CHAPTER 9

Cognitive Abilities and Personality: Two Comprehensive General Factors

TWO FACES OF A HUMAN PERSON

Personality and intellect are probably the most researched domains of stable and enduring psychological characteristics in the human species. Personality traits and cognitive abilities represent two faces of a human person. However, personality traits are strongly related to other important noncognitive domains, as we have seen in the Chapters 5 and 8. Thus, both faces of our personhood comprise a very broad complex of the noncognitive traits including the personality on the one hand and a complex of cognitive abilities including intelligence on the other hand. In the scientific approach to human characteristics, the individual differences in both areas evidently form the focus of the great majority of the psychological research.

Brief Historical Sketch

In ancient Greek philosophy, the intellect (*nous*) was traditionally conceived as a bearer of higher cognitive functions as thinking, reasoning, and wisdom. *Nous* was the most important part of human soul or mind (*psyche* in post-Homeric Greek). It is an essential part of human nature and does not exist in nonhuman beings.

The greatest ancient philosophers, Plato and Aristotle, clearly delineated the intellectual from the emotional and appetitive part of the soul. Both philosophers introduced the trilogy of human mind that has tremendously influenced philosophical and later even scientific psychology (see also Fig. 9.1).

According to Plato (Vorländer, 1977), the human mind or soul can be divided into three parts: the appetitive soul governing our bodily needs and basic instincts (*epithymetikon*); the emotive soul governing self-assertion, ambitions, and emotions (*thymoeides*); and the reasoning soul governing our knowledge, thinking, reasoning, and philosophical search for the truth (*logistikon*).

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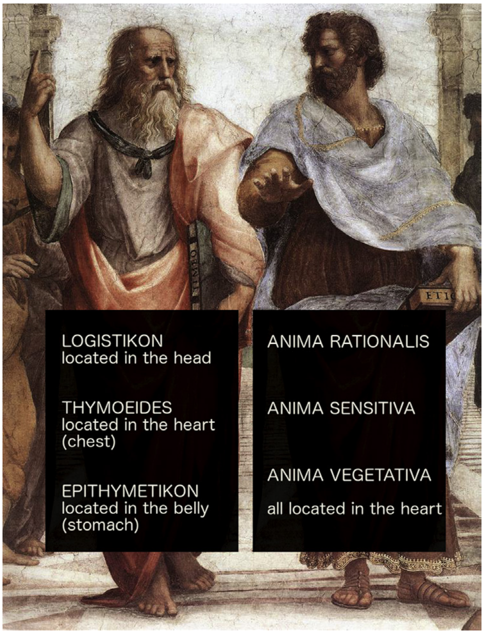

Figure 9.1 The trilogy of the human mind according to the theories of Plato (left) and Aristotle (right). See the text for details.

According to Aristotle (Vorländer, 1977), the intellect involves higher cognitive functions (*anima rationalis*), while the lower parts of the mind or psyche regulate physique, nutrition and growth (*anima vegetativa*) and motility, perception, emotions, and instincts (*anima sensistiva*). Note that Aristotle emphasized the difference between vegetation (plants), animals, and human beings. Only humans possess the highest level of the mind, the *noetikon* or *logistikon* (*anima rationalis*), and are capable of thinking and reasoning. The most important functions of the *anima rationalis* are skills (*techné*), knowledge (*episteme*), practical rational thinking (*phronesis*), and philosophical reasoning or wisdom (*sophia*). The rules of the rational mind are universal and the highest levels of reasoning and thinking are the same for every person. Yet, the personality and character differences between the people encompass also the functioning of the lower parts of the psyche, the emotions, motivation (desires), and physical functions.

Thus, in the eyes of the ancient Greek philosophers, the *nous*, *logistikon*, *noetikon*, or *anima rationalis* have distinct attributes and functions, which can be easily compared with the higher cognitive functions and abilities later defined by scientific theories of intelligence. Yet, the ancient models of the intellect never explicitly included the essential part of psychological study, namely the individual differences.

However, it is precisely this aspect of analytic interest that was present in the ancient precursors of the personality models. The ancient typologies focused on the individual differences. This is true for the typology of temperament by Hippocrates and Galen as well as for the typology of characters by Theophrastus. We may conclude therefore that, in ancient thought, more progress toward the later scientific approach was made in the field of personality than in the field of intellect, which was otherwise far more elaborated at the philosophical level. Personality in the modern sense is a term that was unknown to the ancient Greeks. Thus, it is somehow paradoxical that the ancient philosophers never developed a clear concept of the human personality, whereas the concept of intellect was quite well elaborated. On the other side, the ancient fathers of medicine developed the earliest notions of personality and individual differences (four types of temperament, see Fig. 1.3). In the history of scientific psychology, the situation was reversed: the scientific study of intelligence occurred before the proper scientific study of personality.

Intelligence: The Heritage of Darwin and Galton

Charles Darwin's theory of evolution gave the decisive impetus to the onset of the scientific study of human intellect. Intelligence and other cognitive capacities were conceived as the crucial tool of human species in the processes of natural selection. Instead of being an immeasurable gift of supernatural forces, intelligence also became a natural human characteristic that can be observed and measured. Francis Galton, a cousin of Darwin, enthusiastically started the scientific inquiry of intelligence, which soon yielded important results in the work of the London school adherents like Karl Pearson, Charles Spearman, and their successors Cyrill Burt, Philip E. Vernon, and Raymond B. Cattell. The members of London school developed salient methods for discovering the structure of human intelligence (factor analysis) and strongly contributed to establishment of the first psychometrically founded theoretical models of intelligence.

Almost simultaneously with the introduction of valid intelligence testing by Alfred Binet and Henri Simon (Binet & Simon, 1905/1916), Spearman's finding of the general factor of intelligence or g-factor gave theoretical meaning to the use of intelligence tests. Spearman's two-factor theory was thus the first psychometric theory of intelligence (Spearman, 1904, 1923, 1927). Later, the concurrent theory of the group factors of intelligence was proposed (Thurstone, 1933, 1938) and soon some attempts were made in order to reconciliate the models of Spearman and Thurstone (Burt, 1949; Vernon, 1940, 1950). Still later, the concept of the g-factor gained new elaboration in the work of Cattell (1971, 1987), Horn (1988), Horn and Noll (1997, pp. 53–91), Carroll (1993, 1997, pp. 122–130) and Jensen (1998). Until now, the theory of g-factor retained the role of the leading concept in psychometrical modeling of intelligence. Indeed, in the recent neuroscientific approaches to intelligence, the crucial terms like working memory and executive functions are linked with the g-factor (Baddeley, 1986; Baddeley & Hitch, 1974, pp. 47–89). The broader nonpsychometric theories of intelligence also cannot avoid or ignore the saliency of the g-factor in explaining a large and essential part of the intelligent behavior in the widest sense of meaning. G-factor explains a lot of the analytic type of intelligence in Sternberg's triarchic theory of intelligence (Sternberg, 1985, 1996; Sternberg & Kaufman, 1998) and at least four of the forms of intelligence in Gardner's model of multiple intelligences (Gardner, 1983/2003, 1993, 1999). Besides, g-factor is the best-known theoretical construct that can be linked to IQ, the most widely used measure of intelligence.

Personality: From Characterology to Psychometric Theories

The modern research of personality began with renovated or new typologies (James, 1890; Pavlov, 1955, 1960), psychoanalysis (Freud, 1895, 1905, 1910, 1915, 1923; Jung, 1921/1971, 1931/1969, 1964), and characterology (Klages, 1927; Lersch, 1942, 1970; Spranger, 1930). Unfortunately, the resulting models of personality in this phase of research were never tested or controlled by rigorous scientific methods and therefore became very vulnerable to arbitrary and populistic interpretations and generalizations. A similar developmental path produced vaguely defined concepts related to the personality, which were later developed in the frame of humanistic psychology (Maslow, 1950, pp. 1–34; Rogers, 1961). However, some authors contributed the theoretical concepts and constructs that became crucial for the scientific elaboration of the human personality, e.g., the term *personality trait* in the sense proposed by Allport (1937) and similar terms *Persönlichkeitseigenschaft* or *Persönlichkeitsmerkmal* proposed by German characterologists (Klages, 1927; Lersch, 1942, 1970; Stern, 1900).

In some way, personality psychology was opposed to the behavioristic paradigm in psychology. Behavioral psychology was suspicious with regard to the traditional notion of personality and also remained critical of the trait-oriented conceptualization of personality (Mischel, 1968). Nevertheless, the famous controversy between personalism, situationism, and interactionism resulted in theoretically and methodologically improved models of research in psychology. More than ever, personality continues to be one of the most important psychological concepts, and, more than ever, personality research is linked with the psychometric approach.

Thus, the most extensive scientific research of personality is based on the psychometric approach and appeared soon after the onset of the psychometric modeling of intelligence. Interestingly, some of the research of personality and intelligence was conducted by the same authors, notably Joy P. Guilford, Raymond B. Cattell, and Hans-Jürgen Eysenck. The psychometrically based theories of personality culminated in theoretical models of Cattell (1946, 1950, 1965), Eysenck (1947, 1952, 1967, 1970) and the Five-Factor Model (FFM: Digman, 1990; Goldberg, 1990; John, 1990, pp. 66–100; McCrae & Costa, 1987, 1998). FFM has dominated the scene of the psychometric approach to personality in last decades and stimulated new structural models of personality including the general factor of personality (GFP) paradigm. The work on the GFP emerged from the research within the FFM (Figueredo et al., 2016; Musek, 2007; Rushton & Irwing, 2011; Van der Linden, te Nijenhuis & Bakker, 2010) and was discussed in detail in previous chapters.

PERSONALITY AND INTELLIGENCE

Joint systematic research of personality and intelligence can be dated back to 1915, when Webb discovered that a wide general factor exists on the "character side" of mental activity beside the already known g-factor on the "intellective side" (Webb, 1915, p. 58). According to Eysenck (1947, p. 40), Webb's w-factor ("w" from "Will") comprises the trait-like characteristics such as "perseverance in facing the obstacles, kindness, trustworthiness, conscientiousness, excellence of character and strength of will" and can be interpreted as the opposite of the dimension of neuroticism. Maybe the w-factor is wider than that and can be viewed as a precursor of the GFP and even Super-g (see Chapter 8). Apart from the methodological differences, the main difference between w-factor and GFP is in the fact that the former is much closer to the traditional concept of character, and, consequently, the w-factor should be most appropriately labeled as the general factor of character. It has been linked to the resistance to suggestions representing thus the opposite of suggestibility (Brogden, 1940; Cracknell, 1939; both cited in Eysenck, 1947).

Independent or Connected?

Thus, the personality and intellect have been treated as separate and independent domains from the beginnings of scientific psychological research. Nevertheless, the possible connections between both domains were often examined (for an early review, see Ackerman & Heggestad, 1997). The research evidence clearly excluded the total independence as well as the very strong association of personality and intelligence. Instead, both domains often seem to be connected with low but significant correlations (Furnham, Moutafi, & Chamorro-Premuzic, 2005). Thorndike (1940, pp. 273–274) already noticed that "the various sorts of intelligence… are positively related; intelligence in general is correlated with virtue and goodwill toward men; both are correlated with skill and control of hand, eye, voice, etc.; all these are correlated with health, poise, sanity, and sensitiveness to beauty." Later, the connections between intelligence and Big Five dimensions of personality were examined many times (Furnham et al., 2005). Openness has the strongest connections with intelligence (Zeidner & Matthews, 2000, pp. 581–610); indeed it is substantially correlated with crystallized intelligence (Gc) but not with the fluid intelligence (Gf; DeYoung, Peterson, & Higgins, 2005). Neuroticism exhibits modest yet significant negative correlations with intelligence, while extraversion tends to correlate positively with intelligence (Ackerman & Heggestad, 1997). The research results concerning the conscientiousness and agreeableness as predictors of intelligence are less conclusive yet point to a very low or zero correlation (Ackerman & Heggestad, 1997; Furnham et al., 2005; Zeidner & Matthews, 2000, pp. 581–610).

GFP and Intelligence

What about the relationship between the GFP and intelligence? From the life history theory standpoint, essential connections between the GFP and g-factor are expected (Figueredo et al., 2016; Rushton, Bons, & Hur, 2008; Rushton & Irwing, 2011), yet the empirical research confirmed only low associations (Dunkel, 2013). However, using Q-sorted data, Dunkel (2013) found quite substantial associations between the GFP and IQ scores. In an extensive study on 4462 participants, Irwing, Booth, Nyborg, and Rushton (2012) found low correlation (−0.23) between g-factor and reversely coded GFP. The authors suggested two reasons for the low correlation: "One possible reason for the low correlation is restriction of range in the sample. Another is that intelligence and personality are to a degree mutually exclusive strategies, the first aimed at generating resources and the second at maximizing one's share of resources" (Irwing et al., 2012, p. 296).

We also know from Chapter 6 that the life history theory provided the genetic basis of GFP and g-factor (Figueredo et al., 2016). Yet, the research evidence suggests that despite the confirmed genetic basis of both constructs (Rushton et al., 2008), they are not genetically correlated (Loehlin et al., 2015; Woodley, 2011). If this is true, we can speculate that although personality and intelligence do not share the same genes, they are both oriented toward evolutionary benefits for humans.

TWO GENERAL DIMENSIONS: G-FACTOR AND SUPER-G

The most representative variables share the substantial common variance in several domains of psychology including cognitive abilities, personality, well-being, self-concept, self-esteem, affect, coping, and others. It is therefore not surprising that different general dimensions or general factors have been identified in these domains, notably the g-factor or the general factor of intelligence (Spearman, 1904, 1923, 1927), GFP (Musek, 2007; Rushton et al., 2008), the general factor of well-being (Musek, 2008, 2010; Wissing, Wissing, du Toit, & Temane, 2006), the general factor of self-concept (Marsh & Hocevar, 1985), and even the general factor of psychopathology (Caspi et al., 2014; Lahey et al., 2012). Consequently, Ree, Carretta, and Teachout (2015) introduced the concept of the dominant general factor (DGF) that pervades the variables in many psychological domains including personality (where the GFP represents DGF), cognitive abilities, emotional intelligence, beliefs and attitudes, psychomotor ability, job performance, entrepreneurship, organizational citizenship, leadership, and others.

A logical question can be raised, however, of whether different DGFs represent mutually independent dimensions or dimensions that are correlated and therefore share common variance. On the basis of empirical data, it can be argued that at least some very important DGFs are related. As we have seen in Chapter 5, very substantial connections of the GFP with other psychological domains have been reported. Even more, a common very general dimension labeled Super-g can be traced representing the shared variance of personality, emotionality (affect), well-being, self-esteem, coping, religious (spiritual) attitudes, generativity, spirituality, empathy, adjustment to home, family and job, and others (see Chapter 8). It is quite possible therefore, that in the realm of noncognitive traits, different DGFs form a hierarchical structure with the one very general dimension at the apex. Thus, the psychological structure of the noncognitive dimensions (mostly representing personality, affective, and conative traits) resembles the psychological structure of cognitive abilities, where an analogous superdimension, the g-factor, has been known for more than a century in psychological research.

In the psychological literature, very few studies simultaneously examined the structure of noncognitive traits and cognitive abilities. Stankov (2005, pp. 279–293) performed a structural analysis of the Big Five dimensions and four cognitive abilities. The author found two clearly separated general factors that do not correlate ($r = .02$). Irwing et al. (2012) conducted an extensive investigation on a large sample ($N = 4462$) that included 15 cognitive abilities and nine Minnesota Multiphasic Personality Inventory (MMPI) scales. As mentioned before, the authors reported two separate general factors (interpretable as g-factor and GFP), which are very modestly related.

The Study: Analysis of 28 Variables

It can be hypothesized therefore that the major domains of psychological variables have a hierarchical structure dominated by two superdimensions, the Super-g and g-factor. The first dimension represents the noncognitive traits and the second dimension stands for the cognitive abilities. The research of the structure of variables concerning different psychological domains can also answer the question of whether both superdimensions are independent or correlated. Some authors claim that both cognitive abilities and other personality traits may share a common variance due to the evolutionary presses favoring the socially appropriate competences and traits (Figueredo & Rushton, 2009; Figueredo et al., 2016; Rushton et al., 2008; Veselka, Schermer, Petrides, & Vernon, 2009). On the other hand, there exists strong empirical evidence supporting the view that the connections between intelligence and personality are rather weak (see also previous sections). Thus, a special study was designed in order to analyze the structure of both great domains of psychological variables, the cognitive abilities and noncognitive traits including the personality dimensions.

The data being analyzed in the study were collected from the Midlife in the United States II (MIDUS II) survey, conducted in 2004–06 (Ryff & Davidson, 2011; Ryff et al., 2007) and MIDUS II Cognitive Project (Ryff & Lachman, 2010a, 2010b). The survey was performed on a large US national representative sample and the analyzed data were obtained from

4963 participants from both sexes (2316 males and 2647 females) in the age range from 28 to 84 years (M = 55.43 years, SD = 12.45). The MIDUS II data are available for free research purposes and can be publicly accessed via the Interuniversity Consortium for Political and Social Research (ICRPSR) Website (ICPSR Web Site, 2011).

MIDUS II represents a second phase of the longitudinal project MIDUS, a survey that was done in 1995–96. It recruited a national US sample of adults of both sexes ages 25 to 75 years. As a follow-up study, MIDUS II was conducted about 10 years later on the same respondents. Data were collected from 2004 to 2006. The data in MIDUS II together with the MIDUS II Cognitive Project contain the results of a great number of psychological and demographic variables as well as the results of the Cognitive Test Battery including cognitive variables (Lachman, Tun, Murphy, & Agrigoroaei, 2009).

In this study, the data for 28 variables was analyzed by a number of statistical methods including the various multivariate analyses. All statistical analyses were conducted using the relevant packages in R program language (R Core Team, 2015) as well as the statistical package IBM SPSS 23 (IBM Corp. Released, 2015).

Variables and Measures

The MIDUS II data was selected for the analyses in the present study for several reasons. First, the data was drawn from a large and highly representative sample contributing thus to the high degree of external validity and generalizability of the results. Yet the most important advantage of the MIDUS II data is a very wide range of included scales that clearly represent most important noncognitive and cognitive psychological variables. From the MIDUS II data, 28 variables were selected into our present research model on the basis of their relevance in relation to the research problem and their psychometric viability. The selection was based on the theoretical and methodological grounds focused on the variables that are generally accepted as representative for both large domains of psychological dimensions, noncognitive traits and cognitive abilities. Two sets of variables were included in the research model: 20 noncognitive variables including affect, self-esteem, personality, well-being, control, generativity, coping, spirituality, and perceived intellectual aging; and eight variables measuring cognitive abilities. The latter were selected as the most representative from the two batteries measuring cognitive abilities, the Brief Test of Adult Cognition by Telephone (BTACT) and the Stop & Go Switch Task (SGST) (see Ryff & Lachman, 2010a, 2010b).

More detailed insight into the variables included in the research model and the scales measuring these variables is provided in Table 9.1, which displays the names of the variables, their codes used in MIDUS II documentation and in this study, the names of the respective scales, the respective pages in the main MIDUS II documentation reference (Ryff et al., 2007; Ryff & Lachman, 2010a, 2010b), and additional referential sources. All listed variables were put into the research model, which was designed as a correlational and multivariate study.

RESULTS AND DISCUSSION

The correlation coefficients were calculated for the first insight into the relationships between the variables in the research model. According to the expectations, the associations within the both domain-specific variables (noncognitive and cognitive) are very substantial, while the connections between both sets of variables are low or even insignificant. The correlations between the noncognitive traits are quite substantial. They extend from .77 to −.53. However, the correlations between the cognitive abilities are even higher, extending from .78 to .15. Yet, the correlations between noncognitive and cognitive variables are rather low, extending from .22 to −.16 (see Table 9.2). Due to the high number of the participants, all correlations of absolute value .064 or higher are already significant. As expected, the perceived intellectual aging (b1sintag) has most essential correlations with the cognitive abilities among the noncognitive traits.

Factor analysis is probably the best way to obtain the confirmation of the hypothesis that two dominant factors should be expected across all variables in our research model. The correlation matrix of the 28 variables indicated very high suitability for the factor analysis. The Kaiser–Meyer–Olkin index was .920 and the Bartlett test of sphericity was highly significant. Consequently, the factor or component analyses were strongly recommended. Therefore, several relevant factor and component analyses were performed in order to reveal the structure of the variables in the research model. The criteria for the number of extracting factors suggested nine factors and five components (see Fig. 9.2). However, the solution with two extracted factors is most acceptable due to the theoretical reasons. According to the just-mentioned hypothesis, two very general dimensions could be expected, the first underlying the noncognitive traits and the second loading the cognitive abilities. Both factor and component analyses yielded very similar two-factor solutions. For the sake of sparing space, we shall focus on

Table 9.1 Variables, variable codes, the scales, the pages in the documentation reference (Ryff et al., 2007), and respective source references

Variable	Code	Name of the scale in MIDUS II	Pages in Ryff et al. (2007)[a]	Source references
Negative affect	b1snegpa	PANAS negative adjectives	16–20	Mroczek & Kolarz (1998)
Positive affect	b1spospa	PANAS positive adjectives	16–20	
Self-esteem	b1sestee	Self-esteem	37–38	Rosenberg (1965)
Neuroticism	b1sneuro	Neuroticism	41–45	Rossi (2001)
Extraversion	b1sextra	Extraversion	41–45	
Agreeableness	b1sagree	Agreeableness	41–45	
Openness to experience	b1sopen	Openness to experience	41–45	
Conscientiousness	b1scons2	Conscientiousness	41–45	
Autonomy	b1spwba2	Autonomy	28–32	Ryff (1989), Ryff & Keyes (1995)
Environmental mastery	b1spwbe2	Environmental mastery	28–32	
Personal growth	b1spwbg2	Personal growth	28–32	
Positive relations with others	b1spwbr2	Positive relations with others	28–32	
Purpose in life	b1spwbu2	Purpose in life	28–32	
Self-acceptance	b1spwbs2	Self-acceptance	28–32	
Perceived control	b1sctrl	Perceived control	33–36	Lachman & Weaver (1997)
Personality in intellectual aging	b1sintag	Personality in intellectual aging contexts scale	21–22	Lachman (1986), Lachman, Baltes, Nesselroade, & Willis (1982)
Generativity	b1sgener	Loyola generativity scale	80–81	McAdams & de St. Aubin (1992)
Problem-focused coping	b1sprcop	Problem-focused coping	64–69	Carver, Scheier & Weintraub (1989)
Emotion-focused coping	b1semcop	Emotion-focused coping	64–69	

Continued

Table 9.1 Variables, variable codes, the scales, the pages in the documentation reference (Ryff et al., 2007), and respective source references—cont'd

Variable	Code	Name of the scale in MIDUS II	Pages in Ryff et al. (2007)[a]	Source references
Optimism	b1sorien	Optimism overall	52–53	Scheier & Carver (1985)
Spirituality	b1sspiri	Spirituality	105–110	Garfield, Ryff & Singer (2001)

Variable	Code	Name of the scale in MIDUS II cognitive project	Pages in Ryff & Lachman (2010b)	Source references
Word list recall	B3TWLITU	Word list recall immediate	4	Ryff & Lachman (2010a, 2010b)
Backward digit span	B3TDBS	Backward digit span	4	
Category fluency	B3TCTFLU	Category fluency	4	
Number series	B3TNSTOT	Number series total	5	
Backward counting	B3TBKTOT	Backward counting total	5	
Word list delayed	B3TWLDTU	Word list delayed total	6	
Latencies	B3TSMB	SGST mean latencies	9	
Reaction time	B3TSMXBS	SGST reaction time	10	

[a]Main documentation source for all scales included in MIDUS II. It represents a basic reference for the MIDUS-II datasets and provides essential information concerning scale construction and treatment of the scales. Each scale is described in terms of scale construction, coding, missing data treatment, psychometric characteristics (especially reliability), and source articles. Source references for the first set of variables (noncognitive variables) are listed in the References section in Chapter 8.

Table 9.2 Correlations between noncognitive and cognitive variables

	B3TWLITU	B3TDBS	B3TCTFLU	B3TNSTOT	B3TBKTOT	B3TWLDTU	B3TSMB	B3TSMXBS
b1snegpa	.022	−.007	.045	−.039	.030	.033	.004	−.007
b1spospa	.028	.031	−.020	.002	−.027	.016	.010	.002
b1sestee	.024	.047	.032	.083***	.013	.000	.038	.059
b1sneuro	.004	−.049	.012	−.068*	.049	.011	.024	.003
b1sextra	.049	.021	−.016	−.083***	−.050	.027	.011	−.005
b1sagree	.062	.024	−.064*	−.128***	−.113***	.032	−.005	−.033
b1sopen	.092***	.073**	.133***	.062	.032	.070*	.027	.022
b1scons2	.097***	.059	.017	.053	.049	.080**	.045	.048
b1spwba2	−.005	.029	.000	.003	−.001	−.037	.026	.043
b1spwbe2	.014	.064*	−.016	.050	−.006	−.006	.029	.036
b1spwbg2	.122***	.089***	.106***	.102***	.061	.104***	.084***	.067*
b1spwbr2	.071*	.037	−.026	−.012	−.065*	.047	.021	.004
b1spwbu2	.103***	.068*	.087***	.093***	.066*	.083***	.078**	.072**
b1spwbs2	.032	.054	.020	.079**	−.002	.011	.034	.027
b1sctrl	.086***	.097***	.066*	.089***	.079**	.078**	.106***	.113***
b1sgener	.119***	.082***	.089***	.075**	.034	.099***	.030	.005
b1sprcop	.086***	.062	.032	.031	−.016	.061	−.011	−.021
b1semcop	−.055	−.094***	−.088***	−.159***	−.085***	−.045	−.090***	−.117***
b1sspiri	.054	−.015	−.019	−.082***	−.083***	.073**	−.050	−.062
b1sintag	.158***	.158***	.162***	.222***	.157***	.135***	.132***	.139***

Codes with the respective variable names are listed in Table 9.1.
*$P < .05$, **$P < .01$, ***$P < .001$ (two-tailed).

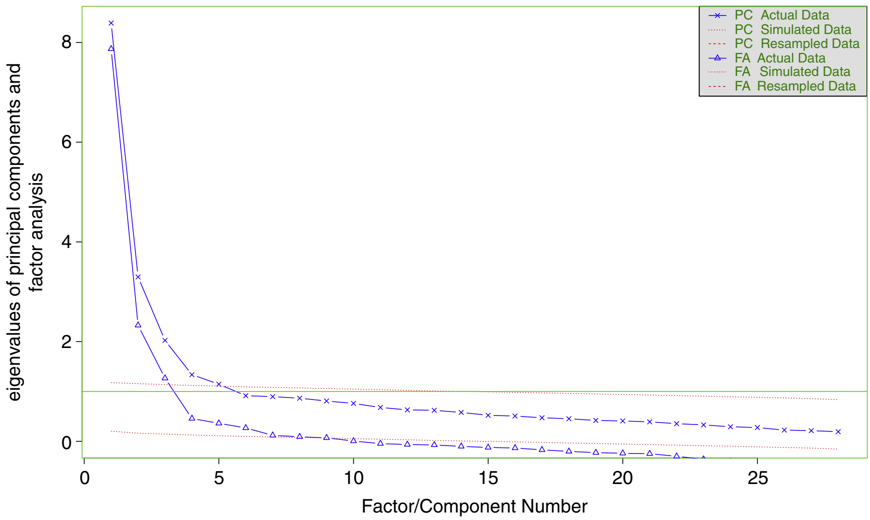

Figure 9.2 Screen test results for factor and component analysis of 28 variables. The parallel test criterion suggests nine-factor and five-component solution.

the results of two-factor solution using the MINRES algorithm of factor analysis (Harman & Jones, 1966).

The loadings of the variables on both extracted factors are displayed in Table 9.3. The great majority of the noncognitive traits have modest to very high saturations on the first factor (MR1), while all cognitive abilities have only negligible loadings. The opposite is true for the second factor (MR2): all cognitive abilities have rather high saturations and all noncognitive traits have low or negligible loadings. The only exception is the perceived intellectual aging (b1sintag), which correlates .43 with the first and .26 with the second factor. This variable is obviously somewhat closer to the cognitive abilities than other noncognitive traits.

Now we can investigate the hierarchical structure of the variables in the model more thoroughly. The best way to do this is to perform a hierarchical cluster analysis, which can display the associations between the variables on different levels extending from the level where all variables form only one cluster to the level where each variable represents a particular cluster. Several algorithms of hierarchical cluster analysis are available, however, the *iclust* technique (Revelle, 2015) seems to be very useful for our purposes. First, the results of the iclust algorithm can be based on the correlation matrix and are therefore quite comparable to the results of factor analysis. Furthermore, the resulting statistics include two measures of reliability or internal consistency (even in the graphical context), the

Table 9.3 Loadings of the variables on first and second factor (pattern matrix)

	MR1	MR2	h2	u2	com
b1snegpa	−.56	.09	.32	.68	1.1
b1spospa	.69	−.07	.47	.53	1
b1sestee	.83	−.02	.69	.31	1
b1sneuro	−.55	.07	.3	.7	1
b1sextra	.55	−.08	.3	.7	1
b1sagree	.34	−.10	.12	.88	1.2
b1sopen	.50	.08	.26	.74	1.1
b1scons2	.46	.07	.22	.78	1
b1spwba2	.59	−.03	.34	.66	1
b1spwbe2	.84	−.05	.71	.29	1
b1spwbg2	.75	.11	.59	.41	1
b1spwbr2	.73	−.08	.53	.47	1
b1spwbu2	.77	.08	.61	.39	1
b1spwbs2	.88	−.04	.77	.23	1
b1sctrl	.77	.09	.61	.39	1
b1sgener	.46	.08	.22	.78	1.1
b1sprcop	.58	.01	.34	.66	1
b1semcop	−.46	−.13	.24	.76	1.2
b1sspiri	.17	−.06	.03	.97	1.2
b1sintag	.43	.26	.27	.73	1.6
B3TWLITU	.02	.57	.33	.67	1
B3TDBS	.04	.46	.22	.78	1
B3TCTFLU	−.01	.54	.29	.71	1
B3TNSTOT	.03	.56	.32	.68	1
B3TBKTOT	−.05	.65	.42	.58	1
B3WLDTU	.00	.54	.29	.71	1
B3TSMB	.00	.59	.34	.66	1
B3TSMXBS	.00	.53	.28	.72	1
Eigenvalues	8.39	3.30			
% Of variance	28	10			

Codes with the respective variable names are listed in Table 9.1.

well-known Cronbach alpha coefficient (the average split half reliability) and Revelle's beta coefficient (the worst split half reliability, Revelle, 2015), which indicates the loading on the general factor of the variables in the resulting cluster. In our case, the results of the iclust analysis closely resemble the factorial composition in the corresponding factor analyses (two-, five-, and nine-factor solutions). For the sake of the parsimony, we shall focus therefore on the results of the iclust hierarchical clustering shown on Fig. 9.3.

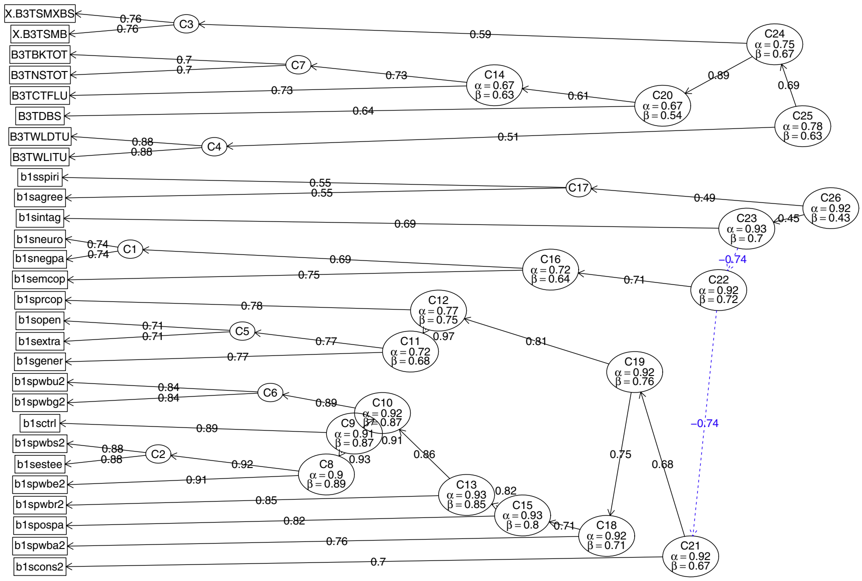

Figure 9.3 *Iclust* hierarchical clustering of 28 variables. See the text for detailed description.

We can see at first glance that all 28 variables are divided into two completely separate clusters, C25 and C26. The first subsumes all cognitive abilities (from B3TSMXBS to B3TWLITU). It is internally consistent (Cronbach alpha = .78) and, according to Revelle's beta (.63), has a strong underlying common denominator, which should be almost certainly identical with the famous Spearman's g-factor (general factor of intelligence). The further structure of C25 is also interesting. The strongest subcluster (C24) contains first six cognitive variables (B3TSMXBS to B3TTDBS), all of them connected with the executive functioning and speed of mental processing. The underlying common dimension of these variables can be interpreted therefore as the dimension of executive functioning. This dimension very probably resembles so-called fluid intelligence, while the common dimension underlying two remaining cognitive variables (C4 represented by B3TWLDTU and B3TWLITU) includes episodic memory and seems close to crystallized intelligence (Carroll, 1997, pp. 122–130; Cattell, 1971; Horn & Noll, 1997, pp. 53–91).

The second great cluster (C26) encompasses all noncognitive variables (b1sspiri to b1scons2). It is more complex at first glance and is based on the underlying common dimension, which is somewhat less compact in comparison to the cognitive super-g: compare Revelle's beta (.43) to the beta of the latter (.63). Nevertheless, it obviously represents a highest-order dimension parallel to the cognitive super-g. It can be said that this dimension is a kind of GFP of all noncognitive variables including the noncognitive GFPs. Consequently, this dimension can be interpreted as the trait super-g.

C26 has several subclusters related to the noncognitive variables. The majority of them represent the major domains of the noncognitive traits, as, for example, well-being, personality, affect, and coping. However, the noncognitive variables from different domains are not strictly separated for the reason that the variables from the different domains are strongly associated. It is interesting that supercluster C26 disjoins into a small subcluster, C17, where another subcluster, C23, is related to all other noncognitive variables. Thus, within C23, we can identify the subclusters with highly correlated variables, for example, C19, which encompasses the variables of well-being (b1spwbu2, b1spwbg2, b1spwbs2, b1spwbe2, b1spwbr2 and b1spwba2), control (b1sctrl), self-esteem (b1sestee), and positive affect (b1spospa). Subcluster C12 subsumes the variables of problem coping (b1sprcop), personality (b1sopen, b1sextra), and generativity (b1sgener). Subcluster C22 is related to the variables indicating neuroticism (b1sneuro), low conscientiousness (b1scons2), negative affect (b1snegpa), and emotional coping (b1semcop). The variables related to subcluster C17, spirituality (b1sspiri) and agreeableness (b1sagree), represent the traits that are less connected to the other noncognitive variables or domains. All other subclusters not mentioned previously are nested within the already mentioned clusters.

Even more transparent graphical display can be obtained by the spatial representation of both ICLUST clusters (C26 and C25). All 28 variables are located in two-dimensional space in two strongly separated clusters corresponding to the cognitive abilities (C25) in the middle at the top and noncognitive traits (C26) right and left below (Fig. 9.4). Very clearly, intellectual aging (b1sintag) is closest to the cognitive abilities cluster. The next noncognitive traits closest to the cognitive abilities are generativity (b1sgener), conscientiousness (b1scons2), and openness (b1sopen).

We should ascertain again that the variables in both domains, noncognitive and cognitive, are not associated substantially. However, it does not mean that they are not associated at all. By performing the canonical correlation analysis of both sets of the variables (using R package yacca; Carter, 2012), we found five significant canonical roots or variates that accounted together for about 27% of the canonical variance (the shared variance

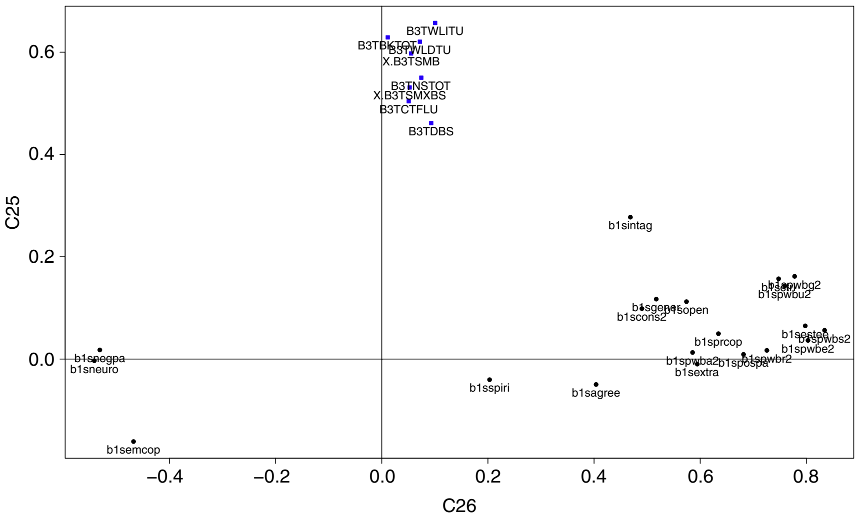

Figure 9.4 The locations of 28 variables in the dimensional space of two main clusters (C25 and C26). See the text for more detailed description.

among the canonical variates). The redundancy between two sets of the variables is low. Noncognitive traits explain 6.6% of information in the cognitive-abilities set, while the cognitive abilities explain 2% of information in the noncognitive traits set. It is clear therefore that the connection between both domains of the variables is significant yet weak.

The connections between both sets or domains of the variables can be further inspected by means of multiple regression analysis (MRA). MRA is an extension of ordinary linear regression, which can be used when we have more than one variable as a criterion (Cohen, 1982). Thus, it is recommended in our case to see how the variables in the set of cognitive abilities can be predicted from the variables in the set of noncognitive traits. In this study, the setCor algorithm measuring Cohen's set correlation was performed as one of the best methods for calculating multiple regression (Cohen, Cohen, West, & Aiken, 2003; Revelle, 2015). setCor analyzes the relationships between the predictors or independent variables (noncognitive traits in our case) on the dependent variables or criteria (cognitive abilities). Table 9.4 shows the resulting beta weights for all between-sets pairs of the variables as well as the values of Multiple R and Multiple R squared for all dependents. As we can see, the predictors explain significant yet low amounts of the variance in the dependents (from 4% to 11%). Again, the explanatory contribution of the perceived intellectual aging (b1sintag) is the highest among all predictors. The general squared Cohen's set correlation

Table 9.4 Results of multiple regression: beta weights, multiple R and multiple R squared

	B3TWLITU	B3TDBS	B3TCTFLU	B3TNSTOT	B3TBKTOT	B3TWLDTU	B3TSMB	B3TSMXBS
b1snegpa	.04	.05	.05	.02	.02	.04	.03	.03
b1spospa	−.02	−.02	−.05	−.07	−.04	−.01	−.02	−.03
b1sestee	−.06	−.05	.01	.02	−.01	−.07	−.01	.05
b1sneuro	.01	−.02	.01	−.02	.07	.00	.07	.06
b1sextra	−.01	−.02	−.04	−.10	−.01	−.01	.01	.01
b1sagree	.00	.02	−.08	−.12	−.09	−.04	.02	.01
b1sopen	.02	.01	.15	.05	.02	.02	−.02	−.02
b1scons2	.06	.01	−.02	.03	.05	.06	.02	.02
b1spwba2	−.08	−.05	−.08	−.13	−.05	−.11	−.01	.00
b1spwbe2	−.10	.02	−.11	−.05	−.06	−.11	−.06	−.06
b1spwbg2	.06	.03	.07	.06	.06	.06	.06	.03
b1spwbr2	.06	−.02	−.03	−.02	−.08	.05	−.02	−.03
b1spwbu2	.06	−.01	.09	.01	.08	.05	.05	.05
b1spwbs2	−.05	.00	.00	.10	−.03	−.05	−.03	−.06
b1sctrl	.08	.06	.05	−.01	.10	.11	.13	.14
b1sgener	.07	.05	.06	.09	.06	.06	.02	.00
b1sprcop	.00	.00	−.05	−.02	−.07	−.01	−.09	−.09
b1semcop	−.03	−.05	−.06	−.09	−.06	−.03	−.08	−.10
b1sspiri	.01	−.04	−.02	−.07	−.07	.04	−.06	−.06
b1sintag	.14	.14	.13	.20	.14	.12	.11	.11
Multiple R	.24	.20	.29	.34	.28	.24	.22	.23
Multiple R^2	.06	.04	.08	.11	.08	.06	.05	.05

Codes with the respective variable names are listed in Table 9.1.

between both sets of the variables is not negligible at all—it is .26, indicating that both predictors and dependents share an essential amount of the variance (26%). The value of the squared Cohen's set correlation is almost identical with the above-mentioned 27% of the shared variance among the canonical variates.

GENERAL DISCUSSION AND CONCLUSIONS

The hypothesis that only two highest-order general dimensions dominate over the variables in the research model is strongly corroborated by the results of our data analyses. The first general dimension pervades not only the great majority of single variables in the domain of noncognitive traits yet also the GFPs representing the most important noncognitive subdomains (personality, well-being, affect, coping). Similarly, the second general dimension covers all single cognitive abilities as well as both subdomains of them (memory and executive processing). Thus, we may conclude that the variance of the most important psychological variables can be effectively explained by two latent superdimensions, the trait super-g representing the noncognitive traits and their domain-specific GFPs (including the general factor of well-being and GFP), and the general factor of cognitive abilities, cognitive super-g, which is practically identical with the Spearman g-factor.

On the side of the cognitive abilities, all eight variables shared a substantial amount of the variance and therefore cluster together (C25). The common dimension that accounted for this variance can be interpreted as cognitive super-g that is very close to the classical Spearman's g-factor. Further, we meet two large subclusters, the executive function cluster (C24), which resembles fluid intelligence, and the episodic memory cluster (C4), which is close to crystallized intelligence. The executive function cluster contains a further remarkable subcluster (C3), which is closely related to the speed of mental processing represented by reaction and response latency variables (B3TSMXBS and B3TSMB).

On the side of noncognitive traits, all 20 variables cluster together (C26) sharing a common dimension, which is parallel to the cognitive super-g and can be interpreted as the trait super-g, obviously a superordinated GFP of the domain-specific variables and GFPs. The great cluster of noncognitive traits also has several subclusters covering different domains and variables including well-being, personality, affect, coping, self-esteem, generativity, and others.

The connection between both domains, noncognitive and cognitive, is low although significant. The cognitive abilities are weakly associated with the noncognitive traits. It seems that of all variables perceived intellectual aging (b1sintag), generativity (b1sgener), conscientiousness (b1scons2), and openness (b1sopen) mostly contribute to this connection.

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