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**Article — Accepted Manuscript (Postprint)**

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Applied Economics Letters

**Provided in Cooperation with:**

German Institute for Economic Research (DIW Berlin)

*Suggested Citation:* Anger, Silke; Heineck, Guido (2010) : Cognitive Abilities and Earnings – First Evidence for Germany, Applied Economics Letters, Taylor & Francis, London, Vol. 17, Iss. 7, pp. 699-702,  
<https://doi.org/10.1080/13504850802297855> ,  
<http://www.tandfonline.com/doi/abs/10.1080/13504850802297855>

This Version is available at:

<https://hdl.handle.net/10419/68493>

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# Cognitive Abilities and Earnings – First Evidence for Germany

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## ABSTRACT

We provide first evidence on the relationship between cognitive abilities and earnings in Germany using data from the German Socio-Economic Panel Study. The estimates suggest that mechanics abilities are positively related to wages of West German workers, even when educational attainment is controlled for. Pragmatics of cognition are not related to earnings. In line with studies for other countries, we find that ability and education are inseparable determinants of earnings.

**JEL:** J24, J31, I21

**Keywords:** Cognitive abilities, earnings regressions, returns to education, ability bias

**Running Title:** Cognitive Abilities and Earnings

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## **INTRODUCTION**

A large number of studies reveal substantial returns to cognitive abilities in the US and Great Britain. For example, Cameron and Heckman (1993), Blackburn and Neumark (1993), and Bronars and Oettinger (2006) provide evidence for a positive relationship between abilities and earnings. Herrnstein and Murray (1994) even argue that intelligence is the most important determinant of social and economic success. Their findings have however been strongly criticized on grounds of measurement error, omitted variables for family background and lack of control for education (e.g. Korenman and Winship, 1995). Moreover, Bound et al. (1986), and Murnane et al. (1995) report that cognitive ability has barely any effect on earnings, as coefficients are not statistically significant and do not explain much of the earnings variance. Cawley et al. (2001), and Zax and Rees (2002) conclude that cognitive ability is a poor predictor of earnings compared to a direct measure of education, family background, and environment. More recently, Heckman et al. (2006) point to the importance of non-cognitive skills for social and economic success. We add to this literature examining the relationship between cognitive abilities and earnings in Germany for the first time.

## **DATA AND METHODOLOGY**

Following Baltes et al. (1999) intellectual functioning can be distinguished in two components, the mechanics and the pragmatics of cognition. Mechanics abilities comprise general and largely innate abilities and refer to the performance and speed of solving tasks that are related to new material. The pragmatics of cognition, such as verbal knowledge, concern the fulfillment of more specific tasks which improve with

knowledge and skills acquired in the past.<sup>1</sup> Based on this distinction, two ability tests were included in the 2005 wave of the German Socio-Economic Panel (SOEP) for the first time.<sup>2</sup> Since fully-fledged IQ tests were not feasible, two ultra-short tests of cognitive ability were developed (Lang, 2005): one speed of cognition test and one word fluency test. The former was developed after the symbol-digit-modalities-test (Smith, 1995): Respondents have 90 seconds to assign with a keyboard as many correct signs as possible to consecutively displayed digits on a screen, while the appropriate assignment code is visible to them. The latter has been developed after the animal-naming-task (Lindenberger and Baltes, 1995): Respondents name as many different animals as possible within 90 seconds. Both tests were previously shown to produce outcomes which are sufficiently correlated with test scores of more comprehensive and well-established intelligence tests (Lang, 2005).

The 2005 SOEP study consists of 1,012 randomly drawn persons in East and West Germany (Schupp and Wagner, 2006). We restrict our sample to West German respondents of age 20 to 60 to avoid estimation problems that could arise from structural differences between East and West German labor markets.<sup>3</sup> Our subsample consists of 433 observations of which 187 are full-time workers.<sup>4</sup>

We expand a standard Mincer-type earnings regression to include measures of cognitive abilities. The dependent variable is the log of gross monthly earnings.<sup>5</sup> Let  $y$  be monthly earnings,  $x$  a vector of characteristics, and  $c$  the ability test score. The specification of the earnings regression then is:

$$\ln y_i = \beta' x_i + \gamma' c_i + u_i ,$$

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where  $\beta$  and  $\gamma$  are vectors of parameters to be estimated, and  $u_i$  denotes the idiosyncratic error term. The covariates included are a gender dummy, education in years, age (also squared), being married, actual working hours, a large firm size dummy and a dummy on whether earnings are imputed.<sup>6</sup> Selectivity bias is corrected using Heckman's two-step selection model, where the probability of being full-time employed is estimated on the number of dependent children (also interacted with gender), the local unemployment rate and the covariates used in the second stage. Equations with earnings as a linear function of schooling, ability, and an uncorrelated random variable imply that education and ability are perfect substitutes. However, previous research has shown that there is a positive interaction between ability and education levels and that the linear model may be misspecified by not allowing for this interaction (Hause, 1971). Therefore, we additionally include an interaction term of ability test scores and schooling to investigate the separability of these variables. We further test for differences by gender.

## **RESULTS**

The regressions results reveal that even after controlling for education, earnings are significantly positively related to speed test scores,<sup>7</sup> while the coefficients on the word fluency test are not statistically significant (Table 1).<sup>8</sup> Accordingly, an increase in the speed test score by ten units, i.e. about one standard deviation, is associated with a 5% earnings increase for full-time workers, which is almost 1.5 as large as the return to one year of schooling. This type of measured cognitive ability therefore seems to be an important determinant of earnings, indicating that workers benefit

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from their flexibility and competence to adapt to new problems and situations in the workplace, in addition to their education and potential experience.

(Table 1 about here)

Accounting for the possible interaction between ability and education, the estimates reveal a small, yet statistically significantly positive joint effect. The negative main ability effect is furthermore outweighed by the positive joint effect even for the lowest level of schooling in our sample. That is, higher cognitive ability test scores are beneficial for every full-time worker, and even more beneficial for those with higher education. Our results support the findings of Heckman and Vytlačil (2001) who remark that ability and schooling appear to be inseparable, i.e. interaction effects matter, and not main effects.

As for gender differences, the results in Table 2 suggest that males in particular benefit from higher mechanics abilities: an increase in the test score of about one standard deviation yields an increase of about 12% in males' wages. A somewhat puzzling result is found for the pragmatics of cognition: while the positive interaction effect is not statistically significant at the 10% level,<sup>9</sup> the coefficient of the main effect implies lower earnings for females with higher abilities.

(Table 2 about here)

This finding might for example arise because of females' self-selection in educational forms that are not highly rewarded on the labor market. With the data at

hand, however, we cannot examine further whether this implausible result is related to the type of college degree.

## **CONCLUSION**

We analyze whether earnings of German workers are related to cognitive abilities. Using data from the SOEP, the results suggest a positive relationship between mechanics ability and labor income particularly for men, while the pragmatics of cognition are less important. Allowing for the interaction between cognitive ability as being measured by speed test scores and schooling, the model yields no measurable main effects of ability, but a positive joint effect. That is, educational sorting makes it difficult to disentangle the effects of education and ability on earnings.

## **ACKNOWLEDGEMENTS**

We would like to thank Frieder R. Lang, Regina T. Riphahn, and Gert G. Wagner for helpful comments and advice, and Anita Kottwitz.

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## TABLES

**Table 1: Ability, education, and earnings**

	Without ability	Speed test		Word fluency test	
	(I)	(II)	(III)	(IV)	(V)
Education (yrs.)	0.038 (3.64)***	0.036 (3.52)***	-0.018 (0.58)	0.041 (3.84)***	0.065 (2.82)***
Test score	–	0.005 (1.67)*	-0.017 (1.42)	-0.002 (0.89)	0.010 (0.96)
Test score x education	–	–	0.002 (1.85)*	–	-0.001 (1.18)
Controls	+	+	+	+	+
Log likelihood	-297.223	-295.771	-294.076	-295.871	-295.178

*Notes:*  $N = 433$ ; absolute value of  $z$  statistics in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Dependent variable: log of monthly gross earnings

Controls: Male, age, age squared, weekly working hours, large firm size dummy, imputation dummy.

Additional first stage controls: Number of dependent children (also interacted with male), local unemployment rate.

*Source:* SOEP 2005

**Table 2: Ability, gender, and earnings**

	Speed test		Word fluency test	
	(II)	(III)	(IV)	(V)
Male	0.332 (4.56)***	-0.018 (0.10)	0.339 (4.52)***	0.184 (1.46)
Test score	0.005 (1.67)*	-0.003 (0.68)	-0.002 (0.89)	-0.006 (1.75)*
Test score x male	-	0.012 (2.06)**	-	0.006 (1.54)
Controls	+	+	+	+
Log likelihood	-295.771	-293.683	-295.871	-294.701

Notes:  $N = 433$ ; absolute value of z statistics in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Dependent variable: log of monthly gross earnings

Controls: Education, age, age squared, weekly working hours, large firm size dummy, imputation dummy.

Additional first stage controls: Number of dependent children (also interacted with male), local unemployment rate.

Source: SOEP 2005

## NOTES

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<sup>1</sup> This concept is closely related to the distinction of “fluid” (mechanics) and “crystallised” (pragmatics) abilities (Cattell, 1987).

<sup>2</sup> For more information on the SOEP see <http://www.diw.de/soep>.

<sup>3</sup> We do not provide analyses for East German workers because of sample size restrictions.

<sup>4</sup> Descriptive statistics are available upon request.

<sup>5</sup> Missing earnings data are imputed using the Stata implementation of the MICE (multivariate imputation by chained equations) method of multiple multivariate imputation (Royston, 2004).

<sup>6</sup> Additional indicators for public sector, blue-collar worker, and job tenure are included in supplementary estimations but are not presented, since results do not change substantially.

<sup>7</sup> Given the relatively small sample size.

<sup>8</sup> Results are robust to variations in the ability measures, such as normalised test scores, dummies for test scores above and below average, dummies for test score distribution quintiles, and normalised residuals from regressions of ability test scores on age and education.

<sup>9</sup> Yet it is at the 12.5% level.