Intergenerational Mobility in Socio-emotional Skills*

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January 2024

Abstract

This paper investigates the intergenerational transmission of socio-emotional skills during childhood, using data from the 1970 British Cohort Study (BCS70) in the United Kingdom. This dataset enables us to measure two dimensions of socio-emotional development: internalising and externalising skills. More importantly, we can use multiple measures of parents' skills collected during both their childhood and their adulthood. Whereas parent-child skills are strongly related when both are measured contemporaneously, they remain correlated when both are measured in childhood, with a stronger transmission observed from mothers to their children. Additionally, by leveraging the BCS70 data on socio-emotional skills for three generations, we estimate multi-generational persistence. Notably, we find a correlation between the grandmother's internalising skill and the grandchildren's skills, even after accounting for parental skills.

JEL codes: J62, D63, I21, J24

Keywords: Intergenerational Mobility, Inequality, Socio-emotional Skills, Spectral gap mobility index.

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1 Introduction

It is now widely accepted that human development has many dimensions that jointly determine life course outcomes, ranging from labour market earnings and criminal activities, to subjective well-being and health (Currie and Almond, 2011; Almlund et al., 2011; Almond et al., 2018). These different dimensions include cognitive and socio-emotional skills, with the former including the ability to complete simple and complex tasks as well as the ability to learn, pay attention and solve problems, while the latter refers to psychological and preference traits, such as sociability, emotional stability, locus of control and self-esteem, and personality (e.g. conscientiousness, risk aversion and time preferences).

It is also well established that parental skill endowments and parental investment play an important role in determining their children's development. These influences are particularly visible in the early years of life, because of the brain's rapid development and malleability and the fact that parents are typically the main source of interaction for very young children (Cunha and Heckman, 2007; Cunha, Heckman, and Schennach, 2010). It is therefore likely that different types of skills are transmitted across generations and that this transmission plays an important (although not exclusive) role in the intergenerational transmission of inequality. The economic literature has examined extensively the intergenerational transmission of income and education. Nevertheless, the evidence on the intergenerational transmission of different types of skills and in particular of socio-emotional skills is still scarce, despite the fact that these skills are now accepted to be important in determining different dimensions of well-being (Currie and Almond, 2011; Almlund et al., 2011; Almond et al., 2018).[1]

In this paper, we study different aspects of the evolution of socio-emotional skills across generations. We do so by exploiting some of the unique longitudinal dimensions of the 1970 British Cohort Study (BCS70), who are followed from birth onwards, In addition, the BCS70 contains information about the cohort members' parents, in the first and subsequent sweeps of the survey, and about their offspring, if any, measured in the age-34 sweep. We can therefore observe three connected generations. Moreover, when characterising the relation between socio-emotional skills of the second and third generations (i.e., the cohort members and their offspring), we can use skills their measured *before adulthood*, rather than skills observed *at the same calendar time*. Finally, as the cohort members are of both genders and we observe their offspring, we can study the possibility that socio-emotional skills are transmitted differently (if at all) by *fathers and mothers*.

To study the dynamics of socio-emotional skills and cognition across generations, we need to define what they are and how they are measured. Following the literature (see e.g. Heckman and

[1] An excellent review paper on intergenerational mobility is Black and Devereux (2011). Some prominent studies on mobility include, for example, Chetty et al. (2014), that maps the geography of intergenerational mobility in the United States. Card et al. (2022) study the intergenerational transmission of human capital for children born in the 1920s and educated during an era of expanding but unequally distributed public school resources in the United States. Alesina et al. (2021) map the intergenerational mobility in educational attainment in Africa. Guell et al. (2015) propose an alternative approach to measure mobility by using cross-sectional data on income and the surname of the individual. There is also a growing interest in intergenerational mobility in other outcomes, such as in wealth (Charles and Hurst, 2003) and health (Halliday et al., 2020).

Zhou (2022)), we use factor analysis to extract a measure of cognitive skill and two dimensions of socio-emotional skills, which we label 'internalising' and 'externalising'. The first dimension of socio-emotional skills captures children's ability to focus their drive and determination, while the second one captures their ability to relate to others (Achenbach, 1966; Achenbach et al., 2016; Attanasio et al., 2020). In addition, since we analyse socio-emotional skills measured at slightly different ages and for different generations, we pay attention to the comparability of these measures across generations (Wu and Estabrook, 2016).

We make three contributions to the understanding of the development of socio-emotional skills. First, we study the intergenerational transmission of skills looking at the socio-emotional skills of cohort members and their offspring. Furthermore, our paper assesses separately the role played by fathers and mothers in the intergenerational transmission of socio-emotional skills. The literature estimating income mobility has mostly focused on the intergenerational correlation between fathers and sons due to the lower likelihood of maternal participation in the labor force (see for example Blanden (2013) and Black and Devereux (2011)).[2] Our data from the age-34 sweep implies that for some children we have information on their mothers; and for others, on their fathers. The evidence we uncover is suggestive that mothers play a predominant role in the intergenerational transmission of socio-emotional skills.

Second, we investigate to what extent the cohort members' skills measured *during childhood* are associated with their children's socio-emotional skills. A possible issue with most of the existing work on the intergenerational transmission of socio-emotional skills is the use of measurements for parents' and children's skills obtained *at one point in time*, typically in adulthood for the parents and in adolescence for the children. At these development stages, skills and attitudes are likely to have developed and changed for other reasons, such as schooling and peer effects. On the other hand, socio-emotional skills during childhood are not fully developed and may still be quite malleable (Almlund et al., 2011). Furthermore, while the main direction of intergenerational transmission is presumably from parents to children, it is also possible that children influence their parents' values and skills. A high (low) correlation between parents and children's socio-emotional skills and attitudes could, therefore, be found because of a convergence (or divergence) in skills and attitudes during adulthood when the children can also affect parents' personality and attitudes.[3] When using contemporaneously measured skills (i.e., with parental skills measured in adulthood), which are also available in the BCS70, we find estimates that are larger than those we obtain using age-compatible measures. Whereas correlations in contemporaneous measurements may themselves be of interest, it is important to highlight how estimates are sensitive to different measurement timings. The 'life-cycle bias' connected with the measurement of certain variables over different intervals of the life cycle is somewhat similar to the one encountered when studying income mobility using earnings data at only one point in time that do not correspond to lifetime

[2] A recent study by Hu and Qian (2023) shows that father-child associations in educational status have become weaker, while mother-child associations have become stronger around the world since 1960.

[3] Dohmen et al. (2011) try to tackle reverse causality due to contemporaneous measurements by using religion as an instrumental variable for the child's attitude, but the first stage indicates a weak instrumental variable problem even if one accepts its validity.

earnings. Whether a specific measure has a 'bias' or not depends on what concept one ultimately is after. However, it is important to know how and why different estimates may differ. Our findings show that parental skills during *their own* childhood predict their child's internalising and externalising skills measured between the age of 3 and 16.

Finally, for our third contribution, the data we use allow us to estimate the association of grandparents' socio-emotional skills with their grandchildren's socio-emotional skills, even after controlling for parents' skills. We show that the association of socio-emotional skills might be relevant across more than one generation. Information on grandmother and grandchildren's socio-emotional skill is *not* often found in datasets. The BSC70 is an exception because the cohort members' mother was asked to complete the Malaise Inventory (Rutter et al., 1970) in the 1975, 1980 and 1986 sweeps.[4] We do however note that, in contrast with the preceding analysis where parents' and children's measurements are taken at similar ages and thus not contemporaneously, grandmothers' and parents' measurements here are contemporaneously taken.

Our study is not the first to look at the intergenerational correlation of skills. Two noteworthy contributions to this literature in economics are Dohmen et al. (2011) and Anger (2012). These papers use data from the German Socio-Economic Panel Study (SOEP) to study respectively the transmission of attitudes and skills from parents to children *during adulthood*. In another contribution, Grönqvist et al. (2017) study the intergenerational transmission of skills in Sweden, using data only on 18-year-old men's cognitive and socio-emotional skills from military enlistment records. Alan et al. (2017) study the transmission of risk attitudes from mothers to children through elicitation of risk aversion in an incentivised experiment in Turkey.

The psychology literature has also studied the intergenerational correlation of socio-emotional skills. For example, Duncan et al. (2005) uses the data from the National Longitudinal Survey of Youth (NLSY) to study personal traits and behaviours measured during adolescence. Loehlin (2005) and Groves (2005) review the psychology literature and conclude that the correlation in socio-emotional skills ranges between 0.10 to 0.30 for young adult children. Unfortunately, these studies in psychology are based on a small number of observations and may lack representativeness.

The rest of the paper is organised as follows. In Section 2, we introduce the 1970 British Cohort Study data used in the analysis. Section 3 and 4 present respectively the derivation of the three dimensions of skills we analyse and the measures of intergenerational mobility in socio-emotional skills and cognition. In Section 5, we present estimates of intergenerational mobility in socio-emotional and cognitive skills. Section 6 investigates the multi-generational persistence in socio-emotional skills by examining the correlation between grandmother and grandchild's skills. Section 7 summarizes the results and concludes.

[4] Our analysis is complementary to the literature examining multi-generational mobility in mental health. For example, Johnson et al. (2013), Hancock et al. (2013) and Bütikofer et al. (ming) study multi-generational mobility in mental health across three generations respectively in the United Kingdom, Australia and Norway. We discuss their approach to study multi-generational mobility in mental health when we measure multi-generational in socio-emotional skills. We notice that they focus only on one dimension of mental health, while socio-emotional skills are multi-dimensional and often divided into internalising and externalising skills.

2 Data Sources and Available Measures

We make use of a unique longitudinal database, the 1970 British Cohort Study (BCS70), which follows the lives of people born in England, Scotland and Wales in a single week (April, 5-11) of 1970 and is publicly available at the UK Data Service. Cohort members have been contacted nine times, resulting in information at ages 5, 10, 16, 26, 30, 34, 38, 42, 46 and 51.

Table 1: Rutter A and Strengths and Difficulties Questionnaire Scales

Rutter A scale administered to parents when they were 5, 10 and 16 years old	
1. Very restless. Often running about or jumping up and down. Hardly ever still.*	2. Is squirmy or fidgety.*
3. Often destroys own or others' belongings.	4. Frequently fights other children.*
5. Not much liked by other children.	6. Often worried, worries about many things.*
7. Tends to do things on his/her own, is rather solitary.*	8. Irritable. Is quick to fly off the handle.
9. Often appears miserable, unhappy, tearful or distressed.*	10. Sometimes takes things belonging to others.
11. Has twitches, mannerisms or tics of the face or body.	12. Frequently sucks thumb or finger.
13. Frequently bites nails or fingers.	14. Is often disobedient.*
15. Cannot settle to anything for more than a few moments.*	16. Tends to be fearful or afraid of new things or new situations.*
17. Is over fussy or over particular.	18. Often tells lies.
19. Bullies other children.*	A. Complains of headaches.*
B. Complains of stomach-ache or has vomited.*	C. Complains of biliousness
D. Has temper tantrums (that is, complete loss of temper with shouting, angry movements, etc.).*	

Strengths and Difficulties Questionnaire scale administered to children when they were between the age 3-16	
1. Considerate of other people's feelings^{+}	2. Restless, overactive and not able to sit still for long*
3. Often complaining of headaches, stomach-aches or sickness*	4. Sharing readily with other children (treats, toys, pencils etc.)$^{+}$
5. Has often had temper tantrums or hot tempers*	6. Rather solitary, tending to play alone*
7. Generally obedient, usually doing what adults requested* $^{+}$	8. Many worries, often seeming worried*
9. Helpful if someone was hurt, upset or feeling ill^{+}	10. Constantly fidgeting and squirming*
11. Has had at least one good friend $^{+}$	12. Has often had fights with other children or bullies them*
13. Often unhappy, downhearted or tearful*	14. Generally liked by other children $^{+}$
15. Easily distracted, concentration wandered*	16. Nervous or clingy in new situations, easily loses confidence*
17. Kind to younger children $^{+}$	18. Often lied or cheated†
19. Picked on or bullied by other children	20. Has often volunteered to help others (parents, teachers, other children)$^{+}$
21. Able to think things out before acting† $^{+}$	22. Stole from home, school or elsewhere†
23. Getting on better with adults than with other children	24. Many fears, easily scared
25. Has seen tasks through to the end, good attention span $^{+}$	

Note. The Rutter and Strengths and Difficulties Questionnaire items are rated on three levels: 'Does not apply', 'Somewhat applies', 'Certainly applies'. Since they are all behaviours indicating lower skills, we recode all of them in reverse, i.e. 'Certainly applies' = 0, 'Somewhat applies' = 1, 'Does not apply' = 2. The question of the Rutter items in the BCS70 administered when parents were 16 years old refers to the teenager. Items denoted by $^{+}$ are positively coded in the original scale and we do not reverse the order for those items. Items denoted by * are comparable (similarly-worded) questions in the Rutter and Strengths and Difficulties Questionnaire shown in Table 3. Items denoted by † are asked only to the children aged 6-16.

The age 34 sweep provides substantial information on the offspring of the cohort members, including a number of tests aimed at measuring their socio-emotional skills. We concentrate on the sample of cohort members linked to their children and present descriptive statistics on the sample of BCS70 with children in Table E1 in Appendix E. An important limitation of this data structure is that the children of the BCS70 cohort, if present when the age-34 sweep was collected, have, inevitably, different ages. This makes the comparison of several dimensions of their development difficult, as different tests are used. This is particularly salient for cognitive skills. For this reason we limit our analysis to children of the BCS cohort aged between 3 and 16 at the age-34 sweep

and consider only socio-emotional skills, for which a common metric can be identified.[5]

The BCS70 sample's socio-emotional skills were measured using the Rutter A and Strengths and Difficulties Questionnaire (SDQ) at ages 5, 10 and 16 for the cohort members and at the age-34 sweep for the children of the cohort members aged between 3 and 16 respectively. In Table 1, we present the questions from these tests (Rutter et al., 1970; Goodman, 1994). The Rutter A and SDQ are behavioural screening scales, where mothers are asked whether their children exhibit a series of behaviours. The SDQ scale was developed to consider advances in child psychopathology and includes positive as well as undesirable traits. Items take one of three values: 'Does not apply', 'Somewhat applies', and 'Certainly applies'. Since the questions are about behaviours indicating low skills, we recode all of them in reverse for the ease of interpretation, with higher values associated with better socio-emotional skills. We augment the Rutter Scale with three additional parent-reported questions from the parental questionnaire, items A, B, and D in Table 1. These are rated on 4 levels: 'Never in the last 12 months', 'less than once a month', 'at least once a month', and 'at least once a week'.[6]

Finally, teachers to the cohort members were also asked to answer socio-emotional questions similar to the ones asked to the cohort member's mothers in the Rutter A questionnaire at the age-10 sweep. In Appendix C.3, we use these data to address possible concerns about misreporting bias and obtain similar estimates.

The cognitive skill measure we use comes from a factor model combining information from three tests administered at the age of 5 (Copy Designs, Human Figure Drawing, English Picture Vocabulary Test) and four tests administered at the age of 10 (Shortened Edinburgh Reading Test, Friendly Math Test, Spelling Dictation Task and Pictorial Language Comprehension Test).[7]

3 The dimensions of skills and their measurement

Skills in childhood are intrinsically difficult to measure. As discussed in the previous section, a wide range of measures are available, typically behavioural screening scales, where parents or teachers are asked to evaluate a number of items on the child's behaviour, and cognitive tests. To extract efficiently estimates of socio-emotional and cognitive skills from these measures, the use of factor models has become common. We follow much of the literature and focus on one single cognitive factor and two factors for socio-emotional skills reflected in the available measures

[5]Tables E2 and E3 in Appendix E, respectively, report sample sizes in age 34 sweep and response rates for the socio-emotional questions retained in the analysis in the age 5, 10, 16 and 34 sweeps.

[6]We recode these into binary indicators, with 'Never' and 'Less than once a month' to 1 and zero otherwise. At the age 10 sweep, the Rutter A scale is continuous from 0 to 100, where 0 means 'Does not apply' and 100 means 'Certainly applies'. We recode it in reverse. In order to make it comparable to the Rutter A scale in the other waves, we recode the items as follows: if the response is below 40, we code the answer as 0; if the response is between 40 and 70, we code the answer as 1; if the response is between 70 and 100, we code the answer as 2.

[7]In the cognitive tests administered at the age 5 the following tasks were tested: in the copy design, the child is asked to copy simple designs adjacently; in the human figure drawing, the child draws an entire human figure; in the English picture vocabulary test, the child identifies the picture referring to a word among four pictures. The Pictorial Language comprehension test at the age of 10 was based on the English Picture Vocabulary Test administered at the age of 5, where the child identifies the picture referring to a word among four pictures

(Achenbach, 1966; Achenbach et al., 2016). We use Exploratory Factor Analysis to identify which measures are relevant for which factor and test the hypothesis that a dedicated system, where a single factor loads on each of the available measures, represents the data well. Using this evidence, we then proceed to the estimation of the factor models we use in our analysis of intergenerational mobility.

3.1 Exploratory analysis

In what follows, we analyse the intergenerational transmissions of cognition and socio-emotional skills. We follow the previous literature, which has identified two dimensions of socio-emotional skills, which have been labeled as 'externalising' and 'internalising' skills (Attanasio et al., 2020; Moroni et al., 2019). These two constructs have also been used extensively in the psychology literature (Achenbach, 1966; Achenbach et al., 2016). The first factor captures the ability of children to relate to others and the second one their ability to focus, their drive and determination.

Table 2: Subscale of comparable items

Itm.	Factor	Cat.	Title	Rutter Wording (Parents during childhood)	SDQ Wording (Children aged 3-16)
1	EXT	3	*Restless*	Very restless. Often running about or jumping up and down. Hardly ever still	Restless, overactive and not able to sit still for long
2	EXT	3	*Squirmy/fidgety*	Is squirmy or fidgety.	Constantly fidgeting and squirming
3	EXT	3	*Fights/bullies*	Frequently fights other children	Has often had fights with other children or bullied them
4	EXT	3	*Distracted*	Cannot settle to anything for more than a few moments.	Easily distracted, concentration wandered
5	EXT	2/3	*Tantrums*	Has temper tantrums (that is, complete loss of temper with shouting, angry movements, etc.)	Has often had temper tantrums or hot tempers
6	EXT	3	*Disobedient*	Is often disobedient	(+) Generally obedient, usually doing what adults requested
7	INT	3	*Worried*	Often worried, worries about many things	Many worries, often seeming worried
8	INT	3	*Fearful*	Tends to be fearful or afraid of new things or new situations	Nervous or clingy in new situations, easily loses confidence
9	INT	3	*Solitary*	Tends to do things on his/her own, is rather solitary	Rather solitary, tending to play alone
10	INT	3	*Unhappy*	Often appears miserable, unhappy, tearful or distressed	Often unhappy, downhearted or tearful
11	INT	2/3	*Aches*	Complains of headaches + stomach-ache or has vomited	Often complaining of headaches, stomach-aches or sickness

Note. Itm. is item number. Factor is the latent construct to which the item loads - EXT is externalising skills, INT is internalising skills. Cat. is the number of categories in which the item is coded - 2 denotes a binary item (applies/does not apply) and 3 denotes a 3-category item. Title is a short label for the item. Wording columns show the actual wording in the scales used in each of the cohort studies. Since they are all behaviours indicating lower skills, we recode all of them in reverse, i.e. 'Certainly applies' = 0, 'Somewhat applies' = 1, 'Does not apply' = 2. Items denoted by (+) are positively coded in the original scale.

To establish which measures are related to each of the two factors, we perform an Exploratory Factor Analysis (EFA) and concentrate on the 11 items from the Rutter A and Strengths and Difficulties Questionnaire (SDQ) scale that are common across the cohort members and their children, listed in Table 2, as in Attanasio et al. (2020). The EFA is based on decomposing the polychoric correlation matrix of the items and using maximum likelihood estimation (Olsson, 1979).[8]

[8]The polychoric correlation is an estimate for the correlation between two normally distributed continuous random

Table 3 presents the estimates of the EFA of the division proposed in Table 2. The factor loadings in this Table show a clear separation between items. We highlight that the factor loadings have a similar magnitudes across groups, pointing out that there is a similar association between the item and the factor across groups.

Table 3: Loadings from exploratory factor analysis

		Parents at age 5		Parents at age 10		Parents at age 16		Children aged 3-16	
Item	Title	EXT	INT	EXT	INT	EXT	INT	EXT	INT
1	*Restless*	**0.8648**	-0.1281	**0.8108**	-0.1640	**0.8000**	-0.1228	**0.6040**	0.0785
2	*Squirmy/fidgety*	**0.7816**	0.0100	**0.6919**	0.0263	**0.7286**	0.0103	**0.6166**	0.1066
3	*Fights/bullies*	**0.4830**	0.2039	**0.4955**	0.0021	**0.6111**	0.0058	**0.6875**	-0.0050
4	*Distracted*	**0.6431**	0.0556	**0.5927**	0.0705	**0.6493**	0.0709	**0.7113**	0.0553
5	*Tantrums*	**0.5466**	0.1570	**0.4892**	0.1756	**0.4998**	0.1262	**0.7244**	-0.0164
6	*Disobedient*	**0.5732**	-0.0575	**0.6684**	0.0288	**0.6890**	-0.0016	**0.8162**	-0.1781
7	*Worried*	-0.1092	**0.7993**	-0.0981	**0.7030**	-0.0055	**0.7953**	-0.0701	**0.7747**
8	*Fearful*	0.0657	**0.4692**	-0.0921	**0.5659**	-0.1245	**0.7277**	-0.0798	**0.6837**
9	*Solitary*	-0.0391	**0.4794**	0.0989	**0.2828**	0.0463	**0.3125**	0.1060	**0.4432**
10	*Unhappy*	0.0492	**0.7948**	0.2346	**0.5117**	0.2664	**0.5016**	0.3889	**0.4102**
11	*Aches*	-0.0078	**0.5367**	-0.0492	**0.4103**	-0.0360	**0.3897**	0.1322	**0.1758**

Note. The table displays the factors loadings obtained from exploratory factor analysis (EFA) by sample. The EFA is based on the decomposition of the polychoric correlation matrix, and uses PROMAX rotation. Since they are all behaviours indicating lower skills, we recode all of them in reverse, i.e. 'Certainly applies' = 0, 'Somewhat applies' = 1, 'Does not apply' = 2.

3.2 Factor model

We specify a factor model to estimate the relationship between internalising and externalising skills and the available measures, the Rutter and SDQ items, based on the results of the exploratory analysis described in section 3.1. For most of our analysis, we consider two groups of individuals $c \in \{C_1, C_2\}$, corresponding respectively to the children of the cohort members and the cohort members. In Figure 2, we examine instead four groups of individuals $c \in \{C_1, C_2, C_3, C_4\}$, corresponding respectively to the children of the cohort members and the cohort members at the age of 5, 10 and 16.

Each individual is denoted by $i = 1, ..., N_c$. For each individual and group, we observe categorical item responses Z_{ijc}, corresponding to the common Rutter/SDQ questions (Table 2) where j indexes the 11 available items. We follow the literature and assume a latent bi-dimensional vector of externalising and internalising socio-emotional skills $Y_{ic} = (Y_{ic}^{EXT}, Y_{ic}^{INT})$.

The relationship between the latent factors Y_{ic} and the available measures Z_{ijc} is characterised by item- and group-specific intercepts v_{jc} and loadings λ_{jc} and is affected by an independent measurement error term u_{ijc}. The measures are defined in terms of the following variable:

$$Z_{ijc}^{*} = v_{jc} + \lambda_{jc}^{\top} Y_{ic} + u_{ijc}. \tag{1}$$

variables observed as ordinal variables. The solution is rescaled using oblique factor rotation obtained via the PROMAX protocol outlined in Hendrickson and White (1964) (with $k = 3$). Since we use a dedicated factor structure based on the oblique factor rotation matrix suggested above, our factor scores (i.e., skills) are *not* orthogonal. Their estimated correlation is presented in Table E4.

We consider a dedicated factor structure, where each item loads only on one latent dimension, and follow the structure found in the exploratory factor analysis (Heckman et al., 2013; Conti et al., 2010). We estimate a baseline model which is characterized by the bare minimum number of assumptions with the parameterisation defined below (Wu and Estabrook, 2016).

Given the specification of the behavioural scale, the measures Z_{ijc} have a discrete nature and take one of an ordered number of values. To allow for such measures, we introduce item- and group-specific threshold parameters τ_{jc} as follows:

$$Z_{ijc} = s \quad \text{if} \quad \tau_{s,jc} \geq Z^*_{ijc} \geq \tau_{s+1,jc} \quad \text{for} \quad s = 0, 1, 2, \tag{2}$$

with $\tau_{0,jc} = -\infty$ and $\tau_{3,jc} = \infty$. The values taken by Z_{ijc}, $s = 0, 1, 2$, correspond to those in our data ('Certainly applies' = 0, 'Somewhat applies' = 1, 'Does not apply' = 2).

Following the literature, we assume that the latent factors and the measurement error terms are normally distributed:

$$Y_{ic} \sim \mathcal{N}(\kappa_c,\, \sigma^2_{Y_c}) \quad \text{and} \quad u_{ijc} \sim \mathcal{N}(0,\, \sigma^2_c). \tag{3}$$

Finally, we make the normalization assumption needed to deal with factor indeterminacy by setting the mean κ_c and the variance $\sigma^2_{Y_c}$ of the factor equal to 0 and 1 respectively. In addition, the intercepts v_{jc} are equal to zero and the error variance σ^2_c to 1, while the loadings λ_{jc} and threshold τ_{jc} are free to vary. In Appendix A, we follow Attanasio et al. (2020) and test for measurement invariance since any comparison between socio-emotional skills across different generations requires that the socio-emotional measures we derived have the same relationship with the latent constructs (Vandenberg and Lance, 2000; Putnick and Bornstein, 2016). We fail to reject measurement invariance, so that the latent factors measured for the different groups are comparable.

While the focus of the analysis is on the intergenerational transmission of socioemotional skills, in what follows we want to check whether the links we identify are robust to controlling for parental cognitive skills, for which we have a variety of markers. To measure parental cognitive skills during childhood, we consider a factor model with continuous items. The continuous items are the raw scores from the Copy Designs, Human Figure Drawing, English Picture Vocabulary Test, Shortened Edinburgh Reading Test, Friendly Math Test, Spelling Dictation Task and Pictorial Language Comprehension Test. Figure E1 in the Appendix shows the distributions of the latent factors: internalising, externalising and cognitive skills.

4 Measuring intergenerational mobility

We perform the analysis of intergenerational persistence of skills in one step, estimating the measurement system and the regression jointly. In particular, we analyse how different dimensions of development of the cohort members observed during childhood relate to the socio-emotional development (internalising and externalising) of their children, observed in 2004, when the parents

where 34.[9]

To perform this analysis, we estimate jointly a measurement system and the relationship among the factors following the procedure in Muthen (1984) to estimate parameters of interest jointly, avoiding biases that would arise from a two step procedure. We describe the estimation methodology in Appendix B.

4.1 Intergenerational mobility

To study how socio-emotional and cognitive skills can be transmitted across generations, we relate outcomes observed in the children of our cohort members to outcomes observed in their parents *prior to their adulthood*.

In particular, for each BCS member, who we identify as parent i, we identify a child in household i, if present in 2004 and included in the study, and estimate:

$$Y_i^C = \phi + \gamma^\top Y_i^P + \rho^\top \mathbf{X}_i + \epsilon_i, \tag{4}$$

where Y_i^C is the child i's socio-emotional skill score and γ is a vector of parameters measuring intergenerational mobility in skills (i.e. internalising, externalising and cognitive skills). Higher values of the coefficient γ correspond to lower mobility. The vector Y_i^P represents the socio-emotional and cognitive skills of the parent of child i's parent's as measured during the parent's childhood. As these skills are observed when the parent (cohort member) is 5, 10 and 16, estimates of the Y_i^P vector are obtained from a factor model aggregating the measurements available at these ages. In particular, parents' internalising and externalising skills during childhood are measured by combining the Rutter A questionnaires administered at the age-5, 10 and 16 sweeps. On the other hand, parents' cognitive skills during childhood are measured by combining the cognitive tests administered at age-5 and 10 sweeps.[10]

In our specifications, we control for a vector $\mathbf{X}_i$ of individual characteristics, which include the parent's region of birth, the parent's gender, the child's gender and age, the number of children in the cohort member and child's household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. We include these controls to accommodate some other possible channels that might relate to skills. For example, the employment variables are here to proxy for other channels like income that might explain skills. Region of birth fixed effects can account for the fact that parents were born in different geographical areas. We also include controls for family characteristics to consider the fact that the family composition can influence skills.

As mentioned in the introduction, the nature of the data allows us to study separately the role

[9] We do not consider the children's cognitive development, as they were of different ages, posing comparability problems with those measures.

[10] We do not include the cognitive tests administered at age 16 because of a teacher-led industrial strike, disrupting the dissemination of the questionnaire. The strike led to administer only 2 cognitive tests (spelling test and vocabulary test) – out of 4 tests proposed – only to a small subset of the cohort members.

played by mothers and fathers in the intergenerational transmission of skills. To do this we can estimate equation (4) separately for male and female cohort members. Furthermore, we can also split the sample further on the basis of the offspring gender.

We compute standard errors by bootstrap. More specifically, we first generate 200 samples by block sampling with replacement from the original sample (i.e. we randomly draw the entire history of the parent-child link with replacement from the original sample). Then, for each bootstrap sample, we estimate the measurement system and the regression equation jointly.

Intergenerational rank transitions Another common measure of intergenerational mobility is to study the children's outcomes (R_i^C) from parents (R_i^P) at a given quintile of the distribution (Chetty et al., 2014). For example, a measure which is often reported is the probability of going from the lowest to the highest quintile of the skill distribution (Corak and Heisz, 1999):

$$LH = Pr(R_i^C \geq 80 | R_i^P < 20). \tag{5}$$

We thus produce matrices of transition probabilities across quintiles of the skill distribution. We do this for the parents' internalising, externalising and cognitive skills during childhood to document how mobility may differ at different points of the skill distribution.

To facilitate comparison across the several matrices, we propose a summary measure to compare the different transition matrices and order them in terms of mobility. Our measure is based on the difference between the largest and the second largest eigenvalues in the transition matrix. This difference is usually referred to as the 'spectral gap.' We thus call this measure the *'spectral gap mobility index'*. This measure is useful to understand how far the intergenerational transition matrices are from an identity matrix, which corresponds to a table with no mobility across quintiles: all its eigenvalues are equal to one and the measure above, *(1 - second largest eigenvalue)*, is zero. The discrepancy between one and the second largest could be seen as a departure from zero mobility, where higher numbers of the *'spectral gap mobility index'* corresponds to higher mobility.[11]

5 Intergenerational correlations of socio-emotional skills

In this Section, we present evidence on the correlation of children's internalising and externalising socio-emotional skills with their parents' skills in different domains. In particular, we first look at the correlation between internalizing and externalizing socio-emotional skills of children of the 1970s cohort with different dimensions of their parents skills, including and socio-emotional skills measured at different points in the life cycle. As mentioned in the introduction, we will also distinguish this type of intergenerational correlation by parent's gender. We then look at how the ranking of the children's skills is affected by the ranking of their parents, by estimating transition matrices.

[11] In the sociology literature, Sommers and Conlisk (1979) also note the use of the second largest eigenvalue as a measure of immobility.

For this purpose, we use data from the sweep that contains information on the children of the 1970 cohort, which was collected when the cohort members were about 34 years-old. In what follows, we refer to the cohort members as parents.

5.1 Intergenerational mobility: average and gender specific.

In Table 4, we report the results we obtain estimating equation (4) for the whole sample, using the latent variables on internalising and externalizing socio-emotional skills and cognition, extracted from the available measures using the factor model discussed above.

Table 4: Intergenerational mobility in socio-emotional skills

Panel A:				
Dependent variable:		**Child's Internalising (INT) Skill**		
	(1)	(2)	(3)	(4)
Parent's INT (during childhood)	0.168***	0.165***	0.153***	0.192***
	(0.050)	(0.047)	(0.052)	(0.067)
Parent's EXT (during childhood)				-0.082
				(0.071)
Parent's COG (during childhood)			0.141***	0.157**
			(0.047)	(0.052)
Observations	1035	1035	1035	1035
R^2	0.027	0.114	0.131	0.135
Region of birth FE (BCS70 5y)	No	Yes	Yes	Yes
Child's age FE	No	Yes	Yes	Yes
Other controls	No	Yes	Yes	Yes
Panel B:				
Dependent variable:		**Child's Externalising (EXT) Skill**		
	(1)	(2)	(3)	(4)
Parent's INT (during childhood)				-0.040
				(0.057)
Parent's EXT (during childhood)	0.259***	0.256***	0.222***	0.243***
	(0.047)	(0.048)	(0.048)	(0.054)
Parent's COG (during childhood)			0.154***	0.153***
			(0.042)	(0.041)
Observations	1035	1035	1035	1035
R^2	0.063	0.146	0.164	0.165
Region of birth FE (BCS70 5y)	No	Yes	Yes	Yes
Child's age FE	No	Yes	Yes	Yes
Other controls	No	Yes	Yes	Yes

Note. The Table presents estimates for equation 4 on the intergenerational mobility in skills (regression of child's socio-emotional skills on parent's skills *during childhood*). The measurement system and the intergenerational mobility equation are estimated jointly. Other controls include the parent's gender, the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

The different specifications we report are informative about how parental internalising, externalising and cognitive skills, as measured during childhood, relate to their children's socio-emotional skills during childhood, even after including a large set of controls. In particular, parents' skills are taken as an average of the skills measured at ages 5, 10 and 16 and we interpret

the coefficients on these variables as measuring intergenerational mobility. In Panel A, we present intergenerational mobility estimates for the child's internalising skill, while in Panel B we present the child's externalising skill.

A clear pattern emerges: the child's internalising skill is highly correlated with the parent's internalising and cognitive skills, while it is not associated with the other dimension of the parent's socio-emotional skills (i.e., the externalising skill). Analogously, children's externalising skills are correlated with parents' cognition and *externalising* skills but not with parents' internalising skills.

A potential criticism of these results is that they are estimated on the sample of children of the 1970 cohort, when the cohort members are 34. Cohort members with no children at 34, therefore, cannot be included in the analysis. It is not surprising, for instance, that a larger number of females than males is present in this sample. Selection into this sample is unlikely to be random and this selection process can bias our results. To address these issues, we re-estimate the specification in Column 4 of Table 4 by using a Heckman selection model to account for the potential selection bias induced by fertility decisions. The results, which we report in Appendix Table C1, are essentially unaffected.[12]

Differently from previous studies, in Table 5, we examine whether intergenerational mobility in socio-emotional skills differs by the parent's gender. The BCS70 allows us to perform this exercise as both genders are represented in the survey and both have their children tested. The only caution we need to have comes from the different ages at which males and females have children. As a consequence, the children of cohort members of different gender have, on average, different ages. As noted previously though, we do control for the child age in all our regressions which may be particularly relevant in this case. (Results are quantitatively very similar when the child's age is not included as a control.)

The most striking result in Table 5 is the fact that most of the skill correlation between parents and children is between mother and child rather than father and child.[13] This evidence is consistent with Hu and Qian (2023), showing that father-child educational mobility have become weaker, while mother-child educational mobility have become stronger around the world since 1960. We conjecture that child-care sharing arrangements between father and mother may be related to those findings (see Craig and Mullan (2011)). This finding calls for further investigation and rich information on both parents' care-giving responsibilities to investigate the mechanisms behind this finding.

As a robustness check on both the results in Tables 4 and 5 , we use the data collected on the cohort members at the age-10 sweep from Rutter A questionnaire administered to their teachers.

[12] In the Heckman selection model for the fertility decision at age 34, we add marital status alongside other cohort member covariates in the selection equation.

[13] Appendix Tables C2 and C3 present some additional specifications of the estimates presented in Table 5. Additionally, Appendix Table C4 re-estimates Columns 1 and 3 of Panel B (Table 5) by randomly selecting a subsample of mothers and children, ensuring that it matches the size of the sample of fathers and children. Even with a smaller randomly-selected mother-child sample, we still find statistically significant estimates for the transmission of internalising and externalising skills from mothers to children. This suggests that the non-significant estimates for the father-child sample is not driven by power considerations. Finally, Appendix Table C5 reproduces Columns 2 and 4 of Table 5 by using a Heckman selection model to account for the potential selection bias induced by fertility decisions and find similar evidence.

Table 5: Intergenerational mobility in socio-emotional skills by the parent's gender

Panel A: Mother-child				
Dependent variable:	**Child's Internalising (INT) Skill**		**Child's Externalising (EXT) Skill**	
	(1)	(2)	(3)	(4)
Parent's INT (during childhood)	0.219***	0.221***		-0.065
	(0.062)	(0.081)		(0.074)
Parent's EXT (during childhood)		-0.096	0.300***	0.288***
		(0.079)	(0.054)	(0.072)
Parent's COG (during childhood)		0.173**		0.190***
		(0.063)		(0.058)
Observations	752	752	752	752
R^2	0.046	0.159	0.083	0.182
Region of birth FE (BCS70 5y)	No	Yes	No	Yes
Child's age FE	No	Yes	No	Yes
Other controls	No	Yes	No	Yes
Panel B: Father-child				
Dependent variable:	**Child's Internalising (INT) Skill**		**Child's Externalising (EXT) Skill**	
	(1)	(2)	(3)	(4)
Parent's INT (during childhood)	-0.011	0.152		0.070
	(0.109)	(0.158)		(0.171)
Parent's EXT (during childhood)		-0.099	0.094	0.045
		(0.150)	(0.104)	(0.159)
Parent's COG (during childhood)		0.164		0.114
		(0.145)		(0.114)
Observations	283	283	283	283
R^2	0.000	0.165	0.009	0.174
Region of birth FE (BCS70 5y)	No	Yes	No	Yes
Child's age FE	No	Yes	No	Yes
Other controls	No	Yes	No	Yes

Note. The Table presents estimates for equation 4 on the intergenerational mobility in skills by parent's gender (regression of child's socio-emotional skills on parent's skills *during childhood*). The measurement system and the intergenerational mobility equation are estimated jointly. Other controls include the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

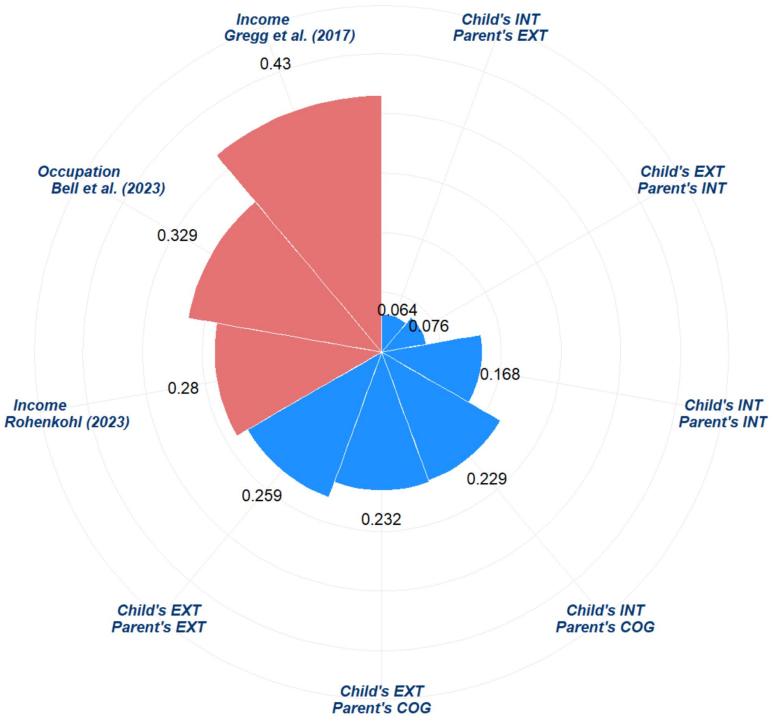
We can exploit these data to address possible concerns about misreporting bias and estimate intergenerational mobility in socio-emotional skills by using the questions answered by the teachers - instead of the cohort members' mothers. Appendix Tables C6 and C7 reproduce Tables 4 and 5, using this information.

We notice that the magnitudes of our estimates are similar to, though somewhat smaller than, the ones in the UK for intergenerational mobility in occupation (Bell et al., 2023), and income (Gregg et al., 2017; Rohenkohl, 2023). This is shown in the Nightingale rose chart (Figure 1), which compares the mobility estimates from the studies mentioned above with the mobility estimates in socio-emotional skills for each skill separately without controls (Appendix Figure C1).[14] We however urge caution in comparing our results to the findings in intergenerational mobility in

[14] Appendix F contextualizes our estimates on intergenerational mobility in skills during childhood by estimating the relationship between skills during childhood and log pay at age 42 in Table F1, providing evidence that skills during childhood are predictive of log pay. A similar result is also presented in Papageorge et al. (2019).

income and/or occupation because of different datasets, variables and model specifications.

Figure 1: Comparison of the mobility measures



Note. The Nightingale rose chart presents a comparison of the mobility measures in socio-emotional skills from the non-instrumented regressions without controls (equation 4 with no controls) to the mobility measures (i.e., coefficients from the OLS regressions) in other economic domains. The measurement system and the mobility equation are estimated jointly with no controls. Bell et al. (2023) and Rohenkohl (2023) study an older cohort born respectively in 1974-83 and 1973-1991. Gregg et al. (2017) study mobility in income for the BCS70. Higher values of the OLS coefficient correspond to lower mobility.

5.2 The timing of parental measures

In Table 4, we characterise intergenerational mobility estimates using parental internalising, externalising and cognitive skills *during childhood* combining measurements obtained at different ages. To complement the evidence from this Table and offer a graphic representation of the mobility results, we residualise the child's socio-emotional skills (internalising and externalising) and parent's socio-emotional at the ages of 5, 10 and 16 and cognitive skills at ages 5 and 10 separately against the control variables in Table 4 and plot these residuals in Figure 2 along with the best fitting line for each plot.[15] The pattern emerges from the panels in this figure is similar to the

[15]We project each socio-emotional skill on the parent's gender, the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975, the number of children in the parent's household when the parent is 5 years old, region of the parent's birth fixed effects and age of child fixed effects and obtain the residualised skill. Second, we plot the residualised skill of child against the residualised skill of the parent. The residualisation emulates the Frisch-Waugh-Lovell Theorem, which establishes that the multiple regression coefficient of a specific variable can also be obtained by first netting out the effect of other variable(s) in

evidence in Table 4. The slope coefficients in plots (A), (B) and (E) from Figure 2 are broadly comparable to the coefficient estimates in Panel A from Table 4, while plots (C), (D) and (F) are comparable to Panel B from Table 4.

An important difference between the results we present and most evidence in the literature on intergenerational mobility is that in the latter childrens' and parents' skills or attitudes were measured contemporaneously, implying that parental skills are measured in adulthood, while we use measurements obtained during the *childhood* of both generations. To investigate the importance of this difference, Table 6 presents estimates for intergenerational mobility, both using measures of parents' internalising skills measured during their childhood (as in Table 4) and measured at the same time as those of their children (see for example, in Dohmen et al. (2011) and Anger (2012)).[16]

Table 6: Intergenerational mobility estimates (childhood and adult measures of parental skills)

Dependent variable:	**Internalising (INT) Skill**		
	Child	Child	Child
	(1)	(2)	(3)
Parent's INT (during childhood)	0.208***		0.137*
	(0.067)		(0.078)
Parent's INT (contemporaneous - age 34)		0.426***	0.393***
		(0.077)	(0.090)
Observations	919	919	919
R^2	0.093	0.198	0.208
Region of birth FE (BCS70 5y)	Yes	Yes	Yes
Child's age FE	Yes	Yes	Yes
Other controls	Yes	Yes	Yes

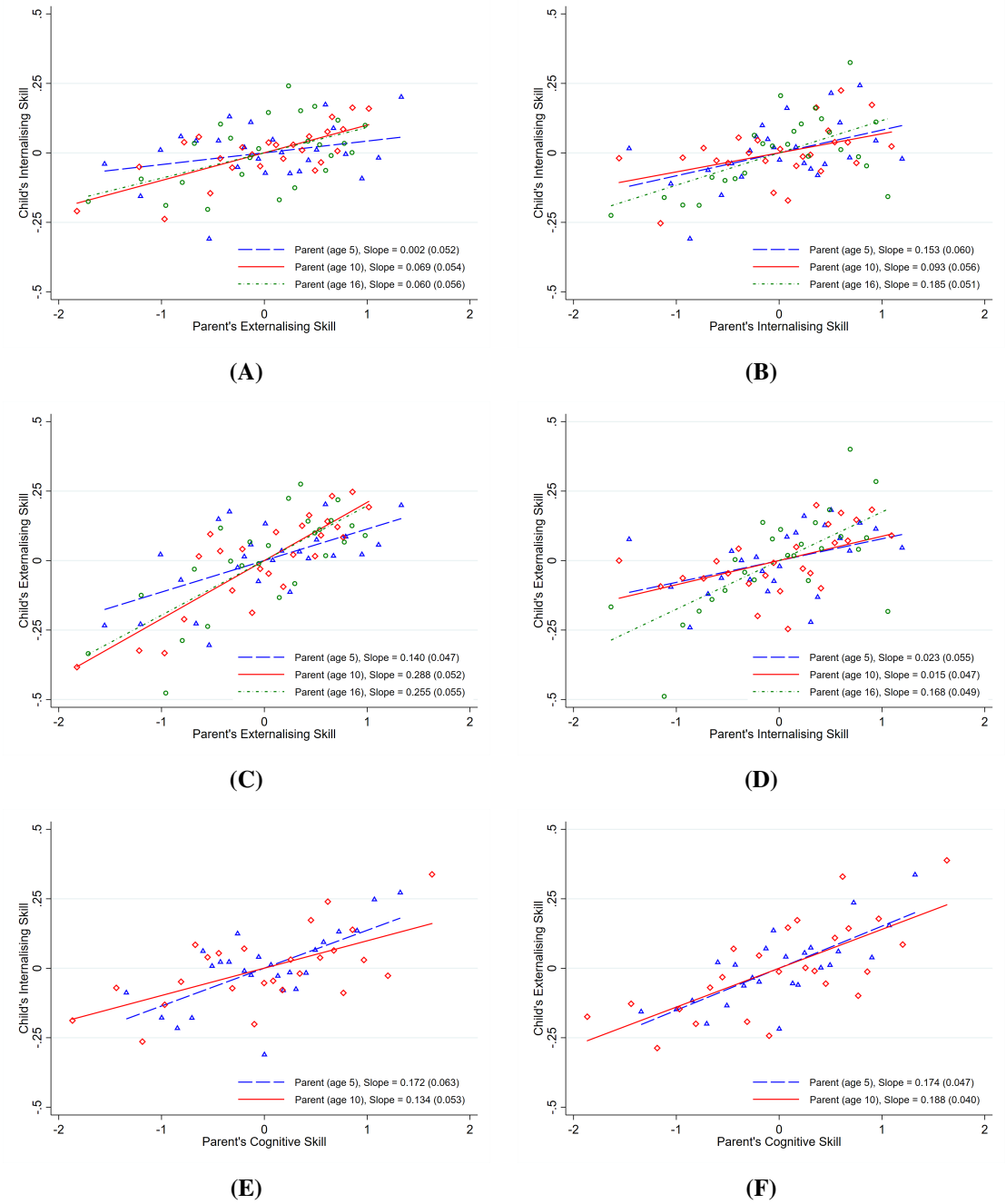
Note. The Table presents estimates for equation 4 on the intergenerational mobility in socio-emotional skills. The measurement system and the intergenerational mobility equation are estimated jointly. The internalising skill is derived by a factor model that considers 3 items (unhappy, worried and fearful) common across the 4 different sweeps to assure comparability/measurement invariance across measures (the age-34 measure comes from the Malaise questionnaire). Other controls include the parent's gender, the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education on 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

When we use contemporaneously measured internalising skills for parents and children, the estimated coefficient on parent's internalising skill (column 2, Table 6) is twice as large as the one we estimate when using measures of socio-emotional skills collected in different waves during childhood both for parents and children (column 1, Table 6). Moreover, as is apparent from comparing the R^2 of the different columns, parental skills measured contemporaneously are better predictors of children skills.

the regression model from both the dependent and independent variable of interest and performing a simple regression using those residuals. Note here nonetheless that we also estimate the skills simultaneously.

[16]We focus on internalising skill to assure comparability/measurement invariance of skills across different ages as internalising skill can be measured with similarly-worded questionnaire items (i.e., unhappy, worried and fearful) for children and parents during childhood and adulthood (the age-34 measure comes from the Malaise questionnaire). Interestingly, our estimates of intergenerational mobility do not change even if we use fewer items to measure socio-emotional skills. We notice that the estimates of mobility in Column 2 in Panel A of Table 4 are robust and similar to the ones in column 1 in Table 6.

Figure 2: Association between the children's residualised socio-emotional skills and the parents' residualised skills at different ages.



Note. These figures present binned scatter plots of the relationship between the children's and the parent's residualised skills. Each panel plots the mean child skill within each parent skill bin. To construct each series, we group parents into 25 equally sized (4 percentile points) bins and plot the mean child's skill versus the mean parent's skill within each bin. The slopes are obtained by estimating the measurement system and the mobility equation jointly. All standard errors in parentheses are obtained using 200 bootstrap repetitions.

The larger role played by skills measured during adulthood could occur for several reasons. The transmission of skills may appear more persistent due to contemporaneous environmental

factors or reverse causality, leading to greater correlation between parents and children's skills. Instead, skills measured during childhood may not have fully developed yet, which could explain the smaller coefficient estimate.The estimated coefficient is even higher when one instruments the contemporaneously measured parental internalising skill with parental internalising skill measured at age 26. This pattern is also observed in Dohmen et al. (2011) when contemporaneously measured parental trust and risk attitudes are instrumented (see Tables 1 and 5 in their paper). This indicates that, even when instrumented, estimates using contemporaneously measured parental skills are much higher than those measured in childhood.

To better understand this phenomenon, in Column 3 of Table 6 we relate children's skills with parental skills as measured both during childhood and adulthood. Interestingly, both skills are important predictors, underscoring the sensitivity of the estimates to the timing of skill measurement. The coefficient on parental skill measured during adulthood, however, is estimated to be almost three times larger than that on skills measured during childhood.

5.3 Intergenerational rank transitions

We now turn to a different measure of mobility, relating the position in the skill distribution of the 1970 cohort with the position of their children. We do so in Table 7, which reports the transition matrices from the quintile of a skill distribution a parent belongs to, to the quintile of a skill their child is. For the parents we consider internalising, externalising and cognitive skills during childhood, while for the child we consider externalising and internalising skills.

In particular, the transition probabilities report measures of directional mobility, highlighting how mobility may change at different quintiles of the skill distribution. One advantage of reporting transition matrices is to gain a better understanding on whether intergenerational persistence in socio-emotional skills arises from what happens in the tails. For each matrix, we also present the *'spectral gap mobility index'* introduced earlier to facilitate comparison across matrices.[17]

Interestingly, children of very low- or very high-skill parents mostly stay in the same quintile as their parents, while children of parents in the middle of the skills distribution often end up in a different quintile from their parents. We also notice that there are large variations in the percentage of children staying in the same quintile of their parents as well as those moving up or down across different skills and ages. The probability of moving from the lowest to the highest quintile ranges from 13.1 to 17.7, highlighting the importance of distinguishing between skills.

The *'spectral gap mobility index'* indicates that the intergenerational transition matrix with higher mobility is the one relating the child's internalising skill to the parent's externalising skill during childhood, while the one with lower mobility is the one relating the child's externalising skill to the parent's externalising skill during childhood. The correlation between the *'spectral gap mobility index'* and the intergenerational mobility coefficients without any controls is -0.898 (the correlation is negative because a higher coefficient implies lower mobility, while a high spectral gap mobility index implies higher mobility).

[17] Bootstrap standard errors of the *'spectral gap mobility index'* from 200 repetitions are presented in parentheses.

Table 7: Intergenerational transition matrix

Child's EXT - Parent's EXT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	33.5	15.9	19.3	14.9	12.5
	2	21.3	21.7	21.7	17.8	19.9
	3	18.3	21.3	22.2	18.3	19
	4	12.7	21.3	13.5	24	26.9
	5	14.2	19.8	23.2	25	21.8

Spectral gap mobility index: 0.800 (0.038)

Child's INT - Parent's EXT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	25.4	13.5	18.8	15.4	22.2
	2	26.9	21.7	21.3	17.8	13.9
	3	18.8	19.8	17.4	22.6	21.3
	4	15.2	21.3	20.8	23.1	21.8
	5	13.7	23.7	21.7	21.2	20.8

Spectral gap mobility index: 0.913 (0.025)

Child's EXT - Parent's INT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	17.2	21.4	18.8	20.3	17.5
	2	24.2	21.4	15.5	24.6	17.1
	3	18.7	19.4	20.3	17.4	23
	4	22.2	19.4	23.2	18.8	15.7
	5	17.7	18.4	22.2	18.8	26.7

Spectral gap mobility index: 0.898 (0.031)

Child's INT - Parent's INT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	22.7	20.4	18.8	16.9	16.6
	2	21.2	25.7	17.4	19.8	17.1
	3	22.2	18.4	24.2	18.8	16.6
	4	18.7	18.4	20.3	21.7	23
	5	15.2	17	19.3	22.7	26.7

Spectral gap mobility index: 0.885 (0.034)

Child's EXT - Parent's COG (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	26.3	22.8	17.3	20.3	9.3
	2	23.2	19.9	21.6	19.3	18.5
	3	19.7	24.3	14.9	21.3	19
	4	15.7	17	23.1	15.5	27.3
	5	15.2	16	23.1	23.7	25.9

Spectral gap mobility index: 0.844 (0.035)

Child's INT - Parent's COG (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	25.8	20.4	17.8	18.4	13.4
	2	25.8	22.3	20.2	20.3	13
	3	16.2	22.8	19.7	20.3	20.8
	4	19.2	15	18.8	23.2	25.9
	5	13.1	19.4	23.6	17.9	26.9

Spectral gap mobility index: 0.862 (0.038)

Note. The Tables present the percent frequency with which a child is in certain skill quintile (row) when parent is in a certain skill quintile (column). The spectral gap mobility index is computed by taking the difference between one and the second largest eigenvalues of the transition matrices. The transition matrices are stochastic matrices; therefore, their largest eigenvalue is always one. The discrepancy between one and the second largest could be seen as a departure from zero mobility, which corresponds to an identity matrix. Higher numbers of the spectral gap mobility index corresponds to higher mobility. All standard errors of the spectral gap mobility index in parentheses are obtained using 200 bootstrap repetition, taking into account the factor estimation stage that precedes the estimation of the transition matrix and its respective eigenvalues.

As we did with our previous measure of intergenerational mobility, we also consider the transition matrices reported in Table 7 for the mother-child and father-child pairs, which we report in Appendix Tables C8 and C9. Examining the transition probabilities by gender directly unveils heterogeneities not readily apparent when focusing solely on the spectral gap mobility index. To highlight these patterns, Table 8 presents the difference between the mother-child and father-child transition matrices.

On average, we observe lower mobility in the mother-child transition matrices. Namely, there tends to be a higher probability for the child to stay in same quintile as the mother compared to a father in the same quintile and a lower relative probability of moving to another quintile. This can be observed when comparing the diagonals, which indicate the probability of the child staying in the same quintile as the mother minus the probability of staying in the same quintile as the father, as reported in Table 8. Furthermore, there is lower mobility at the lower end for mother-child pairs compared to father-child pairs. Specifically, the probability of children ending up in the first quintile is consistently higher when the mother is in the first quintile, indicating a more

Table 8: Difference in intergenerational transition matrix between mother-child and father-child

Child's EXT - Parent's EXT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	**8.5**	-0.3	-10.8	5.2	-3.0
	2	5.1	**0.5**	4.2	-7.4	-2.4
	3	1.7	3.2	**-8.8**	1.3	3.4
	4	-9.5	-13.3	7.8	**3.4**	9.0
	5	-6.0	9.9	7.5	-2.4	**-6.9**

Δ Spectral gap mobility index: -0.057

Child's INT - Parent's EXT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	**8.5**	2.6	-6.1	-1.9	-3.1
	2	-3.7	**6.9**	-8.1	-5.7	9.0
	3	-3.7	-6.6	**4.0**	6.7	1.9
	4	0.1	-2.6	1.5	**2.8**	1.1
	5	-1.1	-0.3	8.8	-1.9	**-8.8**

Δ Spectral gap mobility index: 0.018

Child's EXT - Parent's INT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	**6.0**	-0.4	13.8	-13	-6.1
	2	-3.3	**1.4**	7.8	-13.8	7.2
	3	-9.7	-4.4	**-3.1**	8.4	8.7
	4	6.0	-2.4	-9.2	**6.0**	-2.3
	5	0.9	5.8	-9.3	12.4	**-7.6**

Δ Spectral gap mobility index: 0.075

Child's INT - Parent's INT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	**18.1**	-6.0	13.1	-18.6	-5.7
	2	-10.0	**2.5**	4.6	5.3	-4.2
	3	-14.8	-2.3	**11.2**	1.4	6.4
	4	5.1	6.2	-16.9	**3.4**	5.2
	5	1.6	-0.4	-12.0	8.7	**-1.6**

Δ Spectral gap mobility index: 0.045

Child's EXT - Parent's COG (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	**13.0**	3.2	-9.6	-5.8	-0.6
	2	-5.2	**5.0**	-1.5	-4.6	5.5
	3	-0.1	5.4	**0.5**	0.5	-5.2
	4	-2.7	-10.4	12.7	**-1.3**	-0.3
	5	-5.0	-3.2	-2.0	11.0	**0.7**

Δ Spectral gap mobility index: -0.093

Child's INT - Parent's COG (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	**6.5**	3.4	-7.6	-2.2	-0.2
	2	-1.4	**8.3**	-2.9	-11.0	5.3
	3	-1.3	-0.9	**3.3**	-7.4	8.5
	4	-1.7	-5.4	8.0	**13.7**	-11.2
	5	-2.0	-5.4	-0.9	6.9	**-2.5**

Δ Spectral gap mobility index: -0.050

Note. The Table presents the difference in intergenerational transition matrix between mother-child and father-child (i.e., the mother-child transition matrix minus the father-child transition matrix). The Δ spectral gap mobility index is the difference in the spectral gap mobility index between mother-child and father-child one.

challenging escape from the bottom of the distribution for children whose mothers have lower skills. This contrasts with the situation at the top of the distribution, where the pattern is reversed. Notably, children with fathers at the top are more likely to remain at the top quintile than those with mothers at the top.

6 Multi-generational persistence in socio-emotional skills

During the 1975, 1980 and 1986 sweeps, the mothers of the subjects (i.e., grandmothers to the children of the 1970 cohort) were also asked some socio-emotional related questions. We exploit these data to study multi-generational persistence in socio-emotional skills, that is, the relationship between the grandmother and grandchild's socio-emotional skills.

The data on the grandmother's socio-emotional skill in adulthood come from the cohort members' mothers who have completed the Malaise Inventory (Rutter et al., 1970) in the 1975, 1980 and 1986 sweeps. Appendix Table D1 presents the set of 24 'yes-no' self-completion questions asked to the grandmothers to measure their levels of psychological distress, or depression.[18] For

[18]The 1975-sweep scale is binary, the 1980-sweep scale is continuous from 0 to 100 and the-1986 sweep scale has 3 categories. We convert them to binary. The continuous scale between 0 and 100 (where 100 means "seldom or never")

example, individuals responding 'yes' to eight or more of the 24 items are considered to be at risk of depression.[19]

We use comparable information between grandmothers and grandchildren, shown in Appendix Table D2, to measure the grandmother's and grandchild's 'internalising skills'. Subsequently, we estimate the measurement system and the multi-generational mobility equation jointly.

Table 9 presents the estimates of multi-generational mobility. Panel A presents the estimates for internalising skill, while Panel B for externalising skill. Column 1 of both panels presents the intergenerational mobility estimates when we correlate the grandmother's internalising skill to the parent's internalising (Panel A) and externalising skill (Panel B). In this instance, the measures of skills for the mothers (aged around 25 years old in 1975) and the cohort members are contemporaneous. These results hint at the bias that we highlight in Section 5 when we estimate intergenerational mobility in socio-emotional skills using contemporaneous measures. The intergenerational mobility coefficients obtained from using contemporaneous measures of socio-emotional skills are larger than the ones in Section 5 when we used parents' socio-emotional skills *before they reached adulthood*

Columns (2)-(5) present the estimates for multi-generational persistence in the internalising and externalising skills in Panels A and B. The estimates show that the grandmother's internalising skill in adulthood is predictive of the grandchild's internalising and externalising skills during childhood. This finding hints at a strong persistence in socio-emotional skills, which goes back even to the grandmother's generation.[20]

These findings complement the literature investigating multi-generational mobility in mental health, which is related to a certain extent to socio-emotional skills. For example, Johnson et al. (2013) and Hancock et al. (2013) study multi-generational mobility in mental health in the UK and Australia respectively. Their approach to study multi-generational mobility, however, does not consider the multi-dimensionality of children's skills. In addition, their estimates may suffer from some of the problems, which we have mentioned in the introduction and discussed in Section 5, as they use contemporaneous measures of parents' and children's mental health, which could lead to reverse causality if the disruptive child affects the parents' mental health.[21]

is recoded 'no behavioural problem' (dummy equal to 1) if the answer is below 70. We have tried different cutoffs and the results are robust.

[19] Rodgers et al. (1999) show that that the internal consistency of the scale is acceptable and holds in different socioeconomic groups. Rutter et al. (1970) notice that 'the inventory differentiates moderately well between individuals with and without psychiatric disorder.

[20] Adermon et al. (2021) study long-run intergenerational persistence in human capital, proxied by the child's GPA in the last year of compulsory schooling, using information on outcomes for the extended family in Sweden. Their results point to the importance of considering extended families, spanning from grandparents to parents' cousins.

[21] Johnson et al. (2013) construct a measure of grandchildren's mental health, which is not directly comparable to grandmothers and parents' one because they use questionnaires containing different items and obtain their measure by averaging the responses, instead of estimating a factor model.

Table 9: Multi-generational mobility in socio-emotional skills

Panel A: grandchild's internalising skill					
Dependent variable:	**Parent's Internalising Skill**	**Grandchild's Internalising Skill**			
	(1)	(2)	(3)	(4)	(5)
Grandmother's INT	0.708***	0.138***	0.117**	0.137***	0.074
	(0.071)	(0.053)	(0.049)	(0.051)	(0.075)
Parent's COG (during childhood)			0.164***	0.176***	0.184***
			(0.051)	(0.054)	(0.049)
Parent's EXT (during childhood)				-0.054	-0.094
				(0.059)	(0.063)
Parent's INT (during childhood)					0.145*
					(0.075)
Observations	994	994	994	994	994
R^2	0.350	0.078	0.102	0.103	0.115
Region of birth FE (BCS70 5y)	Yes	Yes	Yes	Yes	Yes
Child's age FE	No	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Panel B: grandchild's externalising skill					
Dependent variable:	**Parent's Externalising Skill**	**Grandchild's Externalising Skill**			
	(1)	(2)	(3)	(4)	(5)
Grandmother's INT	0.478***	0.159***	0.132***	0.058	0.108*
	(0.048)	(0.043)	(0.043)	(0.051)	(0.057)
Parent's COG (during childhood)			0.231***	0.196***	0.191***
			(0.039)	(0.046)	(0.044)
Parent's EXT (during childhood)				0.191***	0.221***
				(0.058)	(0.051)
Parent's INT (during childhood)					-0.106*
					(0.062)
Observations	994	994	994	994	994
R^2	0.207	0.063	0.110	0.135	0.141
Region of birth FE (BCS70 5y)	Yes	Yes	Yes	Yes	Yes
Child's age FE	No	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes

Note. The Table presents estimates for the multi-generational mobility in socio-emotional skills. The measurement system and the mobility equation are estimated jointly. Other controls include the cohort member's gender, the age of the cohort member's mother at birth, the grandchild's gender. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

7 Conclusion

This study investigates intergenerational mobility in skills during childhood in the United Kingdom, using unique data from the 1970 British Cohort Study. We document that parental skills *during childhood* are predictive of their children's socio-emotional skills *during childhood*. These results contribute to the literature by tackling some of the concerns from previous estimates of intergenerational skill transmission.

First, we depart from previous research by incorporating multiple assessments of parental

socio-emotional skills gathered throughout *both childhood and adulthood*. This is in contrast to prior literature, that primarily focuses on measuring parental socio-emotional skills exclusively during adulthood. By examining skills across different stages of life, we show that the transmission of skills from parents to children becomes increasingly persistent when parental skills are measured later in life. It is also important to note that the measurement of parents' and children's socio-emotional skills does not occur concurrently in the BCS70. As a result, we can reasonably infer that the primary direction of intergenerational transmission is from parents to children, thereby ruling out the possibility of children influencing their parents' skills.

Second, we estimate heterogeneity in the transmission process *by mother and father* and move beyond estimating the intergenerational transmission by correlating parents and children. We find that most of the transmission occurs from mothers to children.

Finally, multi-generational mobility in socio-emotional skills is investigated, presenting evidence that the transmission of socio-emotional skills remains persistent. The grandmother's socio-emotional skill predicts her own grandchild's socio-emotional skills.

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Appendices to "Intergenerational Mobility in Socio-emotional Skills"

A Measurement invariance

As in Attanasio et al. (2020), we test for measurement invariance since any comparison between socio-emotional skills across different generations requires that the socio-emotional measures we derived have the same relationship with the latent constructs (Vandenberg and Lance, 2000; Putnick and Bornstein, 2016). Specifically, the items in the age-5, 10 and 16 sweeps for the cohort members and the child-sweep must measure internalising and externalising in the same way.

This is a formally testable property following the assumptions introduced by Wu and Estabrook (2016). Intuitively, this is done by comparing the baseline model, namely the minimal identifiable model, with a series of models with stronger restrictions on the item- and cohort-specific intercepts v_{ic} and loadings λ_{ic}, requiring them to be the same across groups. Their fit is compared to see if the models with stronger restrictions have a worse fit. If this is not the case, invariance is achieved.

We estimate three models with additional restrictions that we can compare with the baseline model and assess their relative fit. First, we estimate the threshold invariant model which is observationally equivalent to the baseline model when each item is a categorical variable with three categories (Wu and Estabrook, 2016). We highlight that the number of parameters and fit are indeed the same for the baseline and threshold invariant model.

Second, we estimate the loading- and threshold-invariant model, which imposes stronger restrictions. Namely, we impose that the factor loadings λ_{ic} and the threshold on the parameters must be the same between parents and children. This means that the items in the Rutter/SDQ scale from the children and parents have the same relationship with the latent skill because the factor loadings are the same across groups. If the fit of the model is similar to the baseline one, then socio-emotional skills can be placed on the same scale and we can compare the variance.

Third, we estimate a loading-, threshold-, and intercept-invariant model. Namely, we impose that the factor loadings λ_{jc}, the intercepts v_{jc} and the threshold be the same between parents and children. If the fit of the model does not worsen compared to the baseline model, we can also compare the means of the socio-emotional skills between the two groups.

Table A1 compares the fit of each model. We first present the χ^2 statistic, but also other alternative goodness-of-fit indices commonly used, such as the root mean squared error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis index (TLI).[2]

The baseline model fits the data well. When we restrict the threshold and loadings to be the same across groups, this yields a fit comparable to the baseline one. The fit worsens when we also

[2]The RMSEA is defined as $\sqrt{(\chi^2 - df)/df(N-1)}$, where df are the degrees of freedom and N is the sample size. Lower values imply a better fit and MacCallum et al. (1996) suggest measures between 0.05 and 0.08 to be fair. On the other hand, CFI and TLI determine how far our model is from the model where the variables have no correlation across them). The CFI is defined as $(\epsilon_{\text{Null Model}} - \epsilon_{\text{Alternative Model}})/\epsilon_{\text{Null Model}}$, where $\epsilon = \chi^2 - df$, whereas the TLI is defined as $(\epsilon_{\text{Null Model}} - \epsilon_{\text{Alternative Model}})/(\epsilon_{\text{Null Model}} - 1)$, where now $\epsilon = \chi^2/df$. Both indices are between 0 and 1 and a higher value corresponds to a better fit for the alternative model.

Table A1: Measurement invariance fit comparison

Model	Number of parameters	χ^2	RMSEA	CFI	TLI
Baseline model/ Threshold Invariance	136	1876.094	0.060	0.959	0.948
Threshold and loading invariance	108	2803.019	0.069	0.938	0.932
Threshold, loading, and intercept invariance	81	6457.661	0.100	0.851	0.856

Note. The table compares the optimal number of factors suggested by different approaches. RMSEA stands for the root mean squared error of approximation, CFI for the comparative fit index, and TLI for the Tucker-Lewis index.

restrict the intercepts to be the same, but still provides comparable fit according to the measures above.

B Joint Estimation of Regressions and Factor Model

We outline here the estimation method developed by Muthen (1984) in the psychometric literature to estimate structural equation models (SEM) with categorical items.[3] We adopt this approach to estimate each of the regressions proposed in Section 4 jointly with the factor model introduced in Section 3.2. Since social-emotional skills correspond to the factors in the model presented in Section 3.2, an intuitive estimation strategy would proceed in two steps. First, the factor model is estimated. Second, the predicted factors from the factor model are used in the regression. Because the estimation error in the first step would emulate a measurement error, this might lead to concerns about measurement error bias. The joint estimation of the regression of interest and factor model addresses this potential concern.

We briefly describe here the strategy proposed by Muthen (1984) to estimate the measurement system and the regression jointly. The estimation protocol first estimates the parameters for the "reduced form" implied by the factor model and regression of interest. This is a categorical model for the observed item responses Z_{ijc} as functions of the observable covariates $\mathbf{X}_i$ in the regression of interest. These reduced form parameters comprise the thresholds τ_{jc} and intercept, slope and covariance parameters that are functions of the "structural" parameters in the factor model and regression of interest. Letting σ denote the reduced form parameters (as in Muthen (1984)) and θ denote the structural parameters, we thus have that $\sigma = g(\theta)$ for a known function $g(\cdot)$. Given the normality assumption on u_{ijc}, the reduced form parameters collected in σ can be estimated by maximum likelihood methods. Let $\hat{\sigma}$ denote the estimates obtained in this initial stage.

Once the estimates $\hat{\sigma}$ are obtained, the procedure fits the structural parameters using a minimum distance estimator based on the following objective function:

$$F_W(\theta) = (g(\theta) - \hat{\sigma})^\top \mathbf{W}^{-1}(g(\theta) - \hat{\sigma}), \tag{6}$$

for a weight matrix $\mathbf{W}$, to be minimised with respect to θ. Muthen (1984) suggests using as $\mathbf{W}$ a consistent estimator for asymptotic covariance matrix of $\hat{\sigma}$. The corresponding estimator for θ is referred to in the psychometrics literature as the Weighted Least Squares (WLS) estimator. Alter-

[3] Goldberger (1971) is an excellent review of the common themes between econometrics and psychometrics.

native weight matrices, computationally more tractable and often better performing statistically in small samples, are instead: (1) the diagonal of **W** (Diagonally Weighted Least Squares, DWLS) or the (2) the identity matrix (Unweighted Least Squares, ULS). We adopt the DWLS weight matrix in the estimation. The estimation is carried out through the R Lavaan package version 0.6-8 (Rosseel, 2012).

C Mobility in socio-emotional skills

C.1 Heckman selection

Table C1: Heckman selection: Intergenerational mobility in socio-emotional skills

Dependent variable:	**Child's Internalising (INT) Skill**		**Child's Externalising (EXT) Skill**	
	(1)	(2)	(3)	(4)
Parent's INT (during childhood)	0.192***	0.177**	-0.040	-0.059
	(0.067)	(0.067)	(0.057)	(0.053)
Parent's EXT (during childhood)	-0.082	-0.082	0.243***	0.243***
	(0.071)	(0.075)	(0.054)	(0.059)
Parent's COG (during childhood)	0.157**	0.168**	0.153***	0.173***
	(0.052)	(0.057)	(0.041)	(0.044)
Inverse Mills ration		-0.228		-0.279
		(0.195)		(0.203)
Observations	1035	1035	1035	1035
R^2	0.135	0.138	0.165	0.172
Heckman selection	No	Yes	No	Yes
Region of birth FE (BCS70 5y)	Yes	Yes	Yes	Yes
Child's age FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Note. The Table presents estimates for equation 4 on the intergenerational mobility in skills (regression of child's socio-emotional skills on parent's skills *during childhood*). Even columns present the estimates for the Heckman selection model. In the Heckman selection model for the fertility decision at age 34, we add marital status alongside other cohort member covariates in the selection equation. The measurement system and the intergenerational mobility equation are estimated jointly. Other controls include the parent's gender, the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

C.2 Mobility in socio-emotional skills by gender

Table C2: Intergenerational mobility in internalising skill by the parent's gender

Panel A: Child-mother

Dependent variable:	Child's Internalising (INT) Skill					
	(1)	(2)	(3)	(4)	(5)	(6)
Parent's INT (during childhood)	0.219***	0.195***		0.173***		0.221***
	(0.062)	(0.059)		(0.055)		(0.081)
Parent's EXT (during childhood)			0.060		0.010	-0.096
			(0.061)		(0.073)	(0.079)
Parent's COG (during childhood)				0.153***	0.174**	0.173**
				(0.057)	(0.089)	(0.063)
Observations	752	752	752	752	752	752
R^2	0.046	0.136	0.105	0.153	0.126	0.159
Region of birth FE (BCS70 5y)	No	Yes	Yes	Yes	Yes	Yes
Child's age FE	No	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	Yes	Yes	Yes	Yes

Panel B: Child-father

Dependent variable:	Child's Internalising (INT) Skill					
	(1)	(2)	(3)	(4)	(5)	(6)
Parent's INT (during childhood)	-0.011	0.090		0.087		0.152
	(0.109)	(0.113)		(0.107)		(0.158)
Parent's EXT (during childhood)			-0.006		0.023	-0.099
			(0.107)		(0.123)	(0.150)
Parent's COG (during childhood)				0.148*	0.155	0.164
				(0.090)	(0.096)	(0.145)
Observations	283	283	283	283	283	283
R^2	0.000	0.144	0.138	0.163	0.158	0.165
Region of birth FE (BCS70 5y)	No	Yes	Yes	Yes	Yes	Yes
Child's age FE	No	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	Yes	Yes	Yes	Yes

Note. The Table presents estimates for equation 4 on the intergenerational mobility in skills (regression of child's socio-emotional skills on parent's skills *during childhood*). The measurement system and the intergenerational mobility equation are estimated jointly. Other controls include the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

Table C3: Intergenerational mobility in externalising skills by the parent's gender

Panel A: Child-mother						
Dependent variable:	**Child's Externalising (EXT) Skill**					
	(1)	(2)	(3)	(4)	(5)	(6)
Parent's INT (during childhood)			0.097**		0.063	-0.065
			(0.048)		(0.050)	(0.074)
Parent's EXT (during childhood)	0.300***	0.303***		0.253***		0.288***
	(0.054)	(0.057)		(0.060)		(0.072)
Parent's COG (during childhood)				0.190***	0.245***	0.190***
				(0.054)	(0.047)	(0.058)
Observations	752	752	752	752	752	752
R^2	0.083	0.152	0.082	0.179	0.133	0.182
Region of birth FE (BCS70 5y)	No	Yes	Yes	Yes	Yes	Yes
Child's age FE	No	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	Yes	Yes	Yes	Yes

Panel B: Child-father						
Dependent variable:	**Child's Externalising (EXT) Skill**					
	(1)	(2)	(3)	(4)	(5)	(6)
Parent's INT (during childhood)			0.075		0.071	0.070
			(0.105)		(0.116)	(0.171)
Parent's EXT (during childhood)	0.094	0.093		0.081		0.045
	(0.104)	(0.099)		(0.091)		(0.159)
Parent's COG (during childhood)				0.113	0.119	0.114
				(0.096)	(0.115)	(0.114)
Observations	283	283	283	283	283	283
R^2	0.009	0.161	0.159	0.171	0.170	0.174
Region of birth FE (BCS70 5y)	No	Yes	Yes	Yes	Yes	Yes
Child's age FE	No	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	Yes	Yes	Yes	Yes

Note. The Table presents estimates for equation 4 on the intergenerational mobility in skills (regression of child's socio-emotional skills on parent's skills *during childhood*). The measurement system and the intergenerational mobility equation are estimated jointly. Other controls include the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

Table C4: Intergenerational mobility in socio-emotional skills by the parent's gender (randomly selected sample of mothers and children, ensuring that it matches the size of the sample of fathers and children)

Panel: Child-mother		
Dependent variable:	**Child's Internalising (INT) Skill**	**Child's Externalising (EXT) Skill**
	(1)	(2)
Parent's INT (during childhood)	0.311**	
	(0.125)	
Parent's EXT (during childhood)		0.350***
		(0.094)
Observations	283	283
Region of birth FE (BCS70 5y)	No	No
Child's age FE	No	No
Other controls	No	No

Note. The Table presents estimates for equation 4 on the intergenerational mobility in skills for the mother-child sample. The mother-child sample is randomly selected, ensuring that it matches the size of the sample of fathers and children. The measurement system and the intergenerational mobility equation are estimated jointly. Other controls include the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

Table C5: Heckman selection: Intergenerational mobility in socio-emotional skills by the parent's gender

Dependent variable:	**Child's Internalising (INT) Skill**		**Child's Externalising (EXT) Skill**	
	Mother-child	**Father-child**	**Mother-child**	**Father-child**
	(1)	(2)	(3)	(4)
Parent's INT (during childhood)	0.197***	0.161	-0.090	0.069
	(0.071)	(0.159)	(0.072)	(0.135)
Parent's EXT (during childhood)	-0.087	-0.099	0.291***	0.043
	(0.094)	(0.191)	(0.072)	(0.136)
Parent's COG (during childhood)	0.175**	0.088	0.213***	0.135
	(0.070)	(0.142)	(0.050)	(0.207)
Inverse Mills ration	-0.360*	0.667	-0.307	-0.080
	(0.209)	(0.609)	(0.191)	(0.494)
Observations	752	283	752	283
R^2	0.162	0.157	0.191	0.178
Heckman selection	Yes	Yes	Yes	Yes
Region of birth FE (BCS70 5y)	Yes	Yes	Yes	Yes
Child's age FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes

Note. The Table presents estimates for the Heckman selection model for equation 4 on the intergenerational mobility in skills by the parent's gender (regression of child's socio-emotional skills on parent's skills *during childhood*). In the Heckman selection model for the fertility decision at age 34, we add marital status alongside other cohort member covariates in the selection equation. The measurement system and the intergenerational mobility equation are estimated jointly. Other controls include the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

C.3 Robustness: Mobility estimates with items from questionnaire administered to teachers at the age-10 sweep

To address any concerns about misreporting bias, we present Table C6 which shows the estimates for equation (4) on the intergenerational mobility in socio-emotional skills during childhood, where socio-emotional skills at the age-10 sweep are derived from questionnaire administered to the teachers to the cohort members (i.e., parents) - instead of their parents directly. The estimates are indeed similar to the ones obtained in Section 5 when we use the data from the Rutter A questionnaire administered to the parents. We notice that we have missing data on 5 child-parent pairs when estimating intergenerational mobility using the teachers' data.

Similarly, Appendix Table C7 reproduces Table 5. In the father-child estimates when using the teachers' data, the model has encountered problems to converge. We have experimented with different starting values, such as setting all parameter values to zero, except the factor loadings and (residual) variances, which are set to one. Alternatively, it is also possible to set them as follows: the starting values for the factor loadings are estimated by using a two-stage least squares estimator, the residual variances of observed variables are set to half the observed variance, and all other (residual) variances are set to 0.05. The remaining parameters (regression coefficients, covariances) are set to zero. We have used the second set of starting values which leads to a lower objective function than alternative starting values.

Table C6: Intergenerational mobility regression of child's socio-emotional skills on parent's skills - Socio-emotional skills at the age-10 sweep derived from questionnaire administered to teachers to the cohort members (i.e., parents).

Dependent variable:	**Internalising (INT) Skill**			**Externalising (EXT) Skill**		
	(1)	(2)	(3)	(4)	(5)	(6)
Parent's INT (during childhood)	0.208***		0.229***	0.115**		0.037
	(0.056)		(0.068)	(0.049)		(0.052)
Parent's EXT (during childhood)		0.032	-0.050		0.243***	0.230***
		(0.059)	(0.059)		(0.046)	(0.052)
Parent's COG (during childhood)	0.116**	0.140**	0.127**	0.196***	0.149***	0.146***
	(0.052)	(0.057)	(0.056)	(0.045)	(0.048)	(0.044)
Observations	1030	1030	1030	1030	1030	1030
R^2	0.120	0.087	0.124	0.139	0.173	0.174
Region of birth FE (BCS70 5y)	Yes	Yes	Yes	Yes	Yes	Yes
Child's age FE	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes

Note. The Table presents estimates for equation 4 on the intergenerational mobility in socio-emotional skills. Socio-emotional skill at the age-10 sweep derived from the questionnaire administered to teachers. The measurement system and the intergenerational mobility equation are estimated jointly. We do not include items for disobedient and aches because teachers were not administered such questions. Other controls include the parent's gender, the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

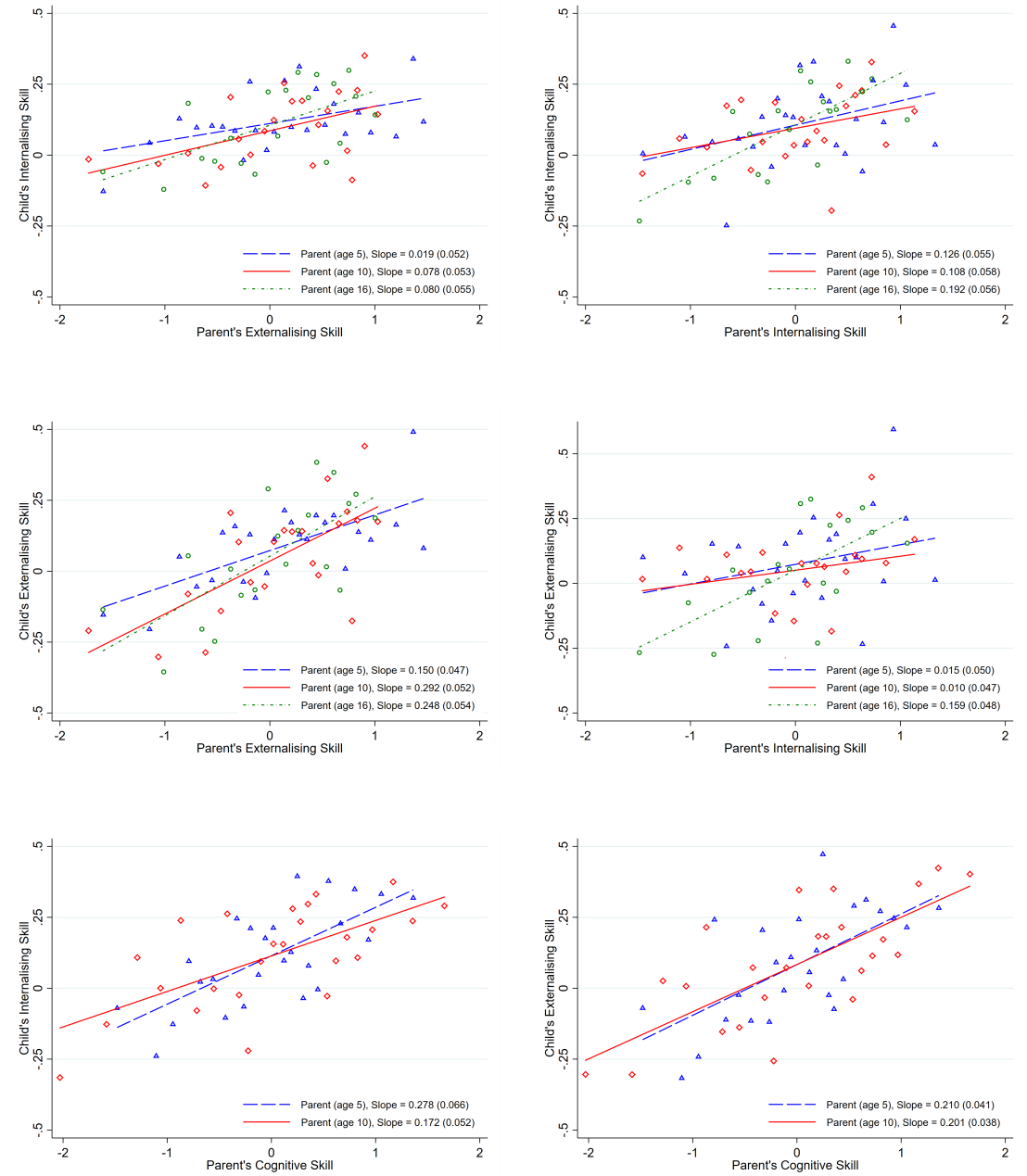
Table C7: Intergenerational mobility in socio-emotional skills by the parent's gender (age-10 sweep questionnaire administered to teachers)

Panel A: Mother-child				
Dependent variable:	**Child's Internalising (INT) Skill**		**Child's Externalising (EXT) Skill**	
	(1)	(2)	(3)	(4)
Parent's INT (during childhood)	0.347***	0.259***		0.025
	(0.069)	(0.070)		(0.067)
Parent's EXT (during childhood)		-0.008	0.328***	0.270***
		(0.074)	(0.056)	(0.072)
Parent's COG (during childhood)		0.112*		0.174***
		(0.061)		(0.058)
Observations	751	751	751	751
R^2	0.108	0.278	0.097	0.444
Region of birth FE (BCS70 5y)	No	Yes	No	Yes
Child's age FE	No	Yes	No	Yes
Other controls	No	Yes	No	Yes
Panel B: Father-child				
Dependent variable:	**Child's Internalising (INT) Skill**		**Child's Externalising (EXT) Skill**	
	(1)	(2)	(3)	(4)
Parent's INT (during childhood)	0.023	0.213		0.149
	(0.188)	(0.190)		(0.173)
Parent's EXT (during childhood)		0.249*	0.222**	0.135
		(0.156)	(0.108)	(0.120)
Parent's COG (during childhood)		0.232*		0.107
		(0.127)		(0.102)
Observations	279	279	279	279
R^2	0.001	0.413	0.047	0.389
Region of birth FE (BCS70 5y)	No	Yes	No	Yes
Child's age FE	No	Yes	No	Yes
Other controls	No	Yes	No	Yes

Note. The Table presents estimates for equation 4 on the intergenerational mobility in skills by parent's gender (regression of child's socio-emotional skills on parent's skills *during childhood*), using the age-10 sweep questionnaire administered to teachers. The measurement system and the intergenerational mobility equation are estimated jointly. Other controls include the child's gender, the number of children in the household, the mother's age at the parent's birth, a dummy equal to 1 if the parent is the first born, the parent's employment status at the age of 34, the grandmother's employment status and education in 1975 and the number of children in the parent's household when the parent is 5 years old. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).

C.4 Association between the children's and parents' socio-emotional skills at different ages

Figure C1: Association between the children's (non-residualised) socio-emotional skills and the parents' (non-residualised) skills at different ages.



Note. These figures present non-parametric binned scatter plots of the relationship between the children's and the parent's skills when we do not include any controls. Each panel plots the mean child socio-emotional skill within each parent skill bin. To construct each series, we group parents into 25 equally sized (4 percentile points) bins and plot the mean child's skill versus the mean parent's skill within each bin. The slopes are obtained by estimating the measurement system and the mobility equation jointly. All standard errors in parentheses are obtained using 200 bootstrap repetitions.

C.5 Intergenerational rank transitions by sex

Table C8: Intergenerational transition matrix (mother-child)

Child's EXT - Parent's EXT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	34	15.8	14.2	13.7	18.1
	2	21.5	23.7	20.3	16.3	18.7
	3	18.1	21.1	21.6	21.6	17.4
	4	16	17.1	20.3	20.3	26.5
	5	10.4	22.4	23.6	28.1	19.4

Spectral gap mobility index: 0.823 (0.051)

Child's INT - Parent's EXT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	28.5	15.1	13.5	15	23.2
	2	23.6	23	16.9	16.3	21.3
	3	18.1	18.4	23.6	20.3	19.4
	4	14.6	22.4	17.6	24.8	23.9
	5	15.3	21.1	28.4	23.5	12.3

Spectral gap mobility index: 0.921 (0.035)

Child's EXT - Parent's INT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	20.8	20.7	24.5	13.3	15.9
	2	20.8	20.7	18.5	21.3	19.1
	3	18.1	16.7	21.9	20.7	22.3
	4	20.8	18.7	21.2	20	19.7
	5	19.4	23.3	13.9	24.7	22.9

Spectral gap mobility index: 0.938 (0.030)

Child's INT - Parent's INT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	29.2	13.3	23.8	14.7	14.6
	2	21.5	20	22.5	19.3	17.8
	3	16.7	24	21.9	20.7	16.6
	4	18.1	22	15.2	22.7	25.5
	5	14.6	20.7	16.6	22.7	25.5

Spectral gap mobility index: 0.859 (0.037)

Child's EXT - Parent's COG (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	31.5	22.5	17.2	15.3	9.6
	2	18.9	22.5	19.9	20	19.1
	3	20.3	21.2	16.6	23.3	18.5
	4	14	15.9	25.2	18	26.8
	5	15.4	17.9	21.2	23.3	26.1

Spectral gap mobility index: 0.814 (0.044)

Child's INT - Parent's COG (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	28.7	19.2	19.2	15.3	13.4
	2	24.5	25.8	18.5	15.3	17.2
	3	15.4	21.9	21.2	20.7	20.4
	4	16.8	13.9	20.5	26	26.1
	5	14.7	19.2	20.5	22.7	22.9

Spectral gap mobility index: 0.824 (0.047)

Note. The Tables present the percent frequency with which a child is in certain skill quintile (row) when parent is in a certain skill quintile (column) for the mother-child pairs. The spectral gap mobility index is computed by taking the difference between one and the second largest eigenvalues of the transition matrices. The transition matrices are stochastic matrices; therefore, their largest eigenvalue is always one. The discrepancy between one and the second largest could be seen as a departure from zero mobility, which corresponds to an identity matrix. Higher numbers of the spectral gap mobility index corresponds to higher mobility. All standard errors of the spectral gap mobility index in parentheses are obtained using 200 bootstrap repetition, taking into account the factor estimation stage that precedes the estimation of the transition matrix and its respective eigenvalues.

Table C9: Intergenerational transition matrix (father-child)

Child's EXT - Parent's EXT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	25.5	16.1	25	8.5	21.1
	2	16.4	23.2	16.1	23.7	21.1
	3	16.4	17.9	30.4	20.3	14
	4	25.5	30.4	12.5	16.9	17.5
	5	16.4	12.5	16.1	30.5	26.3

Spectral gap mobility index: 0.880 (0.053)

Child's INT - Parent's EXT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	20	12.5	19.6	16.9	26.3
	2	27.3	16.1	25	22	12.3
	3	21.8	25	19.6	13.6	17.5
	4	14.5	25	16.1	22	22.8
	5	16.4	21.4	19.6	25.4	21.1

Spectral gap mobility index: 0.903 (0.050)

Child's EXT - Parent's INT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	14.8	21.1	10.7	26.3	22
	2	24.1	19.3	10.7	35.1	11.9
	3	27.8	21.1	25	12.3	13.6
	4	14.8	21.1	30.4	14	22
	5	18.5	17.5	23.2	12.3	30.5

Spectral gap mobility index: 0.863 (0.047)

Child's INT - Parent's INT (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	11.1	19.3	10.7	33.3	20.3
	2	31.5	17.5	17.9	14	22
	3	31.5	26.3	10.7	19.3	10.2
	4	13	15.8	32.1	19.3	20.3
	5	13	21.1	28.6	14	27.1

Spectral gap mobility index: 0.814 (0.046)

Child's EXT - Parent's COG (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	18.5	19.3	26.8	21.1	10.2
	2	24.1	17.5	21.4	24.6	13.6
	3	20.4	15.8	16.1	22.8	23.7
	4	16.7	26.3	12.5	19.3	27.1
	5	20.4	21.1	23.2	12.3	25.4

Spectral gap mobility index: 0.907 (0..051)

Child's INT - Parent's COG (during childhood)

		Parent quintile				
		1	2	3	4	5
Child quintile	1	22.2	15.8	26.8	17.5	13.6
	2	25.9	17.5	21.4	26.3	11.9
	3	16.7	22.8	17.9	28.1	11.9
	4	18.5	19.3	12.5	12.3	37.3
	5	16.7	24.6	21.4	15.8	25.4

Spectral gap mobility index: 0.874 (0.052)

Note. The Tables present the percent frequency with which a child is in certain skill quintile (row) when parent is in a certain skill quintile (column) for the father-child pairs. The spectral gap mobility index is computed by taking the difference between one and the second largest eigenvalues of the transition matrices. The transition matrices are stochastic matrices; therefore, their largest eigenvalue is always one. The discrepancy between one and the second largest could be seen as a departure from zero mobility, which corresponds to an identity matrix. Higher numbers of the spectral gap mobility index corresponds to higher mobility. All standard errors of the spectral gap mobility index in parentheses are obtained using 200 bootstrap repetition, taking into account the factor estimation stage that precedes the estimation of the transition matrix and its respective eigenvalues.

D Mother malaise questionnaire

Table D1: Malaise Inventory Questions

Cohort members' mothers (i.e. grandmothers to the children of the 1970 cohort) answered the following questions	
1. Tired Most of Time	13. Easily Upset or Irritated
2. Often Feel Depressed	14. Frightened of Going Out
3. Often Have Bad Headaches	15. Constantly Keyed Up, Jittery
4. Often Get Worried	16. Suffer From Indigestion
5. Sleeping Difficulty	17. Suffer From Upset Stomach
6. Waking Unnecessarily Early	18. Is Appetite Poor
7. Worn Out Worrying About Health	19. Everything Gets on Nerves
8. Often Get Into Violent Rage	20. Does Heart Race
9. Do People Annoy and Irritate	21. Often Have Bad Pains in Eyes
10. Had Twitching of Face,Head	22. Rheumatism, Fibrositis
11. Scared for No Good Reason	23. Had Nervous Breakdown
12. Scared to be Alone	24. Other Health Problems

Note. The table reports the Malaise inventory questions. Cohort members' mothers (i.e. grandmothers to the children of the 1970 cohort) answered them at the age-5 sweep. The Malaise inventory questions are a set of self-completion questions which combine to measure levels of psychological distress, or depression. The 24 items of the inventory are 'yes-no' questions.

Table D2: Subscale of comparable items between grandmother and grandchild

Itm.	Factor	Cat.	Title	Mother's malaise (grandmother)	Rutter Wording (Children aged 3-16)
1	INT	2	*Worried*	Often Get Worried	Many worries, often seeming worried
2	INT	2	*Fearful*	Scared for No Good Reason	Nervous or clingy in new situations,
3	INT	2	*Unhappy*	Often Feel Depressed	Often unhappy, downhearted or tearful
4	INT	2	*Aches*	Suffer From Upset Stomach stomach-ache or has vomited	Often complaining of headaches, stomach-aches or sickness
5	INT	2	*Solitary*	Scared to be alone	Rather solitary, tending to play alone

Note. Itm. is item number. Factor is the latent construct to which the item loads - EXT is externalizing skills, INT is internalizing skills. Cat. is the number of categories in which the item is coded - 2 denotes a binary item (applies/does not apply). For the Rutter Wording (Children aged 3-16), 3-category item is converted to be binary (Does not apply is 1). Title is a short label for the item. Wording columns show the actual wording in the scales used in each of the cohort studies.

E Descriptive Statistics

Table E1 reports the descriptive statistics for the sample of parent and children linked. Table E2 presents the number of responses in the BCS70 at the age-34 sweep. Table E3 reports the response rates for the questionnaire items used in the main analysis. Table E4 reports the correlation matrix of internalising and externalising skills at different ages.

Table E1: Descriptive statistics

	Household characteristics		
	Mean	St.Dev.	N
	(1)	(2)	(3)
Grandparents at age-5 sweep			
Grandmother's age	25	4.87	1035
Grandmother has higher education degree (%)	5.89	23.56	1035
Grandmother is not employed (%)	57.29	49.49	1035
Parents (BCS70 cohort members)			
Number other children in HH (5y)	1.54	1.03	1035
First born (%)	40.58	49.13	1035
Male (%)	27.34	44.59	1035
Employed at age 34 (%)	74.78	43.45	1035
Region of birth			
North (%)	19.90	39.95	1035
Yorksh. + Humbers. (%)	10.72	30.96	1035
East Midlands (%)	7.15	25.78	1035
West Midlands (%)	11.50	31.91	1035
South West (%)	7.63	26.57	1035
East + SE (%)	29.95	45.83	1035
Wales (%)	5.41	22.63	1035
Scotland (%)	7.73	26.72	1035
Children at age-34 sweep			
Total number of children	2	0.89	1035
Child's age	7	3.35	1035
Child's sex (%)	51.90	49.02	1035

Note. The mean is reported in column 1, the standard deviation in column 2, and the number of observations of parent-children link in column 3.

Table E2: Number of responses in British Cohort Study (BCS70) at the age-34 sweep

	Number of observations
BCS70 cohort members:	
Core interviews	9,665
Parent and Child Survey:	
Parent Interview	5,207
Parent self-completions:	
Children aged 0-11 months	414
Children aged 1-2 years	825
Children aged 3-5 years	1,259
Children aged 6-16 years	2,285

Note. This Table presents the sample sizes of the age 34 sweep. It contains the number of completed interviews by the cohort members and parents (namely, cohort members with children). The sample sizes are also divided by children's age for the parents. The socio-emotional skill questions were administered only to the parents who have children between the age of 3 and 16.

Table E3: Response rates for children and parents at age 5, 10, 16 and 34 sweeps

Itm.	Factor	Children	Parents (age 5)	Parents (age 10)	Parents (age 16)
1	*Restless*	0.997	0.804	0.852	0.619
2	*Squirmy/fidgety*	0.997	0.801	0.850	0.620
3	*Fights/bullies*	0.998	0.810	0.850	0.617
4	*Distracted*	0.998	0.809	0.851	0.618
5	*Tantrums*	0.998	0.775	0.813	0.625
6	*Disobedient*	0.998	0.808	0.848	0.620
7	*Worried*	0.997	0.808	0.850	0.615
8	*Fearful*	0.998	0.809	0.851	0.622
9	*Solitary*	0.997	0.807	0.852	0.619
10	*Unhappy*	0.999	0.809	0.850	0.620
11	*Aches*	0.997	0.795	0.849	0.625

Note. Itm. is item number. Title is a short label for the item. The response rate is lower at the age 16 sweep because of a teacher-led industrial strike distrupting the dissemination of the questionnaire.

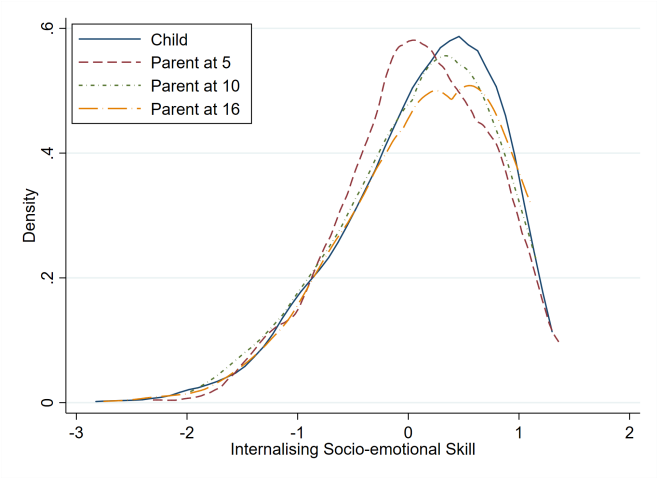
Table E4: Correlation matrix of internalizing and externalizing skills at different ages

	INT (age 5)	INT (age 10)	INT (age 16)	EXT (age 5)	EXT (age 10)	EXT (age 16)
INT (age 5)	1					
INT (age 10)	0.44	1				
INT (age 16)	0.43	0.41	1			
EXT (age 5)	0.66	0.32	0.33	1		
EXT (age 10)	0.31	0.66	0.35	0.46	1	
EXT (age 16)	0.40	0.37	0.82	0.45	0.48	1

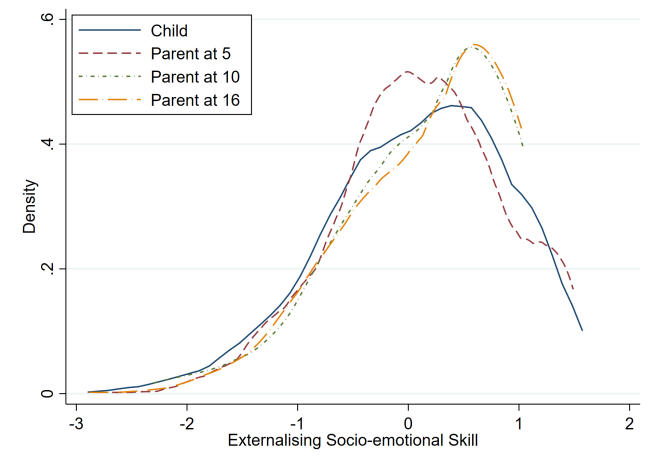
Note. The table reports the Pearson correlation of the internalizing and externalizing factor scores at different ages.

Figure E1: Distribution of Factor Scores

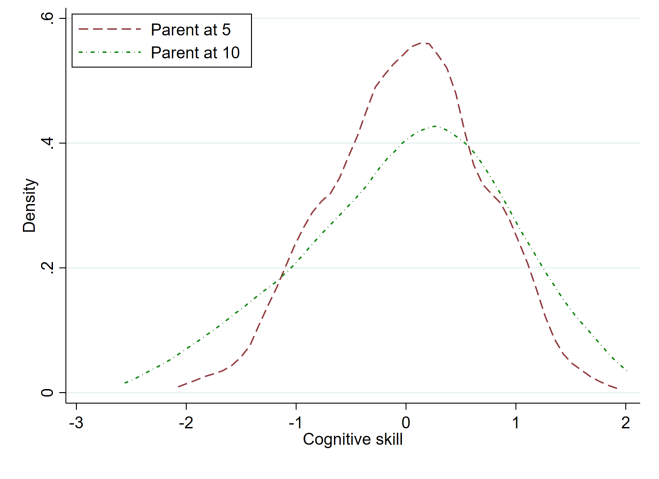
Internalising



Externalising



Cognitive



Note. These figures present the distributions of the internalising and externalising socio-emotional skills for the children and parents respectively at age 5, 10, and 16 and parents' cognitive skills at age 5 and 10. Higher scores correspond to better skills. The distribution is estimated nonparametrically, using an Epanechnikov kernel. The scale of the Rutter/SDQ items at the age-5, age-16 and child-questionnaire sweep is categorical. The scale of the Rutter items at the age-10 sweep is converted to a categorical variable. The scale of the cognitive test items is continuous.

F Relationship between skills during childhood and log pay during adulthood

Table F1 presents estimates for the regression of BCS70 parents' skills (during childhood) on economic outcomes at age 42.

Table F1: Log pay at age 42

Dependent variable:	**Log Pay (age 42)**				
	(1)	(2)	(3)	(4)	(5)
Internalizing skill (during childhood)	0.129***			0.135***	0.126**
	(0.048)			(0.052)	(0.054)
Externalizing skill (during childhood)		0.058		-0.003	-0.076
		(0.049)		(0.054)	(0.057)
Cognitive skill (during childhood)			0.217***		0.225***
			(0.033)		(0.038)
Observations	719	719	719	719	719
R^2	0.021	0.004	0.059	0.022	0.078
Controls	No	No	No	No	No

Note. The Table presents estimates for the regression of BCS70 parents' skills (during childhood) on economic outcomes at age 42 (BCS70 sample). The measurement system and the equation are estimated jointly. Gross weekly pay is weekly pre-tax pay from the respondent's main activity, conditional on being a paid employee or self-employed. The mean of weekly pre-tax log pay is 5.821. The employment rate in the sample is 85%. The cognitive skill measure comes from a factor model where three tests administered at the age of 5 and 10 are combined: Copy Designs (child is asked to copy simple designs adjacently), Human Figure Drawing (child draws an entire human figure), English Picture Vocabulary Test (child identifies the picture referring to a word among four pictures), Shortened Edinburgh Reading Test, Friendly Math Test, Spelling Dictation Task and Pictorial Language Comprehension Test. All standard errors in parentheses are obtained using 200 bootstrap repetitions (*** p<0.01, ** p<0.05, * p<0.1).