Childhood intelligence and personality traits neuroticism and openness contributes to social mobility: A study in the Aberdeen 1936 Birth Cohort

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ABSTRACT

Background Social mobility has been linked to intelligence, education, personality traits and childhood socioeconomic status (*SES*). We explore these influences to evaluate their relative importance as sources of individual differences in social mobility.

Methods Data are from the Aberdeen Birth Cohort of 1936 (ABC36) for whom childhood intelligence scores are available. Social mobility of participants was estimated from comparisons between their childhood and adult circumstances age 64. Personality traits were assessed using the Five Factor model. Structural Equation Modelling was used to investigate associations between social mobility, socioeconomic variables, childhood and adult intelligence, education and personality traits.

Results Childhood *SES* directly affects adult or destination *SES.* Personality traits of Openness (positive) and Neuroticism (negative) affect adult *SES* indirectly after adjusting for Childhood SES, Childhood intelligence and education. Neuroticism had a significant direct influence on adult SES after adjusting for the same variables. Education and adult cognitive ability are significant influences on adult *SES*.

Conclusions Socioeconomic destination is determined in this sample by childhood intelligence and socioeconomic status and the adult personality traits of Openness and Neuroticism. Educational exposure and gains in cognitive ability over the life course mediate these influences.

Keywords cohort study; social mobility; intelligence; education; personality; socioeconomic status.

1 INTRODUCTION

A complete understanding of the interaction between potential drivers for social mobility and their prospects for modification is yet to be realized. At the population level, two broad and inter-related trajectories of life course development reveal the many possibilities for a sustained intergeneration reproduction and accentuation of social, economic and health inequalities. Notably, within cohorts, as people develop from childhood through to old age, there is a tendency for increased diversity across a range of social, economic, and health outcomes coupled with a systemic pattern of cumulative advantage/disadvantage (Dannefer 2003). In other words, as cohorts develop throughout the life course patterns of increased diversity within any single group are not purely random. Cumulative advantage/disadvantage highlights a systemic pattern of divergence of developmental outcomes whereby, 'initial comparative advantage of trained capacity, structural location, and available resources make for successive increments of advantage such that the gaps between the haves and the have-nots increase' (MERTON 1968). Support for Cumulative advantage/disadvantage theory comes from studies of both income and health inequalities, with systemic patterns of inter-individual divergence repeatedly observed for different cohorts across decades of international research, even in the context of dramatic changes in the absolute amount of age-specific inequality or poverty (Dannefer 2003).

The phenomena that influences social mobility are probably multi factorial and multilevel. Indeed, Bronfenbrenner previously proposed a model (Bronfenbrenner 1979) that describes a multilevel system within which humans interact. The limited availability of data makes it difficult to account for all factors at all levels across the life course (*Chronosystem*). Nevertheless, evidence suggests that social structural factors such as socioeconomic status of one's parents and educational opportunities and individual factors such as intelligence, personality and motivation can influence both the intergenerational reproduction and accentuation of economic and social inequalities, while influencing patterns of social mobility within cohorts (Forrest, Hodgson et al. 2011, CRYSTAL, SHEA 1990). As such, within the broader Cumulative advantage/disadvantage profile, there are also unique and varied trajectories of both upward and downward social mobility.

Social mobility is defined as "*the movement of an individual between social classes over his or her life course*" (Forrest, Hodgson et al. 2011). Social mobility and social inequalities in health are among the most important topics in social epidemiology. Lower economic and social status at the individual level and high economic and social inequalities at the population level can have a negative effect on health and mortality (Lynch, Smith et al. 2004, Lorgelly, Lindley 2008). Although it is unclear if upward social mobility can improve health and reduce mortality, there is some optimism that it might (Hart, Smith et al. 1998). If so, identification of the nature and strength of factors that facilitate social mobility as well as those that obstruct its progress would be relevant to public policies that aim to ameliorate social inequalities in health.

Controversy remains about the nature of major influences on social inequalities. It was not unusual in the last century to encounter forceful arguments that the lower social classes carried personal responsibilities for their poor position made worse by their excess use of alcohol and tobacco, poor diets, and ineffective or inappropriate use of health services. Over time, interest shifted towards the study of individual differences in personal attributes that might promote social mobility (Mackenbach 2010). These include differences in general cognitive ability (intelligence), certain personality traits as well as in the early origins of the diseases of late life in foetal development and during a disadvantaged childhood (Whalley 2006). The wide range of social structural influences on social mobility includes geographical variation in school education, economic opportunities and temporal trends in funding of higher education and occupational opportunity. Personal attributes such as intelligence and personality may also be important, but we currently have limited insight into their relative influence on social mobility.

The relative influences of intelligence and achieved education level on social mobility were examined in a several studies. For example, Cassidy and Lynn (CASSIDY, LYNN 1991), in a longitudinal study tracking young people from ages 16 to 23 years, found that higher levels of educational attainment and achievement motivation, but not parental socioeconomic status, predicted upward social mobility. Although higher intelligence did not directly influence socioeconomic status in the study by Cassidy and Lynn, it had a positive effect on educational attainment. Another study tracking social mobility between ages five and 49 – 51 years (Forrest, Hodgson et al. 2011) found that both achieved education level and childhood IQ were significantly and independently associated with upward social mobility.

In relation to personality, Elder (ELDER 1969) examined longitudinal trajectories of social mobility in a sample of 69 men from high school through to adulthood (ages 33 – 38 year) and found that, during adolescence, the upwardly mobile were more ambitious and scored higher on personality measures of ego integration and competence. Evidence from cross-sectional studies also suggests that personality may influence patterns of social mobility. For example, Turner and Martinez (TURNER, MARTINEZ 1977) found that women scoring higher on a Machiavellian personality scale (i.e., a disposition to focus on power; being cool, distant, and manipulative) achieved higher levels of occupational prestige and higher income levels. However, for men, a similar positive relationship was only found for those with above-average educational attainment. Conversely, a negative relationship between Machiavellian personality and occupational prestige and higher income levels was observed for men with below-average educational attainment. Other studies have found that higher scores on personality traits of Neuroticism and Agreeableness and lower scores on Conscientiousness, Extraversion and Openness are more frequent in lower status occupations (Chapman, Fiscella et al. 2010). Alessandri and Vecchione (Alessandri, Vecchione 2012) also found that stability (i.e., a personality factor characterised by higher conscientiousness, lower neuroticism, and higher agreeableness), but not plasticity (i.e., higher openness and extraversion) predicted better job performance. At the same time, the role of personality in longitudinal trajectories of socioeconomic status remain uncertain. The mechanism by which factors combine and are mediated by life course exposures such as education is also unclear. Authors such as Von Stumm (von Stumm, Gale et al. 2009) and Cheng (Cheng, Furnham 2012) have used structural equation models to determine the direct and indirect influences of similar factors, finding significant results for Extraversion and Conscientiousness and 'locus of control' which has been linked to Neuroticism.

A longitudinal study by Cassidy and Lynn (CASSIDY, LYNN 1991) found that an aggregate measure of personality (including extraversion and neuroticism) was associated with upward social mobility. However, the study by Cassidy and Lynn focused on a narrow age range (ages 16 to 23 years) and it is unclear how childhood intelligence, educational attainment and personality influence patterns of social mobility over the long term. In a UK birth cohort study, we seek a better understanding of how social mobility is related to childhood socioeconomic status (*SES*), and the specific personal attributes of childhood intelligence, adult personality, and early education. Absolute occupational intergenerational social mobility is difficult to capture in the context of structural changes in the labour

market in the UK. The UK in general has reduced its manufacturing base in favour of more service industries, although the exact nature of this shift varies from location to location.

Aberdeen, the city on which this study is centred, shifted from a provincial city with a falling population reliant on light engineering, farming, shipbuilding and fishing, in the mid twentieth century, to one predominantly centred on the oil industry with huge increases in service industries with many highly paid administrative jobs (Tiesdell, Allmendinger 2004). Our data are contemporaneous with the transformation of the labour market in the post-war period and afford a unique opportunity to examine the predictors of social mobility during a time of unprecedented socioeconomic improvement enjoyed in a single Scottish city. We are in the fortunate position to hold data on Aberdeen resident who had taken part in the Scottish Mental Survey of 1947 when aged about 11 years (Whalley, Murray et al. 2011), thus allowing this life course analysis. In order to examine factors that influence the movement of individuals between social classes from early childhood to late life, we considered the direct effect of childhood socioeconomic status, childhood intelligence, and personality on adult socioeconomic status, and also the indirect effect of these predictors as mediated by years of education and adult cognitive ability.

2 METHODS

2.1 THE SAMPLE

All data were provided by the Aberdeen Birth Cohort of1936. This is a subsample of the Scottish Mental Survey (1947) which was a national survey of childhood intelligence. Children who sat Scottish Mental Survey of 1947 in an Aberdeen City School were traced by gender, date of birth and unmarried name using the Community Health Index, General Registrar Office public records and National Health Centre Records (Scotland and England). The local Family Doctors' Research Committee requested that invitations to take part should be made by letter, each signed by the prospective participant's family doctor to exclude those who were recently bereaved or suffering a life-threatening illness. An extended description of recruitment and data acquisition is available (Whalley, Murray et al. 2011). Following guidance by the Local Ethics of Research Committee who approved study procedures, volunteers gave written informed consent to a longitudinal observational study of brain ageing and health. We invited individuals who could be matched exactly by birth name and date of birth with the Scottish Mental Survey (1947) archive; 506 of 676 (75%) agreed to participate. Of these 443 participants provided personality data, 213 were women. In general, those individuals who were traced and who agreed to take part performed better in 1947 than those who refused. Those took part in the 1947 survey but moved away from the area performed better in 1947 that those that remained and were asked to participate (Whalley, Murray et al. 2011). The demographic description of the sample is shown in Table 1. A preliminary analysis showed no difference between the genders with the exception of Demi-span (the distance (cm) between the tips of the fingers and the centre of the chest) where males were larger than females as expected.

2.2 INTELLIGENCE

Childhood intelligence data were provided by the Scottish Council for Research in Education (SCRE) from data archived in the Scottish Mental Survey (1947). Almost all children born in 1936 and at school in Scotland on the 4th of June 1947 when aged 11 (±0.5) years sat a group administered intelligence test (The Moray House Test (MHT)) (Whalley, Deary 2001) supervised by their class teacher. Some private schools declined to take part. The Moray House Test comprised 71 items including arithmetic, reasoning, spatial items and word classification. The maximum possible score was 76. The Moray House Test is highly correlated (at about r=0.8) with the Stanford-Binet intelligence test (Scottish Council for Research in Education 1933). This test has been shown to have to have substantial stability between childhood and late life (Deary, Whalley et al 2000).

The National Adult Reading Test (NART) (Nelson, Oconnell 1978) was administered by a trained psychologist following standard procedures. This was administered at age about 64 years in the 1936 cohort. NART estimates adult intelligence and its stability across the life course (Crawford, Deary et al. 2001) is considered to reflect "crystallized intelligence". The test has high test retest reliability (.90) (Crawford et al 1988)

2.3 SOCIO-ECONOMIC STATUS, CHILDHOOD HOME ENVIRONMENT, SOCIAL MOBILITY AND EDUCATION

Demographic data were obtained from a structured interview at age 64 (±1) years by a trained researcher detailed elsewhere (Whalley, Murray et al. 2011). Participants were asked to recall their home conditions and paternal occupation when they participated in the Scottish Mental Survey aged 11 (±0.5) years. These included the number of rooms in the family home, the usual number of occupants, giving the number of residents/room to quantify overcrowding (*OCR*); how many shared their sanitation facility (number of people per facility, *SAN*).Participants' best-ever occupation provided their Occupational Social Class in adulthood (OSC_A). Similarly, paternal occupation was used to categorise Occupational Social Class (OSC_P). For both paternal and participant's own occupation, *OSC* was coded using the United Kingdom Office of Population Statistics (Registrar General, Scotland) Classification of Occupations HMSO, 1971. We coded occupations so that high values represented occupations of higher status. The participant's current UK (Scotland) post code was recorded and then used to estimate the relative level of affluence/deprivation at that address using the Scottish Index of Multiple Deprivation (*SIMD*) based on small area

census returns (http://www.gov.scot/Topics/Statistics/SIMD). High values represent areas with less deprivation. Demi-span (*DEMI*) is the distance (cm) between the tips of the fingers and the centre of the chest. It provides an estimate of participants' maximum height during adult life and reflects aspects of childhood nutrition (Weinbrenner, Vioque et al. 2006).

Childhood socioeconomic status (SES_C) is derived as a latent, unobserved variable, composed of overcrowding (*OCD*), number of people sharing a sanitation facility (*SAN*), paternal occupational social class (OSC_P) and childhood nutritional measure (*DEMI*). These data were taken from participants' recollection of their social circumstances at age about 11 when they took the IQ test. Adult socioeconomic status (SES_A) is derived from participants' occupational social class (OSC_A) and residential affluence/deprivation (*SIMD*). At interview, we recorded levels of educational achievement (*EDU*) and coded these on a scale of 1-9 with none coded as 1 and high professional qualification as 9. Women who described their occupation as "housewife" were placed in their husband's' occupational category.

2.4 Personality.

Personality traits were scored using the 120-item Five Factor Neuroticism-Extraversion-Openness Personality Inventory (*NEO)* (Mccrae, Costa 1987) completed on recruitment at age 64 years (±1). The five traits measured were: Extraversion (*NEO-E*); Agreeableness (*NEO-A*); Conscientiousness (*NEO-C*); Neuroticism (*NEO-N*); and Openness to experience (*NEO-O*). The inventory is reliable with test-retest reliability estimated for each trial between .83 and .63 (Mccrae, Costa 1992).

2.5 Statistical Methods and the Structural Model

Conventional data analysis was carried out using SPSS (IBM Corporation, New York, NY). Structural equation modelling was performed using AMOS 23 (AMOS Development Corporation, Crawfordville, FL, USA). Figure 1 is a schematic outline of the hypothesised model used in these analyses. In this model, SES_C is described by a latent factor that contributes to OSC_P, the overcrowding measure (*OCR*), the nutritional measure (*DEMI*) and the number of people sharing a sanitation facility (*SAN*). Adult socioeconomic status (SES_A) is described by a latent factor that contributes to participant occupational social class (OSC_A) and residential affluence/deprivation (*SIMD*). The SES_C

directly affects SES_A, personality traits (*NEO*), education (*EDU*), and adult intelligence (*NART*). Childhood intelligence (*MHT*) directly affects *EDU, NEO*, adult ability (*NART*) and SEP_A. *EDU* directly affects SES_A and *NART*. Personality traits were modelled to affect directly *EDU, NART,* and SES_A. As is usual, exogenous variables, *MHT*, NEO and SES_C were allowed to correlate with each other (see double-headed arrows in Figure 1). For clarity, the error terms for all the endogenous variables are not shown. For parsimony and clarity, we modelled the effects of each personality variable separately, and where significant direct or indirect effects on SEP_A were observed, we combined personality traits into the one model to examine their relative influence. Only effects of openness and neuroticism were observed, and are reported below. Preliminary analysis, using subjects with complete data only, indicated that no modifications to the model would produce a superior fit to the data. Multiple imputations of the missing data using different randomization seeds produced a virtually identical set of results. The modification approach was as described in Jöreskog and Sörbom (Jöreskog, Sörbom 1984) achieved within AMOS 23.

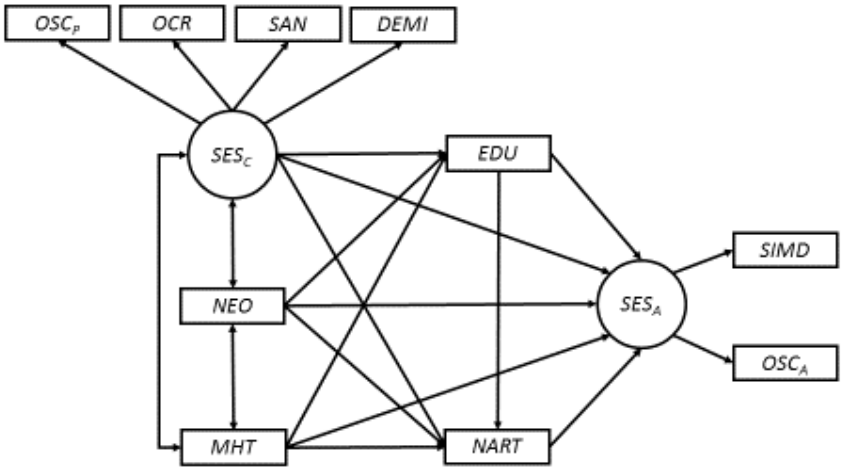

Figure 1: A schematic outline of the hypothesised structural equation model tested in this analysis. *MHT* – Moray House Test (Childhood Intelligence); OSC_P – paternal occupational social class; *OCR* – overcrowding estimate; *SAN* – Number of people sharing the sanitation; *DEMI* – the demi spam measure; *EDU* – The number of years of full time education; OSC_A – participant adult occupational social class; *SIMD* – Scottish Index of Multiple deprivations; SES_C –

Socioeconomic Status Childhood; SES_A – Socio-Economic Status Adult; NEO-*N* –Neuroticism; *NEO-E*-Extraversion; *NEO-O*-Openness; C-Conscientiousness; *NEO-A* Agreeableness; *NART* - The National Adult Reading Test

3 RESULTS

Descriptive statistics and correlations are presented in Table 1. Data collection for other variables was incomplete, with 1.0% of data missing. Standardised Pearson correlations indicate that almost all of the cognitive and childhood socioeconomic variables correlate with adult socioeconomic variables. Similarly, personality traits are correlated with adult socioeconomic class.

1936	*MHT*	*NART*	*OSC_P*	*OCR*	*SAN*	*DEMI*	*EDU*	*SIMD*	*OSC_A*	*NEO-N*	*NEO-E*	*NEO-O*	*NEO-A*	*NEO-C*
N	*443*	*435*	*440*	*436*	*423*	*433*	*358*	*430*	*439*	*443*	*443*	*443*	*443*	*443*
Mean (SD)	42.7 (13.2)	32.7 (8.3)	3.8 (2.3)	1.7 (0.7)	7.8 (4.7)	85.8 (5.1)	4.3 (3.4)	6.7 (3.0)	5.3 (2.2)	17.6 (7.7)	27.1 (5.9)	24.5 (5.8)	33.0 (5.1)	35.1 (6.0)
Range	1-72	2-48	1-9	0.4-5	2-48	60-98	1-9	1-10	1-9	0-47	2-43	10-44	15-46	11-48
MHT	1	.70**	-.19**	-.30**	-.25**	.04	.53**	.34**	.52**	-.17**	.09	.32**	.15**	.05
NART		1	-.16**	-.26**	-.21**	.09	.52**	.36**	.48**	-.16**	.01	.38**	.12*	.05
OSC_P			1	-.23**	-.16**	.05	.23**	.17**	.21**	.02	-.01	.07	.05	.01
OCR				1	.48**	-.04	-.29**	-.25**	-.28**	.01	-.02	-.17**	-.10*	-.06
SAN					1	.01	-.20**	-.20**	-.23**	.06	-.05	-.16**	-.08	-.05
DEMI						1	.10	.12*	.11*	-.11*	-.07	.05	-.17**	-.05
EDU							1	.33**	.61**	-.21**	.06	.42**	.11**	.12**
SIMD								1	.39**	-.10*	.02	.19**	.06	.02
OSC_A									1	-.20**	.11*	.32**	.14**	-.11*

Table 1: Means, Standard Deviations (SDs), ranges, and Pearson correlations between the variables in the Structural Equation Model. Note:*p<.05, **p<.001. *MHT* – Moray House Test (Childhood Intelligence); *OSC_P* – paternal occupational social class; *OCR* – overcrowding estimate; *SAN* – Number of people sharing the sanitation; *DEMI* – the demi span measure; *EDU* – Educational attainment; *OSC_A* – participant adult occupational social class; *SIMD* – Scottish Index of Multiple deprivations; *SES_C* – Socioeconomic Status Childhood; *SES_A* – Socio-Economic Status Adult; NEO-*N* –Neuroticism; *NEO-E*-Extraversion; *NEO-O*-Openness; C-Conscientiousness; *NEO-A* Agreeableness; *NART* - The National Adult Reading Test

Comparing men and women no differences were found between the sexes with the exception of demi-span where men were greater than women ($p<.001$) and neuroticism and agreeableness where women scored higher than men ($p<.05$). Results from the Structural Equation Model for each personality trait are shown in Table 2. In each case, the goodness of fit measures indicate a good to excellent fit to the data (Normative Fit Index>0.95, Comparative Fit IndexI>0.95, Root Mean Square Error of Approximation <.05 (Jöreskog, Sörbom 1984). The direct and indirect effects on the endogenous variables on *NART* and Adult Socioeconomic Status (SES_A) are shown in Table 3. Table 2 indicates that in all cases Childhood Socioeconomic Status (SES_C*),* Childhood ability *(MHT),* Education *(EDU)* and adult ability *(NART)* significantly directly affect Adult Socioeconomic Status (SES_A). Neuroticism (*NEO-N*) had a significant direct negative effect on Adult Socioeconomic Status (SES_A) (see Table 2).Openness had a significant indirect effect on SES_A (see Table 3). Extraversion, Conscientiousness, Agreeableness had no direct or indirect effects on SES_A. Openness (*NEO-O*) had a significant direct effect on adult cognitive ability. As expected, childhood ability (*MHT*) and Education (*EDU*) had a direct effect on adult cognitive ability (*NART*). Childhood socio-economic status (SES_C*)* was observed to have a significant influence on adult cognitive ability (*NART*) only in the Extraversion model (*NEO-E*). As expected, childhood ability (MHT) and socioeconomic status (SES_C) both influenced educational attainment (*EDU*). Openness and neuroticism influenced educational attainment positively and negatively, respectfully.

	Model		*1* *NEO-N*	*2* *NEO-E*	*3* *NEO-O*	*4* *NEO-A*	*5* *NEO-C*
SES_C	←→	*MHT*	0.41**	0.42**	0.42**	0.42**	0.42**
SES_C	←→	*NEO*	-0.04	0.03	0.24**	0.12*	0.07
MHT	←→	*NEO*	-0.17**	0.08	0.32**	0.15**	0.05
EDU	←	*MHT*	0.42**	0.44**	0.38**	0.44**	0.44**
EDU	←	SES_C	0.18*	0.17*	0.13*	0.17*	0.17*
EDU	←	*NEO*	-0.11*	0.01	0.25**	0.01	0.07
NART	←	*NEO*	-0.03	-0.05	0.12*	0.02	0.00
NART	←	*MHT*	0.59**	0.59**	0.57**	0.59**	0.59**
NART	←	SES_C	0.05	0.05*	0.04	0.05	0.05
NART	←	*EDU*	0.18**	0.18*	0.14*	0.18**	0.18**
SES_A	←	*MHT*	0.21*	0.20*	0.21*	0.21*	0.22*
SES_A	←	*NEO*	-0.09*	0.08	0.04	0.04	0.05
SES_A	←	*NART*	0.18*	0.19*	0.18*	0.18*	0.18*
SES_A	←	SES_C	0.23*	0.22*	0.23*	0.22*	0.22**
SES_A	←	*EDU*	0.44**	0.45**	0.44**	0.45**	0.45**

Table 2: The standardised Structural Equation Modelling results across five runs of the model, one for each personality variable. Note: *p<05; **p<.001.←→Represents a correlation; ← Represents a direct effect. *MHT* – Moray House Test (Childhood Intelligence); *EDU* – Educational attainment; SES_C – Socioeconomic Status Childhood; SES_A – Socio-Economic Status Adult; NEO-*N* –Neuroticism; *NEO-E*-Extraversion; *NEO-O*-Openness; C-Conscientiousness; *NEO-A* Agreeableness; *NART* - The National Adult Reading Test

Splitting the models by gender and repeating modelling as a multi-group analysis found differences between the genders in terms of the *MHT*→*NART* and SES_C→*NART* effects. In all models it was found that childhood ability had a bigger influence on adult ability in males than females, with standardize regression weights ~0.65 for males compared with ~0.45 for female's ($p<.05$). In addition, childhood socio-economic status on adult ability had a greater influence in females than males with standardize regression weights~-0.02 for men compared with ~0.21 for women. In this case the regression weight for males was not significant. All other modelled effects were not different between males and females.

Table 3 shows that the effect of Childhood intelligence (*MHT*) on NART is predominantly direct with the direct effect sizes around .57. The effect of Childhood intelligence (*MHT*) on SES_A is a mixture of direct and indirect effects ranging from .22 to .23 and .29 to .31 respectively. Childhoods SES_C had a significant direct effect on Adult SES_A (Table 2). The indirect influence of SES_C on SES_A was smaller in comparison to the calculated direct effect (see Table 3). Neuroticism's influence on SES_A was calculated to be predominately direct around -.10 compared with -.05 indirect effect. The effect of Openness on *NART* was predominately direct, around .11 compared with .04 indirect effect. Conversely, the effect of Openness on SES_A was predominately indirect, around .18 compared with .04 indirect effect.

		SESc	NEO-N	MHT	SESc	NEO-E	MHT	SESc	NEO-O	MHT	SESc	NEO-A	MHT	SESc	NEO-C	MHT
Total	*NART*	.10	-.04	.65	.10	-.05	.66	.09	.15	.62	.10	.02	.65	.10	.01	.66
Direct	*NART*	.07	-.02	.57	.07	-.05	.58	.06	.11	.56	.07	.01	.57	.07	.00	.58
Indirect	*NART*	.03	-.02	.08	.03	.00	.08	.02	.04	.05	.03	.01	.08	.03	.01	.08
Total	SES_A	.34	-.14	.51	.34	.07	.52	.32	.18	.48	.34	.05	.53	.33	.07	.53
Direct	SES_A	.25	-.10	.22	.24	.07	.22	.24	.04	.23	.24	.03	.22	.24	.05	.23
Indirect	SES_A	.09	-.05	.29	.10	.00	.31	.08	.13	.26	.09	.02	.30	.09	.03	.30

Table 3 - The total, direct and indirect standardized effects for each model for the endogenous variables *NART* (via *EDU*) and SES_A (via *EDU* and *NART*). *EDU* – Educational attainment; SES_C – Socioeconomic Status Childhood; SES_A – Socio-Economic Status Adult; NEO-*N* –Neuroticism; *NEO-E*-Extraversion; *NEO-O*-Openness; C-Conscientiousness; *NEO-A* Agreeableness; *NART* - The National Adult Reading Test

4 DISCUSSION

We quantified the relative contributions of childhood intelligence, childhood socioeconomic status and personality to destination socioeconomic status and cognitive ability in a well-characterised group of participants born in 1936 and of whom almost all had completed their working lives in and around Aberdeen City. In addition, when tested in late life almost all participants had completed their working lives and were unlikely to undergo additional mobility. The results indicate that Adult socioeconomic status (SES_A) is predicted by all three parameters and that these effects are in part mediated by educational exposure and intellectual changes over the life course. Two personality traits in particular emerged as significant: there was a significant (largely direct) negative effect of *neuroticism* on Adult SES_A, whereas *Openness* had a significant positive (largely indirect) effect on Adult SES_A mediated by educational attainment and adult cognitive ability. *Extraversion, Agreeableness* and *Conscientiousness* were not found to influence destination SES_A directly or indirectly after adjusting for childhood socioeconomic status (SES_C) and childhood ability. A similar pattern of significant effects was found for crystallized adult cognitive ability (*NART*), suggesting that social mobility and the accumulation of crystallized intelligence go hand in hand and that the personality trait openness to experience, in particular, influences both cognitive ability and social mobility outcomes. Considering these findings in terms of the multi-level theoretical framework (Bronfenbrenner 1979), we have predominately considered individual parameters (gender, personality, cognitive ability) and micro-level measures such as socio economic circumstance and education. The macro-level factors are influenced by the historical points in time when measured (*Chronosystem*), and the particular environmental context in which the cohort is developing such as the economic and work environment in which social mobility is constrained and the generalizability may be limited.

Extraversion, Agreeableness and *Conscientiousness* were not found significantly to influence destination SES_A directly or indirectly after adjusting for SES_C and childhood ability. A study by Cheng et al (Cheng, Furnham 2012) using a similar but not identical structural model found small direct influences on occupational social class aged 50 of

Extraversion and *Conscientiousness* (*Agreeableness* was not tested). Our findings are not necessarily contradictory given the additional power in the Cheng study and the differences in the measures and model.

Neuroticism had a small negative direct and indirect influence on both Adult SES_A and *NART* mediated by education. This is consistent with a similar analysis (Cheng, Furnham 2012) but contrary to other studies where Neuroticism had no effect on earnings (Heineck 2011). Lower perceived internal control over the enviroments is often linked to Neuroticism, and higher control is found to predict upward social mobility (von Stumm, Gale et al. 2009, de Vries, Rentfrow 2016).Table 3 also indicated that greater childhood ability was associated with lower neuroticism scores and higher childhood socioeconomic status. Intelligent children tend to manage their negative emotions (low mood, worry) better (Bennett, Bendersky et al. 2005) and this in turn may enhance perceptions of control and increase the potential for upward social mobility.

Openness was found to have a predominantly indirect effect on SES_A via educational attainment and adult ability. This is consistent with the finding of Cheng et al (Cheng, Furnham 2012) who found that the influence of Openness on occupational prestige age 33 was entirely mediated by education after adjusting for childhood ability. However, the same study also reported a small direct influence of openness on occupational prestige at age 50. Dimitrijević and Altaras (Dimitrijevic 2012) found that intellectually gifted students score higher on Openness, consistent with findings in this study. Other studies have reported weak correlations (.20 to .26) between Openness and Scholastic Aptitude Test (SAT) performance and GPA scores (Noftle, Robins 2007). However, research suggests a stronger relationship between *Openness* and divergent thinking ability, that is, the ability to generate multiple solutions to a problem, a key indicator of creativity. McCrae (Mccrae 1987) reported strong associations between Openness and divergent thinking performance (i.e., approximately .40), and these associations remained significant after controlling for age, years of education, and vocabulary scores. Studies that have examined the personality traits of creative individuals also highlight a link between Openness and creativity (Gough 1979). Importantly, levels of Openness are open to change as a result of training experiences. For example, Jackson and colleagues (Jackson, Hill et al. 2012), in a study that focused on developing inductive reasoning among older adults, found that the training group increased on measures of *Openness* to Ideas. The direct and indirect influence of openness on crystallized intelligence was observed previously in this cohort (Hogan, Staff et al. 2012). The current study extends this analysis

by establishing that this association is independent of socio-economic status (SES_C) and highlights the apparent synchronicity between the accumulation of crystallized abilities and social mobility. Modelling both Openness and Neuroticism at the same time produced similar results to those shown in Tables 2 and 3 indicating the independence of these influences.

The differences between the genders in terms of body size and personality were as expected. However, the influences of childhood ability (*MHT*) and childhood socioeconomic circumstance (SES_C) on late life cognition varied between the genders. With childhood ability being more important to men and childhood socioeconomic circumstance being more important to women in terms of the accumulation of crystalized ability (*NART*). This may reflect the differences in opportunity open to men compared to women. Similarly, women from higher status backgrounds may have had opportunities for accumulation not given to their less fortunate peers.

Educational attainment was clearly the largest direct contributor to late life ability and socioeconomic status. The literature in the economics of education assumes the primacy of cognitive ability in producing successful lifetime outcomes (Hanushek, Woessmann 2011). Our results indicate that childhood socioeconomic status (SES_C) has a significant role to play both directly and indirectly through facilitating education and cognitive accumulation. To a lesser degree Openness and the absence of Neuroticism also facilitate socioeconomic gains via the same mediators. A number of studies explored motivational beliefs and goals in order to examine mechanisms that lead to social mobility (Eccles, Wigfield 2002). A measurement of these factors would improve our study.

Politicians across many ideological spectra espouse a desire for more social mobility and outcomes based on merit. The provision of good educational infrastructure and educational opportunities has in part gone some way to towards that goal. It is, however, unclear how governance and educational infrastructures might foster equality of opportunity in the context of variation in personality. Given the literature on the relative stability of such traits in adult life it would be reasonable to assume that any intervention would have a better chance of success if applied in childhood. However, as noted above, openness to experience can increase as a result of interventions in adulthood. Also, negative emotions linked to neuroticism can be reduced (Kemeny, Foltz et al. 2012). These many influences on social mobility are also highly inter-related. The contribution of education on status achievement is attributable in part to its relationship with intelligence. In general, smarter children tend to have greater educational exposure.

Those children from a higher social class also have more exposure to education (Duncan, Brooks-Gunn et al. 1994).This is either because of opportunities given to brighter children or familial expectation, or both. Early life deprivation is also associated with poorer educational outcomes and health (Wilkinson, Pickett 2007). The influences of intelligence on destination social class can, therefore, comprise at least two forms. Firstly, a direct influence where the intellectually endowed ascend the social structure through promotion at work or success in business; or secondly an indirect influence via education which permits entry into occupations of higher social strata. Studies have shown links between early cognitive ability, educational outcomes and destination social class (Feinstein, Bynner 2004). Family social status at birth is associated with early life cognitive development (Tong, Baghurst et al. 2007). We have not modelled this association as a causal link here (assuming that SES_C is representative of birth *SES*), but it may well be the case. In contrast, there appears to be only a small influence of SES_C on adult crystallized ability (*NART*) after adjusting for the other exogenous variables in the model. It may well be that those from less privileged backgrounds are able to 'catch up' in terms of cognitive performance over the life course, with these effects driven in part by personality and education. This 'catch up' phenomenon is less clear in terms of destination social status (SES_A) with SES_C remaining a significant predictor in late life, although the size of the effect is reduced. Although we have modelled the relationship between crystallized ability (*NART*) and adult socioeconomic status (SES_A) as causal from *NART* to SES_A, the direction of this affect may be in an opposite direction with SES_A driving the accumulation of ability. Alternatively, this association may also be brought about by some other life course feature not modelled that has a common causal influence on both outcomes.

Study limitations: Self-reported childhood socioeconomic status SES_C provided by volunteers in late middle age is open to criticism although descriptions given are consistent with historical accounts of life in Scotland (Abrams, Brown 2010). Variables used to measure childhood socioeconomic status *SES* were a mixture of occupational defined class (OSC_p) and home life conditions over crowding *OCR* and sanitation *SAN* which may be biased by reconstructed memory effects. These measures capture the number of persons and neglects the qualitative dimension such as the positive feature of the home enviroments such as kindness, agreeableness and cordiality. The reliability of self-reported circumstance in childhood has previously been studies by Batty et al (Batty et al 2005) in a similar cohort and found the associations between childhood social class based on adult recall of parental

occupation and health outcomes, including cognition, are likely to underestimate real effects. This was brought about by adults reporting a more favourable socio-economic position than that recorded in childhood. A similar phenomena may be at play here. A possible superior alternative would be to construct an ecological equivalent of the *SIMD* score for the 1930s and 1940s, which would facilitate comparisons between childhood and late middle age measures and reduce self-reported errors. In general, our data derives from a variety of sources with a mixture of the historical, self-reported, census and directly measured. It would be expected that the reliability and quality of this data would also differ potentially biasing our results. Our model is also open to criticism given the assumption that personality measures in late middle age are representative of early life personality. Personality is fixed throughout most of adult life but may be modifiable earlier in life. However, given evidence in relation to the relative stability of personality across the lifespan (Specht, Egloff et al. 2011), it is reasonable to assume that the later life measure is representative of the early personality. Given the size of our data set and the number of fitted variables, the level of parsimony could be criticised. However, we have analysed sub portions using different combinations of the variables in our model and found excellent fits to the data which were no different from the large model we report here.

In this study we have separately computed the structural model for each of the NEO measures. This approach was largely driven by statistical parsimony concerns of introducing more than one personality trait at a time. This however has the disadvantage of the models not being comparable, since they have different covariance structures and does not allow an assessment of potential mediating effects of the five personality traits. For example, an individual with a low openness score may be able to compensate by having a high conscientiousness score. Just how and individuals traits combine with each other to form a personality profile to facilitate life course change is a difficult to assess because of the multiple combinations of traits (profiles) possible. In Appendix 1 we compare two such profiles in an exploratory post hoc model using k-means approach to define the profiles. The result suggest that a low neuroticism and high extraversion, openness, conscientiousness and agreeableness profiles enables individuals to make good the disadvantages of early life SES when compared to the contrary profile. The validity of this approach is questionable since the clustering approach we have taken is one of many and any such exploratory

model would require confirmation with an independent data set.

These findings identify the relative importance of factors that significantly influence destination SES_A and potentially downstream health and wellbeing. The results suggest that interventions that enhance educational opportunities and to reduce the destructive influence of *neuroticism* and promote enhanced openness may lead to enhanced social mobility. If this is the case then the relative importance of childhood *SES* over the life course may be reduced, of possible relevance to lifelong health and wellbeing.

1 APPENDIX

1.1 EXPLORATORY POST HOC MODELLING OF PERSONALITY PROFILES CLUSTERS.

1.1.1 Introduction

By convention our sample size seems reasonable but the necessary lack of parsimony in our model limits the power to examine those combinations of personality traits that allow an individual to compensate for a disadvantageous score in a particular trait with an advantageous score in another. For example, a poor neuroticism score may be offset by a high conscientiousness score. The structure of "The Big Five" personality traits suggests a large number of possible combinations could be tested. In the absence of an *a priori* hypothesis, one approach is to explore how our personality data clusters into particular profiles. This supplementary analysis aims to examine the validity of our model and the robustness of our findings using 'naturally' occurring subsamples based on a cluster analysis approach.

1.1.2 Method

Using only the personality data, we gather participants into two clusters using a k-means approach provided by SPSS software SPSS (IBM Corporation, New York, NY). This method split the study sample into two groups containing 258 and 185 participants for groups 1 and 2 respectively. The model shown in Figure 1 was modified by removing the personality component and split to use the multi-group analysis availably within AMOS (AMOS Development Corporation, Crawfordville, FL, USA). In order to match the power between groups, 185 participants were randomly selected from the larger group.

1.1.3 Results

An independent t test found mean personality score differences ($p<.001$) were found in each case (Table S1). With group 1 having lower Neuroticism and higher Extraversion, Openness, Conscientiousness and Agreeableness. Table S2 shows standardised regression weights for parameter effects in the model in each group. The split group model produced a good fit to the data (Normative Fit Index>0.95, Comparative Fit Index>0.95, Root Mean Square Error of Approximation <.05). The results indicate a significantly stronger correlation ($p<.001$) between SESc and MHT for group 2 than group 1. Comparing the direct effects on Adult SES, we found SESc→SESa was significant in group 2 but not in

group 1. Similarly, the indirect effects show SESc→EDU was significant in group 2 but not in group 1. Comparing these direct effects no significant differences were found.

	Group	N	Mean	SE
NEO-N	1	258	12.845	.2885
	2	185	24.238	.4490
NEO-E	1	258	30.124	.2956
	2	185	23.000	.3408
NEO-O	1	258	25.647	.3696
	2	185	23.005	.3951
NEO-A	1	258	34.081	.2953
	2	185	31.470	.3775
NEO-C	1	258	37.233	.3173
	2	185	32.157	.4376

Table S1 - Comparison of personality traits NEO-*N* –Neuroticism; *NEO-E*-Extraversion; *NEO-O*-Openness; *NEO-C*-Conscientiousness; *NEO-A* Agreeableness; SE—Standard error.

			Group	*1*	*2*
	SES_C	←→	*MHT†*	0.26	0.58**
Indirect	*EDU*	←	*MHT*	0.43**	0.41**
	EDU	←	SES_C	0.11	0.26*
Indirect	*NART*	←	*MHT*	0.60**	0.63**
	NART	←	SES_C	0.13	-0.05
	NART	←	*EDU*	0.19*	0.19*
Direct	SES_A	←	*MHT*	0.17	0.16
	SES_A	←	*NART*	0.24*	0.15*
	SES_A	←	SES_C	0.17	0.29*
	SES_A	←	*EDU*	0.52**	0.45**

Table S2- The standardised Structural Equation Modelling results across five runs of the model, one for each personality variable. Note: *p<.05; **p<.001; † Comparison between groups p<.001; ←→Represents a correlation; ← Represents a direct effect. *MHT* – Moray House Test (Childhood Intelligence); *EDU* – Educational attainment; SES_C – Socioeconomic Status Childhood; SES_A – Socio-Economic Status Adult; *NART* - The National Adult Reading Test

1.1.4 Discussion

This supplementary analysis identifies those personality profiles that help an individual to make good the disadvantages of early life SES. The absence of a significant association - either direct or indirect via education and adult ability indicates that group profile 1 described above may have that ability. The significant associations found for group 2 indicates that social origin plays a significant part in their social destination. Group 2 also indicates a

significant covariance between early life ability and SES not present in group 1, which could suggest that in group 1 ability and circumstance may share a common cause such as parental ability.

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