis with an age-limited sample as well ( $N = 474$ , mean age: 48.6, range: 26–74). The results with the limited sample did not differentiate remarkably (see Supplementary material). The ordering of occupational statuses may also be problematic and could be handled in different ways. In addition to our approach, it would have been possible to use the scales of Erikson–Goldthorpe (i.e., three point scale). In fact, we controlled the robustness of our results to the use of the three-point scale, obtaining results similar to those based on the six-point scale. This bolstered our decision to use a similar ordering of occupations as some of the previous studies in social mobility (i.e., Deary *et al.*, 2005; Saar, 2010).

The strength of the current study is thorough intelligence testing, which allowed us to analyze the contribution of the separate cognitive domains but also provided the comprehensive measure of general cognitive ability. The sample was nationally representative, although the size of the sample was not large. This can be partly explained by the relatively small population of Estonia, compared to other populations that have conducted these kinds of studies (Damian *et al.*, 2015; Deary *et al.*, 2005). The study provides data from a rarely studied geographical and sociohistorical setting.

In conclusion, our results confirmed that there is an interplay between influences from socioeconomic status, cognitive ability, and educational level to social mobility and occupational attainment in Estonia. The greatest predictor of occupational

attainment is the individual's own educational level, but cognitive ability is also important in both, predicting the educational level and occupational status. Parental education as a socioeconomic status measure is also a significant predictor of educational and occupational attainment, but compared to other influencers, the association with parental social class is probably partly mediated by cognitive ability and educational level. Interestingly, the verbal component of cognitive ability had the highest influence on occupational attainment. It adds more proof to further analyze the probable interplays in different geographical settings, especially when the genetic data is available and can aid with disentangling questions about social mobility.

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#### SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article:

**Table S1.** Regression analysis summary for predicting participant's educational level (limited sample).

**Table S2.** Regression analysis summary for predicting participant's occupational status (limited sample).

**Table S3.** Summary of regression analysis for predicting participant's occupational status adding own education and different components of g as predictor variables.