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Beyond Literacy: The Incremental Value of Non-Cognitive Skills

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This working paper has been authorised by Andreas Schleicher, Director of the Directorate for Education and Skills, OECD.

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Abstract

During the past decade, non-cognitive skills have gained attention as predictors of life outcomes over and above cognitive skills. This paper summarises several of our recent studies investigating the predictive power of the Big Five personality domains and grit on success at work, school and beyond using recent large-scale data. We also explored whether non-cognitive skills beyond the framework of the Big Five substantially add to explaining the variance in these outcomes. Together, these studies demonstrate that non-cognitive skills are largely independent of cognitive skills and that they are incrementally associated with indicators of life success in youth and adulthood. Most of these associations can be generalised across countries. Measures of non-cognitive skills are thus valuable addendums to large-scale assessments like PIAAC.

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1. Introduction

1.1. Why non-cognitive skills matter

Cognitive skills, such as literacy and numeracy, are undoubtedly powerful predictors of important life outcomes (Herrnstein and Murray, 1996[1]). Results of the Survey of Adult Skills (2012) conducted within the framework of the OECD Programme for the International Assessment of Adult Competencies (PIAAC) once again confirmed that cognitive skills are strongly related to educational attainment, income, labour force participation, and health (OECD, 2013[2]). However, during the past decade, the focus of the search for the determinants of life success has increasingly shifted to traits beyond cognitive skills, for example personality traits, motivation, interests, self-concepts, and beliefs (OECD, 2015[3]; Gutman and Schoon, 2016[4]). Collectively, these traits are now often referred to as "non-cognitive skills", an umbrella term originally coined by the sociologists Samuel Bowles and Herbert Gintis (1974[5]) to denote potentially relevant skills other than those captured by standardised cognitive test scores (e.g. IQ or literacy).[1]

Although researchers have reached no clear consensus as to what specific skills should be included under this umbrella term, many studies on non-cognitive skills have used as a guidepost the Big Five framework, which is currently the most well-validated and widely used model of personality. The Big Five aims to describe an individual's personality on the most global level with five largely independent dimensions (De Raad, 2000[6]; Goldberg, 1990[7]; John, Naumann and Soto, 2008[8]). These dimensions are extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience.[2] They each comprise several more specific facet traits.

This shift towards studying non-cognitive skills is not a purely academic exercise; rather there is a straightforward, real-world reason for it: non-cognitive skills matter (Roberts et al., 2007[9]; Ozer and Benet-Martínez, 2006[10]). From a conceptual point of view, non-cognitive skills can be seen as resources that can be used to attain goals and that are incremental and largely independent of cognitive skills. For example, the abilities to control impulses and emotions, maintain long-term motivation, and co-operate with others are skills that are important over and above purely cognitive skills such as literacy and numeracy. Indeed, from an empirical point of view, results of several landmark studies attest to the power of the Big Five personality traits and other non-cognitive skills to predict a broad range of important life outcomes, including educational attainment and achievement (Poropat, 2009[11]; Borghans et al., 2016[12]), occupational attainment and income (Roberts et al., 2007[9]; Hogan and Holland, 2003[13]; Judge, Livingston and Hurst, 2012[14]; Mueller and Plug, 2006[15]), health and longevity (Allison et al., 2003[16]; Arthur and Graziano, 1996[17]; Bogg and Roberts, 2004[18]; Rasmussen, Scheier and Greenhouse, 2009[19]; Borghans et al., 2016[12]), marital stability (Roberts et al., 2007[9];

[1] Although widely used, the term "non-cognitive skills" is somewhat controversial because these traits are hardly devoid of cognition (Gutman and Schoon, 2016[4]). Moreover, the term creates a false dichotomy, as cognitive and non-cognitive skills do not work in isolation but rather interact and cross-fertilize each other (Chamorro-Premuzic and Furnham, 2005[37]). Commonly used alternatives to the term "non-cognitive skills" include "soft skills", "character skills", "socio-emotional skills", or simply "personality traits". The Second Cycle of the Survey of Adult Skills, which will include an assessment of the Big Five domains, will refer to them as "social and emotional skills".

[2] The terms referred to here are the most commonly used labels. For this reason, we will use them as consistently as possible throughout the text. However, for some instruments, we report results on domains that are labelled slightly differently.

Roberts and Bogg, 2004[20]), and mental health and life satisfaction (Rammstedt, 2007[21]; Borghans et al., 2016[12]).

Importantly, several of the studies in this literature show that, compared to cognitive skills, non-cognitive skills are often equally potent—and sometimes even more potent—predictors of important life outcomes (Roberts et al., 2007[9]; Heckman and Kautz, 2012[22]; Borghans et al., 2016[12]). Several researchers have argued that the predictive power of non-cognitive skills may still be underestimated, whereas that of cognitive skills may have been overestimated by previous research. This is because many widely-used purported measures of cognitive skills, such as grade point average (GPA), are substantially confounded with non-cognitive skills (Borghans et al., 2011[23]; Borghans et al., 2016[12]). Consequently, these researchers have called for further research that pits the predictive power of cognitive and non-cognitive skills against each other (Borghans et al., 2011[23]; Borghans et al., 2016[12]).

1.2. Limitations of existing research on non-cognitive skills

Despite the impressive empirical advances made in research on the relationship between non-cognitive skills and life outcomes during the past decade, this body of evidence still has several limitations. First, the majority of these studies have relied mainly on North American samples, and often on samples that were small and non-representative. This raises the question as to whether existing findings are sufficiently replicable and generalisable to countries outside the North American context. Second, most studies so far have not jointly considered non-cognitive and cognitive skills and tested their predictive power against each other (for exceptions, see Roberts et al. (2007[9]) and Borghans et al. (2016[12])). However, even when this was done, the instruments used to assess cognitive and/or non-cognitive skills were often inadequately validated and of insufficient psychometric quality. This is because the assessment of cognitive skills is often costly and time-consuming, and the assessment of non-cognitive skills has long lagged behind that of cognitive skills in terms of validity and reliability.

1.3. Research opportunities afforded by recent large-scale surveys

Fortunately, a number of current large-scale survey programmes afford unprecedented opportunities to remedy some of the aforementioned limitations and to broaden the knowledge base on the role of cognitive and non-cognitive skills in predicting important life outcomes. Motivated by the growing body of encouraging findings and by prominent calls for the inclusion of non-cognitive skills (Borghans et al., 2008[24]; Heckman, Stixrud and Urzua, 2006[25]), several ongoing large-scale survey programmes have incorporated measures of personality and other non-cognitive skills into their core questionnaires. These programmes include, for example, the German Socio-Economic Panel (SOEP), the German National Educational Panel Study (NEPS), Household, Income and Labour Dynamics in Australia (HILDA), the UK Household Longitudinal Study (UKHLS), and international surveys such as the World Values Survey (WVS) and the International Social Survey Programme (ISSP). Likewise, large-scale comparative surveys conducted under the auspices of the Organisation for Economic Co-operation and Development (OECD) have become increasingly interested in measuring personality traits and other non-cognitive skills in addition to the classical cognitive skill measures. For example, the OECD has set up a specific Study on Social and Emotional Skills, that is now at its second cycle. The inclusion of non-cognitive skill measures is also progressing in the well-established OECD Programme for International Student Assessment (PISA). Finally, a set of non-cognitive skill measures has been included in

the second cycle of the Survey of Adult Skills, part of the OECD Programme for the International Assessment of Adult Competencies (PIAAC). The authors of this paper are members of a working group that has been established to identify the most central non-cognitive skills for this module.

2. Review of recent large-scale studies on non-cognitive skills

Although it may take years until the full benefits of these new large-scale, cross-nationally comparative datasets can be reaped, nascent research based on some of the new datasets already provides a glimpse of the potential of such data for investigating the role of non-cognitive skills in shaping important life outcomes. In the present paper, we illustrate this potential by summarising five recent investigations conducted by our own research group. All these investigations drew on recent large-scale, high-quality data sources and capitalised on the extensive cognitive and non-cognitive skill measures included in these datasets, thus allowing us to extend previous findings on the linkages between non-cognitive skills, cognitive skills, and life outcomes.

Together, these studies addressed four central issues. First, we asked how non-cognitive skills related to cognitive skills, a question that has recently received renewed attention (Borghans et al., 2011[23]; Borghans et al., 2016[12]). Second, we shed light on the power of non-cognitive skills to predict important life outcomes – the acid test for judging the utility of including non-cognitive skills measures in large-scale surveys. Third, in so doing, we pitted the predictive power of non-cognitive skills against that of cognitive skills such as IQ and literacy, thereby revealing the *incremental* predictive validity of non-cognitive skills over "classical" cognitive skill measures. Fourth, although we used the Big Five framework as a well-established guidepost, we explored the added value of investigating (a) more specific facet traits of the Big Five instead of, or in addition to, their five global dimensions, and (b) additional constructs beyond the Big Five framework.

Because PIAAC is a study of adult skills, the target populations in our studies were mostly working-age adults. Skills measured in PIAAC and their relations to life outcomes were compared across countries. We follow this perspective in the present paper by including cross-national results. In order to broaden the picture and to cross-validate our findings, we also report results based on a German secondary school student population using NEPS data.

2.1. Data sources

Our five investigations were based on data from (1) the German PIAAC survey (2012; N = 5 465) and the first wave of the German PIAAC longitudinal study (PIAAC-L, 2014; N = 4 122); (2) Starting Cohort 4 (ninth-grade students) of the German National Educational Panel Study (NEPS; N = 13 649), which we included in order to investigate effects of non-cognitive skills on scholastic achievement; (3) an international pilot study investigating the power of non-cognitive skills in five countries for the second cycle of PIAAC (N = 6 894); (4) the international PIAAC field trial (2010; N = 7 102), in which a measure of grit[3] was assessed. In what follows, we briefly describe the samples, research designs, and key measures used in our studies. We refer the reader to more detailed treatments where necessary.

[3] Grit is defined as perseverance and passion for long-term goals (Duckworth et al., 2007[29])

1) The German PIAAC longitudinal study (PIAAC-L)

PIAAC-L (Rammstedt et al., 2017[26]) is a follow-up survey to the PIAAC Survey of Adult Skills in Germany (Rammstedt et al., 2015[27]). For the analyses reported here, we combined data from the German PIAAC survey (2012), which comprised assessments of literacy and numeracy, with the first wave of PIAAC-L (2014). In the first wave of PIAAC-L, 4 122 of the original 5 465 PIAAC participants representative of the adult population in Germany (aged 16 to 65 years) were re-interviewed. Among other things, respondents completed a short Big Five questionnaire that had already been validated in the German Socio-Economic Panel (SOEP; Schupp and Gerlitz, (2014[28])) and a short scale for the measurement of grit (Duckworth et al., 2007[29]) originally implemented in the PIAAC field trial (2010). For a detailed description of the study design and the technical implementation, see (2016[30]).

2) The German National Educational Panel Study (NEPS)

NEPS is a multi-cohort longitudinal study that investigates educational trajectories and key competencies. For the analyses reported here, we investigated Starting Cohort 4, a representative sample of ninth-grade students in Germany (N = 13 649). These data include the results of standardised achievement tests, school grades, two relatively pure measures of cognitive basic skills (reasoning and processing speed) as well as a short measure of the Big Five that was previously validated for the German population (Rammstedt and John, 2007[31]). For a more detailed description of the sample and the analytical approach, see (Lechner, Danner and Rammstedt, 2017[32]).

3) The OECD's International Non-Cognitive Skills Pilot

Whereas PIAAC-L and NEPS are large-scale surveys conducted in Germany, the other data sources we used were cross-nationally comparative surveys. In 2016 and 2017, the OECD commissioned an international pilot study to investigate the predictive power of various non-cognitive skills for the second cycle of PIAAC. This pilot study was conducted using Amazon's Mechanical Turk panel based on quota samples of the adult populations in five OECD countries (France, Germany, Poland, Spain, USA). Thus, these data allow cross-nationally comparative analyses to be performed. The questionnaire included a comprehensive and validated Big Five instrument reflecting the hierarchical (i.e. facet) structure of the Big Five (Soto and John, 2017[33]), which formed part of a battery measuring various non-cognitive skills. In addition, the questionnaire measured a range of life outcomes and included a short test of cognitive ability. The cleaned dataset used for the present analyses comprised a total of N = 6 894 respondents.

4) The OECD's PIAAC field trial

Our second cross-national data source was the international PIAAC field trial (2010) for PIAAC – Round 1. The field trial was conducted in parallel in all Round 1 countries. In each country, the sample was heterogeneous with regard to the target population in PIAAC (N = 7 002)[4]. As the field trial was designed as a final rehearsal of the PIAAC main study, it included the extensive assessment of literacy and numeracy used in the PIAAC survey. In addition, a short-scale measure of grit was administered. Grit can be conceived of as a facet of the Big Five domain conscientiousness that emphasises perseverance and the pursuit of long-term goals rather than more micro-momentary aspects of conscientiousness such as self-control (Eskreis-Winkler et al., 2014[34]).

[4] For a detailed description of the study design, see Danner, Lechner and Rammstedt (2020[44]).

2.2. Key findings

In what follows, we present the key findings from our five investigations based on these data sources. We begin by exploring the association between cognitive and non-cognitive skills and addressing the validity of the Big Five in predicting life outcomes during adulthood based on the German PIAAC/PIAAC-L samples. Next, we extend these analyses to a cross-national perspective based on the International Non-Cognitive Skills Pilot conducted in five countries. We then report findings on the power of the Big Five to predict scholastic achievement in NEPS. Whereas these first three studies focused on global Big Five domains, the next study addressed the added value (in terms of explained variance) of including the more specific facets of the Big Five and was based on the results of the PIAAC field trial in 19 countries. Finally, we explore whether additional constructs that are not covered by the Big Five and their facets add to explaining the life outcomes in focus – a question that we addressed using, again, the OECD's International Non-Cognitive Skills Pilot.

Personality and adult life outcomes: findings from PIAAC/PIAAC-L in Germany

In the first study (Rammstedt, Danner and Lechner, 2017[35]; Rammstedt, Danner and Martin, 2016[36]) based on data from the German PIAAC survey (2012) and the German PIAAC-L study (2014), we investigated the associations between the Big Five domains and literacy and numeracy and the power of the Big Five personality domains to predict central life outcomes measured in PIAAC above and beyond cognitive skills. As expected, the study revealed only small overlaps between cognitive and non-cognitive skills. Results indicated that emotionally stable individuals and individuals with an intermediate level of conscientiousness tended to have higher cognitive skills; particularly high levels of conscientiousness were associated with lower cognitive skills. In addition, our results suggest that individuals with low levels of educational attainment, in particular, benefit more from higher levels of openness. This buttresses the view that cognitive and non-cognitive skills should not be seen as an unrelated dichotomy (Chamorro-Premuzic and Furnham, 2005[37]; Borghans et al., 2011[23]; Borghans et al., 2016[12]) but rather as a set of skills that influence each other and jointly shape life outcomes. Our findings also demonstrate that simple linear relationships may not suffice to capture the links between cognitive and non-cognitive skills.

Our results reveal that the Big Five domains clearly possess incremental value for the prediction of central life outcomes. In particular, we investigated educational attainment, labour market participation (working full-time vs. part-time employed or not employed), participation in continuing education (participated in courses in the past 12 months vs. did not participate), income, self-rated health, and life satisfaction. To investigate these relationships, we ran linear and logistic regression analyses with three different models per outcome indicator. In the first model, we estimated linear and quadratic associations of the Big Five domains with the six life outcomes. In the second model, we estimated the associations between literacy[5] and the six life outcomes. Finally, in our third model, we jointly considered the effects of personality and literacy in order to test the extent to which the Big Five personality dimensions explained variance over and above the competencies (incremental predictive validity). In all three models, we controlled for the

[5] We used literacy as a measure of cognitive skills but obtained the same results in alternative models using numeracy (the two correlate at $r > .86$).

sociodemographic variables age, gender, educational attainment, and migration status. The standardised regression coefficients (β) are shown in Table 1 and Table 2.

Results reveal that (at least some of) the Big Five personality domains were related to all six indicators of life success. The portion of variance explained by personality was in most cases similar to, and sometimes larger than, that explained by cognitive skills. Cognitive and non-cognitive skills were similarly associated with income, employment, and continuing education. However, the explanatory power of non-cognitive and cognitive skills differed markedly across the outcomes under investigation. Whereas cognitive skills were more strongly associated with educational attainment, non-cognitive skills were more strongly associated with health and life satisfaction. After adjusting for the cognitive skills, personality was incrementally predictive of life satisfaction and health and, to a lesser extent, educational attainment, employment status, and income.

Table 1. Relationships between personality, literacy, and important life outcomes

	Educational attainment (ISCED)[1]						Employment status (employed full-time)[1,2]						Participation in continuing education in the past 12 months[1,2]					
Model	I		II		III		I		II		III		I		II		III	
Extraversion (linear)	−.09	***			−.04	*	.01				.02		−.02				−.01	
Agreeableness (linear)	−.04	*			−.03		−.12	***			−.12	***	−.05	*			−.05	
Conscientiousness (linear)	−.03				.01		.17	***			.17	***	.03				.04	
Emotional stability (linear)	.12	***			.06	***	.12	***			.12	***	.06	*			.05	*
Openness (linear)	.14	***			.10	***	−.02				−.02		.01				.01	
Extraversion (quadratic)	−.02				−.02		.05				.05		−.04				−.05	*
Agreeableness (quadratic)	−.04	*			−.03		−.02				−.01		.02				.02	
Conscientiousness (quadratic)	−.07	***			−.03		.01				.01		−.03				−.02	
Emotional stability (quadratic)	−.03				−.02		−.01				−.01		−.02				−.02	
Openness (quadratic)	−.01				.00		−.01				−.01		.01				.02	
Literacy			.50	***	.48	***			.09	**	.10	***			.20	***	.20	***
Age	.16	***	.25	***	.24	***	−.15	***	−.11	***	−.13	***	−.07	**	−.02		−.03	
Gender (women)	−.01		−.03		−.02		−.53	***	−.53	***	−.53	***	−.03		−.05	*	−.04	
Education	−		−		−		.27	***	.23	***	.23	***	.34	***	.26	***	.25	***
Migration (migrant)	−.09	***	.01		.01		−.03		−.02		−.01		−.08	***	−.05	*	−.05	*
N	3 174		3 174		3 174		2 868		2 868		2 868		2 800		2 800		2 800	
R^2	.08		.27		.28		.31	[4]	.29	[4]	.31	[4]	.13	[4]	.15	[4]	.15	[4]

Note: Values are standardised regression coefficients.
[1] Only respondents who have completed their education (paus1_14); [2] Only respondents who were not retired; [3] Only respondents in full-time employment
* p < .05, ** p <.01, *** p < .001.

Table 2. Relationships between personality, literacy, and important life outcomes (continued)

	Income (log)[2,3]							Health							Life satisfaction					
Model	I		II		III			I		II		III			I		II		III	
Extraversion (linear)	.03				.04			.02				.02			.01				.02	
Agreeableness (linear)	−.02				−.01			.05	**			.05	**		.09	***			.09	***
Conscientiousness (linear)	−.02				.01			.04	*			.04	*		.13	***			.14	***
Emotional stability (linear)	.01				.00			.21	***			.20	***		.32	***			.31	***
Openness (linear)	−.12	***			−.12	***		−.01				−.01			.00				.00	
Extraversion (quadratic)	−.02				−.03			.00				.00			−.01				−.01	
Agreeableness (quadratic)	.05	*			.06	*		.00				.00			.02				.02	
Conscientiousness (quadratic)	−.04				−.03			−.02				−.02			.00				.01	
Emotional stability (quadratic)	−.02				−.02			−.04	**			−.04	*		−.02				−.02	
Openness (quadratic)	−.07	**			−.07	**		−.02				−.02			−.03				−.03	
Literacy			.14	***	.14	***				.10	***	.09	***				.12	***	.11	***
Age	.22	***	.26	***	.26	***		−.34	***	−.30	***	−.31	***		−.12	***	−.06	**	−.08	***
Gender (women)	−.13	***	−.14	***	−.13	***		.00		−.03		.00			.03	*	−.01		.03	*
Education	.28	***	.20	***	.21	***		.14	***	.12	***	.10	***		.11	***	.09	***	.06	***
Migration (migrant)	−.01		.00		.01			−.02		−.01		.00			−.04	**	−.04	*	−.02	
N	1 626		1 626		1 626			3 716		3 716		3 716			3 717		3 717		3 717	
R^2	.19		.18		.20			.16		.11		.16			.17		.04		.17	

Note: Values are standardised regression coefficients.
[1] Only respondents who have completed their education (paus1_14); [2] Only respondents who were not retired; [3] Only respondents in full-time employment;
* p < .05, ** p <.01, *** p < .001.

Zooming in on the outcomes that were most strongly predicted by the Big Five, which of the five dimensions emerged as most crucial? As regards overall life satisfaction, the more emotionally stable (β = .32), conscientious (β = .13) and agreeable (β = .09) a person was, the higher he or she rated his or her satisfaction. Overall, personality and the sociodemographic control variables together explained 17% of the variance in life satisfaction (Model I).[6] By contrast, the model that included only literacy and the same set of control variables explained only 4% of this rating (Model II). Combining non-cognitive and cognitive skills in Model III did not alter the amount of explained variance compared to Model I, which included only the personality dimensions (17%).

As regards self-rated health, the most predictive Big Five domain in this context was, again, emotional stability (β = .21). Non-cognitive skills and the sociodemographic control variables explained 16% of the variance in self-rated health. Cognitive skills (Model II) also contributed to explaining self-rated health. However, this model, which included only literacy and the control variables, explained markedly less variance (11%) than did Model I. Again, including cognitive skills in the model (Model III) did not increase the amount of explained variance in self-rated health.

Labour force participation could also be markedly explained by the non-cognitive skills (31%) – their explanatory power was slightly higher than that of the cognitive skills (29%). Again, taking both cognitive and non-cognitive skills into consideration did not alter the total amount of explained variance.

Whereas the amount of variance in continuing education, and even in income, explained by either the non-cognitive or the cognitive skills was about the same (13% and 15%, respectively, for continuing education and 19% and 18%, respectively, for income) educational attainment was primarily explained by cognitive skills (27% vs. 8%).

Although these data did not allow any causal claims to be made (the associations could be due, for example, to selection rather than causation), these findings show that the predictive power of personality rivals that of cognitive skills for most outcomes and surpasses that of cognitive skills, especially for health and well-being. A caveat to this comparison is that cognitive skills were measured in the PIAAC survey (2012), whereas non-cognitive skills were measured in the first wave of PIAAC-L (2014), and hence in the same wave as the outcomes. Moreover, the Big Five were measured with a short 15-item scale only, whereas cognitive skills were measured with an hour-length test.

Personality and adult life outcomes: a cross-national perspective

Although this study was among the first to contrast the predictive validity of non-cognitive and cognitive skills for several central life outcomes based on a large-scale population-representative sample offering extensive measures of cognitive skills, it was confined to the German context. This raises the question of the degree to which our findings can be generalised to other countries and cultures. In addition, the PIAAC-L study included only a very brief measure of the Big Five, which may further limit the generalisability of the findings.

To address these issues, we investigated the generalisability of our findings across five different countries based on data of the OECD's International Non-Cognitive Skills Pilot. The study included a measure of cognitive skills as well as a comprehensive measure of non-cognitive skills, namely the Big Five Inventory-2 (BFI-2; Soto and John, (2017[33])). Furthermore, it included a similar set of outcome indicators, this time measured on the same

[6] Fourteen percent of the variance could be explained by personality alone – not taking sociodemographic variables into account.

occasion. As can be seen from the first two columns for each country in Table 3, results of this study largely support our previous findings obtained in Germany: For all outcome variables investigated, and in all countries, the Big Five personality domains explained an additional portion of the variance (Model II) compared to the variance explained by sociodemographic variables and cognitive skills alone (Model I). The size of this increment varied significantly across the outcome variables investigated; as in our initial study, in all countries it was highest for life satisfaction and health.

Table 3. Explained variance (in percent) in different life outcomes by sociodemographic variables, cognitive skills, Big Five personality domains, and Big Five facets separately in five countries

	Income			Education			Employment			Job satisfaction			Life satisfaction			Social trust			Health		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
USA	.21	.25	.27	.25	.26	.27	.13	.17	.18	.04	.12	.18	.02	.38	.48	.03	.09	.13	.07	.22	.28
Germany	.12	.16	.17	.27	.30	.31	.27	.31	.35	.01	.10	.14	.01	.34	.43	.04	.09	.10	.12	.25	.30
France	.17	.20	.21	.15	.16	.17	.08	.10	.12	.02	.05	.08	.03	.24	.31	.01	.07	.11	.13	.21	.24
Spain	.21	.23	.24	.19	.20	.21	.14	.17	.18	.02	.09	.11	.02	.26	.35	.01	.06	.11	.10	.19	.21
Poland	.19	.22	.24	.12	.13	.14	.13	.15	.18	.00	.09	.11	.01	.28	.34	.02	.05	.09	.14	.21	.23
Average	.18	.21	.23	.20	.21	.22	.15	.18	.20	.02	.09	.12	.02	.30	.38	.02	.07	.11	.11	.22	.25

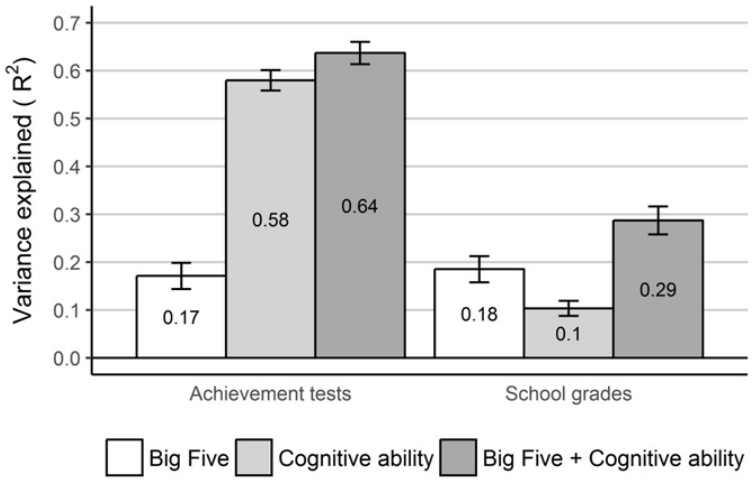
Note: Model I included sociodemographic variables (age, gender, education, parents' education) and cognitive ability; Model II included sociodemographic variables (age, gender, education, parents' education), cognitive ability and the Big Five domain scales; Model III included sociodemographic variables (age, gender, education, parents' education), cognitive ability, the Big Five domain scales and the Big Five facet scales.

Taken together, the results of our studies clearly show that the non-cognitive skills in terms of the Big Five personality domains explain a substantial portion of variance in life outcomes above and beyond cognitive skills. Even though the increment varies quite markedly between different outcomes, these effects are highly comparable across the five OECD countries.

Personality and scholastic achievement: findings from NEPS

So far, we have focused on the predictive power of non-cognitive skills in adulthood. In order to investigate whether personality is already predictive of important life outcomes at school age, we investigated in another recent study (Lechner, Danner and Rammstedt, 2017[32]) the degree to which personality and cognitive skills contributed to scholastic achievement, measured with achievement tests and school grades. We used the NEPS data (Starting Cohort 4), which are representative of ninth-grade students in Germany. Figure 1 illustrates the incremental validity of the Big Five personality dimensions in predicting achievement tests (modelled as a latent variable comprising test scores in maths, German, science, and technological and information literacy) and school grades (grade point average in German, English, maths, biology, physics, and chemistry) after adjusting for general cognitive skills (reasoning and processing speed). Personality explained an additional 6% of the variance in achievement over and above cognitive skills, and an additional 19% of the variance in school grades. Whereas the Big Five personality dimensions alone proved to be equally good predictors of performance in achievement tests and school grades, the predictive power of general cognitive skills differed markedly for these two achievement measures. Although cognitive skills explained 58% of the variance in achievement tests, they could predict only 10% of the school grade variance. Personality alone explained almost twice as much variance in school grades as general cognitive skills did.

Figure 1. Variance in scholastic achievement tests and school grades explained by (a) Big Five, (b) general cognitive ability and (c) the combination of Big Five and general cognitive ability



Although here too the data do not allow causal claims to be made, these findings are compatible with the notion that non-cognitive skills contribute to achievement over and above cognitive skills. In line with the work of other authors (Borghans et al., 2011[23]; Borghans et al., 2016[12]), the findings show that this is particularly true for school grades. This may explain why school grades are often more predictive of life outcomes than

relatively pure measures of intelligence: the former contain more variance in non-cognitive skills than the latter – skills that (as our first two studies showed) matter in shaping life success (Borghans et al., 2016[12]).

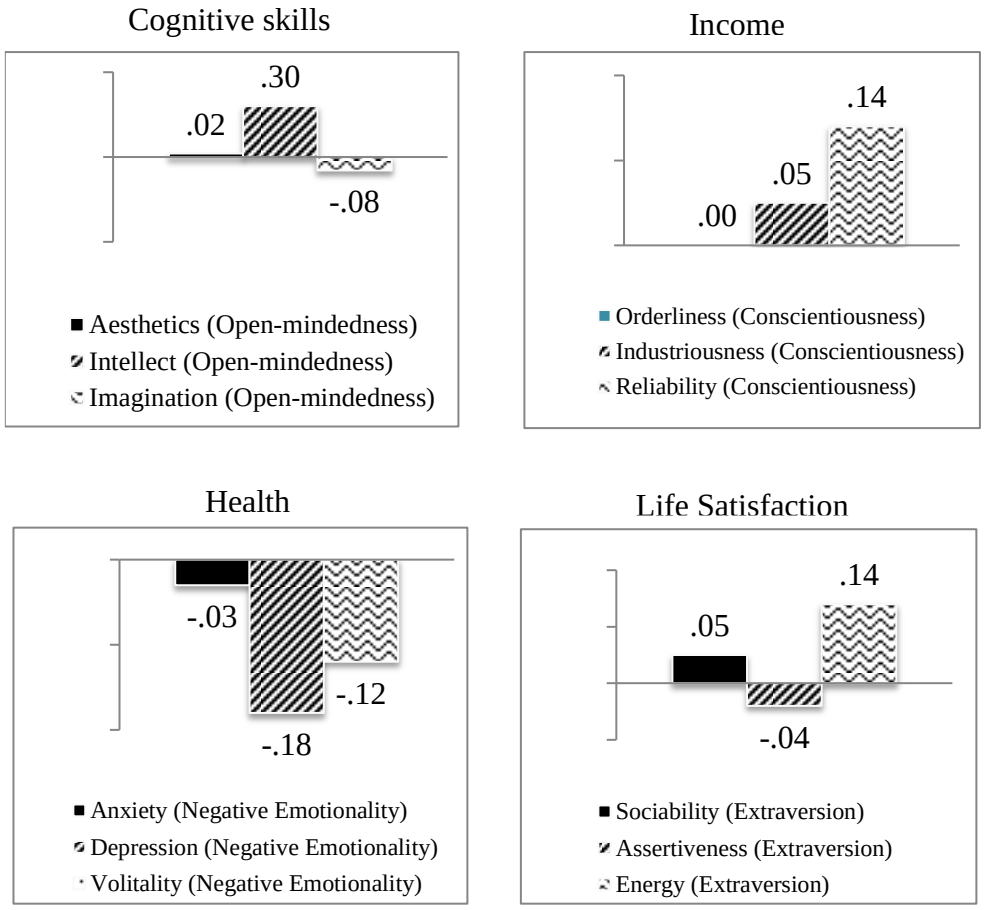
The incremental validity of Big Five facets for predicting adult life outcomes

All three studies reported thus far focused on the global Big Five domains as measures of non-cognitive skills. Recently, however, there have been prominent calls in the field of personality psychology that personality trait–outcome research should also consider facet-level, traits (see Mõttus, (2016[38]), and peer commentaries). In a recent set of studies, we therefore explored the merits of investigating more specific, fine-grained non-cognitive skills in addition, or as an alternative to the global Big Five domains.

One of these studies used a recently developed faceted Big Five instrument, the BFI-2 (Soto and John, 2017[33]). Within the BFI-2 framework, each domain (e.g. conscientiousness) can be described both on a global level and on the level of three specific facets that are hierarchically clustered within that domain (e.g. organisation, responsibility, productiveness, the facets of conscientiousness). The purpose of our study was to investigate whether the Big Five facets explained additional variance in outcome variables over and above the domain scales, and whether the facets yielded a more nuanced picture of the predictions of these outcomes. For example, we were interested in whether facets from within the same domain were differentially related to life outcomes, a possibility raised by Mõttus (2016[38]). To address these questions, we compared the variance explained by the Big Five facets (e.g. intellectual curiosity, creative imagination, and aesthetic sensitivity as facets of open-mindedness) to that explained by the global domains, and we inspected the pattern of predictive relationships that emerged. As a data source, we again used the International Non-Cognitive Skills Pilot conducted in five countries. As can be seen from the third column for each country in Table 3, the Big Five facets incrementally predicted all life outcomes compared to the global domain scales. Although the magnitude of the increment in explained variance yielded by the facets varied across outcomes, it was highly comparable across the countries investigated: in all countries, the gain in explained variance achieved by including the Big Five facets was greatest for life satisfaction, health, and social trust, with average increments of 8, 4, and 3 percentage points, respectively.

Investigating personality facets in addition to the global personality domains not only yields an increment in explained variance in the outcome variables, but also provides a more fine-grained and sometimes differential picture of the associations of personality with life outcomes. Figure 2 illustrates such differential associations (based on the U.S. sample of the International Non-Cognitive Skills Pilot): The association of cognitive skills and the personality domain *open-mindedness* is primarily driven by a strong association with the open-mindedness facet *intellectual curiosity*. The other two facets of this personality domain (*aesthetic sensitivity* and *creative imagination*) show more or less zero associations, which is in line with Mõttus (2016[38]). In a similar way, income was primarily associated with the conscientiousness facet *responsibility,* whereas the correlations with the other two facets of that domain (*organisation* and *productiveness*) ranged around zero. The emotional stability facets *depression* and *emotional volatility* were much more strongly (negatively) related to health than the facet *anxiety*. Finally, life satisfaction was more strongly associated with the *energy* facet of extraversion than with its facets *sociability* and *assertiveness*.

Figure 2. Differential associations of Big Five facets with various outcome variables



One methodological limitation of these analyses should be mentioned. Although the results demonstrate that specific personality facets have an incremental predictive value over and above global domains, the interpretation of the impact of single facets is limited because the regression analyses were based on manifest facet scores that may share different amounts of variance with the global domains.

Another prime example of a more specific non-cognitive skill is *grit*, a construct that has received widespread research attention and attracted considerable media interest since its introduction about a decade ago by Duckworth and colleagues (Duckworth et al., 2007[29]). Grit is defined as perseverance and passion for long-term goals (Duckworth et al., 2007[29]; Duckworth, 2016[39]); it can be regarded as a facet of the Big Five domain of conscientiousness that focuses on long-term aspects of self-regulation as opposed to more micro-momentary aspects such as temptation resistance (Duckworth and Gross, 2014[40]; Eskreis-Winkler et al., 2014[34]). Motivated by findings portraying grit as a key determinant of success, particularly in academic settings, that outranks even cognitive ability and socio-economic background goals (Duckworth et al., 2007[29]; Duckworth, 2016[39]), large-scale intervention efforts are currently underway with the aim of increasing levels of grit in children and young people in order to help them to successfully navigate the life course. For example, under the auspices of the World Bank, all population cohorts of primary school students in Macedonia have received training to increase their levels of grit; a similar intervention was conducted among primary school children in Türkiye (Alan, Boneva and Ertac, 2019[41]). Results of the latter study reveal that the participating children not only

increased their soft skills but also scored about one-fifth of a standard deviation higher in a language test and about one-third of a standard deviation higher in maths.

Notwithstanding its popularity, the predictive power of grit has not yet been firmly established (for a critical review and meta-analysis, see Credé, Tynan and Harms, (2017[42])), especially for outcomes other than those in the academic domain (e.g. school grades, retention). Moreover, the vast majority of studies on grit have relied on samples from North America, whereas research from other world regions is sorely lacking. Two further current investigations of ours addressed this gap. Our aims in these studies were twofold: first, to illuminate whether higher levels of grit are desirable and beneficial with respect to adult life outcomes; second, to investigate the extent to which the associations between grit and life outcomes are consistent or vary across countries. In the first of these investigations (Lechner, Danner and Rammstedt, 2019[43]), we used an employed subsample from the German PIAAC-L study (n = 2 246) to examine grit's predictive power in relation to subjective and objective career-related outcomes, a topic that – in contrast to grit's relationship to achievement in the educational domain – is still under-researched (Credé, Tynan and Harms, 2017[42]). As indicators of career success, we chose income, job prestige (SIOPS scale), and job satisfaction; indicators of career engagement were overtime work (number of hours per month), participation in continuing professional development (number of courses taken in the past year), and respondents' attitudes towards lifelong learning.

Results reveal that grit was positively related to all six career outcomes. Although effect sizes were small to moderate, the beneficial effects of grit held even after accounting for cognitive skills (numeracy). Whereas grit's effects on income and job prestige were smaller than those of cognitive skills, its effects on the other four career outcomes were significantly larger than those of cognitive skills. At least as far as objective dimensions of success (income, prestige) are concerned, these findings contradict the notion that grit matters more for success than do cognitive skills. Overall, however, the findings support the incremental predictive validity of grit vis-à-vis objective and subjective indicators of career success and career engagement. On a side note, grit was uncorrelated with cognitive skills in the PIAAC-L data, lending support to the notion that grit is a resource that can be cultivated independently of ability or innate talent (Duckworth, 2016[39]).

Along similar lines, in the second of our studies on grit (Danner, Lechner and Rammstedt, 2020[44]), we investigated the incremental predictive validity of grit for income, job satisfaction, and health – again over and above cognitive skills and a range of sociodemographic characteristics. Moreover, in what is, to our knowledge, the first cross-nationally comparative analysis of the predictive power of grit, we explored whether these associations varied across major sociodemographic strata (age groups, gender, educational attainment) and across national contexts with varying economic (unemployment rates) and cultural (individualism–collectivism) conditions. This investigation was based on the PIAAC – Round 1 field trial data. Aggregated across 19 countries, we could show, that – in addition to sociodemographic variables and cognitive skills – grit could explain between 2% and 3% more of the variance in job satisfaction and health. In line with our first study, a higher level of grit did not prove to be of additional benefit for job success, in terms of income (see Table 4).

Table 4. Grit-predicted health, income, and job satisfaction

	Relative income							Job satisfaction						Health					
Model	I		II		III			I		II		III		I		II		III	
Grit	.08	***			.05	**		.20	***			.19	***	.10	***			.15	***
Age			.25	***	.25	**				.05	**	.02				-.27	***	-.30	***
Gender (men)			.44	***	.44	***				-.03		-.03				.05	*	.05	*
Education			.30	***	.30	***				.05	**	.04	**			.11	***	.09	***
Migration (native)			.10		.11					.13		.15				.02		.00	
Cognitive skills			.13	***	.13	***				.02		.02				.07	***	.07	***
R^2	.01		.28		.28			.03		.01		.04		.01		.12		.14	
N	2 251		2 251		2 251			4 158		4 158		4 158		6 032		6 032		6 032	

Note: The table shows standardised regression coefficients. * p < .05, ** p < .01, *** p < .001.

To what extent do these findings generalise across cultures and countries? Additional analyses revealed that the associations between grit and life outcomes were highly comparable across sociodemographic strata and across countries, and that they were moderated neither by individual characteristics, such as cognitive ability, nor by country-specific characteristics, such as unemployment rate.

Accordingly, the results of our studies indicate that (a) the social and economic returns of grit are limited in size and are generally larger for career engagement than for job success and (b) these findings seem to be robust across different countries.

Overall, our studies on grit thus attest to the added value of considering more specific personality facets, in addition to global domains, as potential ingredients of life success. Conceptually, it makes great sense that some facets are more strongly related to specific outcomes than are global domains. Specific facets and outcomes may be related on a functional level. For example, the openness facet *intellectual curiosity* may share similar underlying motivations with cognitive ability beyond global openness, whereas the openness facet *aesthetic sensitivity* may not. Furthermore, specific facets, such as the emotional stability facet *depression*, and self-rated health may be similar to specific outcomes on a symptomatic level.

Additional non-cognitive skills beyond the Big Five framework

Several other constructs besides the Big Five domains and their facets can be subsumed under the category of non-cognitive skills (Gutman and Schoon, 2016[4]). In the course of the International Non-Cognitive Skills Pilot, we investigated several additional constructs that are commonly used in psychological and educational research. Our results reveal that most of these constructs do not contribute to explaining substantial additional variance in education, employment status, income, health, or life satisfaction over and above the Big Five. The only set of constructs that provided incremental validity in this context was vocational interests. The concept of vocational interests was advocated by Holland (1977[45]) as far back as the 1970s. According to Holland (1977[45]), vocational choice is highly dependent on a person's enduring vocational interests. In his so-called RIASEC

model, he distinguished on a global level the six vocational interests *realistic*, *investigative*, *artistic*, *social*, *enterprising* and *conventional*. Our results reveal that these six interests can explain up to 4% more variance in educational attainment, income, and health. This suggests that the Big Five domains and their facets demonstrate the strongest associations with life outcomes such as education, professional success, and satisfaction, but also that additional non-cognitive skills such as interests play an albeit minor role in understanding these life outcomes.

3. Discussion

What are the ingredients of success and happiness at school, work and beyond? This question continues to energise researchers, practitioners, and laypersons alike. Zooming in on this question, the present paper aimed to cast light on the incremental value of non-cognitive skills for large-scale assessments such as PIAAC. We investigated how non-cognitive skills relate to cognitive skills and important life outcomes, and to what extent these associations can be generalised across countries.

How are non-cognitive skills related to cognitive skills? From a conceptual point of view, it is obvious that non-cognitive skills, such as the ability to control emotions and impulses or to plan systematically, are complementary to cognitive skills such as literacy or numeracy. Our studies demonstrate that non-cognitive skills – and, in particular, the Big Five personality domains – are also empirically complementary to cognitive skills, and that they describe incremental resources that help individuals to pursue life goals.

Can non-cognitive skills predict life outcomes over and above cognitive skills? The answer is an unequivocal yes. We investigated the merits of the Big Five personality domains in predicting life outcomes, as these traits can be regarded as the most central and least debatable non-cognitive skills, conceptually and empirically. In addition, we analysed the merits of including in the predictions both the global Big Five dimensions and their more specific facets. In a next step, we explored whether other constructs that are not covered by the Big Five and their facets substantially added to explaining the life outcomes in focus. Taken together, the results of our studies yield robust large-scale evidence that, together, non-cognitive skills incrementally predict life outcomes above and beyond cognitive skills. Our results also reveal that, of the various non-cognitive skills investigated – which differed in terms of content and granularity – the global Big Five personality domains contribute most to explaining the outcome variables over and above the cognitive skills. In particular, the global domains *openness* and *conscientiousness* were found to predict educational success, such as educational attainment or school grades, whereas *emotional stability* was found to predict criteria such as health or life satisfaction (Rammstedt et al., 2017[26]). Moreover, our results revealed that specific facets, such as grit, defined as perseverance and passion for long term goals, can further predict specific success criteria such as job satisfaction or work engagement (Danner, Lechner and Rammstedt, 2020[44]; Lechner, Danner and Rammstedt, 2017[32]). In the OECD's International Non-Cognitive Skills Pilot, we found further evidence that non-cognitive skills beyond the Big Five framework, for example vocational interests, can incrementally predict several life outcomes. These results suggest that non-cognitive skills are useful resources over and above cognitive skills, and that achieving educational, professional, and personal life success depends on these non-cognitive skills.

Comparing the predictive power of non-cognitive skills with that of cognitive skills or sociodemographic variables yielded further insights. First, the usefulness of non-cognitive skills varies across life domains. Whereas some outcomes such as educational attainment are primarily associated with cognitive skills, outcomes such as income are equally

associated with cognitive skills and non-cognitive skills, and outcomes such as health or life satisfaction are primarily associated with non-cognitive skills. Second, pathways leading to life success differ. In all datasets investigated, we found independent and incremental effects of cognitive and non-cognitive skills. This suggests that the underlying mechanisms leading to success are independently affected by cognitive and non-cognitive skills. For example, in the PIAAC-L study, educational attainment was largely explained by cognitive skills, but there was also an incremental association with the Big Five domain *openness*. This suggests that the ability to read and write and to do arithmetic, as well as the disposition to be curious and open-minded, lead to educational success.

Can the associations between non-cognitive skills and life outcomes be generalised to the population within one country and across countries? We criticised previous studies on non-cognitive skills for not using representative samples from different countries. Do the studies reviewed here contribute to closing this research gap? We believe they do. The NEPS and PIAAC-L studies are based on representative samples of the general German population, and are thus not affected by self-selection of specific sociodemographic subgroups. The OECD's International Non-Cognitive Skills Pilot is based on a heterogeneous quota sample of five OECD countries, and the OECD's PIAAC field trial was based on heterogeneous samples in 19 OECD countries. All studies revealed incremental associations between non-cognitive skills and important life outcomes such as educational success, professional success, health, and life satisfaction. Furthermore, we found that associations between non-cognitive skills and life outcomes were robust and did not vary substantially across countries.

3.1. Limitations and future research avenues

Despite the progress made by our own investigations, there are a number of limitations that future research should address in order to further advance this line of investigation.

First, the research presented here describes – but does not causally explain – the associations between non-cognitive skills and life outcomes. Although the present findings clearly confirm that non-cognitive skills matter (Roberts et al., 2007[9]; Ozer and Benet-Martínez, 2006[10]), they do not enable us to fully understand how non-cognitive skills work and via what variables they are mediated. Are conscientious individuals more often employed because they try harder to get a job interview or because they are perceived to be more efficient? Do emotionally stable students get better grades because they can cope better with stress or because they demonstrate less test anxiety? Longitudinal studies tracking non-cognitive skills and life outcomes over time are needed to firmly establish causality and to discern causation effects (e.g. people high in conscientiousness may obtain more demanding and highly paid jobs) from selection effects (e.g. people in demanding jobs may become more conscientious over time).

Second, like most studies on non-cognitive skills, our investigations were based on self-report measures. Although valid and reliable measures of non-cognitive skills (especially the Big Five) are now available and were included in the large-scale surveys on which we based our five investigations, self-report measures are still prone to potential biases such as social desirability. In addition, one could argue that the explained variance in outcomes found here might be overestimated as both non-cognitive skills and the investigated outcomes were assessed using the same method, namely self-reports.

Third, although we incorporated cross-nationally comparative analyses wherever possible, thereby moving an important step forward in addressing the issue of generalisability, our analyses were limited to a reduced set of – mostly highly developed – OECD countries included in the large-scale surveys we used. Although the samples in our cross-national

studies were heterogeneous with regard to the key sociodemographic variables, they were in most cases not representative of the corresponding populations. Thus, the generalisability of our cross-national findings to the corresponding populations and to other, less developed, countries should be addressed in future research.

4. Conclusions

In this paper, we summarised several of our recent studies that explored the merits of investigating non-cognitive skills. Together, these studies provide robust evidence that (1) non-cognitive skills are largely independent of cognitive skills, (2) non-cognitive skills are incrementally associated with life success over and above cognitive skills, and (3) most of these associations can be generalised across countries. Although effect sizes varied considerably, incremental effects of non-cognitive skills emerged for a broad range of life-success indicators. In particular, the global Big Five domains extraversion, agreeableness, conscientiousness, emotional stability, and openness, and the more specific Big Five facets (especially grit, conceived of as a facet of conscientiousness), revealed strong conceptual and empirical value over and above cognitive skills and are thus valuable addendums to large-scale assessments such as PIAAC.

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