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Do Smart Parents Raise Smart Children?

The Intergenerational Transmission of Cognitive Abilities

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ABSTRACT

Complementing prior research on income mobility and educational transmission, we provide evidence on the intergenerational transmission of cognitive abilities using data from the German Socio-Economic Panel Study. Our estimates suggest that individuals' cognitive skills are positively related to the abilities of their parents, even when educational attainment and family background is controlled for. We differentiate between mothers' and fathers' IQ transmission and find different effects on the cognition of sons and daughters. We show that cognitive skills which are based on past learning are more strongly transmitted from parents to children than cognitive skills which are related to innate abilities. Our findings are not compatible with a pure genetic model, but rather point to the importance of parental investments for the cognitive outcomes of children.

JEL: J10, J24, I20

Keywords: Cognitive abilities, intergenerational IQ transmission, skill formation

Running Title: Intergenerational Transmission of Cognitive Abilities

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1. INTRODUCTION

There is abundant evidence that societal inequality is related to the transmission of economic status between parents and children. The issues typically addressed in this type of research are a) income mobility (e.g. Solon, 2002; Corak, 2006; Oreopoulos, 2003; Nicoletti and Ermisch, 2007), and b) educational attainment (e.g. Hertz et al., 2007; Heineck and Riphahn, 2008). Complementing that, there is a separate albeit small economic literature which examines whether it is the transmission of cognitive abilities that drives intergenerational correlation patterns (Agee and Crocker, 2002; Bowles and Gintis, 2002; Blanden et al., 2007; Black et al., 2008). It seems plausible that smarter parents raise smarter children, but the intergenerational transmission of cognitive abilities is still an under-researched topic in the field of economics. Cognitive abilities play a substantial role for education (Heckman and Vytlacil, 2001) and income (Hanushek and Woessmann, 2008) so that a strong intergenerational transmission of cognition could translate into higher persistence in educational and earnings inequalities. We therefore investigate the determinants of cognitive abilities and ~~to~~ compare the influence of parents' abilities, other family background variables, and education in order to direct policy measures towards less persistence in inequality.

The first study which is based on a large-scale nationally representative dataset is by Black et al. (2008) who use a Norwegian sample of fathers and their sons to calculate intergenerational IQ elasticities. Using composite IQ test scores measures at age 18, they find a strong intergenerational transmission of IQ for fathers and their sons, controlling for family size, birth order, and education.Our paper complements their study in various aspects and thus contributes to the small literature on the intergenerational transmission of cognitive skills.

First, in our data from the German Socio-Economic Panel Study (SOEP), we have both men *and* women, which allows to investigate possible gender differences in IQ transmission and to compute overall transmission effects from both parents. Our analysis is hence the first to examine separate transmission effects of fathers' *and* mothers' cognitive skills on their adult sons *and* daughters abilities using a representative dataset. Second, we examine whether intergenerational IQ transmission behaves differently according to the type of cognitive ability: Our data enable us to employ measures from two ultra-short IQ tests. Specifically, we compare the association between parents' and their children's fluid intelligence (cognitive speed) and crystallized intelligence (verbal fluency). While the former is related to individuals' innate abilities, the latter is based on learning (Cattell, 1987). The use of objective ability measures has the advantage of a lower risk of measurement error which may affect intergenerational analyses on income and education, as earnings and schooling information is mostly self-reported.[1] Finally, our rich dataset enable us to control for a large number of family background and childhood variables so that we can to some extent account for early life stage conditions which are critical for individuals' cognitive development (Shonkoff and Phillips, 2000; WHO, 2007; Ermisch 2008).

The literature considers two main channels for the transmission of cognitive abilities between generations. On the one hand, cognitive skills may be transmitted by the inheritance of genes, or "nature" (e.g. Plomin et al., 1994), as parents pass their genetic endowment on to their biological children. Cognitive skills may on the other hand be transmitted by a positive productivity effect of parental education, or "nurture" (e.g. Sacerdote 2002, Plug and Vijverberg 2003, Ermisch 2008).[2] Higher parental investment by more able parents could lead to better health and education of their offspring, which may translate into higher cognitive skills. Findings from recent research on income and educational mobility suggest the importance of both nature and nurture (e.g. Björklund et al., 2007). As our data do not allow to clearly identifying separate effects, we tentatively approximate the nature vs. nurture elements by comparing the transmission of the two types of cognitive abilities which vary in their degree of dependence on innate abilities. We also refer to recent research by Cunha and Heckman (2007) who lay out the theoretical framework for individuals' ability development, the "technology of skill formation".[3] They point out that the assumed separability of nature and nurture is obsolete as the mechanisms interact in more complex ways.[4]

Our results indicate a significant transmission of both types of cognitive abilities from parents to their children. An increase in the age-standardized cognitive ability test score of parents by one point is associated with a 0.4-point increase in coding speed and 0.5-point increase in word fluency of their children. Hence, although we control for more individual and family background variables, the IQ transmission in our study is stronger than the one found by Black et al. (2008) for Norway, where a one-point increase in father's ability is associated with an increase in the son's ability by about one third of a point. The results also point to maternal effects with respect to fluid intelligence inasmuch as mothers' speed of cognition is more important than fathers' speed test scores for the ability of both sons and daughters. Moreover, we find evidence for own-gender effects with respect to crystallized intelligence, as word fluency is transmitted more strongly from fathers to sons and from mothers to daughters. Furthermore, we find a stronger intergenerational transmission of word fluency, which is based on past experience, than of coding speed. Altogether, our findings are not compatible with a pure genetic model, but rather point to the importance of parental investments for the cognitive outcomes of children.

2. LITERATURE REVIEW

So far, the main part of the economic literature on cognitive abilities concentrates on the determination of earnings. A large number of studies reveals substantial returns to cognition, providing evidence for a positive relationship between abilities and earnings (e.g. Cameron and Heckman, 1993; Green and Riddell, 2003; Bronars and Oettinger, 2006; Anger and Heineck, 2008). Substantial returns to cognitive abilities have been found even when taking into account individuals' background characteristics and non-cognitive skills (Heckman et al., 2006; Mueller and Plug, 2006; Cebi, 2007; Heineck and Anger, 2008) which indicates that cognition plays an important role in socio-economic analyses. A recent article by Hanushek and Woessmann (2008) provides a broad overview of the literature on cognitive skills, emphasizing the importance of a population's cognitive abilities for economic growth.

While the number of studies on returns to cognitive abilities is growing, there is far less economic research on the determinants of cognition and on intergenerational mobility with respect to cognitive abilities. As outlined above, intergenerational research in economics so far concentrates heavily on the analysis of income mobility and the transmission of education.[5] The topic is however not new in psychology: Bouchard and McGue (1981) review psychological studies that show results of the correlations of cognitive abilities within family groupings. They report that "the higher the proportion of genes two family members have in common the higher the average correlation between their IQ's" (Bouchard and McGue, 1981, p. 1055), but also point to considerable environmental effects on the formation of cognitive skills. Furthermore, they do not find evidence for sex-role effects or maternal effects in their reviewed studies. The IQ correlation between parents and their children usually found in the literature ranges between 0.42 and 0.72 (Bowles and Gintis, 2002; Plomin et al., 2000). However, the datasets used by many (mostly psychological) studies are based on a small number of observations and/or lack representativeness. As one of the few economic studies, Agee and Crocker (2002) analyze the importance of parents' discount rates and mean parental IQ for their child's cognitive development using U.S. data on 256 children in the first or second grade. They control for a number of the child's background variables and find that a one-point increase in parental IQ is associated with an increase in the child's verbal IQ by one quarter of a point.[6] A study which is closely related to the literature on intergenerational IQ transmission is carried out by Brown et al. (2007) who use the British National Child Development Study (NCDS) to investigate the link between parental abilities in literacy and numeracy as a child and their children's performance in reading and mathematics. They find evidence for cross-gender effects from fathers to daughters and from mothers to sons, which are even stronger than equivalent own-gender effects. However, as literacy and numeracy are direct outcomes of schooling, it may be preferable to use IQ test scores as a more general measure of cognitive abilities. The recent study by Black et al. (2008) is an exception inasmuch as they investigate the relationship between cognitive abilities of fathers and sons using IQ test scores from a large-scale, nationally representative Norwegian sample. Employing composite IQ test scores based on three subtests conducted at age 18, they find a strong intergenerational transmission of IQ scores for fathers and their sons. A one-point increase in father's ability is associated with an increase in the son's ability by about one third of a point.

Beyond the importance of using representative data, it is relevant to analyze data that represents the whole population, i.e. both fathers *and* mothers and their sons *and* daughters. We contribute to the small economic literature on the intergenerational transmission of cognitive skills by providing evidence on both men and women and investigate gender differences in the transmission of cognitive skills. Hence, to the best of our knowledge, we are the first to examine separate transmission effects of fathers' and mothers' cognitive skills on their adult sons and daughters abilities using a representative dataset. In contrast to many other studies which use cognitive ability test scores of children who are still in school (e.g. Agee and Crocker, 2002; Heckman et al., 2006) we have the advantage of observing adult children who completed their schooling degree. Therefore, feedback effects from cognitive skills on education can be excluded. The data we use furthermore allows for the inclusion of family background and childhood characteristics and for the differentiation between two types of abilities, fluid and crystallized intelligence.

3. DATA AND METHODOLOGY

Our data are drawn from the German Socio-Economic Panel Study (SOEP). The SOEP is a representative longitudinal micro-database that provides a wide range of socio-economic information on private households and their individuals in Germany since 1984.[7] The wave 2006 provides information on cognitive abilities for respondents who were surveyed with a computer assisted personal interview (CAPI): Out of 22,665 persons, about one third were potential CAPI respondents of two ultra-short IQ-tests. In order to be able to use the test scores of the word fluency test (outlined below) we exclude 468 non-Germans from our study since individuals with migration background may have insufficient language skills and may therefore be disadvantaged compared to native speakers when taking the test. Furthermore, we exclude 665 respondents who are still in school in order to avoid feedback effects from cognitive skills on education. Further data cleaning results in an additional drop in sample size. Overall, we have 4,852 respondents with valid information on either of the two IQ-tests.

Although the advantage of the SOEP is that parents and their adult children are observed even if they do not live in the same household, the most severe reduction in sample size was due to the restriction to respondents for whom we have parental information on cognitive abilities.[8] Only for 670 individuals in our sample could either the mother or the father be identified as active SOEP respondents in the year 2006. Moreover, our analysis requires that parents too were CAPI interviewed and participated in the cognitive ability tests, which shrinks the sample by one third. We end up with a final sample of 450 observations of adult children (210 daughters, 240 sons) who took part in at least one of the tests and who could be matched to at least one of their parents with valid information on IQ test scores**.** Our sub-sample of individuals for which there is information on both parents' cognitive ability test scores comprises 251 observations.

Measures of cognitive ability

Since fully-fletched IQ tests cannot be implemented in a large-scale panel survey two ultra-short tests of cognitive ability were developed for the SOEP (Lang et al., 2007, Schupp et al., 2008) and implemented in the year 2006: a symbol correspondence test and a word fluency test. Both tests correspond to different modules of the Wechsler Adult Intelligence Scale (WAIS) which altogether comprises 14 modules, seven on verbal IQ and seven on performance IQ (Groth-Marnat, 1997; Kline, 1999).

The symbol correspondence test (SCT) was developed after the symbol-digit-modalities-test (Smith, 1995) and corresponds to a sub-module in the non-verbal section of the WAIS. The SCT is conceptually related to the mechanics of cognition or fluid intelligence. The latter comprises general and largely innate abilities and refers to the performance and speed of solving tasks that are related to new material. The test was implemented asking respondents to match as many numbers and symbols as possible within 90 seconds according to a given correspondence list which is permanently visible to the respondents on a screen.

The word fluency test (WFT) as implemented in the SOEP is similar to a sub-module in the verbal section of the WAIS and has been developed after the animal-naming-task (Lindenberger and Baltes, 1995): respondents name as many different animals as possible within 90 seconds. Using the distinction of fluid and crystallized intelligence (Cattell, 1987), the WFT is conceptually related to the pragmatics of cognition or crystallized intelligence, such as verbal knowledge. Crystallized intelligence concerns the fulfilment of rather specific tasks which improve with knowledge and skills acquired in the past.[9]

Both WFT and SCT as implemented in the SOEP produce outcomes which are sufficiently correlated with test scores of more comprehensive and well-established intelligence tests (Lang et al., 2007).[10] In the following analyses, we account for age being a strong confounding factor for IQ and IQ tests (Lindenberger and Baltes, 1995) by employing age-standardized scores from both tests.[11]

Control variables

Our main independent variables of interest are the ability test scores of individuals' parents. Ideally, we would like to include both the mother's and the fathers' test score in each estimation. However, out of 450 individuals for whom we have either the test score of the father or that of the mother only 251 individuals could be linked to both parents' test scores. We therefore do not differentiate between fathers and mothers in the first instance but – similar to Bouchard and McGue (1981) – use the average of the parents' test scores in order to maximize the number of observations. In a second step, we rerun our estimates for the subsample of individuals for whom we have the cognitive ability information for both parents in order to distinguish the effect of the father from the influence of the mother. Similar to the dependent variables, all parental test scores are age-standardized.[12]

Other potential determinants of cognitive abilities derive from family context, childhood environment (for instance, Agee and Crocker, 2002), and educational background.[13] Schooling effects are accounted for by including the following dummies for educational degrees: dropout/unknown schooling degree, high school/no college, and college/university degree; other secondary/intermediate degree is used as the reference category. We further take into account that cognitive abilities may be affected by family size

(Black et al. 2007a) and therefore include the number of brothers and sisters in our estimations. In addition, we distinguish between first-born and later-born children in our dataset: birth order has been shown to negatively affect children's IQ scores (Black et al., 2007b), although Black et al. (2008) do not find strong evidence of a large impact of birth order on intergenerational IQ transmission. Additional family background variables we use are whether a child has been raised by a single parent and dummy variables for educational degrees of both mother and father: secondary school and intermediate school degree, with no schooling degree as reference category. We further include a set of childhood area dummies: childhood in a town, city, urban area, or unknown childhood area, where childhood in a rural area serves as reference category. This is to control for individuals' childhood environment which will partially capture socio-economic conditions (health, nutrition, educational provision etc.) that are critical to cognitive development. Complementing that, we use individuals' body height - which has been shown to be a significant predictor of cognitive skill outcomes (Case and Paxson, 2008; Heineck, 2009) - as a composite indicator of health and nutritional conditions in early childhood development.

Furthermore, we use the following characteristics of the adult children as additional controls in robustness checks: work experience, unemployment experience, marital status, and region of current residence (East Germany, North, Middle, South). To take into account potential effects from physical or mental health, we control for the health status of an individual by adding a dummy variable for disability. However, we are aware that these variables are potentially endogenous and do not include them in our preferred specification.

Descriptive Evidence

The raw cognitive ability test scores, educational degrees, and the other variables used in the regression analyses are summarized in Table 1. Note that the average test scores of mothers and fathers are clearly below the test scores of the children, especially for the coding speed. This can be partially explained by the so-called *Flynn effect* which indicates a rise in average cognitive ability test scores for at least three generations (Flynn, 1994).[14] Another reason is that the ability tests have been conducted in the same year (SOEP wave 2006), and differences between parents and children can be explained by cognitive decline at old age (Lindenberger and Baltes, 1995).[15] As outlined above, we therefore employ age-standardized test scores to assess the dimension of intergenerational transmission of cognition independent of age effects.

Figure 1 shows the distributions of children's age-standardized scores for both cognitive ability measures by gender and schooling level. The graphs show that coding speed is not normally distributed but left-skewed for both sons and daughters. It is apparent that both males and females with more years of schooling achieved higher speed test scores. Gender differences are clearly visible with respect to verbal fluency. Whereas female college/university graduates did better than daughters with other educational degrees, the gap between highly educated and less educated sons is less obvious for the word fluency test. Averaged over all individuals, there are no male-female differences for children with respect to the cognitive abilities test scores. The obvious relationship between education and post-school cognitive abilities demonstrates the importance of controlling for education when estimating the intergenerational transmission of cognitive abilities.

[Table 1 about here]

[Figure 1 about here]

Estimation methods

In the following, we examine the determinants of cognitive abilities using OLS regressions. The estimated functions are based on the form

$$y_i = x_i^{'}\beta + c_i^{'}\gamma + u_i \ , \qquad (1)$$

where y_i are individual i's age-standardized cognitive ability test scores, x is a vector of individual characteristics, c is the vector that includes parental characteristics and their age-standardized intelligence test scores, β and γ are the corresponding parameter vectors to be estimated, and u_i denotes the idiosyncratic error term.

As mentioned above, we estimate the intergenerational transmission of cognitive ability test scores for different sub-samples. In a first step, our estimates are based on all individuals for whom we have either maternal or paternal test scores in order to maximize the number of observations. We use the average of the parents' test scores, when test scores of both parents are available, and maternal (paternal) test scores, when only the test scores for the mother (father) are available. We distinguish the effect of the mother from the effect of the father in a second step and rerun the regression for the sub-sample of individuals for whom we have the cognitive ability information for both parents. In a third step, we run separate regressions for males and females to distinguish the effect that mothers' and fathers IQs have on their daughters from the effect on their sons.

We include covariates as outlined above and, in addition, a gender dummy in the regressions that are based on the merged male-female sample.

4. RESULTS

The following tables display intergenerational associations in cognitive abilities allowing for different individual characteristics, family background, and childhood environment. In the most basic specification we regress children's cognitive ability test scores on their education, since schooling has been found to be an important determinant of post-school cognitive skills (Falch and Sandgren, 2006). We then add the parents' IQ test scores to the regression to investigate whether parental test scores have explanatory power in addition to schooling.[16] As could be expected, the regression results indicate a positive relationship between education and both types of ability test scores (Table 2, columns (1) and (3)), although the explained variation is very small.[17] Particularly individuals with a college or university degree attain significantly higher test scores compared to their counterparts with lower secondary schooling. This positive association however vanishes once parents' cognitive skills are included. The coefficient for parents' speed test score is highly statistically significant (Table 2, column (2)).[18] It implies that an increase in parents' ability by one age-standardized SCT score (about 9 units in the speed test) increases the child's coding speed by 0.44 points, which roughly corresponds to 5 units in the SCT.[19] The intergenerational link is equally statistically significant and even stronger for the word fluency test (Table 2, column (4)). A one-point increase in the age-standardized WFT score of parents (about 11 units in the word fluency test) is associated with a 0.51 point increase for their children, which corresponds to approximately 5 units in the WFT. Note further that the test score of parents are not only highly statistically significant after controlling for education but they increase the explained part of the variance considerably compared to the first specification in which only schooling is controlled for.

[Table 2 about here]

The positive association between parents' and their children's ability test scores in the basic specification could be driven by third variables, such as the family's social background, which correlate with IQ. We therefore take advantage of our rich dataset and include controls for family background and childhood environment in an extended specification. For the reasons described in the data section above, we add the number of brothers and sisters, parental education, childhood area dummies, and body height to the equation. In a further step, we check the robustness of the intergenerational transmission effect by adding labor-market related variables and other factors which might possibly affect individuals' cognitive skills. We therefore further include work experience, unemployment experience, marital status, dummies for the region of current residence (North, Middle, South; East Germany as the reference category), and disability status.

Table 3 provides estimates of these extended specifications including family background and childhood environment (Table 3, columns (1) and (4)), as well as the controls related to labor-market experience, marital status, region, and health (Table 3, columns (2) and (5)). Interestingly, the estimates show barely any significant effects of the family background, childhood environment, and other control variables on children's cognitive abilities.[20] In contrast, the regressions show a very robust finding for parents' cognitive abilities. The coefficient only slightly decreases from 0.44 to 0.43 for the speed test, and even slightly increases from 0.51 to 0.54 for the word fluency test when controlling for the full set of control variables (Table 3, columns (3) and (6)). Hence, although we control for more individual and family background variables, the IQ transmission revealed by our regressions is larger than the one found by Black et al. (2008) for Norway, where a one-point increase in father's ability is associated with an increase in the son's ability by about one third. Our transmission effect is also stronger than the one revealed by Agee and Crocker (2002) who find that a one-point increase in parental IQ is related to an increase in the child's verbal IQ by one quarter in the U.S..

Apart from parental cognitive skills, there are only two other predictors for individuals' speed test scores in these equations. First, there is a non-linear gradient between individuals' stature and the SCT outcome which is in line with the findings of Heineck (2008). Second, there is a link between coding speed and unemployment experience inasmuch as one additional year of unemployment is associated with a 0.12-point decrease in the age-standardized coding speed. Again, we are aware that this covariate might be endogenous, since lower cognitive skills might have led to unemployment in the first place. In contrast, individuals' height and unemployment history are not related to the word fluency test (Table 3, column (6)). The only control variable which has a sizeable and statistically significant effect on word fluency is the respondent's disability status which lowers their age-standardized ability test scores by 0.75 points.[21] The coefficients on having been raised by a single parent and being the first-born child have the expected signs but are not statistically significant. Likewise, parental schooling does not have any significant effect on the child's cognitive ability test scores.[22]

[Table 3 about here]

We so far estimated the cognitive ability test score of individuals for whom we have the test score of either father or mother without distinguishing effects of fathers and mothers on their sons and daughters. Now, Table 4 and Table 5 provide results for three sub-samples of our data to disentangle the effects by gender of the parents and of the children. We first present estimates for all children for whom there is information on both parents' cognitive abilities (Table 4 and Table 5, column (1)), followed by estimates for all children with available information on both parents' separately for daughters and sons (Table 4 and Table 5, columns (2) and (3)).

Most coefficients on parents' test scores remain highly statistically significant when the sample is restricted so to include both parents' test scores in order to compare the influence of father and mother (Table 4 and Table 5, column (1)). For both types of ability tests we find a maternal effect, as the influence of the mother is stronger than the influence of the father.[23] For coding speed, the coefficient of the mother's ability amounts to 0.26 which compares to the father's ability coefficient of 0.19. The difference between parents is smaller for the word fluency test: 0.27 for the mother versus 0.24 for the father. Note that this result is consistent with the findings above (Table 2), as the sum of the individual ability effects of the mother and the father is almost exactly the same size as the effect for both parents together found before (0.44 for the SCT, 0.51 for the WFT). Moreover, the results in Table 4 and Table 5 show that the distinction between both parents' test scores is important as we obtain additional insights with respect to the relative importance of mothers and fathers for the transmission of cognitive skills. Our finding of a maternal effect is in line with previous research on educational mobility which provides evidence for a larger effect of the mother's educational qualification on the child's educational performance (e.g. Ermisch and Francesconi, 2001).

[Table 4 about here]

In order to investigate whether the role that mother and father play for their offspring depends on the gender of the child, we separate the sample by daughters and sons (Table 4 and Table 5, columns (2) and (3)). Table 4 shows that there are no significant differences between females and males with respect to the effect of mothers' or fathers' fluid intelligence. The coefficients on the father's SCT scores is virtually the same in the estimates for sons and daughters (about 0.17), and statistically significant at the 10% level. Likewise, there are no significant differences between males and females with respect to the effect of mothers' SCT scores. However, for both sons and daughters, the influence of the mother is clearly stronger, with a highly statistically significant coefficient of about 0.27. This result reinforces the earlier finding of a maternal effect in the transmission of coding speed.

Table 5 displays the transmission of mother's and father's crystallized intelligence according to the gender of the child (Table 5, columns (2) and (3). It is striking that fathers' WFT scores are not related to the word fluency of their daughters, whereas they play the major role for their sons' verbal fluency. Unlike the coefficient for the SCT score, the coefficient of the father's WFT score is highly statistically significant for sons, and more than twice as large as the coefficient in the estimates of the SCT scores (0.36 compared to 0.17). The mothers' word fluency is still an important determinant for the ability of sons (coefficient of 0.22), whereas the coefficient is slightly higher for daughters (0.28), although this gender difference is not statistically significant.[24] The relative higher importance of fathers for sons and of mothers for daughters is evidence for an own-gender effect in the transmission of crystallized intelligence.

[Table 5 about here]

To compare our results directly to the findings by Black et al. (2008) for the IQ transmission from fathers to sons in Norway, we additionally estimate only fathers' IQ transmission for the sample of sons, disregarding any effects of mothers' cognitive skills. Our estimates show a coefficient of 0.32 (standard error: 0.077) for coding speed, which equals the findings for Norway.[25] For verbal fluency, our coefficient of 0.42 (standard error: 0.082) is clearly higher than the one found by Black et al. (2008). This small exercise reveals two findings: First, depending on the type of cognitive abilities, the IQ transmission from fathers to sons in Germany is of equal or larger size than that in Norway. Second, the comparison of our estimates with and without the mother's IQ shows that the overall intergenerational IQ transmission is larger when the mother's IQ is considered. It therefore is important to take into account both fathers' *and* mothers' cognitive abilities to get a full picture of IQ transmission.

Our results moreover imply that it is important to distinguish between different types of cognitive abilities: the findings point to substantial gender differences with respect to the transmission of fathers' verbal fluency, i.e. these skills are transmitted from fathers to their sons but not to their daughters. Coding speed on the other hand is passed on from fathers independent of the child's gender, which however has a lower influence on the child's ability than the mothers' coding speed. Unlike revealed by the psychological study of Bouchard and

McGue (1981) who do not find evidence for either sex-role or maternal effects, we conclude that there exist own-gender effects with respect to word fluency and maternal effects with respect to coding speed.

Although our estimates of intergenerational IQ transmission do not allow to clearly identifying genetic effects from environmental influences, some of the results above may be cautiously interpreted in the light of the nature vs. nurture debate. First, we find a stronger intergenerational transmission of verbal fluency, i.e. cognitive abilities which are based on knowledge and skills acquired in the past, than for coding speed, which comprises general and largely innate abilities. The stronger transmission of the cognitive ability type which is prone to be malleable may point to the importance of the home environment, such as parenting style. Second, our estimates show maternal effects for coding speed. Similarly to the literature on educational mobility the interpretation could be that, on average, mothers spend more time with their children than fathers which may strengthen the link between mother's and child's performance of solving tasks that are related to new material.[26] Third, the finding of significant own-gender effects with respect to the transmission of word fluency is not compatible with a pure genetic model. The strong IQ transmission between fathers and sons and between mothers and daughters points to the importance of upbringing. Altogether, these findings provide evidence that parental investments are relevant for the transmission of cognitive skills, but do not refute the existence of genetic effects.

5. CONCLUSION

It is widely accepted that societal inequality is partially related to the intergenerational transmission of socio-economic status. So far, economic research mainly concentrated on income mobility or the transmission of educational attainment as potential links. We complement this research by studying the less researched transmission of parents' cognition to their adult children's abilities using for the first time nationally representative data for Germany. Specifically, we use parents' and children's scores on two ultra-short intelligence tests on coding speed (symbol correspondence test) and on verbal fluency (word fluency test) from the German Socio-Economic Panel Study (SOEP). In contrast to previous studies on the intergenerational transmission of cognitive skills, we use nationally representative data. In addition, we are able to link both males *and* females to their fathers *and* mothers, which allows to analyze potential gender differences. Furthermore, we account for family background, childhood environment, labor market related variables, and other relevant factors for the determination of two different types of cognitive skills. For both the symbol correspondence test and the word fluency test, we find evidence for the intergenerational transmission of cognitive abilities: individuals' cognitive abilities are substantially associated with the skills of their parents. Furthermore, individuals' educational attainment becomes statistically meaningless as soon as parents' abilities are accounted for. The transmission coefficients we find – about 0.4 for coding speed and 0.5 for word fluency – are higher than those found in comparable studies for other countries, and they are very robust to the inclusion of family background, childhood variables and other factors which potentially affect an individual's ability. Furthermore, we study the channels of intergenerational IQ transmission by examining the respective influence of each parent. Our results show that mothers play a more important role than fathers in the transmission of cognitive speed to children. This maternal effect is observable for both sons and daughters, but only with respect to fluid intelligence. For crystallized intelligence, we find evidence for own-gender effects: word fluency is transmitted more strongly from father to son and from mother to daughter.

The supportive evidence for a transmission of cognitive skills from parents to children adds to a better understanding of low intergenerational mobility in various socio-economic outcomes. The persistence in income inequality and education has been intensively investigated by a large number of studies but few studies considered the transmission of cognitive skills from parents to children as one of the underlying mechanisms. Taking into account the importance of the intergenerational transmission of cognitive abilities may significantly alter the policy implications of those studies**.** If intergenerational correlation of education is mainly driven by IQ transmission from parents to children, then investments in children's higher education would be less profitable than previously thought. Future research should hence investigate the importance of IQ transmission for educational mobility.

Policy recommendations to raise parental IQ for the benefit of future generations will be misplaced if the correlation between parents' and children's IQ is driven by confounding factors which are related to IQ at adult age. However, our finding of an intergenerational transmission of cognitive skills is robust to the inclusion of a number of factors that are possibly correlated with cognitive abilities.

This study adds to the discussion on intergenerational IQ transmission in various aspects. Our estimates show that for a full understanding of intergenerational IQ transmission it is indispensable to take into account both fathers' *and* mothers' cognitive abilities, and to analyze the IQ transmission from parents to both sons and daughters. Furthermore, our results point to the importance of distinguishing between different types of cognition, as these vary in their degree of dependence on innate abilities and hence are not equally malleable. Moreover, it is remarkable that despite controlling for more individual and family background variables, the IQ transmission found in our analysis is stronger than the one found by Black et al. (2008) for Norway and by Agee and Crocker (2002) for the U.S. This finding corresponds to the relatively high educational transmission, i.e. low educational mobility, in Germany compared to other developed countries (Pfeffer, 2008), and corroborates the need to direct future research towards a closer examination of the link between IQ transmission and educational mobility.

The question we could not fully answer is whether the transmission of abilities is a direct effect in the sense that children inherit the cognitive skills of their parents or whether the transmission works indirectly through third variables, such as nutrition, and other health related or social factors. In case that intelligence is fully biologically inherited, not much can be done to fight inequality persistence. If however children's outcomes such as cognitive skills can be influenced by other factors, policy actions should be taken to enhance socio-economic mobility. As the SOEP data do not allow us to further disentangle these aspects, we refer to recent research by Cunha and Heckman (2007) who point out the importance of both nature and nurture, which interact in complex ways. Likewise, our results should be interpreted in light of a compound effect which comprises factors such as the inherited genetic endowment, education, nutrition, other health factors, or even parenting style. If children's cognitive skills can be influenced by such factors, resources should be allocated to the fostering of a favorable home environment in childhood and to the support of positive parental attitudes with respect to investment in their children. Our finding of a stronger intergenerational transmission of verbal fluency, i.e. those cognitive abilities that improve with skills acquired in the past, points to the importance of parental investments. The evidence of a maternal effect for coding speed and of an own-gender effect for verbal fluency corroborates the role of nurture. To the extent that cognitive skills are malleable, policy could take actions to alleviate inequality persistence and to enhance socio-economic mobility by creating favorable environments which will help everyone to achieve their potential.

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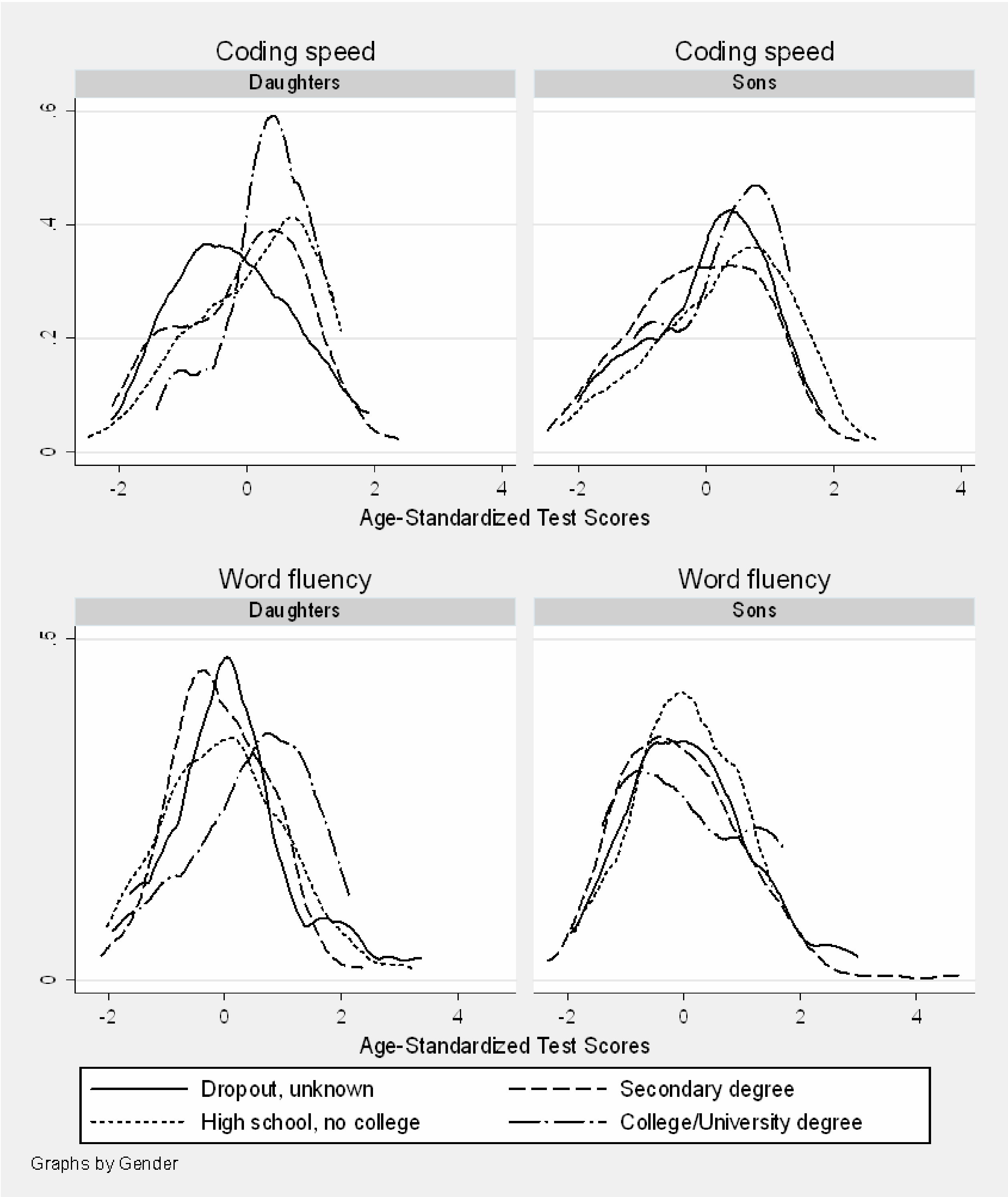
Figure 1: Distributions of Age-Standardized Symbol Correspondence Test Scores (Coding Speed) and Word Fluency Test Scores by Gender and Schooling



Source: SOEP 2006.

Table 1: Summary Statistics: IQ Test Scores, Education, and Family Background

	Women				Men			
Variable	Mean	(SD)	Min	Max	Mean	(SD)	Min	Max
Child's Information								
Speed test score	32.53	(9.50)	10	53	32.42	(10.31)	5	60
Word fluency test score	26.45	(9.66)	6	63	25.85	(10.69)	2	74
Age	25.47	(6.57)	17	48	25.94	(7.26)	17	48
No school degree	0.15	(0.36)	0	1	0.14	(0.35)	0	1
Other secondary degree	0.51	(0.50)	0	1	0.62	(0.49)	0	1
High School, no college	0.25	(0.43)	0	1	0.17	(0.38)	0	1
College/University degree	0.10	(0.29)	0	1	0.06	(0.24)	0	1
Height (in cm)	167.93	(6.59)	150	186	180.55	(6.51)	163	200
Single parent	0.11	(0.31)	0	1	0.12	(0.33)	0	1
First born	0.44	(0.50)	0	1	0.43	(0.50)	0	1
Number of brothers	0.93	(1.25)	0	7	1.04	(1.15)	0	6
Number of sisters	0.93	(1.02)	0	6	0.92	(1.08)	0	7
Childhood area: rural	0.33	(0.47)	0	1	0.34	(0.47)	0	1
Childhood area: town	0.19	(0.39)	0	1	0.18	(0.39)	0	1
Childhood area: city	0.16	(0.37)	0	1	0.24	(0.43)	0	1
Childhood area: urban	0.24	(0.43)	0	1	0.18	(0.39)	0	1
Mother's Information								
Speed test score	25.43	(9.05)	4	44	26.18	(9.11)	5	49
Word fluency test score	25.87	(9.89)	1	56	25.50	(10.04)	2	55
No school degree	0.03	(0.17)	0	1	0.02	(0.15)	0	1
Second. degree	0.48	(0.50)	0	1	0.56	(0.50)	0	1
Intermediate degree	0.41	(0.49)	0	1	0.30	(0.46)	0	1
Upper degree	0.08	(0.27)	0	1	0.12	(0.32)	0	1
Father's Information								
Speed test score	26.05	(9.58)	2	50	25.31	(10.01)	2	45
Word fluency test score	24.59	(10.40)	1	49	23.46	(11.39)	1	54
No school degree	0.04	(0.19)	0	1	0.04	(0.21)	0	1
Second. degree	0.56	(0.50)	0	1	0.59	(0.49)	0	1
Intermediate degree	0.26	(0.44)	0	1	0.22	(0.42)	0	1
Upper degree	0.13	(0.34)	0	1	0.14	(0.34)	0	1
Individuals	210				240			

Source: SOEP 2006.

Table 2: Intergenerational Associations in Cognitive Ability

	Speed test		Word fluency test	
	(1)	(2)	(3)	(4)
Male	0.0292	-0.00101	-0.0217	-0.00830
	(0.0948)	(0.0861)	(0.0973)	(0.0872)
No school degree	0.0319	-0.100	0.177	0.0311
	(0.140)	(0.128)	(0.141)	(0.127)
High School, no college	0.261**	0.0616	0.0718	-0.154
	(0.120)	(0.111)	(0.124)	(0.113)
College/University degree	0.394**	-0.00704	0.341*	0.0391
	(0.179)	(0.168)	(0.187)	(0.170)
SCT score parents		0.438***		
		(0.0446)		
WFT score parents				0.508***
				(0.0482)
Constant	-0.106	0.0471	-0.0475	0.0630
	(0.0835)	(0.0773)	(0.0860)	(0.0777)
Observations	450	450	450	450
F-Test schooling degrees	2.764*	0.401	1.429	0.815
Adjusted R-squared	0.010	0.185	0.001	0.199

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable: age-standardized test scores of the child's speed test / word fluency test.

"SCT score parents" and "WFT score parents" refer to the average of parents' test scores when test scores for both parents are available.

Source: SOEP 2006.

Table 3: The Importance of Parents' IQ Test Scores and Family Background

	Speed test			Word fluency test		
	(1)	(2)	(3)	(4)	(5)	(6)
Male	0.104	0.0398	0.129	0.169	-0.00995	0.158
	(0.122)	(0.0863)	(0.122)	(0.122)	(0.0876)	(0.122)
No school degree	-0.0971	-0.120	-0.122	0.0984	0.0685	0.0976
	(0.133)	(0.130)	(0.134)	(0.132)	(0.131)	(0.134)
High School, no college	0.0315	0.0135	-0.0111	-0.0791	-0.169	-0.104
	(0.118)	(0.112)	(0.119)	(0.118)	(0.114)	(0.119)
College/University degree	-0.0662	-0.0438	-0.0839	0.0603	0.00421	0.0390
	(0.172)	(0.167)	(0.172)	(0.172)	(0.169)	(0.172)
Test score parents	0.427***	0.443***	0.428***	0.511***	0.519***	0.539***
	(0.0463)	(0.0445)	(0.0466)	(0.0506)	(0.0484)	(0.0513)
Single parent	-0.0969		-0.0500	-0.0224		-0.0281
	(0.137)		(0.139)	(0.137)		(0.139)
First born	0.106		0.0790	0.118		0.112
	(0.0932)		(0.0928)	(0.0929)		(0.0929)
Number of brothers	-0.0267		-0.0291	-0.0472		-0.0310
	(0.0411)		(0.0409)	(0.0381)		(0.0384)
Number of sisters	-0.00118		0.00701	0.0261		0.0367
	(0.0444)		(0.0444)	(0.0439)		(0.0441)
Father Secondary school degree	0.0229		-0.0661	0.193		0.227
	(0.234)		(0.235)	(0.236)		(0.238)
Father Intermediate degree	0.00792		-0.0374	0.409		0.415
	(0.249)		(0.251)	(0.250)		(0.254)
Father Upper school degree	0.207		0.122	0.0586		0.0680
	(0.264)		(0.264)	(0.264)		(0.266)
Mother Secondary degree	0.0597		-0.0325	0.261		0.228
	(0.282)		(0.285)	(0.286)		(0.288)
Mother Intermediate degree	0.0234		-0.0738	0.258		0.157
	(0.293)		(0.296)	(0.296)		(0.299)
Mother Upper school degree	-0.0354		-0.125	-0.146		-0.195
	(0.315)		(0.317)	(0.320)		(0.321)
Childhood in town	-0.132		-0.120	0.0171		0.0445
	(0.126)		(0.126)	(0.127)		(0.128)
Childhood in city	-0.150		-0.180	-0.0380		-0.00354
	(0.121)		(0.122)	(0.123)		(0.124)

Childhood in urban area	-0.102		-0.143	0.0705		0.192
	(0.125)		(0.130)	(0.125)		(0.131)
Unkown childhood area	-0.144		-0.175	0.124		0.204
	(0.190)		(0.196)	(0.191)		(0.198)
Height	0.328**		0.324**	0.0545		0.0796
	(0.141)		(0.143)	(0.142)		(0.144)
Height, squared/100	-0.0964**		-0.0949**	-0.0186		-0.0257
	(0.0403)		(0.0407)	(0.0404)		(0.0410)
Work experience		0.00910	0.00672		-0.00282	-0.00646
		(0.00776)	(0.00835)		(0.00782)	(0.00831)
Unemployment experience		-0.150***	-0.131***		-0.00728	-0.00261
		(0.0447)	(0.0464)		(0.0448)	(0.0460)
Married		-0.0954	-0.0465		0.0102	-0.0166
		(0.129)	(0.135)		(0.131)	(0.136)
Disabled		-0.366	-0.378		-0.750***	-0.729**
		(0.302)	(0.314)		(0.280)	(0.289)
Residence in North Germany		0.00716	0.0264		-0.177	-0.155
		(0.137)	(0.145)		(0.139)	(0.146)
Residence in South Germany		-0.0720	-0.106		0.0860	0.0921
		(0.138)	(0.143)		(0.140)	(0.144)
Residence in Middle Germany		0.127	0.149		-0.178	-0.193
		(0.118)	(0.130)		(0.120)	(0.131)
Constant	-27.77**	0.0455	-27.40**	-4.370	0.190	-6.465
	(12.41)	(0.119)	(12.55)	(12.44)	(0.121)	(12.65)
Observations	450	450	450	450	450	450
F-Test schooling degrees	0.301	0.346	0.337	0.516	1.059	0.640
Adjusted R-squared	0.184	0.204	0.200	0.216	0.210	0.225

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable: age-standardized test scores of the child's speed test / word fluency test.

"Test score parents" refers to the average of parents' test scores when test scores for both parents are available.

Source: SOEP 2006

Table 4: Transmission of Cognitive Abilities According to Parent and Gender (Speed Test)

	All	Daughters	Sons
	(1)	(2)	(3)
No school degree	-0.0244	-0.0963	-0.106
	(0.172)	(0.236)	(0.265)
High School, no college	0.0322	-0.0721	-0.0562
	(0.153)	(0.203)	(0.243)
College/University degree	-0.277	-0.172	-0.448
	(0.208)	(0.286)	(0.314)
Male	0.211		
	(0.152)		
SCT score Dad	0.192***	0.179*	0.173*
	(0.0630)	(0.0944)	(0.0896)
SCT score Mom	0.260***	0.276***	0.264***
	(0.0676)	(0.102)	(0.0927)
Constant	-24.60	51.97	-90.32**
	(15.33)	(36.82)	(38.08)
Observations	251	118	133
F-Test schooling degrees	0.714	0.156	0.701
Adjusted R-squared	0.210	0.169	0.264

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable: age-standardized test scores of the child's speed test.

Source: SOEP 2006.

Table 5: Transmission of Cognitive Abilities According to Parent and Gender (Word Fluency Test)

	All	Daughters	Sons
	(1)	(2)	(3)
No school degree	-0.0248	0.116	-0.227
	(0.152)	(0.231)	(0.215)
High School, no college	-0.172	-0.0777	-0.300
	(0.144)	(0.196)	(0.219)
College/University degree	0.0309	0.376	-0.302
	(0.189)	(0.262)	(0.281)
Male	0.255*		
	(0.140)		
WFT score Dad	0.240***	0.121	0.361***
	(0.0651)	(0.102)	(0.0870)
WFT score Mom	0.270***	0.281**	0.224**
	(0.0759)	(0.119)	(0.103)
Constant	-21.61	12.34	-27.75
	(14.28)	(35.65)	(34.50)
Observations	251	118	133
F-Test schooling degrees	0.565	1.017	0.981
Adjusted R-squared	0.210	0.165	0.277

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable: age-standardized test scores of the child's word fluency test.

Source: SOEP 2006

[1] For example, Bowles and Gintis (2002: 12) note that “for the commonly used Armed Forces Qualification Test (AFQT), for example—a test used to predict vocational success that is often used as a measure of cognitive skills—the correlation between two test scores taken on successive days by the same person is likely to be higher than the correlation between the same person’s reported years of schooling or income on two successive days“.

[2] We do not neglect that the individual’s environments, including peers, grandparents and neighborhood, may also play a role in the development of cognitive and non-cognitive abilities. However, it is plausible to assume that the two channels mentioned mainly affect the critical early life-cycle cognitive development.

[3] According to this framework, the technology varies with the periods of development. In the first stages, the primary care givers (in most cases the individual’s parents) form the environment in which initial conditions, i.e. the individual’s abilities endowment, can thrive. In later stages, there is interaction with parents, the larger family, with friends and in school that affects individuals’ abilities and how these evolve.

[4] Research in neuroscience however emphasizes that genes are the predominant determinant of IQ transmission (e.g. Toga and Thompson, 2005).

[5] Another strand of literature combines the analysis of income mobility with cognitive skills. Bowles and Gintis (2002) identify cognitive abilities as one of the minor causal channels of intergenerational transmission of economic status. Blanden et al. (2007) show that parental income is strongly associated with children's cognitive abilities which in turn significantly affect their earnings later in life.

[6] A study which is closely related to the literature on intergenerational IQ transmission is carried out by Brown, McIntosh, and Taylor (2007) who use the British National Child Development Study (NCDS) to investigate the link between parental abilities in literacy and

numeracy as a child and their children's performance in reading and mathematics. They find evidence for cross-gender effects from fathers to daughters and from mothers to sons, which are even stronger than equivalent own-gender effects. However, as literacy and numeracy are direct outcomes of schooling, it may be preferable to use IQ test scores as a more general measure of cognitive abilities.

[7] For more detailed information on the SOEP, see Wagner et al. (2007).

[8] Matching parents' information to their children is possible for (grown up) children who lived at some point of time during the survey years in the same household as the parents. Only then are mother and father identifiers available. This requirement naturally excludes relatively old respondents from our sample since these were less likely to be observed in the same household as their parents during the survey years. 54% of the individuals in our sample live in the same household as their parents: 49% of females, and 57% of males.

[9] It might be argued that the time constraint of 90 seconds interferes with the concept of crystallized intelligence inasmuch as factors like for example working memory come into play. Working memory however is related to executive function and thus to fluid intelligence rather than crystallized intelligence only. It should therefore be kept it mind that the WFT scores may be a mixture of fluid and crystallized intelligence.

[10] Both WFT and SCT show test-retest coefficients of 0.7 (Lang et al., 2007). This suggests that there is a substantial random component to cognition test scores in our data, which may lead to downward bias estimates of IQ correlations.

[11] Age-standardized test scores are generated by calculating the scores' standardized value (deviation from the sample mean divided by the standard deviation) for every year along the age distribution. Note that the age-standardized test scores from our subsample differ only slightly from the age-standardized test scores based on the whole sample of individuals with available test score information.

[12] Note that the parents' ability test scores have been age-standardized using the whole sample of individuals with available test score information because there were too few persons in some of the age groups. The higher number of observations further allowed to age-standardize the test scores for males and females separately.

[13] Although formal education in part depends on early cognitive ability, it has been shown that additional years of schooling increase IQ later in life (Falch and Sandgren, 2006).

[14] The massive IQ gains over time and across nations have been traced back to the improvement of education and better nutrition.

[15] It is striking that there is only a minor difference between parents' and children's word fluency test scores. This is in line with the notion in psychology that crystallized intelligence remains fairly stable, whereas cognitive speed declines at old age.

[16] Pure correlations of age-standardized ability test scores between parents and their children reveal correlation coefficients of about 0.45 for both tests.

[17] We cross-checked this using the initial sample of 4,470 observations before merging the data to the respondents' parents. However, regressing the IQ-test scores on gender and educational attainment for the larger sample yields only slightly higher R^2-values as compared to our final sample. This may seem unexpected at first glance. Again, note that the tests aim at measuring individuals' intelligence and not achievement. This might be behind this first low explained variation.

[18] Adjusting the standard errors to account for heteroskedasticity and for intra-family correlation does not affect the results.

[19] Averaged over the whole sample, one point in the age-standardized SCT scale corresponds to 10.7 units in the speed test for children and to 9.0 units for parents. One point in the WFT scale corresponds to 10.1 units in the word fluency test for children (10.6 units for parents).

[20] In three alternative specifications, we checked for differences between East and West Germany by including a dummy variable for a) living in East Germany, b) being born in the former GDR, c) having spent the childhood (at least 10 years) in the former GDR. However, none of these variables were statistically significant, and the estimates were not affected.

[21] As an additional robustness check we included the disability status of the parents and an interaction term with parents' test scores. Both the main effects and the interaction variables were negative for coding speed, and positive for the word fluency test, but none of them was statistically significant. The coefficients on parental test scores were not affected.

[22] The result that parental education does not affect children's cognitive skills when parental IQ is taken into account is in line with the findings of Brown et al. (2007: 14) who point out that it "does not appear to be the case that the intergenerational effect of parents' test scores occurs via their impact on parents' income or educational attainment, to any great extent."

[23] The maternal effect still exists, albeit slightly weaker, for the subsample of children who spent the first 15 years of their childhood with both parents.

[24] Additional regressions fully interacted with a gender dummy show that the interaction term for mothers' test scores is not statistically different from zero in none of the specifications. The interaction term between gender and fathers' WFT score however is positive and statistically significant at the 10% level whereas the main effect vanishes completely.

[25] Detailed results are available from the authors upon request.

[26] An alternative explanation, which is consistent with the nature element of IQ transmission, could be that fathers are less likely the biological parent of their social child than mothers. We however are not able to identify biological fathers from non-biological fathers in our data. Furthermore, Anderson (2006) reports a median non-paternity rate of only 3.3% in his overview of studies which seems to be too low to explain such strong maternal effects.