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Ability and personality correlates of general knowledge

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Abstract

The relationship of general knowledge (GK) with ability (IQ and abstract reasoning) and personality (Big Five traits and Typical Intellectual Engagement [TIE]) was investigated in a sample of 201 British university students. As predicted, GK was positively correlated with cognitive ability (more so with IQ [$r = .46$] than with abstract reasoning [$r = .37$]), TIE ($r = .36$) and Openness to Experience ($r = .16$), and negatively related to Neuroticism ($r = -.18$) and Extraversion ($r = -.16$). A total of 26% of GK variance was explained by measures of intelligence, though personality traits (particularly Neuroticism and Extraversion) showed incremental validity (5%) in the prediction of GK. Applied and theoretical implications are discussed.

Keywords: General knowledge; Crystallized intelligence; Fluid intelligence; Typical intellectual engagement; Personality; Investment; PPIK; Openness; Conscientiousness

1. Introduction

Although general intellectual ability (*g*) (Spearman, 1904) is the most established and ubiquitous predictor of occupational and educational performance (Lubinski, 2000, 2004; Schmidt

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& Hunter, 2004), there is longstanding evidence (Ackerman, 1994; (Catell 1971/1987); Furnham et al., 2003; Humphreys, 1968; Wolf, 1939) for the fact that, at more advanced stages of life, performance and achievement are best predicted by crystallized intelligence (g_c), rather than the biologically-based, content-free, and so-called "culture-free" tests of fluid abilities (g_f) (traditionally regarded as the best measures of g). It thus seems that the predictive power of g_f tends to decline as individuals progress through the educational system, and as acquired information and learned skills play a greater role in determining job performance (Ackerman, 1996, 1999; Jensen, 1980). "g may be most useful in predicting academic success for children and adolescents, but (that g becomes) less important in predicting academic success as individuals reach young adulthood and beyond" (Ackerman, Bowen, Beier, & Kanfer, 2001, p. 797). In these cases, it appears to be more relevant to measure what a person *already knows*, than what or how fast a person *could learn*. And yet, the measurement of individual differences in knowledge remains largely an unaccomplished goal in differential psychology (Deary, 2001).

1.1. General knowledge

Although general knowledge (GK) has continued to be an area of research in both cognitive (East & Forgas, 2002; Mariani, Sacco, Splinnler, & Venneri, 2002) and differential psychology (Irwing, Cammock, & Lynn, 2001; Lynn, Irwing, & Cammock, 2002; Runco & Nemiro, 2003), semantic inconsistencies have made it difficult to consolidate the area and validate the construct.

As is often the case in psychology, researchers have not always used the same label to refer to the concept of GK. This *jangle* fallacy (Kelley, 1927) has been logically explained as a consequence of the fact that psychologists can name a greater number of variables than they can actually measure or assess independently (Gordon, 1997; Lubinski, 2004). For instance tacit and procedural knowledge both refer to the practical aspects of knowing "how to do" something (e.g., ride a bicycle, shave, dress, etc.), whilst word and declarative knowledge are conceptual and emphasize the relational aspects of represented objects and events (e.g., water is liquid, rain is wet, humans are mammals, etc.).

Within differential psychology, the role of GK as a component of intelligence and a good measure of it remains in dispute. Thus while the Wechsler Adult Intelligence Test (Wechsler, 1981) has a sub-scale called *Information*, which is arguably a GK test, the Stanford–Binet (Terman & Merrill, 1960) does not (though other sub-scales of the Stanford–Binet test, such as *Comprehension*, are probably as crystallized and content-based).

Unlike the pedagogical method, which conceptualized intelligence in terms of "the sum of acquired knowledge" (Binet and Simon 1905/1961, p. 91), Binet's psychological method was initially based on the measurement of learning ability to account for individual differences between young children, rather than learned facts or acquired information in adults. However, Binet and Simon's later definition of intelligence focused on judgment and common sense, for which experience and education were arguably important: "It seems to us that in intelligence there is a fundamental faculty, the alteration or the lack of which, is of the utmost importance for practical life. This faculty is judgment, otherwise called good sense, practical sense, initiative, the faculty of adapting one's self to circumstances. A person may be a moron or an imbecile if he is lacking in judgment; but with good judgment he can never be either. Indeed the rest of the intellectual faculties seem of little importance in comparison with judgment" (Binet and Simon, 1916/1973, pp. 42–43).

1.2. GK, g_c, and investment

Further attempts to describe the structure of intelligence or hierarchy of human mental ability sometimes refer to GK, but usually under the concept of g_c (Carroll, 1993; Cattell, 1967). g_c is understood to be a broad mental ability that results from the investment of fluid ability (reasoning) in broad educational and experiential influences. Crucially, the level of intellectual investment is not only dependent on one's level of reasoning or learning ability, but also personality traits (Kline, 1991, p. 34). The relationship between g_c and GK has been theoretically and empirically examined in Ackerman's (1996, 1999) comprehensive model of intelligence as processes, personality, interests, and knowledge (PPIK). PPIK is an investment theory of intelligence that further develops on Catell's (1971/1987) model. Accordingly, g_f is understood in terms of processes and measured through abstract reasoning, whereas g_c is partly represented by knowledge, which is defined by recognition and recall of declarative facts and procedural skills. PPIK also proposes an integration of ability and non-ability traits, in order to explain the determinants of knowledge.

Recent studies have suggested that individual differences in domain specific knowledge and GK are related to g_c rather than g_f, and that so-called investment personality traits, such as Openness, Typical Intellectual Engagement (TIE), and Extraversion (negatively), reflect level of intellectual orientation and effort and are also significantly related to GK (Ackerman et al., 2001; Rolfhus & Ackerman, 1996, 1999).

On a similar note, Chamorro-Premuzic and Furnham (2004, 2005) have recently proposed that intellectual competence is multi-determined by an array of ability and non-ability traits, and that specific personality traits (notably Conscientiousness positively, and Neuroticism and Extraversion, negatively) play an important role in determining an individual's potential for academic achievement. Studies of academic performance, measured through final examinations and conceptualized as tests of domain-specific knowledge, indicate that personality traits are useful to predict individual differences in educational achievement. The most important predictor of academic performance is no doubt Conscientiousness, and there is also evidence for some consistent negative associations between exam performance and Neuroticism (Chamorro-Premuzic & Furnham, 2003a, 2003b; Furnham et al., 2003). Other traits, such as Openness and Extraversion, have shown more variable associations with educational outcomes, probably due to the moderating effects of classroom environment, type of assessment, and intelligence (see Chamorro-Premuzic & Furnham, 2005 for a review).

1.3. Hypotheses

The present study tested the extent to which both ability and personality traits are related to GK. In line with Ackerman's PPIK (1996) theory and Chamorro-Premuzic and Furnham's (2004, 2005) intellectual competence model, it was expected that:

(H1) GK would be significantly and positively correlated with abstract reasoning, a component of g_f. This would provide further evidence for the predictive power and developmental effects of g_f on the acquisition and consolidation of g_c.
(H2) GK would be positively and significantly associated with IQ, which would be consistent with the idea that GK is an essential component of g_c.

(H3) GK would be more related to IQ than to abstract reasoning, for IQ, like GK, includes items that measure g_c, whilst abstract reasoning is a measure of g_f or process rather than content.
(H4) There would be a significant and positive correlation between GK and TIE. This will be consistent with the theory of PPIK and Cattell's investment theory, positing that personality traits may determine an individual's level of investment and effort in the acquisition of skills, knowledge and information.
(H5) Extraversion would be negatively and significantly related to GK, showing that introverts have a greater tendency toward intellectual investment than their extraverted counterparts do.
(H6) Openness to Experience would be significantly and positively correlated with GK; this would reflect open individuals' greater interests and investment in knowledge.
(H7) Conscientiousness would be positively and significantly correlated with GK. This correlation would be in line with the positive relationship between TIE and Conscientiousness, and the idea that Conscientiousness may partly develop as a compensatory trait for lower g_f (particularly in competitive academic or organizational settings) (Chamorro-Premuzic & Furnham, 2004).
(H8) TIE would show incremental validity (beyond cognitive ability measures) in the prediction of GK, suggesting that levels of intellectual investment can determine levels of GK beyond individuals' IQ and g_f.
(H9) In line with H8, it was expected that Extraversion, Openness to Experience and Conscientiousness would provide additional information about an individual's likelihood to invest in GK acquisition. Like TIE, these Big Five personality traits refer to investment but, unlike TIE, Extraversion may explain investment in terms of sociability levels (low, in the case of introverts), Openness in terms of creativity, interests, and even g_c, whilst Conscientiousness should emphasize an individual's level of drive, discipline and achievement motivation.

2. Method

2.1. Sample and procedure

Data were collected from 201 (134 female) British University students from different courses and degrees. Age ranged from 18 to 31 years, with an arithmetic mean of 20.31 (SD = 3.67) years. There were no significant age or sex differences in any of the tests. Participants completed the measures in a quiet, large, lecture theatre, under the supervision of four examiners. Ability tests were completed first, followed by the GK test, followed by the personality inventories. All students received individual feedback in the weeks after the test completion.

2.2. Measures

2.2.1. General knowledge

2.2.1.1. General knowledge test (Irwing et al., 2001). This is a 60-item test that measures knowledge of six areas: literature, general science, medicine, games, fashion and finance. Each area is measured by 10 items (e.g., "Who discovered penicillin?", "Who wrote 'Anna Karenina'?",

"Which Beatle was shot in New York?"), and each correct response is awarded 1 point (in a few cases, there are two correct responses and not one). The internal consistency of the test for the present sample was $\alpha = .78$.

2.2.2. Personality

2.2.2.1. The Revised NEO Personality Inventory (NEO PI-R) (Costa & McCrae, 1992). This is a 240-item un-timed questionnaire, measuring 30 primary and five super-traits. The five super-traits are Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness. Each item of the test is a statement, to which one must respond on a five-point Likert-type scale, the answers ranging from strongly disagree to strongly agree. A considerable amount of research has been done on the NEO PI-R demonstrating high levels of both internal consistency and validity (Costa & McCrae, 1992). The average scale internal consistency for the major Big Five dimensions was $\alpha = .79$.

2.2.2.2. Typical Intellectual Engagement (TIE) (Goff & Ackerman, 1992). This inventory comprises 59 items. Participants respond on a 6 point Likert-type scale and high scores represent their preference and tendency to engage in intellectual activities (e.g., arts, philosophical discussions, problem solving). For the present sample, the internal consistency of the TIE test was $\alpha = .86$.

2.2.3. Intelligence

2.2.3.1. The Wonderlic Personnel Test (Wonderlic, 1992). This 50-item test is administered in 12 min and measures IQ. Scores can range from 0 to 50. Items include word and number comparisons, disarranged sentences, serial analysis of geometric figures and story problems that require mathematical and logical solutions. The test has impressive norms and correlates very highly ($r = .92$) with the WAIS-R. The internal consistency of the test was $\alpha = .71$.

2.2.3.2. The Baddeley Reasoning Test (Baddeley, 1968). This 60-item test can be administered in 3 min and measures g_f through abstract/logical reasoning. Scores can range from 0 to 60. Each item is presented in the form of a grammatical transformation that has to be answered with "true/false", e.g., "A precedes B – AB" (true) or "A does not follow B – BA" (false). The internal consistency of the test for the present sample was $\alpha = .88$.

3. Results

A series of bivariate correlations were computed on the data to explore the relationship between all constructs; specifically, whether there were any significant ability and personality correlates of GK (all correlation coefficients are reported in Table 1).

As hypothesized, ability measures were significantly correlated with GK. The significant correlation between GK and BRT supported the prediction of a significant relationship between GK and abstract reasoning (a component of g_f) (H1), whilst the significant correlation between GK and WPT scores supported the hypothesis that GK would be positively related to IQ (H1). In line with initial predictions (H3) GK was more strongly correlated with IQ than with g_f (see hierarchical regression analysis and Table 2).

Table 1
Pearson correlation coefficients (r) between all measures and inventories

	1	2	3	4	5	6	7	8	9
X	30.53	28.9	28.5	229.4	108.6	125.3	122.3	114.9	126.8
(SD)	(10.8)	(9.9)	(11.2)	(28.7)	(30.3)	(24.2)	(21.1)	(18.7)	(7.3)
1. GK	–	.37**	.46**	.36**	−.18*	−.16*	.16*	.02	−.05
2. BRT		–	.33**	.00	.05	−.14	.07	.01	−.25**
3. WPT			–	.36**	.00	.02	.17*	−.03	.06
4. TIE				–	−.07	.07	.26**	.06	.25**
5. N					–	−.09	−.03	.03	.07
6. E						–	.19*	.18*	.41**
7. O							–	.16*	.08
8. A								–	.13
9. C									–

Note: Overall $n = 201$. $^{*}p < .05$. $^{**}p < .01$. *Abbreviations:* GK = general knowledge, BRT = Baddeley Reasoning Test (g_f), WPT = Wonderlic Personnel Test (IQ), TIE = Typical Intellectual Engagement, N = Neuroticism, E = Extraversion, O = Openness, A = Agreeableness, C = Conscientiousness.

Table 2
Hierarchical regressions for the prediction of general knowledge (GK)

Model		Unstandardized coefficients		Standardized coefficients, β	t	Sig.
		B	St. error			
1	Constant	9.487	3.278		2.894	.005
	BRT	.258	.102	.206	2.536	.012
	WPT	.447	.087	.419	5.149	.000
$AdjR^2$		.26**				
2	Constant	−4.030	8.391		.480	.632
	BRT	.285	.102	.228	2.792	.006
	WPT	.378	.095	.354	3.984	.000
	TIE	.065	.037	.147	1.747	.083
$AdjR^2$		.27**				
3	Constant	11.534	10.422		1.107	.271
	BRT	.298	.100	.238	2.968	.004
	WPT	.371	.093	.348	3.970	.000
	TIE	.063	.037	.144	1.714	.089
	N	−.078	.032	−.187	2.460	.015
	E	−.079	.038	−.160	2.095	.038
	O	.024	.043	.045	.570	.569
$AdjR^2$		.31**				

Note: Overall $n = 200$. $^{**}p < .01$. *Abbreviations:* GK = general knowledge, BRT = Baddeley Reasoning Test (g_f), WPT = Wonderlic Personnel Test (IQ), TIE = Typical Intellectual Engagement, N = Neuroticism, E = Extraversion, O = Openness, A = Agreeableness, C = Conscientiousness. *Criterion* variable: GK.

Results also supported most predictions on to the relationship between GK and personality traits. There was a significant and positive correlation between GK and TIE (H4). Extraversion was negatively and significantly related to GK (H5), whilst Openness to Experience was positively and significantly related to GK (H6). Against initial expectations (H7), Conscientiousness was unrelated to GK and, though not predicted, Neuroticism was significantly and negatively associated with GK.

A series of hierarchical regressions were then computed in order to test whether (H3) IQ is a more powerful predictor of GK than g_f (abstract reasoning), whether (H8) TIE can account for additional unique variance in GK, even when ability measures are considered, and, finally, whether (H9) Big Five factors – specifically those significantly correlated with GK (i.e., Neuroticism, Extraversion, and Openness to Experience) can significantly improve the prediction of GK (even when IQ, g_f, and TIE are included as predictors in the regression model). All regressions are summarized in Table 2.

As can be seen, cognitive ability measures were the best predictors of GK. Further, WPT scores were better predictors of GK than BRT scores, supporting the initial hypothesis (H3). Together, IQ and g_f accounted for 26% of the variance in GK. This percentage was marginally but significantly increased (by 1%) when TIE was included as a predictor. However, ability measures were still the only significant predictors in this model (H7 was therefore not supported). When the NEO personality traits were added to the predictors, Neuroticism and Extraversion (but not Openness to Experience) were also significant, and the amount of variance accounted for increased to 31% (this confirmed H8).

4. Discussion

The relationship between GK and ability factors found in the present study provide support for Catell's (1971/1987) original two-factor theory of intelligence, and the conceptualization of GK as a major component of g_c. Thus IQ (which measures content as well as processes) provided a better indicator of individual differences in GK than did abstract reasoning scores. This suggests that GK, like other crystallized abilities, is the result of applying g_f over time. Such application has been explained in terms of investment, and, in order to assess the possible role of personality traits in knowledge investment, the relationships between GK and the Big Five and TIE personality traits should be considered.

Results showed that TIE was the most significant personality correlate of GK, supporting initial predictions. It is thus likely that individual differences in *typical* level of intellectual investment can partly determine the level of knowledge acquired. Individuals high on TIE tend to be intellectually curious, driven, and orientated. Likewise, open and conscientious individuals (it is noteworthy that Openness and Conscientiousness were correlated with TIE, not only in the present, but also in past studies (Goff & Ackerman, 1992)) were expected to perform better on the GK test, though only Openness was significantly related to GK. Furthermore, when TIE was taken into account, Openness was not significantly related to GK.

Another predicted finding concerns the correlation between GK and Extraversion: Introverts outperformed extraverts in the GK test. In line with Chamorro-Premuzic and Furnham's (2003a, 2003b, 2004) findings (see also Cattell, 1945; Rolfhus & Ackerman, 1999), this would

suggest that introverts have a greater tendency to invest in intellectual activities and knowledge than extraverts (probably because extraverts prefer – and spend more time – socializing than studying).

Interestingly, Neuroticism was significantly related to GK. This correlation was negative, indicating that emotional stability, rather than Neuroticism, was associated with higher GK. Although this association was not predicted (mainly because Neuroticism has not been previously pointed out as a major marker of intellectual investment; neither in Ackerman's PPIK nor in Chamorro-Premuzic and Furnham's intellectual competence theory) it is consistent with studies looking at the relationship between the Big Five and Gigantic Three personality traits and academic performance (Chamorro-Premuzic & Furnham, 2002, 2003a, 2003b). In some of these studies, Neuroticism was not only negatively related to exam performance, but also indicators of continuous assessment (which are arguably a less stressful method of assessment than final written exams); it is therefore possible that stability is not only an advantage for reducing test anxiety, but also for raising levels of long-term intellectual investment. Given that, in the present study, performance on the GK test had no important consequences for the students taking the test, it would be more reasonable to conclude that the (modest, but significant) correlation between Neuroticism and GK scores is a function of individual differences in ''actual'' GK, rather than test performance.

However, questions emerge from the previous and present findings on the relationship between Neuroticism and intellectual ability (and its different components or aspects). First, in the present sample Neuroticism was not significantly correlated with IQ, which is in conflict with the idea that trait anxiety may be detrimental for intellectual investment. The second and larger issue may be that, according to the evidence derived from large-scale studies (Ackerman & Heggestad, 1997), Neuroticism is negatively correlated with both g_f and g_c, so that the effect is more general than simply impeding the development of GK. Again, this was not the case in the present sample, and it seems difficult to answer why. Thus more research (particularly longitudinal and experimental) is needed to shed light on the processes underlying the relationship between trait anxiety/emotional stability and GK or g_c in general.

Despite the evidence for the relationship between GK and various personality traits (TIE, Openness, Extraversion and Neuroticism), the hierarchical regressions showed that more than a quarter of the variance in GK was accounted for by ability factors (notably IQ). Furthermore, when IQ is taken into account, TIE had little predictive validity with regard to GK (and so did Openness to Experience). On the other hand, two of the Big Five personality traits (traditionally not associated with investment), showed modest but significant incremental validity, over abilities and other investment traits, such as Openness and TIE, in the prediction of GK. It should also be noted that, overall, personality traits did increase the amount of variance explained in GK; although this increase was modest (5%), it points to the direction of PPIK and intellectual competence theories that suggest that non-ability traits may have significant developmental effects in the acquisition of skills and knowledge.

There are obvious methodological and statistical limitations to the present study, which ought to be addressed. The major one concerns the low representativeness of the sample, which was mainly composed of elite university undergraduates. There is therefore a restriction of range in the ability measures, as well as GK and certain key personality dimensions, such as Openness, Conscientiousness and TIE. To complicate things further, the student selection process of UK universities is based, not on students' performance on standardized tests (such as the SAT in

the US) or overall school grades (GPA), but on exam marks on a wide range of non-standardized taught courses. As a consequence, two candidates may have grades for different subjects (from Mathematics to Anthropology), taken at different institutions, and marked by different examiners. This makes it difficult to establish comparisons between students, and creates different interests and different educational backgrounds/trainings, even when levels of g_f may be similar between students.

On the other hand, the fact that the intelligence measures employed were of different length and dissimilar internal consistency (it is highly unlikely that Baddeley's 3-min test of abstract reasoning is as highly reliable as Wonderlic's IQ (see Hartley & Holt, 1971)),[1] makes it difficult to estimate the extent to which the present results are indicative of the "true" relationship of IQ and abstract reasoning with the other ability and non-ability constructs, as well as GK. Critics could therefore argue that the only reason GK correlated higher with g_c than with g_f was that the former construct was more reliably measured than the latter. However, using Spearman's corrected formulae for attenuation yielded near identical results.

4.1. Implications and conclusion

From a theoretical point of view, the present results provide empirical support for recent investment theories of intellectual competence, particularly those focussed on the integration of cognitive and non-cognitive individual differences. Thus in line with PPIK and intellectual competence theories, the results suggest that personality traits, such as TIE, Openness to Experience, Neuroticism and Extraversion, which refer to *typical* rather than *maximal* performance, may play a relevant role in determining levels of crystallized abilities, in particular knowledge.

The implications for educational and organizational settings are equally important. At high levels of academic and occupational performance, expert and lay individuals can be best distinguished on the basis of knowledge, rather than g_f. If, then, certain personality traits have incremental validity in the prediction of knowledge (and probably influence individual differences in knowledge, too), the prediction of performance should be strategically designed so as to include, rather than exclude, the assessment of personality traits. Naturally, this would require some refinement in assessment instruments. Thus, even if personality traits "look" valid predictors of job (Salgado, 1997) or academic (Chamorro-Premuzic & Furnham, 2005) performance, the use of personality inventories can only be justified if we account for moderating variables (i.e., understand *when* and *where which* traits are most and least beneficial) and overcome the potential harm of faking and socially desirable responding.

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[1] Moreover, the higher heterogeneity of the WPT will render internal consistency values lower (as was the case in the present sample).

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