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Intelligence, Personality, and Interests: Evidence for Overlapping Traits

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The authors review the development of the modern paradigm for intelligence assessment and application and consider the differentiation between intelligence-as-maximal performance and intelligence-as-typical performance. They review theories of intelligence, personality, and interest as a means to establish potential overlap. Consideration of intelligence-as-typical performance provides a basis for evaluation of intelligence–personality and intelligence–interest relations. Evaluation of relations among personality constructs, vocational interests, and intellectual abilities provides evidence for communality across the domains of personality of J. L. Holland's (1959) model of vocational interests. The authors provide an extensive meta-analysis of personality–intellectual ability correlations, and a review of interest–intellectual ability associations. They identify 4 trait complexes: social, clerical/conventional, science/math, and intellectual/cultural.

In this article, we briefly review theoretical approaches to intellect, personality, and interests that make contact across these seemingly disparate domains. We also review the empirical evidence and theoretical arguments for an approach to adult intellect that goes beyond the traditional paradigm. The review first focuses on the description of the traditional paradigm for intelligence assessment of children. We next consider the extension of the paradigm to adult intellectual assessment. From this foundation, we review a separation of the constructs of intelligence-as-maximal performance and intelligence-as-typical performance. In an attempt to bridge the separation of maximal and typical performance, we review the literature on the commonality among personality constructs and intellectual abilities in adults and provide a set of meta-analytic results. We also review the literature on the relations between interest constructs and intellectual abilities in adults.

Intelligence Testing as a Paradigm

Assessment of Intelligence of Children

A comprehensive review of the early history of intelligence testing is beyond the scope of this article (although see an extensive review by Peterson, 1925). However, while there were many earlier instances of psychologists making use of mental tests (e.g., J. McK. Cattell, 1890; Galton, 1883/1928), the beginnings of the modern paradigm for intelligence testing can be identified in two of Binet and Simon's (1905/1961, 1908/1961) classic articles. They described a set of higher order mental tests that could be administered to children of various ages in an effort to predict academic success or failure (e.g., see the abridged translation reprinted by Jenkins & Paterson in Binet & Simon, 1908/1961; also see the translation by Town in Binet & Simon, 1911/1915).

The term *paradigm* is too eagerly applied and often overused in psychology, but the kind of mental testing proceduralized by Binet and Simon (1905/1961, 1908/1961) and their followers readily meets many of the classificatory requirements for the existence of a scientific paradigm (Kuhn, 1970). Binet and Simon described the type of procedures that allow assessment of intelligence, specifically they distinguished between three different methods: medical, which focuses on physiology and pathology; pedagogical, which determines intelligence on the basis of the examinee's knowledge; and psychological, which makes direct observations of intelligence (as translated by Kite in Binet & Simon, 1908/1961).

Binet and Simon (1905/1961, 1908/1961) argued that they wished to separate "natural intelligence from instruction" by "disregarding, in so far as possible, the degree of instruction which the subject possesses" (as translated by Kite in Binet & Simon, 1908/1961, p. 93). That is, Binet and Simon attempted to provide an estimate of individual differences in intellectual ability, which was, to a great degree, separated from influences of experience, social privilege, and other confounds of socioeconomic status. Binet and Simon provided cogent arguments for the psychological method over the pedagogical method to assess school children's intelligence.

In an earlier article, Binet and Simon (1896, as cited by Carroll, 1993) considered the use of a wide variety of tests, such as simple psychophysical procedures (like those of Galton, 1883/1928; and J. McK. Cattell, 1890), but ultimately rejected those in favor of tests of higher mental processes, which had

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more substantial validity for predicting academic success (e.g. following directions, memory, counting, etc.). For Binet and Simon (1908/1961), intelligence was best assessed by a large battery of tests that focused on attention, memory, thinking, and other cognitive processes.

Moreover, Binet and Simon (1911/1915) described the specific procedures for constructing the testing situation. Examinations were to take place in "an isolated, quiet room" (as translated by Town, p. 63). The examiner was instructed to

> meet the child pleasantly, do not stare at him when questioning him; if he seems timid, constantly reassure him, not only by a pleasant manner, but using one of the tests which seems most like a game (pictures or making change). Encourage constantly in a kind way throughout the examination; show satisfaction with the answers whatever they are. Never criticise [*sic*], and do not lose time by making a lesson of it . . .. Encouragement should be given by the tone of voice, or by words wholly devoid of meaning which serve only to stimulate: Go on! Quickly now! Hurry up! Good! Very good! Perfect! Marvelous! etc. (p. 63)

Elsewhere in the description of test procedures, Binet and Simon (1911/1915) discussed means to obtain motivated responding from the examinees, for example:

> What should be done [if a child does not respond]? The help of the teacher is often useful. If she is intelligent, she knows what to say to her children to reassure them and arouse their courage. A caress to one, a reprimand to another, and all goes well. (p. 12)

In all these directions, Binet and Simon (1911/1915) made it clear that the purpose of the intelligence test was to assess the child's maximal performance, that is, to estimate the child's capabilities.

In summary, then, the elements of the modern intelligence paradigm, put forth by Binet and Simon (1911/1915), were as follows: (a) tests of higher order mental processes, (b) elimination (as far as possible) from consideration of knowledge acquired through specific instruction, (c) elicitation of maximal effort on the part of the examinee, and (d) school achievement as the fundamental criterion for external validation.

To get a sense of the paradigmatic nature of the Binet–Simon (1911/1915) approach toward eliciting maximal effort, one need look no further than a review by Whipple (1914) on mental and physical tests. In the chapter "General Rules for the Conduct of Tests," Whipple stated, "in particular, attention may be called here to . . . the emotional attitude of the participants toward the investigation, their ability exactly to comprehend what is wanted of them . . . *and their willingness to do their best throughout the test*" (p. 5, italics added).

Assessment of Intelligence of Adults

1890s–1918

Although Galton (1883/1928) was probably the first investigator who performed large-scale testing of adults, the tests used by Galton (hearing, sensitivity, etc.) do not meet the higher mental processes part of the modern conceptualization of intelligence. James McK. Cattell followed in Galton's footsteps, but one notable difference of Cattell's (J. McK. Cattell & Farrand, 1896) early work is that his studies focused exclusively on college students. Specifically, J. McK. Cattell and Farrand

> requested the Freshmen of the School of Arts and the School of Mines to come by appointment. About one-half of them came, and all were interested in the tests and agreed without hesitation to repeat them at the end of the Sophomore and Senior years. (p. 624)

They did not present any additional information about the conditions of testing, but the clear indication from the description of the study was that examinees were volunteers and that no special procedures were used to obtain maximal performance.

In contrast, in a classic investigation, Sharp (1899; in E. B. Titchener's laboratory) only examined the abilities of "seven advanced students in the Sage School of Philosophy . . . all of whom had had training in introspection" (p. 349), clearly a group that had motivation for maximal performance. In addition,

> certain of the tests which are especially adapted for collective study were given not only to these groups, but also, by the aid of Prof. Titchener, to the less advanced students taking the undergraduate (junior year) course in Experimental Psychology. (p. 350)

As in the J. McK. Cattell and Farrand (1896) study, the test scores in Sharp's study had no direct impact on the students' academic status.

In another classic investigation of adult ability, Wissler (1901) conducted "yearly testing [of] sixty to seventy freshmen of Columbia College and repeated with those who remain to the end of the senior year" (p. 4). In this case, though, the participant sample was composed of students in a psychology course who were "carefully instructed in the methods of procedure and taken though the tests, both as participant and observer" (p. 43). The means toward the investigator eliciting motivation for the tests were only described as the following: "At the beginning of the tests in the psychological laboratory a few words are said to the student concerning the object of the tests and the value of the results" (p. 4).

Carothers (1922) reported that, as early as 1915, clear methods were available to attempt to elicit maximal performance from college students who are given intelligence tests. For her study of Barnard freshman, she sent

> letters . . . to individual students in the class, reminding them of the examination, and an account, written by Professor Hollingworth, of the widespread use of similar tests by reliable business firms and their value in selecting candidates for positions along various lines, appeared in the college weekly. (p. 18)

It is perhaps not at all surprising, then, that "out of a class of about one hundred and forty freshmen during 1915–16, one hundred were tested" (p. 18).

In 1915, Yerkes, Bridges, and Hardick described their development of an adult mental ability test. Their description of the testing method was as follows:

> He should then explain briefly what he is going to do, and what is expected of the subject. For example, the examiner may say that he is going to ask some questions, *and that the subject must try to answer them as well as he can*; that some of the questions will be very easy and some more difficult; *that the questions should be answered promptly, and that he should try to answer even those*

> *that he is uncertain about, since a poor answer is better than none.* (p. 139, italics added)

In the early history of intelligence testing, the creation and application of the Army Alpha Examination and, to some degree, the nonverbal Army Beta Examination stand out as the vehicles to fix the paradigm for adult ability assessment. In all, 1,700,000 men were tested with one of these two tests (about 15–20% of the male conscript-aged population of the United States, according to a rough extrapolation of the 1910 and 1920 Census figures). The following are the directions from the Yoakum and Yerkes (1920) manual:

> In giving the following directions E. [the examiner] should speak rather slowly, distinctly, and with proper emphasis. *He should expect and demand perfect order and prompt response to commands.*
>
> When everything is ready E. proceeds as follows: "Attention!" The purpose of this examination is to see how well you can remember, think, and carry out what you are told to do . . .. You are not expected to make a perfect grade, but do the very best you can.
>
> Now, in the Army a man often has to listen to commands and then carry them out exactly. I am going to give *you* some commands to see how well you can carry them out. Listen closely. Ask no questions. (pp. 53–54)

With such unambiguous instructions, there could be no doubt that the examiners intended for the examinees to provide their maximal effort on the tests. However, the development and application of the Army Alpha Examination did serve to broaden the standard intelligence test paradigm because the aim of the test was not to predict school achievement but rather to predict occupational performance.

1919–1925

After World War 1 (WW1), the Army Alpha Examination and other intelligence tests (e.g., L. L. Thurstone's, 1919, Intelligence Test IV; and E. L. Thorndike's, 1920, 1921, College Entrance Tests) became commonplace to test college students. Thurstone's exam had "been given to 6805 Engineering freshmen, 5495 Liberal Arts Freshmen, and to 1575 Normal School Freshmen" (Pintner, 1923, p. 269). Similarly, Pintner reported that the Army Alpha Examination had been administered to an aggregate total of 11,700 college students, at such locales as Brown University, Ohio State University, Syracuse University, University of Minnesota, University of North Dakota, and so on. Toops (1926) conducted a survey of 110 colleges and universities around the United States and showed how intelligence testing of undergraduates had blossomed in just 6 years, from 1918 to 1923–1924. Only 8 (7%) of 110 colleges and universities were using intelligence tests in 1918, but 60% of the colleges were using intelligence tests and 12% were using tests "experimentally" or "temporarily" as of the 1923–1924 academic year. Even for the remaining 28% of the colleges and universities in the survey, several were using tests for "students in certain departments, but not to the entire student body" (p. 26). Although no college or university surveyed reported using the tests exclusively for selection purposes, the colleges and universities reported that these tests were used for everything from a "partial basis for admission" (p. 26) to vocational counseling and creation of special sections of courses.

Thorndike (1920) reported on the development of the Thorndike Intelligence Examination for High School Graduates, created in 1919 for Columbia University, "where it is an optional means of entrance for boys suitably recommended" (p. 330). Of particular interest is Thorndike's somewhat flippant description of the testing procedure:

> The administration of the examination consists simply of giving out the blanks, and instructing the candidates to go ahead at certain times even if they have not finished the work to date. In general, a candidate does test after test without awaiting instructions. (p. 335)

As reported by Whipple (1922), "Professor Thorndike maintains that his tests (which take about 3 hours to complete, in one sitting) show not only a man's intelligence, but also his ability to stick to a long and, at the end, somewhat distasteful task" (p. 259). Also, "from another institution, it was reported that two or three students fainted under the three-hour strain, and the faculty became indignant at this alleged imposition of hardship" (p. 260). Whipple also reported that "many of the students [at Michigan] are very keen to take mental tests; that they are anxious to learn their standing" (p. 261). Undoubtedly, the paradigm for examiners attempting to elicit maximal performance from examinees in a college environment had been fully established for adults by the early 1920s.

Summary

As the modern intelligence testing paradigm formed around the Binet–Simon (1911/1915) approach and the adult extensions during the first 2 decades of this century, aspects of the testing content, procedures, and criteria were explored and formalized. Despite an explosive increase in the frequency of studies on intelligence assessment and application during this period, investigators quickly converged on specific intelligence assessment content (i.e., higher order mental processes), procedures (i.e., encouragement for examinees to provide maximal effort), and validational criteria (i.e., school and college grades and occupational performance).

Finally, as Whipple (1922) asserted,

> it ought to be made clear at the outset that no psychologist is foolish enough to suppose that native intelligence is the sole factor in academic success; all that is contended is that it is one factor, and probably the most important single factor, and that it is measurable by wholesale rapid methods with a reasonable degree of precision. (p. 262)

Maximal Versus Typical Performance

Many early investigators identified the mental test procedure as one designed to elicit maximal effort on the part of the examinee (e.g., Terman's, 1924, distinction between acute and chronic behaviors). However, as Ackerman's (1994) review noted, Cronbach (1949) first explicitly categorized ability tests as measures of maximal performance, in contrast to personality tests, which provide measures of typical performance. Subsequently, Fiske and Butler (1963; Butler & Fiske, 1955) provided a formalized contrast and a rationale to match maximal and

typical behavior with ability and personality measures, respectively. For ability testing,

> first, we want a pure measure, one that is determined almost wholly by one thing, the subject's capacity, rather than a measure which is affected by several influences. Second, we measure maximum performance because it is probably more stable than performance under more lifelike conditions. (Fiske & Butler, 1963, p. 253)

For personality testing, "we are ordinarily concerned with the typical (modal or mean?) strength of this tendency [to respond in a given way] because this provides the best estimate of what a person is most likely to do" (Fiske & Butler, 1963, p. 258).

With this explicit treatment of two respective testing paradigms, clearly the description of an ability testing paradigm begs the question, "Why shouldn't investigators be interested in predicting, from ability testing, what a person is most likely to do?" That is, an understanding of what an individual is likely to do is based partly on personality characteristics but also on how much intellectual effort the individual is likely to put forth, whether in school or at a job—namely, the individual's typical intellectual engagement (TIE). When considered in the context of an individual's typical behavior and in concert with investigators' informal observations about the circumstances when ability test performance and achievement did not match, clearly personality and intelligence are not necessarily orthogonal domains. In addition, conative traits (e.g., interests) may also play a role in the long-term development and expression of intellect, especially as the individual reaches and continues to develop in adulthood. As such, we now consider the theoretical and empirical basis for personality–intelligence and interest–intelligence relations and the implications of these relations for development and expression of adult intellect.

Intelligence Theory and Ability Structure

A formal review of intelligence theory, as independent from theories that attempt to link intelligence with personality and interests, is beyond the scope of this article, and there are already excellent sources that provide this basic information (e.g., see Carroll, 1993; and Sternberg, 1990). However, to conduct a meta-analysis of personality and ability relations, it is necessary to classify constructs for each domain. Fortunately, there is a consensus in the field about how abilities relate to one another and how the basic arrangement of cognitive abilities can be represented in a hierarchical structure. Although there are several competing hierarchical theories of intelligence, most theories specify a general ability at the highest node (i.e., general intelligence), followed by broad group factors at a second node and narrow group factors at lower nodes. Theories that fit this kind of framework are ubiquitous, even if the precise description of broad group factors differ between theories. For details of these hierarchical theories of intelligence, see, for example, R. B. Cattell (1971/1987); Gustafsson (1984); Horn (1965); Snow, Kyllonen, and Marshalek (1984); and Vernon (1950). It is also generally possible to roughly translate each of these approaches to the others, depending on the type of spatial representation one desires (e.g., factor analytic or multidimensional scaling). For our purposes, we adapt a structure and list of ability traits from Carroll's (1993) extensive review and reanalysis of a wide corpus of data in the literature.[1] The structure of abilities is shown in Figure 1. It consists of one third-order factor (General Intelligence), seven second-order factors (Fluid Intelligence [Gf], Crystallized Intelligence [Gc], Ideational Fluency, Knowledge and Achievement, Learning and Memory, Perceptual Speed, and Visual Perception), and two first-order factors (Math Reasoning and Closure). With the exception of General Intelligence, each factor is presented with a list of commonly found test types that load highly on that factor. The hierarchical arrangement indicates that the underlying factor structure is oblique (often called "positive manifold"), with correlations among narrower factors indicating the presence of common broad factors. Note that, although Carroll listed many more factors than we selected, our focus is the generation of a structure and list of abilities that reflect those sampled in studies of personality–intelligence and interest–intelligence relations.

Personality Assessment and Theory

A review of the literature on personality assessment generally confirms Goldberg's (1971) observation that "the most potent source of variance in the determination of the [personality] constructs for past scales and inventories has been sheer historical accident" (p. 335). That is, the literature is rife with isolated personality measures of varying levels of breadth, often with no linkage to any personality theory. From this perspective, there are competing orientations in the classification of personality measures for later analysis: One goal is taxonomic completeness, the other goal is theory coherence. If one were to orient toward the first goal, then a complete list of narrow and broad personality scales could be collected for later analysis—however, the comprehensiveness of this orientation would come at the cost of a failure to provide an organizing framework. In contrast, one or more personality theories could be adopted, and personality scales then could be classified into theory–construct categories. With this approach, though, a large number of measures would be excluded from later analysis because they do not readily fit into the theoretical frameworks. We adopted a "satisficing" solution, a hybrid approach: (1) Select a small number of prevalent factor-oriented theories of personality and create a lowest common denominator list of personality constructs, (2) classify personality scales into the respective personality constructs, and (3) organize as many of the remaining scales into logically coherent constructs, even if they exist outside of the extant personality theories. A brief review of prevalent personality theories follows.[2]

At the outset, note that there is considerably less consensus about the structure of individual differences in personality than in the ability domain; controversy rages over many aspects of

[1] Carroll's review lists far more ability factors than we consider. We have for the most part, though, limited our discussion to abilities that are both well researched and central to most competing hierarchical theories of intelligence. A few additional factors were included in our consideration to accommodate a significant number of cross-trait correlational studies.

[2] Note that our interests lie in the nonpathological population, and, as such, we have excluded from consideration theories of personality that deal primarily with psychopathology.

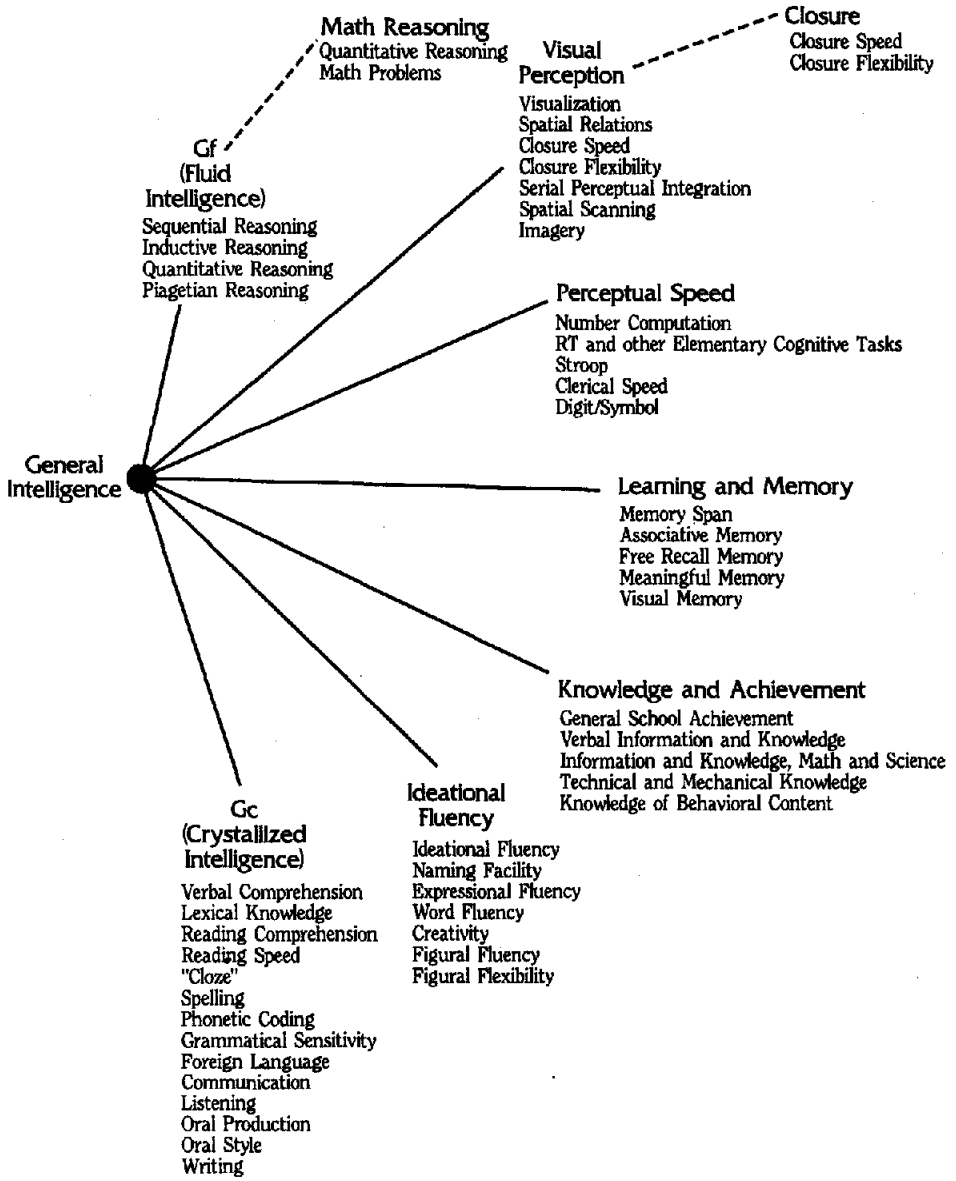

Figure 1. A list and structure of ability constructs. Derived from information in Carroll (1993). Third-order construct = General Intelligence; second-order constructs shown with solid lines; first-order construct shown with dotted lines.

the research and theory development enterprises (see Block, 1995a, 1995b; Church, 1994; Church & Burke, 1994; Costa & McCrae, 1992a, 1992b, 1995; H. J. Eysenck, 1992; Goldberg & Saucier, 1995; and Tellegen & Waller, in press, for some examples). Nonetheless, for our task, we consider three broad theoretical perspectives that have received substantial competitive support in the literature and, at least across the theories, have provided both breadth and a reasonable amount of specificity, so we can consider relations of both broad and relatively narrow personality traits with ability and interest traits. The three personality theories or models are H. J. Eysenck's three-factor theory, the Five-Factor approach (FFA; exemplified by Costa & McCrae's work), and the lowest order of Tellegen's (1982) 11-trait framework.

Eysenck's Theory

H. J. Eysenck's (1947) original theory only included two factors of personality, namely Neuroticism and Extroversion. Later Eysenck (1970) added the Psychoticism factor. His theory is set apart from other factor-based theories because it makes several direct connections to physiological processes (e.g., arousal) and because he claimed that these personality factors

are orthogonal to intellectual ability factors (e.g., see H. J. Eysenck, 1994; and H. J. Eysenck & Eysenck, 1969).

Five-Factor Approach

Although there were earlier attempts to simplify the factor space of personality (e.g., Tupes & Christal, 1961), theoretical and empirical research conducted during the 1970s and 1980s eventually prompted several investigators to converge on a set of five factors that appear across numerous personality inventories (e.g., Goldberg, 1990; see also Digman, 1990, for a succinct review of the broad approaches to personality traits that converge on five common factors). The five factors are broadly classified (although the terms have slightly different meanings) as (1) Extroversion, (2) Agreeableness, (3) Conscientiousness, (4) Neuroticism, and (5) Intellect. Relevant to our interests, Digman reported that H. J. Eysenck's (1947) Psychoticism straddles the Agreeableness and Conscientiousness factors and that R. B. Cattell's (1946) Intelligence factor is aligned with the Intellect factor and that the Extroversion factor subsumes H. J. Eysenck's Extroversion factor and R. B. Cattell's Exvia factor. McCrae (1994; McCrae & Costa, in press) has argued that there is substantial overlap between his conceptualization of Openness to Experience (Intellect in Digman's taxonomy), Conscientiousness, and intellectual ability, amorphously defined (see, e.g., McCrae, 1994, Figure 1, p. 255).

Tellegen's Framework

Tellegen's theory of personality traits is essentially hierarchical (e.g., see Church, 1994; and Tellegen & Waller, in press), with three higher order factors of Negative Emotionality (NEM), Positive Emotionality (PEM), and Constraint. Tellegen's inventory is designed to measure the higher order traits; however, it also provides estimates of 11 lower order traits that have been shown to have substantial commonality with traits identified by H. J. Eysenck (1947), with traits identified by adherents of the FFA, and others. The lowest level traits identified by Tellegen are Well-Being, Social Potency, Achievement, Social Closeness, Stress Reaction, Alienation, Aggression, Control, Harm–Avoidance, Traditionalism, and Absorption. In general, there is a moderate-to-close correspondence between the Tellegen higher order traits and Eysenck's measures: NEM ≈ Neuroticism, Constraint ≈ Psychoticism, and PEM ≈ Extroversion (see Tellegen & Waller, in press).

An Integrative Framework

Drawing on the literature that relates the Tellegen, H. J. Eysenck, and Five-Factor approaches, we are able to depict the prominent relations among each set of constructs (e.g., see Church, 1994; and Church & Burke, 1994). In Figure 2, we present a specification of these interrelations among personality trait measures in a way that includes all three perspectives. The connections between the Tellegen scales or factors and the FFA are derived from three sources: correlations between Tellegen's (1982) Multidimensional Personality Questionnaire (MPQ) and the Costa and McCrea's (1992c) NEO–Personality Inventory (NEO–PI, N = 575 college students; Church, 1994), between the MPQ and FFA trait descriptors (N = 1,015 community adults; Tellegen & Waller, in press), and between the MPQ and

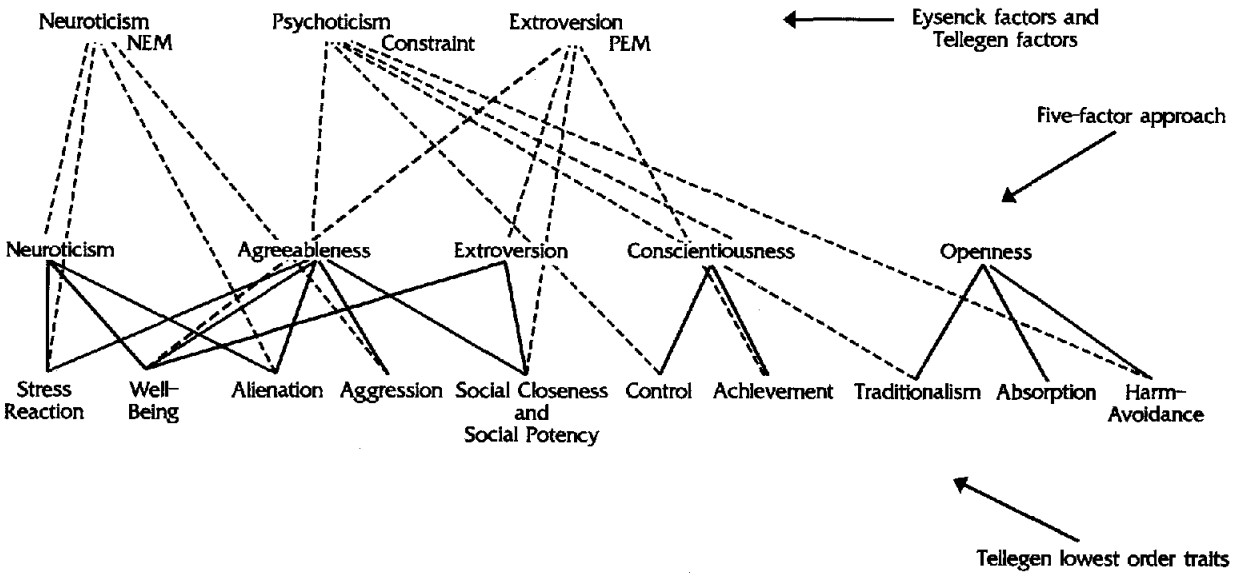

Figure 2. Personality constructs and their relations: lowest order constructs (from Tellegen, 1982); five-factor approach (FFA) constructs (from Costa & McCrae, 1992c; Digman, 1990; and others); highest order constructs (from H. J. Eysenck, 1970; and Tellegen & Waller, in press). Lines indicate both positive and negative correlational (not necessarily causal) relations. Solid lines indicate relations between Tellegen and FFA constructs. Dotted lines indicate relations between Tellegen and FFA constructs and H. J. Eysenck constructs. NEM = Negative Emotionality; PEM = Positive Emotionality.

the NEO–Five-Factor Inventory (a short form of the NEO–PI, N = 150 college students; Kanfer, Ackerman, & Heggestad, 1996). Associations between the FFA and the Eysenck factors are derived from the data and discussions reported by Costa and McCrae (1992a, 1992b) and H. J. Eysenck (1991). Associations between Tellegen's higher order factors and Eysenck's factors derived from Tellegen and Waller's (in press) study of the MPQ and the Eysenck Personality Questionnaire (EPQ; N = 155 college men and women) show the following loadings of the EPQ: Extroversion on PEM (.78), Neuroticism on NEM (.69), and Psychoticism on Constraint (.50). By providing this framework, we are able to triangulate our later discussion of both specific and broad personality traits by locating the trait in Figure 2 and examining the other traits with which it shows substantial communality.

Personality and Intellectual Abilities

Intelligence and Character

1900–1940

One of the first studies of the associations between personality variables and intelligence was reported by Karl Pearson (1906–1907). He reported the correlations between teacher judgments of intelligence and "mental characters" (Temper, Popularity, Self-Consciousness, Shyness, Conscientiousness, and Quiet Habits) for a sample of 5,000 school-aged boys and girls. The results are of only passing interest; teacher judgments of both sets of traits undoubtedly were subject to halo effects. Nonetheless, note that Pearson reported correlations with rated intelligence: Conscientiousness, .45; Popularity, .26; Temper, .21; Shyness, .10, Self-Consciousness, .07; and Quiet Habits, .06.

Another early investigation of the relations between character and intelligence was by Webb (1915). For Webb, character included "emotional and volitional, social and moral qualities" (p. 2). As with Pearson's (1906–1907) earlier investigation, character and intelligence assessments were provided by teacher ratings. In fact, the high correlations between judged intelligence and judged character caused Webb to note what would later be called *halo effects,* namely,

> it throws light upon the nature of estimates of "General Intelligence," as supplied by teachers and others. These have been shown to be not pure measures of intelligence proper (as the "g" is), but to be biased in various manners and in varying degrees for different judges, in favour of individuals who possess other desirable (or criterial) qualities besides the actual intelligence in question. (Webb, 1915, p. 75)

Nonetheless, Webb (1915) described several components of character (such as cheerfulness, depression, aesthetic feeling, esteem, etc.) and a general factor, W:

> *Its nature is best conceived,* in light of our present evidence, *to be in some close relation to "persistence of motives"; i.e., to depend upon the consistency of action resulting from deliberate volition, i.e., from will.* It appears to coincide more with Ach's conception of will than with either "perseveration" or the "secondary function." (p. 76)

Alexander (1935) administered a large series of performance tests and verbal tests to several groups of adolescents, for a total of 374 participants. In addition to the demonstration of a general intelligence factor (g), a verbal factor (v), and a practical intelligence factor (F)—which had high loadings from the performance tests and presumably represented spatial/mechanical abilities—Alexander found two "residual" factors underlying school grades. The first factor was identified as X (similar to Webb's, 1915, W character factor) or rather an "'interest' in school work" (Alexander, 1935, p. 126) factor, also defined as "persistence" and "will to succeed" (p. 128). The second factor, Z, was related to "Shop Work, Mathematics, the number tests, and English" (p. 128) and was only described as "a factor of some importance in school achievement" (p. 128).

The first major review of the personality–intelligence domain was reported by Lorge (1940). Unfortunately, the only thing that one can take away from this short review (actual studies reviewed and specific coefficients were not presented) is the confusion about personality traits and the lack of precision with which they were measured during the first half of this century. Lorge reviewed "some 200 coefficients between intelligence and some scale of personality function" (p. 277). He reported that

> the correlations of intelligence with measures of personality range from +.79 to −.49 with a median at +.04 . . .. Half the correlations, on the basis of absolute size, range between .00 and .15 and only one fourth of them are greater than .30. (pp. 277–278)

Although he did break out some correlations by specific personality scale (e.g., psychoneurotic tendency and Introversion–Extroversion), again no regular correlational patterns could be detected. The only personality measures that showed regular positive correlations with intelligence were tests of "moral" judgment or knowledge; but as Lorge (1940) reported, the knowledge aspect of these scales probably resulted in spuriously high associations with the knowledge components of intelligence. Nonetheless, Lorge concluded that "the correlations between intelligence and measures of personality may underestimate the role of intellect in personality" (p. 281).

1940–1960

First, in an American Psychological Association (APA) presentation (1940), and later in an APA Division of Clinical and Abnormal Psychology address, published in the *American Psychologist* (1950), Wechsler attempted to broaden the consideration of intelligence beyond the kinds of scales that were included in standardized tests, that is, to encompass "cognitive, conative, and non-intellective intelligence" (p. 82). Although Wechsler was firm in his beliefs about the importance of personality and interest components for intelligence, the data available to him were admittedly "meager" and confusing. He cited the work by Webb (1915) and Alexander (1935) and Lorge's (1940) review. However, at the time of his article, there was no general consensus agreement about the important factors of personality or interests. As a result, it was not possible to document specific relations among these conative, affective, and cognitive/intellectual traits. He closed with the following:

> One need not be afraid or ashamed to acknowledge impulse, instinct

> and temperament as basic factors in general intelligence . . .. My main point has been that general intelligence cannot be equated with intellectual ability, but must be regarded as a manifestation of the personality as a whole. (Wechsler, 1950, p. 83)

Up to the end of the 1930s, little coherence among theory and measures of personality existed, thus making a useful summary of personality–intelligence relations impossible. However, in the 1940s, several multiple trait theories and assessment batteries were developed, and several of those batteries continue to be used today. Prominent among personality measures is the Minnesota Multiphasic Personality Inventory (MMPI), although its focus on the clinical population accords little that can be considered directly relevant to general personality–intelligence relations in nonpathological samples.

There were, however, three broad approaches that provide grounds for investigation of personality–intelligence relations, namely those of R. B. Cattell, H. J. Eysenck, and the aggregated FFA perspective. In addition, these and other approaches spawned measures developed for the nonpathological population (e.g., the California Psychological Inventory [CPI]) to provide assessments of broad and narrow personality factors.

R. B. Cattell's theory of personality traits has a distinction to provide a plethora of factors, along with original terms for most of the traits. In his first major effort to classify personality traits, R. B. Cattell (1946) introduced 12 factors. Later, Cattell (1949) refined the original factor descriptions and introduced four additional factors, for a total of 16 "source traits." Rather than an introduction of all of Cattell's terms, it is useful to mention two factors that, from their descriptions, may be related to intellectual abilities (Institute for Personality and Ability Testing staff, 1986): Factor B, concrete thinking versus abstract thinking, and Factor I, tough minded versus tender minded (Harria vs. Premsia).

Clearly, R. B. Cattell's Factor B is seen to be related to intellectual ability. Unfortunately, the questions on the 16 Personality Factor Questionnaire (16PF) that pertain to Factor B are objective ability questions (e.g., analogies and vocabulary) rather than self-report, personality-type questions. As such, Cattell provided no independent personality evaluation of intellect.

In contrast, R. B. Cattell's Factor I has the potential to examine personality–intelligence relations. For example, Premsia is described by Horn (1965) as "sensitivity," with a negative loading of Mechanical Knowledge ability (i.e., "the 'sensitivity' is that of a person who prefers English to mathematics, 'imaginative novels' to 'realistic accounts of military or political battles,' brandy to beer, ballet to burlesque, etc." [p. 294]). This trait, though, appears to share much content with the FFA construct of Openness to Experience/Culture.

Gough (1953) introduced the term "intellectual efficiency" to describe a 52-item scale developed for the purpose of providing a non-ability-test assessment of intellect (with a criterion of IQ test scores). Gough reported that the questions for this scale were selected "on a priori and theoretical grounds, to covary with intellect" (p. 246). Although the correlations reported by Gough were relatively high (median validity coefficient of .47 in cross-validation samples), the content of the scale appears somewhat muddy from a construct–validity perspective. Some of the items could be clearly related to intellect (e.g., "I am quite a fast reader," "I like science," and "I like to read about history"); many of the other questions (mainly from the MMPI) address nonintellectual issues, such as general health or pathology (e.g., "I have had no difficulty in starting or holding my urine" and "My skin seems to be unusually sensitive to touch").

Nonetheless, Gough's (1957, 1987) CPI includes the scale of Intellectual–Efficiency (*Ie*), along with two related scales, Achievement via Conformance (*Ac*) and Achievement via Independence (*Ai*). A person who is high in *Ie* is described as "efficient in use of intellectual abilities; can keep on a task where others might get bored or discouraged" (Gough, 1987, p. 7). A person who is high in *Ac* is described as having a "strong drive to do well, likes to work in settings where tasks and expectations are clearly defined" (p. 7). A person who is high in *Ai* is described as having a "strong drive to do well; likes to work in settings that are vague, poorly defined, and lacking in clear-cut methods and standards" (p. 7).

Intellectence

A body of work by Welsh (e.g., 1975) focuses on a construct called "Intellectence," which he defined as "the personality dimension related to performance on intellectual measures such as the CMT [Terman's Concept Mastery Test]" (p. 69). Welsh converged on this construct (and a contrasting construct, "Origence") through analysis of personality measures (e.g., the Adjective Check List and MMPI) and interest measures (e.g., Strong Vocational Interest Blank [SVIB]) in his investigations of creativity. He described individuals high in Intellectence as

> somewhat introversive . . . more objective in outlook and responds to people in the world around him and to their attitudes and ideas, although he tends to maintain some social and personal distance from them. Most of his responses are intellectualized or rationalized and he seldom acts impulsively. (p. 105)

However, although Welsh's construct has much in common with similarly named personality constructs (e.g., R. B. Cattell's Intelligence personality factor, Gough's *Ie* measure, the FFA Openness to Experience/Culture factor, Hogan and Hogan's [1995] Intelligence factor, etc.), his research is impossible to interpret in our context for several reasons; the most prominent among them is that assessment of Intellectence was often contaminated by ability test scores (e.g., use of the CMT as a measure of Intellectence) or because Intellectence scores were confounded by their being derived from difference scores between other standard measures of personality and interest traits (see, e.g., Welsh, 1971, 1975, and 1977).

TIE

The construct of intelligence-as-typical performance was put forth by Ackerman (1994) to develop a parallel ability construction to the maximal versus typical distinction that Cronbach (1949) established for ability versus personality measures. That is, Ackerman suggested that one reason why intelligence tests do not highly correlate with measures of advanced academic or occupational performance is because intelligence is measured by the maximal paradigm and long-term academic and occupational

performance takes place in a typical environment. He postulated that a measure of intelligence-as-typical performance would be more highly associated with crystallized abilities (i.e. resource-insensitive abilities such as knowledge), whereas intelligence-as-maximal performance would be more highly related to fluid abilities (i.e., more resource-dependent abilities such as memory or abstract reasoning).

To test the inferences about the construct of intelligence-as-typical performance, Goff and Ackerman (1992) created a self-report measure of TIE, essentially a personality scale (with items such as "I would enjoy hearing the details about discoveries in any field" and "I read a great deal"), and correlated scores on the scale with measures of ability, academic achievement, and personality. The results of the first study, with 138 undergraduate students, validated the TIE measure—it correlated positively and significantly with a Gc composite and correlated essentially zero with a Gf composite. In comparison with personality measures, TIE shows a substantial correlation with the Openness to Experience factor of the NEO-PI (r = .65) and a smaller, but significant, correlation with Conscientiousness (r = .27). Later investigations (e.g., see Ackerman & Goff, 1994) included analyses with additional participants (N = 455) and provided an essentially identical correlation between TIE and Openness to Experience (r = .65; see discussion by Rocklin, 1994).

The TIE measure has been administered to multiple samples, along with several intelligence–aptitude batteries. For example, in a study of cognitive and noncognitive determinants and consequences of complex skill acquisition, Ackerman, Kanfer, and Goff (1995) administered the TIE scale and 15 ability tests to 93 university students and graduates. Correlations between TIE scores and four composites were as follows: Verbal Ability (.49), Perceptual Speed (.21), Math Ability (.12), and Spatial Ability (.06). In a field study of skill acquisition (Ackerman & Kanfer, 1994) among 213 U.S. Navy trainees, the TIE measure was administered and compared with Armed Services Vocational Aptitude Battery (ASVAB) scores. Correlations between TIE and ASVAB scales follow, with the scales identified by their factor membership (see Ackerman, 1988): Verbal Ability factor (Paragraph Comprehension [.33], General Science [.31], and Word Knowledge [.29]); Vocational–Technical Information factor (Mechanical Comprehension [.22], Electronics Information [.18], and Auto and Shop Information [−.07]); Math factor (Arithmetic Reasoning [.24] and Mathematics Knowledge [.22]); and Perceptual Speed (Coding Speed [.13] and Numerical Operations [.04]). Along with the earlier results from Goff and Ackerman (1992), these results indicate that the TIE scale is more closely associated with verbal/crystallized abilities than math/fluid abilities.

Test Anxiety

In a thorough review and meta-analysis of 562 studies, Hembree (1988) examined the "correlates, causes, effects, and treatment of Test Anxiety" (p. 47). From his review, Hembree determined that, first of all, significant negative correlations were found between Test Anxiety and measures of intelligence (Mean r = −.23). Second, scales of Test Anxiety were found to be substantially and significantly related to measures of General Anxiety (Mean r = .56), chronic ("A trait"; see Spielberger, 1972) anxiety (Mean r = .53), and transitory ("A state") anxiety (Mean r = .45), as well as components of Worry (Mean r = .57) and Emotionality (Mean r = .54). For further details on Test Anxiety traits, see, for example, Liebert and Morris (1967) and Spielberger. Given that general traits of Anxiety, Worry, and Emotionality would generally be encompassed within Stress Reaction or Neuroticism domains (see, e.g., Church, 1994), one might be tempted to simply identify Test Anxiety as a subfactor of these broader traits. Indeed, Spielberger, Anton, and Bedell (1976) stated that Test Anxiety is a component of Trait Anxiety. However, Hembree's meta-analysis also makes it clear that Test Anxiety is malleable to a nontrivial degree (mean treatment effects as large as 1 *SD* improvement were found), thus suggesting that Test Anxiety is less stable than the personality traits with which it correlates. In addition, it has been suggested (A. Tellegen, personal communication, September 11, 1995) that Test Anxiety may not be a personality trait per se but rather a set of attitudes toward test taking, which are highly influenced by feedback from prior ability-testing situations. Because of the uncertainty of the status of Test Anxiety as a personality trait, when we consider Test Anxiety–ability relations, we keep this construct separate from the other personality traits.

Summary

The theoretical and empirical literature on personality and intelligence reflect two general approaches: One approach infers broad (but unspecified) personality–intelligence relations, the other specific personality–intelligence relations. The former approach (such as that of Webb, 1915; and Wechsler, 1940, 1950) provides a rationale for investigators searching broadly for personality–intelligence relations. The latter approach involves a small set of personality traits that historically have been linked explicitly to intellectual abilities (e.g., Openness to Experience, Intellectence, and Test Anxiety) and provides a rationale for closer investigation of specific trait relations. In addition to the general approaches, the TIE approach is unique because it specifies that this personality trait shows larger correlations with particular intellectual abilities (e.g., Gc, fluency, and knowledge) than other abilities (e.g., Gf, Visual Perception, and Perceptual Speed). With this background, we performed a series of meta-analyses to examine broad and narrow personality–intelligence relations.

Meta-Analysis of Personality and Intelligence

Method

Literature Search

Studies for possible inclusion in the meta-analysis were initially identified by searching several computerized databases. Broadly defined searches were performed using the Educational Resources Information Center's *ERIC on CD-ROM* (1968–1994), American Psychological Association's on-line *FirstSearch* (1962–1973), and the National Technical Information Service (NTIS) CD-ROM Database (1974–1994), on the terms *personality, intelligence, ability,* and *abilities* (with the last three terms conjoined by *or* statements). A more comprehensive search was conducted using *PsycLIT* (1974–1994), in which all pairwise combinations of 47 personality terms and 15 ability terms were searched. The

personality search terms consisted of trait constructs (e.g., impulsivity and introversion) and personality battery names (e.g., 16PF), whereas the ability search terms included ability constructs (e.g., spatial and numerical) and names or abbreviations of ability and aptitude tests (e.g., differential aptitude test [DAT] and scholastic aptitude test [SAT]). In addition to the computerized searches, additional studies were identified by (a) an examination of titles (aided by the topical index) included in the 6,736-item *Bibliography on Human Intelligence* (Wright, 1969), (b) an examination of promising studies found in the reference lists of those studies identified in the computerized searches, (c) an examination of personality and ability battery manuals, (d) an ERIC bibliography on Test Anxiety compiled by Hembree (1988), and (e) a computer search of titles from Phillip L. Ackerman's files (1,500+ items).

Each article identified in these search procedures was subjected to an initial screening in which the abstract (for those articles identified in the computerized searches), or article (for those articles which we did not have abstracts), was examined for indications that both ability and personality constructs were assessed and reported. When the initial screening suggested the possibility of useful data, the entire article was obtained for a more detailed evaluation. A total of 1,073 articles was obtained for further review (for additional details, see Ackerman & Goff, 1995).

Studies were excluded from the meta-analysis if (a) participants were drawn from clinical or artificially or extremely restricted populations; (b) participants were younger than 10 years of age; (c) an extreme groups design was used; (d) the only measures of personality reported were performance-type assessments (e.g., *T* data by R. B. Cattell, 1946, due to method variance shared by such assessments and many intellectual ability tests), state measures (e.g., affect), cognitive styles (e.g., field dependence), attitudes (e.g., political extremism), developmental assessments (e.g., ego or moral development), or measures of psychopathology; or (e) the only measures of ability reported were those of creativity (due to generally poor consensus on just how creativity can be assessed and the generally poor reliability of creativity measures; McNemar, 1964; Weisberg, 1986) or psychomotor abilities. Finally, studies of masculinity–femininity were excluded because a prior meta-analysis has addressed relations between masculinity–femininity and intellectual abilities (Signorella & Jamison, 1986) and because a consideration of gender differences in this analysis would create an unworkable number of comparisons.[3]

One-hundred-thirty-five studies remained after evaluation with the inclusion criteria. These studies contained a total of 188 independent samples, 2,033 correlations, and 64,592 participants. The studies that contributed correlations to the meta-analysis, along with the number of independent samples greater than one contributed (in parentheses) by each study, are indicated by an asterisk in the Reference section.

Classification of the Ability Tests

The hierarchical taxonomy of abilities derived from Carroll's (1993) review, as shown in Figure 1, was used to sort ability scales into ability trait categories. Thus, scales were sorted into 10 categories and 1 miscellaneous ability category (for scales that did not fit within the taxonomy)—with the provision that a scale would be sorted into the lowest level possible. Each trait was prepared on a card (along with the list of marker ability tests from Carroll). We placed the 245 ability scale descriptions on cards and then individually sorted them into the 11 categories. Interrater agreement (between Phillip L. Ackerman and Eric D. Heggested) was quite high (96%, Cohen's $\kappa = .95$). A few disagreements were discussed and resolved, with occasional additional descriptive information obtained from the *Mental Measurements Yearbook* (e.g., Conoley & Impara, 1995). Of the 245 scales sorted, 54 were either not classifiable or did not fit into the taxonomy (so were placed in the miscellaneous category). Thus, 191 ability scales were available for the meta-analysis. A complete listing of the ability scales and classifications is available from this article's authors.

Classification of the Personality Scales

The taxonomy of personality used for our sort starts with the 11 factors from A. Tellegen's MPQ, the 5 factors from the FFA, and the 3 factors (Psychoticism, Neuroticism, and Extroversion) of H. J. Eysenck (although Extroversion identified in the FFA was deemed reasonably equivalent to Eysenck's Extroversion—see Figure 2—and Stress Reaction and Neuroticism were equivalent across the construct space). Also, three additional factors were included, namely, Intellectence, Test Anxiety, and TIE. One miscellaneous personality trait category was added to capture any scales that were not classifiable within this list of the 11 + 5 + 3 + 3 (−3 for the overlapping Stress Reaction–Neuroticism and Extroversion factors), for a total of 19 personality traits. A description of each of the unique 268 personality scales was obtained from manuals (whenever available) or the study that used the scale. We and A. Tellegen individually sorted cards that contained each scale description into the 19 personality trait groups and the miscellaneous category—again with the provision that the scales were to be placed in the lowest level trait category appropriate to the scale. Given the limited amount of information available on many scales, interrater agreement was generally acceptable, ranging from 61% (Cohen's $\kappa = .57$) to 79% (Cohen's $\kappa = .77$). Scales were assigned to categories on the basis of the agreement of two raters. In the event that all three raters disagreed (24 scales, 10%), we placed scales into a category on the basis of a discussion. The number of scales within each category varied from 32 (Stress Reaction) to 1 (TIE). The titles and descriptions of 90 scales were sufficiently uninformative or fell outside of the 19 taxonomic traits and were thus excluded. Each scale was carefully examined to ensure the direction of scoring. Correlations from those scales scored in a direction opposite of our categories (e.g., a scale with high scores representing Introversion rather than Extroversion) were reversed prior to inclusion in the analysis. A total of 178 scales remained for the meta-analysis. A complete listing of personality scales and classifications is available from this article's authors. With a complete crossing of 10 ability traits and 19 personality traits, there were a possible 190 meta-analyses to examine.

Procedure

Missing data. In some studies (e.g., Johnson, Nagoshi, Ahern, & Wilson, 1983), investigators chose to report only significant correlations, although an entire matrix of correlations was apparently computed. Whereas several methods exist for dealing with such cases (see Bushman, 1994; and Bushman & Wang, 1995, for alternative procedures),

[3] In a meta-analysis, Signorella and Jamison examined relations among the personality or self-concept constructs of masculinity–femininity, masculine and feminine aspects of androgyny measures, and androgyny as a balance between these scores and some mental rotation, spatial visualization, mathematical ability, and verbal ability assessments similar to the abilities included in our meta-analysis. For spatial abilities, they found some suggestion that higher masculinity–femininity or masculinity scores were associated with better performance, particularly for women. However, for spatial abilities, effect sizes were substantively small, ranging from near 0% to 4% common variance. They found statistically significant although substantively modest effect sizes, accounting for approximately 1–2% common variance between masculinity–femininity scores and mathematical tasks. There were essentially negligible correlations that involved any of the personality variables and verbal abilities or androgyny and any of the abilities.

we decided to provide an estimate of the missing correlations; that is, when the correlation was reported as nonsignificant and the sign of the correlation was unknown, the expected value, zero, was used as the estimate.[4]

Correction for attenuation due to unreliability of measures. The standard correction of unreliability of measures was used:

$$r_i^* = \frac{r_{xy}}{\sqrt{r_{xx}\, r_{yy}}}, \tag{1}$$

where r_i^* is the correlation between personality variable x and ability variable y for study i, r_{xx} and r_{yy} are the estimated reliabilities of personality variable x and ability variable y, respectively, and r_{xy} is the observed correlation between those variables. Reliability estimates came from a variety of sources. Test–retest reliability estimates provided in test manuals or articles that describe the development of the scales were considered most desirable and were used wherever possible. When test–retest reliability estimates were not available, however, tests of internal consistency from the same sources were used. In a few cases, when these sources could not be located, or when no reliability estimates were reported, an attempt was made to locate reliability estimates reported in other research studies that used these measures. Through these methods, reliability estimates were available for 133 of the 178 personality variables and 117 of the 191 ability measures. For those cases in which reliability estimates remained unavailable, the mean value of the reliability estimates that had been obtained was used (separately for personality and ability).

Aggregation of within-sample effect sizes. Several studies used multiple measures of personality or ability that fell within a single personality–ability classification (e.g., Clarke, 1985). Rather than allowing a single sample to contribute more than one correlation to a personality–ability classification (thereby ignoring the nonindependence of the relations) or simply choosing one of the correlations at random (thereby losing the information contained in the other relations), we chose to use an aggregated estimate by computing the mean correlation (using Fisher's z-transformed correlations). A mean estimate of reliability was also computed and used for correcting the estimated correlation for unreliability.

Correlational analysis. An analysis similar to the type described by Hedges and Olkin (1985) was performed. Because individual differences constructs are under consideration, nearly all studies reported associations as correlations instead of other statistics. The effect size measure for this analysis is therefore the weighted mean correlation after correction of attenuation due to unreliability of measures:

$$\bar{Z} = \frac{\sum_{i=1}^{k} (n_i - 3)\, z_{r_i^*}}{\sum_{i=1}^{k} (n_i - 3)}, \tag{2}$$

where $z_{r_i^*}$ is the Fisher's z-transformed correlation between personality variable x and ability variable y for study i after a correction for attenuation due to unreliability of measures, n_i is the sample size for that correlation, and k is the number of aggregated correlations in the cell. Fisher's z-transformed correlations were used for aggregation to eliminate bias that systematically underestimates effect size. The estimated population correlation ($\hat{\rho}$) is obtained through a z-to-r transformation of $\bar{z}$.

Confidence intervals. Confidence intervals (CIs) for $\hat{\rho}$ were calculated using formulas by Hedges and Olkin (1985, p. 227):

$$Z_L = \bar{Z} - (1.96/\sqrt{N - 3k}) \tag{3}$$

$$Z_U = \bar{Z} + (1.96/\sqrt{N - 3k}), \tag{4}$$

where 1.96 is the two-tailed critical z value for a 95% CI, N is the total sample size, and k is the number of studies. The lower and upper bounds of the estimated population correlation are obtained through a z-to-r transformation of $z_{L(ower)}$ to $\hat{\rho}_{L(ower)}$ and $z_{U(pper)}$ to $\hat{\rho}_{U(pper)}$.

Test of heterogeneity. Assessments of heterogeneity of correlation coefficients were made within each personality–ability pairing, after within-study aggregation, following the procedure of Hedges and Olkin (1985, pp. 234–235),

$$Q = \sum_{i=1}^{k} (n_i - 3)\, (z_{r_i^*} - \bar{z})^2, \tag{5}$$

where n_i is the sample size from study i, $z_{r_i^*}$ is the Fisher's z-transformed aggregated correlation from study i, and $\bar{z}$ is the weighted average correlation within the personality–ability cell. The Q statistic is distributed as χ^2 with $k - 1$ degree of freedom (where k represents the number of $z_{r_i^*}$). A significant Q suggests that more than one distribution may underlie the sample of correlations (i.e., heterogeneity) and that the investigator may not want to pool the data into a single estimate. Because of its relation to the chi-square distribution, however, the Q statistic is sensitive to sample size. Thus, with large enough samples, even small variations among the sample correlations lead to significant heterogeneity statistics. If samples are large, Hedges and Olkin suggested that it may be acceptable to examine the pooled estimate, even if the Q statistic is significant. Because many of the cells in our analyses contained samples with large sample sizes, the alpha level was set to .01 for the heterogeneity tests.

Results

The obtained results of the meta-analysis are shown in Table 1. There are two aspects of the table that clearly stand out. First, for many cells, there are either no data or only a few studies that provide data. Second, many of the estimated population correlations are small, even if statistically significant.

Further examination of the table shows that there are several trait pairings that have a substantial accumulation of studies and samples. For example, Stress Reaction and Extroversion are each represented by as many as 66 studies (Stress Reaction and Gc) or 63 studies (Extroversion and Gc), with combined samples of 19,820 and 24,280 participants, respectively. In addition, many of the estimated population correlations are significantly different from zero. However, close inspection indicates that many trait-pair cells also indicate significant heterogeneity of correlations, suggesting that more than one population correlation may underlie the data, which implicates the presence of moderator variables. These issues are discussed in more detail in *Specific Findings*.

[4] Out of 2,033, 185 (9%) of the correlations were "missing," and their expected value of zero was used in the analysis. The missing correlations came from seven samples in three studies, were distributed over 32 cells, and included eight different abilities categories and nine different personality categories. The impact of these missing values on the conclusions of the analysis is trivial. That is, when these missing values were removed, the estimates of rho were unchanged in 16 of the 32 cells and changed by more than .02 or more in only 6 of the affected cells (the largest change was .05). The estimates that changed by .02 or more did not occur consistently in any one personality or ability grouping. Furthermore, the removal of the missing data did not change any of the conclusions on the significance associated with the estimated values of rho.

Table 1

Correlations Between Personality and Ability Variables With Condidence Intervals (CIs) and Heterogeneity Estimates

Personality variable	General Intelligence (G)	Crystallized Intelligence (Gc)	Ideational Fluency	Knowledge and Achievement	Learning and Memory	Speed	Visual Perception	Closure	Fluid Intelligence (Gf)	Math–Numerical
				Pure measures of Tellegen traits and other lowest level traits						
Well-Being										
$\hat{\rho}$[a]	.08	.11*	.05	.02	.11	.07*	−.03	.15	.16*	.16*
No. of *r*s (*N*)[b]	8 (1,136)	12 (4,005)	2 (308)	2 (665)	1 (138)	4 (991)	3 (821)	1 (138)	5 (2,465)	7 (2,562)
CI[c]	.02 to .14	.08 to .14	−.06 to .16	−.06 to .09	−.06 to .27	.01 to .13	−.09 to .04	−.01 to .31	.13 to .20	.12 to .20
Q[d]	35.43†	46.45†	0.07	1.97	—	10.89	24.77†	—	7.44	53.93†
Social Potency										
$\hat{\rho}$	.09*	.07*	.04	.12*	.00	−.06	.13*	.07	.02	.08*
No. of *r*s	16 (1,718)	19 (4,085)	3 (571)	2 (665)	2 (201)	4 (884)	8 (1,240)	2 (201)	13 (2,229)	6 (1,084)
CI	.04 to .13	.04 to .10	−.05 to .12	.04 to .19	−.14 to .14	−.13 to .00	.07 to .18	−.07 to .21	−.02 to .07	.02 to .14
Q	17.37	52.24†	3.01	0.71	0.14	4.75	22.05†	0.00	23.37	13.45
Achievement										
$\hat{\rho}$	.13*	.12*	.07	.12*	.05	.14*	.10*	.24	.13*	.08*
No. of *r*s	26 (7,410)	26 (4,796)	1 (212)	3 (879)	1 (63)	3 (356)	7 (712)	1 (63)	14 (2,194)	12 (2,077)
CI	.11 to .15	.09 to .15	−.07 to .20	.05 to .18	−.20 to .29	.02 to .24	.03 to .17	−.01 to .46	.08 to .17	.04 to .12
Q	64.23†	210.11†	—	3.79	—	0.62	4.06	—	62.18†	22.92
Social Closeness										
$\hat{\rho}$	.04*	.06*	.09*	.02	.08	.05	−.07*	.07*	.04	−.02
No. of *r*s	18 (2,253)	20 (5,084)	2 (938)	2 (665)	2 (201)	4 (884)	8 (1,240)	4 (1,197)	12 (2,596)	6 (1,084)
CI	.00 to .08	.03 to .08	.03 to .15	−.06 to .09	−.06 to .22	−.01 to .12	−.12 to −.01	.01 to .12	.00 to .07	−.08 to .04
Q	65.90†	99.19†	9.10†	0.14	0.18	6.74	31.57†	4.34	15.78	8.76
Stress Reaction										
$\hat{\rho}$	−.15*	−.09*	−.01	−.13*	−.06*	−.04	−.04*	−.02	−.08*	−.17*
No. of *r*s	30 (6,169)	66 (19,820)	5 (1,970)	11 (2,597)	8 (1,640)	13 (2,744)	13 (3,892)	5 (1,796)	47 (13,664)	19 (4,987)
CI	−.17 to −.12	−.11 to −.08	−.06 to .03	−.16 to −.09	−.11 to −.01	−.08 to .00	−.07 to −.01	−.06 to .03	−.10 to −.06	−.20 to −.14
Q	67.10†	177.53†	5.69	14.44	10.13	22.00	19.60	1.69	183.67†	63.35†
Alienation										
$\hat{\rho}$	−.18*	−.07*			−.03	−.07	−.13	−.10	−.17*	−.20*
No. of *r*s	6 (628)	11 (2,172)			1 (63)	2 (219)	2 (219)	1 (63)	9 (1,131)	3 (367)
CI	−.26 to −.10	−.11 to −.03			−.28 to .22	−.20 to .07	−.26 to .01	−.34 to .16	−.22 to −.11	−.30 to −.10
Q	16.13†	52.55†			—	0.03	0.12	—	20.79†	2.31
Aggression										
$\hat{\rho}$	−.19*	−.07		−.13	.04	.10	−.06*	.14	−.08	−.10
No. of *r*s	3 (392)	3 (346)		1 (63)	1 (63)	2 (219)	3 (1,503)	1 (63)	3 (263)	3 (367)
CI	−.29 to −.09	−.17 to .04		−.36 to .12	−.21 to .29	−.03 to .23	−.11 to −.01	−.11 to .38	−.20 to .04	−.20 to .00
Q	5.12	1.14		—	—	3.49	0.32	—	4.56	0.33
Control										
$\hat{\rho}$	.06*	.06*	.00			−.10	−.10	−.08*	.02	.14*
No. of *r*s	10 (1,218)	17 (5,267)	3 (1,233)			1 (156)	1 (156)	1 (800)	10 (3,480)	4 (1,864)
CI	.01 to .12	.03 to .09	−.06 to .05			−.25 to .06	−.26 to .05	−.15 to −.01	−.01 to .05	.10 to .19
Q	27.93†	76.36†	2.50			—	—	—	10.30	16.35†
Harm–Avoidance										
$\hat{\rho}$		−.11*	−.10			−.21*	−.43*		−.11*	−.15*
No. or *r*s		4 (583)	2 (433)			1 (156)	1 (156)		2 (433)	3 (383)
CI		−.19 to −.03	−.19 to .00			−.35 to −.05	−.55 to −.29		−.20 to −.02	−.24 to −.04
Q		0.27	0.24			—	—		0.95	2.27
Traditionalism										
$\hat{\rho}$	−.01	−.11*	−.12*	.03	.05	−.01	−.03	−.05	−.01	−.04
No. of *r*s	19 (1,783)	22 (4,797)	3 (571)	2 (665)	2 (201)	4 (884)	8 (1,240)	2 (201)	18 (2,786)	7 (1,183)
CI	−.06 to .03	−.14 to −.08	−.20 to −.04	−.04 to .11	−.09 to .19	−.07 to .06	−.09 to .02	−.19 to .09	−.05 to .03	−.09 to .02
Q	70.05†	81.90†	1.60	13.29†	3.82	6.86	16.14	0.02	44.30†	13.10

Table 1 (*continued*)

Personality variable	General Intelligence (G)	Crystallized Intelligence (Gc)	Ideational Fluency	Knowledge and Achievement	Learning and Memory	Speed	Visual Perception	Closure	Fluid Intelligence (Gf)	Math–Numerical
Pure measures of Tellegen traits and other lowest level traits (*continued*)										
Absorption										
$\hat{\rho}$		.17*				−.09	.16*			.05
No. of *rs*		3 (362)				1 (156)	1 (156)			3 (383)
CI		.07 to .27				−.25 to .06	.01 to .31			−.05 to .15
Q		1.40				—	—			0.07
Intellectance										
$\hat{\rho}$	.20*	.05	−.01				.31*		.08*	
No. of *rs*	2 (143)	3 (885)	2 (433)				1 (408)		4 (721)	
CI	.03 to .35	−.01 to .12	−.11 to .08				.22 to .40		.01 to .15	
Q	1.49	24.99†	1.82				—		5.63	
Typical intellectual engagement measure										
$\hat{\rho}$	.22*	.35*	.47*	.23*	.13	.01	.09*		−.07	.09*
No. of *rs*	1 (138)	6 (892)	2 (274)	3 (557)	1 (138)	6 (944)	4 (595)		1 (138)	6 (913)
CI	.06 to .38	.29 to .41	.37 to .55	.15 to .31	−.04 to .29	−.05 to .08	.01 to .17		−.23 to .10	.03 to .16
Q	—	25.58†	0.21	6.30	—	14.17	3.58		—	10.35
Test Anxiety										
$\hat{\rho}$	−.33*	−.24*	−.01	−.16*	−.22*	−.16	−.23*		−.25*	−.27*
No. of *rs*	21 (3,027)	21 (4,714)	2 (607)	5 (1,183)	3 (216)	1 (141)	4 (755)		4 (784)	16 (3,943)
CI	−.36 to −.29	−.27 to −.21	−.09 to .07	−.22 to −.10	−.34 to −.08	−.32 to .00	−.29 to −.16		−.32 to −.19	−.30 to −.24
Q	55.48†	34.42	7.73†	14.43†	1.24	—	7.67		2.59	32.38†
Pure measures of FFA traits (Big Five)[e]										
Extroversion										
$\hat{\rho}$	.08*	.11*	.14*	.05	.05	.06*	.06*	.05	.06*	.09*
No. of *rs*	35 (15,931)	63 (24,280)	4 (1,707)	7 (1,530)	7 (1,577)	12 (2,713)	16 (4,831)	5 (1,899)	40 (11,395)	27 (13,379)
CI	.06 to .09	.10 to .12	.10 to .19	.00 to .10	.00 to .10	.02 to .10	.03 to .09	.00 to .09	.05 to .08	.07 to .11
Q	115.81†	216.71†	4.95	6.51	14.32	25.06†	22.53	7.73	81.33†	84.55†
Agreeableness										
$\hat{\rho}$	.01	.04		−.04	.17	.04	.02		.03	−.05
No. of *rs*	6 (941)	10 (2,206)		1 (163)	1 (138)	3 (457)	2 (321)		5 (591)	3 (426)
CI	−.06 to .07	.00 to .09		−.19 to .12	.00 to .33	−.06 to .13	−.09 to .13		−.05 to .11	−.15 to .04
Q	8.05	6.68		—	—	2.73	0.16		5.32	0.38
Conscientiousness										
$\hat{\rho}$	.02	−.05		−.19*	.07	.04	−.10	−.17	−.08	−.15*
No. of *rs*	3 (4,850)	7 (1,485)		1 (163)	2 (201)	4 (520)	3 (384)	1 (63)	4 (401)	5 (658)
CI	−.01 to .05	−.10 to .01		−.33 to −.04	−.07 to .20	−.04 to .13	−.20 to .00	−.40 to .08	−.18 to .02	−.23 to −.08
Q	13.13†	55.40†		—	0.08	2.09	4.06	—	2.37	8.65
Openness										
$\hat{\rho}$	.33*	.30*		.28*	−.11	−.05	.24*		.08	.01
No. of *rs*	3 (555)	10 (1,695)		2 (230)	2 (205)	4 (524)	3 (388)		2 (205)	6 (741)
CI	.26 to .41	.25 to .34		.16 to .40	−.24 to .03	−.13 to .04	.15 to .33		−.06 to .21	−.06 to .08
Q	14.46†	14.07		0.61	5.45	6.07	4.21		3.85	4.28
Pure measures of Eysenck traits[e,f]										
Psychoticism										
$\hat{\rho}$		−.17*	−.15*		−.15*	−.13*	−.05	−.09*	−.15*	−.14*
No. of *rs*		8 (3,506)	1 (599)		2 (662)	3 (782)	3 (782)	2 (662)	9 (2,699)	2 (232)
CI		−.20 to −.14	−.23 to −.07		−.22 to −.07	−.20 to −.06	−.12 to .03	−.16 to −.01	−.19 to −.12	−.26 to −.01
Q		16.03	—		2.10	1.62	1.23	0.61	22.35†	4.27

Note. *r* and *Q* were only tested with $p = .05$ and .01, respectively. — = impossible to compute *Q* when $N = 1$.
[a]Estimated population correlation (*$p < .05$). [b]Number of correlations (N = total aggregate sample size). [c]95% CI of estimated population correlation. [d]Heterogeneity statistic (†$p < .01$). [e]For Neuroticism values, see Stress Reaction values. [f]For Extroversion values, see Big Five Extroversion values.

General Findings

Although it is not generally appropriate to aggregate the tabled results across columns (abilities), given the a priori heterogeneity of constructs, it is possible to gain insight into the general effects found in the meta-analysis by one examining these correlations with a qualitative perspective. With this tack in mind, some consistencies readily appear. Personality traits that tend to be positively correlated across ability traits include Well-Being, Social Potency, Achievement, Social Closeness, Intellectence, TIE, Extroversion, and Openness to Experience. From a taxonomic view, the positively associated traits fall into two categories: (a) traits associated with the Extroversion category from Eysenck and the FFA or with the PEM category from the hierarchical perspective of Tellegen and (b) traits associated with a broad class of intellectually oriented traits (TIE, Openness to Experience, and Intellectence)—see Figure 2 for an illustration of the hierarchical relations among these traits. Personality traits that tend to be negatively correlated across ability traits include Stress Reaction, Alienation, Test Anxiety, and Psychoticism. With the exception of Test Anxiety, these personality traits are associated with Neuroticism/NEM and Psychoticism/Constraint. The remaining personality traits either have unclear patterns of correlations (e.g., Conscientiousness and Traditionalism) or too little data (e.g., Absorption and Control).

Specific Findings

Indications of significant heterogeneity in the estimated population correlations suggests that sole examination of the estimated mean population correlation may obscure effects that might be attributed to particular choices of sample type, personality measure type, ability measure type, or all three (e.g., see discussions by Hedges & Olkin, 1985; and Rosenthal, 1995). To more closely examine the underlying characteristics of the data, we selected five personality traits that either indicate the widest range of correlations or the largest mean correlations. These traits are Achievement, Stress Reaction, Traditionalism, Test Anxiety, and Extroversion. Then we selected the three ability factors for which the greatest number of studies were found, namely, General Intelligence, Gf, and Gc. For each of the pairwise personality–ability combinations (5×3), frequency distributions of corrected correlation coefficients were created and graphed, along with the 25th- and 75th-percentile values of the correlations (and the estimated mean population correlation coefficient). These results are shown in Figure 3.

From the significant heterogeneity statistics and the frequency distributions shown in Figure 3, it appears that some combinations of personality and ability measures and participant samples may reliably yield substantial correlations between personality and ability measures. Most notable among these data are the substantial negative relations between Test Anxiety and the broad ability measures. Although there is some disagreement about whether Test Anxiety is best thought of as a personality trait per se (see the discussion in *Test Anxiety*), clearly there is a common variance with ability measures.

Although Stress Reaction indicates significant negative correlations, few of the obtained (corrected) correlations actually exceed an estimated population correlation greater than .20. Similarly, for Extroversion measures, although significantly positively correlated with the ability traits, the correlations are small, even at the 75th-percentile level. Achievement, however, does show significant positive correlation for Intelligence (G), Gf, and Gc, and the 75th-percentile data indicate correlations larger than .20 for both G and Gc.

The other frequency distributions are more complex. Although the mean estimated population correlations for Traditionalism are nonsignificant for G and Gf, the significant heterogeneity statistics and the 25th-percentile values suggest that some combinations of measures and samples may more reliably yield negative correlations between Traditionalism and G, and Gf. Moreover, because Traditionalism bears a lower to higher order (negative) relationship to Openness to Experience, the relations of abilities to Traditionalism provide additional support of the presence of relations between broad intellectually oriented personality traits and broad ability classes.

Two other traits, Openness to Experience and TIE, have many fewer coefficients and therefore are not shown in Figure 3. However, the available data suggest that both of these traits have substantial relationships with Gc at least. In reference to Table 1, also note that TIE has a significant and substantial relationship with Ideational Fluency and Knowledge and Achievement—in-line with Ackerman's (1994) notion that TIE is closely related to a broad class of verbal abilities, crystallized abilities, and cultural knowledge. Too few correlations are available to draw any conclusions about the relations between Openness to Experience, TIE, and fluid intelligence.

Summary

The meta-analysis of personality–intellectual ability traits indicates that, first of all, there exist many significant cross-trait relations. Of the 161 nonempty cells of the 19×10 personality trait $\times$ ability trait matrix, 83 (or 52%) are significantly different from zero, with nearly as many significant negative correlations as positive correlations. The personality traits that have ubiquitous negative correlations with ability tend to be from broad categories of Neuroticism/NEM and Psychoticism/Constraint, whereas those personality traits that fall under the broad Extroversion/PEM category tend to have positive correlations with intellectual abilities. Test Anxiety, not fitting well within the taxonomic personality structure (although substantially correlated with Neuroticism; see review by Hembree, 1988), also indicates substantial negative correlations across all the ability traits. Finally, a trait complex of TIE, Openness to Experience, and Intellectence shows substantial positive correlations with intellectual abilities, with TIE showing the greatest associations with Gc and Ideational Fluency factors.

Interests and Intellectual Abilities

Background

Modern interest assessment has nearly as long a history as intelligence assessment, with the genesis of interest assessment being life insurance salesmen at the Carnegie Institute of Technology (Pittsburgh, PA) in 1919 under Yoakum, and Cowdery's interest items for differentiating engineers, lawyers, and physi-

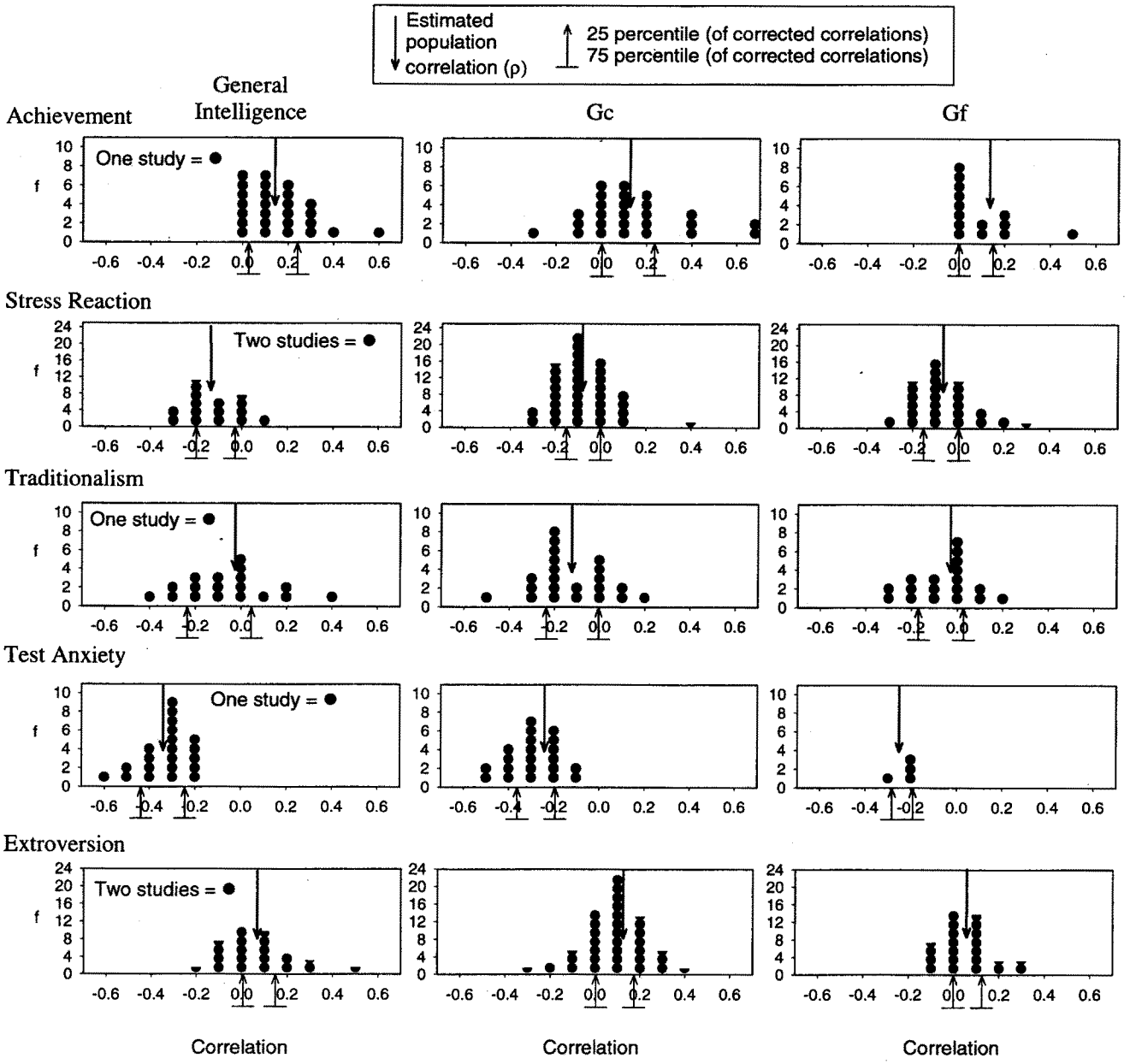

Figure 3. Frequency distributions of corrected correlation coefficients, with 25th-percentile, mean, and 75th-percentile estimates of population correlation coefficient. Gc = Crystallized Intelligence; Gf = Fluid Intelligence.

cians (e.g., see reviews by Campbell, 1971; and Strong, 1952) and later the general development of the SVIB in 1927. Many interest measures had been developed up to 1940, however, as with the SVIB, most of these measures were empirically keyed and essentially atheoretical.

Although there have been many studies of the relations between interests and intellectual abilities (e.g., see Fryer, 1931), relatively few provide the kind of correlational data that would allow for a quantitative meta-analysis procedure to be conducted (as we did for the personality–ability relations). A historical review indicates that there are two main reasons for this situation: (a) Early interest inventories (using or modeled on the SVIB) provided only occupational scores, thus abilities were correlated with occupational similarity indices (which themselves are multifaceted); and (b) other early studies used profile analysis (e.g., by investigators separating high and low general ability respondents and then comparing mean profile patterns). As a result of these limitations, our discussion of the interest–ability relations below is narrative rather than strictly quantitative.

SVIB

In an early study of interest–ability relations with 100 junior college students, Segal (1934) selected a set of six "most independent" interest scores (occupations) from the SVIB (Engineering, Medicine, Law, Life Insurance, Personnel Management, and Purchasing) and correlated the scores on the American Council on Education Psychological Exam (ACE, a general intelligence test) and four tests from the Iowa High School Content Examination (English Literature, Mathematics, Science, and History and Social Science). Although there is good reason to expect a restriction of range in talent among this selected group, two Strong scores showed salient patterns of correlations with the ability measures: Engineering interest score with ACE (r = .10), English Literature (r = −.10), Mathematics (r = .49), Science (r = .36), and History and Social Science (r = −.16); Purchasing interest score with ACE (r = −.32), English Literature (r = −.43), Mathematics (r = .04), Science (r = −.26), and History and Social Science (r = −.26). Segal appeared to demonstrate a divergence in vocational interests much in-line with the demands of at least two different occupations.

In a war-time (WW2) study of 292 enrollees in introductory engineering subjects across a large age span, Moore (1941) presented a set of correlations between three SVIB scores and a set of broad ability measures of math, physics, and mechanical knowledge. Sales occupational interest scores correlated in a range of r = −.37 to −.19, similar to that of Purchasing (r = −.14 to −.27), whereas the Engineering interest scores correlated (r = .11 to .35) with the various measures of general ability and math, physics, and mechanical knowledge. Similar results were also reported by L. Long (1945) in a study of 200 students at the College of the City of New York, on a scientific aptitude battery (correlation between Technical/Math occupational group scores from the SVIB and scientific aptitude was r = .50, whereas the correlation between the Business Contact occupational group score from the SVIB and scientific aptitude was r = −.37). Aside from the difference in samples and ability measures, the results of these studies are generally consistent with those of Segal (1934).

One finding from the SVIB, reported by Terman (1954; also see discussions by French & Steffen, 1960; and Strong, 1943, 1955), is an association between level of intellectual ability and breadth of interests; that is, respondents with high levels of intelligence tend to endorse more interest items across wide ranges of domains, whereas lower levels of intelligence are associated with narrower interests or lower, more general levels of interest.

Kuder Preference Record Studies

In contrast to the SVIB, the experimental edition of the Kuder Preference Record (KPR) provided eight preference themes rather than occupational scores. These themes were Scientific, Computational, Musical, Artistic, Literary, Persuasive, Athletic, and Social Prestige. In a pioneering study of ability–interest associations, with 312 male and 200 female University of Chicago freshmen, Adkins and Kuder (1940) correlated scores on the eight themes of the KPR with scores on Thurstone's Tests for Primary Mental Abilities, which yielded seven composites (Perception, Number, Verbal, Space, Memory, Induction, and Reasoning). Again note that this group represents a restriction of range in ability (as was noted about Thurstone's, 1938, earlier studies on intelligence). As such, correlations between ability measures and interest measures were attenuated to an unknown degree. (Furthermore, an analysis of gender differences, although potentially important and significant in the study, is beyond the scope of this article.) In light of the restriction of range on the ability measures, the correlations between ability scores and interest scales are generally small (only one exceeded r = .30). However, positive correlations were found for Computational interests and Number ability (Mean r = .30), for Induction and Reasoning abilities (Mean r = .24) and for Literary interests and Verbal ability (Mean r = .27); whereas negative correlations were found for Artistic interests and Number ability (Mean r = −.21) and for Athletic interests and Verbal ability (Mean r = −.21). The remaining correlations were all under .20.

A later study by Triggs (1943) of 234 University of Illinois students reported correlations between the KPR scales and two measures from the ACE (Quantitative and Linguistic). Correlations were larger in magnitude but generally similar to those reported by Adkins and Kuder (1940). Positive correlations were found among Computational interests and Quantitative ability (Mean r = .31) and Literary interests and Linguistic ability (Mean r = .41). Negative correlations were found between Social Service interests and both Quantitative ability (Mean r = −.13) and Linguistic ability (Mean r = −.25). Similar patterns of correlations were reported on a smaller sample of participants; again investigators used the KPR but this time with a series of content-based achievement tests. That is, Scientific and Computational interests showed positive correlations with achievement test scores in Mathematics and General Science, as did Literary interests and English Literature achievement test scores, whereas Social Service interests showed negative correlations with all of the achievement tests, with the largest negative correlations for Math, Science, and English Literature. With respect to the association between general intelligence (the Ohio State Psychological Test) and the KPR, Phillips and Osborne (1949) described a study of 152 University of Georgia students. They found a positive correlation between general intelligence and Literary interests (r = .39) but found negative correlations with Mechanical (r = −.18) and Social Service (r = −.24) interests.

Thus, across these different samples and ability tests, there appears to be a robust finding of positive correlations among Scientific and Computational interests with Mathematical abilities and among Literary interests and Verbal abilities but of negative correlations between Social Services interests and many divergent ability measures.

Holland

During the 1950s and 1960s, investigators converged on a structure of occupational interests (e.g., Guilford, Christensen, Bond, & Sutton, 1954; Roe, 1956; Roe & Klos, 1969) that has been generally identified with Holland (1959). Holland's initial specification in "A Theory of Vocational Choice" specified six broad vocational orientations. In 1962 and 1963, Holland

modified the terms to "convey more accurately the nature of the type" (Holland, 1963, p. 548). The original terms and brief descriptions follow (with their revised descriptors in parentheses):

1. Motoric orientation (Realistic): These people "enjoy activities requiring physical strength, aggressive action, motor coordination and skill" (p. 36).
2. Intellectual orientation (Investigative): These are "task-oriented people who generally prefer to 'think through,' rather than 'act out,' problems. They have marked needs to organize and understand the world" (p. 36).
3. Esthetic orientation (Artistic): These people "prefer indirect relations with others. They prefer dealing with environmental problems through self expression in artistic media . . .. They resemble persons with an intellectual orientation in their intraceptiveness and lack of sociability" (p. 37).
4. Supportive orientation (Social): These people "prefer teaching or therapeutic roles, which may reflect a desire for attention and socialization in a structured, and therefore safe, setting. They possess verbal and interpersonal skills" (p. 37).
5. Persuasive orientation (Enterprising): These people "prefer to use their verbal skills in situations which provide opportunities for dominating, selling, or leading others . . .. They avoid well-defined language or work situations as well as situations requiring long periods of intellectual effort" (p. 37).
6. Conforming orientation (Conventional): These people "prefer structured verbal and numerical activities, and subordinate roles. They achieve their goals through conformity" (p. 37).

Holland (1973) also credited a factor analysis by Guilford et al. (1954) to provide a similar typology. Of the nearly 20 factors identified, Guilford et al. found "the well-known factors" of interests, namely, "mechanical," "scientific," "aesthetic," "social welfare," "business," and "clerical" (Guilford et al., 1954, p. 28). As can be seen from this list, the main Guilford et al.'s factors have a categorization that is strikingly similar to that offered by Holland (see also Zytowski, 1986).

Although there has been some controversy about the representation of these six broad interest areas (e.g., Gati, 1991), more recently investigators have been devoted to validating this typology of interests within a hexagon or circumplex representation (e.g., for a meta-analysis, see Tracey & Rounds, 1993). There is little fundamental disagreement in the literature about these broad interest themes.

Occupational Level

In the original formulation of the theory, Holland (1959) also specified that an individual's occupational level is an additive function of intelligence level and self-evaluation level. That is, across the various interest types, an individual's objective intelligence and self concept determine the degree of intellectual challenge or level of achievement within a thematic domain. Later, Holland (1973) abandoned this formula in favor of a model profile, that is, "the closer a person's resemblance to the personality pattern ESAICR [i.e., Enterprising is the highest theme score, followed by Social, and so on], the greater his expected vocational aspiration and eventual achievement" (p. 58). In this fashion, Holland suggested that some interest themes are more in tune with intellectual demands (e.g., the Enterprising or Persuasive theme is more associated with a desire for intellectual challenge than the Realistic or Motoric theme).

Themes and Ability

There are relatively few studies that report correlational associations between Holland's (1973) themes and intellectual ability measures, mainly because most of the research associated with Holland's approach is based on profile interpretations rather than individual theme scores. That is, although Holland's theory and instruments also address and assess self-ratings of ability, respectively, relatively few investigators have examined associations between interest themes and objective measures of abilities. Nonetheless, we identified five empirical investigations that provided direct correlational assessments of Holland's theme–ability relations. The full results of these investigations are shown in Table 2, and each is discussed in turn.

In a review and archival study of vocational counseling clients (N = 846) reported by Randahl (1991), correlations between a subsequent edition of the Strong instrument (Strong Campbell Interest Inventory [SCII], which includes Holland's theme scores) and the General Aptitude Test Battery [GATB]) were reported. Salient positive correlations were found between Realistic interests and Spatial ability (r = .34) and between Artistic interests and Verbal ability (r = .28). Modest positive correlations were also found between Investigative (Intellectual) interests and Verbal (r = .22), Numerical (r = .23), and Spatial (r = .27) abilities.

In another study of interest–ability associations, with 149 female college students, Lowman, Williams, and Leeman (1985) reported multiple correlations between sets of ability measures and Holland themes (from the Self-Directed Search booklet). Although the multiple correlations may overestimate construct overlap, significant relationships were reported for Investigative interests and Reasoning/Mechanical abilities (R = .28; where R is the multiple correlation) and for Artistic interests with Musical talent tests (R = .43).

In a study of 93 college students, Ackerman et al. (1995) administered the Unisex Edition of the American College Testing Interest Inventory (UNIACT; see Lamb & Prediger, 1981), along with Spatial, Verbal, and Math ability tests. With these data, several salient correlations were found between abilities and interest themes, namely, $r_{\text{Artistic, Verbal}}$ = .37, $r_{\text{Realistic, Math}}$ = .38, and $r_{\text{Investigative, Math}}$ = .34.[5] Two other similarly constructed studies were conducted. The first, by Rolfhus and Ackerman (1996) of

[5] The results from this study also shed some light on the meaning of the general factor of interests (e.g., see Prediger, 1982; Rounds & Tracey, 1993; and Terman, 1954). A composite interest score (summed across all six UNIACT scales) shows a substantial correlation with Goff and Ackerman's (1992) TIE measure (.48), somewhat smaller correlations with Extroversion (.30) and Openness to Experience (.25) from the NEO–PI–R (revised), and with Verbal ability (.21). Correlations between the general interest composite and knowledge scales were all positive and significant, with the largest associations cutting across all identifiable fields: sociology (.36), education (.36), physics (.35), geometry (.35), music (.33), poetry (.33), geography (.31), agriculture (.31), and so on.

Table 2
Correlations Between Holland Themes and Intellectual Abilities

Study and ability	*N*	Realistic	Investigative	Artistic	Social	Enterprising	Conventional
Randahl (1991)	846[a]						
Spatial		.34*	.27*	.01	−.13*	−.06	−.06
Verbal		−.03	.22*	.28*	−.01	−.17*	−.08*
Numerical (computation)		.09*	.23*	−.02	.01	−04	.15*
Lowman et al. (1985)	149[b]						
Reasoning/Mechanical Knowledge		*R* = .28*					
Music				*R* = .43*			
Ackerman et al. (1995)	93[c]						
Spatial		.24*	.13	.01	−.04	−.15	.00
Math		.38*	.34*	−.20	−.14	−.15	.18
Verbal		.14	.33*	.37*	−.08	−.32*	−.32*
Perceptual Speed		.08	.12	−.04	.06	−.05	−.07
Rolfhus & Ackerman (1996)	180[c]						
Spatial		.28*	.16*	.06	−.08	−.16*	.01
Mechanical		.35*	.21*	.11	−.21*	−.15*	.04
Math		.27*	.14	.11	−.20*	.01	.19*
Verbal		.23*	.20*	.24*	.03	−.03	−.05
Perceptual Speed		.10	.02	.05	.14	.02	.15*
Kanfer et al. (1996)	150[c]						
Spatial		.26*	.17*	.16*	.00	−.17*	−.12
Math		−.04	.02	−.03	−.09	−.21*	−.09
Verbal		−.12	−.05	.21*	−.09	−.31*	−.22*
Perceptual Speed		.03	.02	−.03	−.10	−.02	.16*

[a]Vocational assessment clients who completed the Strong Vocational Interest Blank. [b]Female college students who completed the Self-Directed Search booklet. [c]College students who completed the Unisex Edition of the American College Testing Interest Inventory.
*$p < .05$ (no distinction is made for higher levels of significance, for example, $p < .01$).

180 college students, found salient correlations between Realistic and Investigative themes and most ability measures. Similar to the Ackerman et al. (1995) results, positive correlations were also found for Artistic interests and Verbal ability. In a second study of 150 college students, Kanfer et al. (1996) again found significant correlations between Spatial ability and both Realistic and Investigative themes but not with Math and Verbal ability, although Verbal ability was positively correlated with Artistic interests.

Summary

From the three broad approaches (SVIB, KPR, and Holland's themes), the associations between ability and interests reported suggest that several sources of overlap exist among these two broad construct domains (shown in Figure 4). In general, though, most reported studies "suffered" from restrictions in range of talent on the ability measures and had interest measures with low reliability, low validity, or both (e.g., see review by Cronbach, 1990). As such, the general findings reported may underestimate construct overlap between interests and abilities:

1. Science and Engineering interests (Investigative and Realistic themes) tend to be positively associated with Math, Spatial, and Mechanical ability scores.
2. Literary interests are positively associated with Verbal ability and Literature achievement
3. Interests in Social Services (which is similar in construct description to Holland's Supportive/Social theme) tend to be negatively correlated with many abilities, especially those in the Math–Spatial domain.
4. From Terman (1954) and Holland (1959), notwithstanding 3 above, there is a positive association between level of intellectual ability (or perceived level) and the depth and breadth of interests.
5. From studies with Holland's theme assessment, (a) Spatial and Math abilities are associated with Realistic and Investigative interests (and Math [computation] is associated with Conventional interests), (b) Mechanical ability appears to be more highly associated with Realistic interests than Investigative interests, (c) Verbal abilities tend to be most highly correlated with

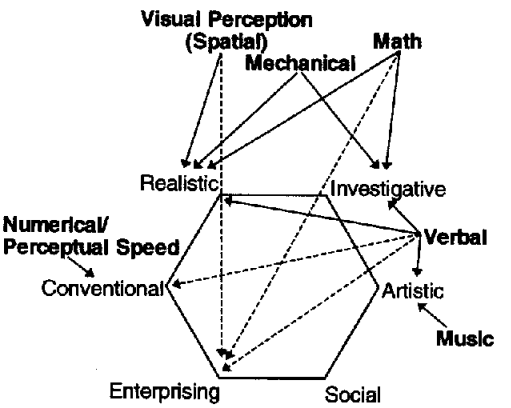

Figure 4. Associations between Holland's interest (regular) themes and intellectual abilities (bold). Solid lines = positive correlations; dotted lines = negative correlations.

Artistic and Investigative interests, (d) negative correlations tend to be found between ability measures and Enterprising and between ability measures and Conventional interests (except for Perceptual Speed/Math computation and Conventional interests), and (e) negligible or negative correlations tend to be found between Social interests and ability measures.

Interests and Personality

Before we continue the discussion of the associations between interest orientations and abilities, a functional representation of interest, personality, and ability requires that we identify the relations between interests and personality traits. A full-scale meta-analysis for this domain is beyond the scope of this article, but a few investigations can be drawn on to gauge trait overlap. For example, Goh and Leong (1993) examined correlations between Holland's orientations and H. J. Eysenck's personality theory, using SCII and EPQ for the respective trait sets. For a sample of 119 undergraduate students, cross-correlations were computed between the six Holland orientations and the three trait scales of the EPQ (Extroversion, Neuroticism, and Psychoticism). However, with the exception of $r_{\text{Realistic/Neuroticism}} = -.32$, no other correlations exceeded .30. A few other correlations were significant but not as large: $r_{\text{Realistic/Psychoticism}} = .24$; $r_{\text{Investigative/Neuroticism}} = -.26$, and $r_{\text{Enterprising/Extroversion}} = .28$. For the most part, such data suggest a relatively low-to-moderate association between personality traits and interests. They speculated that one reason for the low associations is because the sample was made up of college students not older adults, who could be expected to have substantial occupational experience, might provide different results.

In contrast to the Goh and Leong (1993) study, the investigation by Gottfredson, Jones, and Holland (1993) provides greater support for substantial interest–personality associations (i.e., median correlations in the range of $r = .20$ to .38). They incorporated their study of 725 U.S. Navy trainees with a review of other investigations, which all used the FFA to assess personality traits (e.g., NEO-PI and similar measures from other tests, Guilford–Zimmerman Temperament Survey, Hogan Personality Inventory, CPI, etc.). Interests were measured with either Holland's Vocational Preference Inventory (VPI) or his Self-Directed Search booklet. Gottfredson et al. determined that Social and Enterprising interests were correlated with Extroversion, Investigative and Artistic interests were correlated with Openness to Experience, and Conventional interests were correlated with Conscientiousness.

Also, in a study of 150 college students who took the MPQ, TIE, and UNIACT (Kanfer, Ackerman, & Heggestad, 1996), similar sets of significant correlations were found to those obtained from the FFA data (Goh & Leong, 1993; Gottfredson et al., 1993). Specifically, Well-Being correlated positively with Social interests ($r = .28$), Social Potency with Social and Enterprising interests ($r = .31$ and .48, respectively), and Achievement with Enterprising interests ($r = .27$). Both Control and Traditionalism showed positive correlations with Conventional interests ($r = .20$ and .24, respectively), whereas Traditionalism was also negatively correlated with Artistic interests ($r = -.24$). Absorption was positively related to Artistic interests ($r = .55$) and Realistic interests ($r = .31$); whereas Harm–Avoidance was negatively related to Artistic interests ($r = -.26$), Realistic interests ($r = -.33$), and Investigative interests ($r = -.23$). Finally, TIE correlated significantly with Investigative ($r = .42$), Artistic ($r = .35$), and Social ($r = .31$) interests.

From these diverse studies, it is possible to provide a configural summary of the correlations reported between interest and personality measures, as shown in Figure 5.

1. Neither Agreeableness/Psychoticism nor Neuroticism/Stress Reaction correlate appreciably with any of the six Holland orientations.

2. Conscientiousness, Control, and Traditionalism show moderate correlations with Conventional interests. Also, Traditionalism showed moderate (negative) correlations with Artistic interests.

3. Extroversion, Well-Being, and Social Potency show moderate to substantial correlations with both Enterprising and Social interest domains.

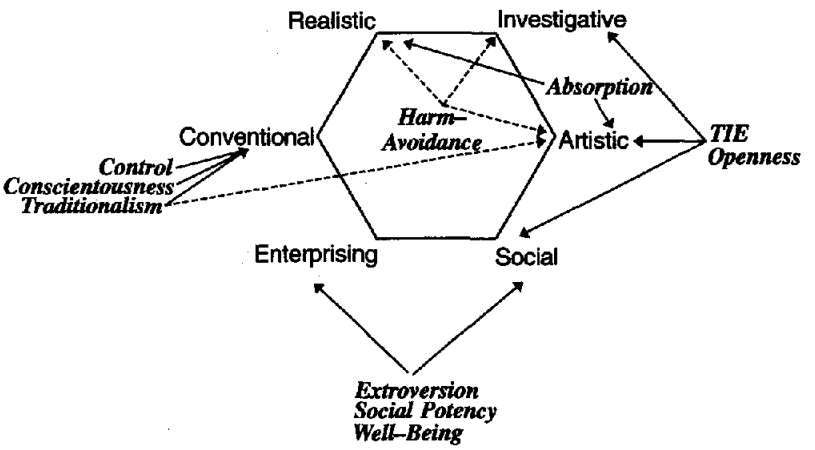

Figure 5. Associations between Holland's interest (regular) themes and personality traits (bold italic). Solid lines = positive correlations; dotted lines = negative correlations; TIE = typical intellectual engagement.

4. Openness to Experience and TIE shows moderate to substantial correlations with Investigative, Artistic, and Social interests. Similarly, Absorption shows substantial correlation with Artistic interests and Realistic interests.

5. Harm–Avoidance shows negative correlations with Artistic, Realistic, and Investigative interests.

An Integrated Representation

It is possible to present integrated representations, based on the meta-analysis of personality–intelligence relations, reviews of interest–personality relations, interest–ability relations, and a few empirical studies with simultaneous assessments of personality, interest, and abilities. However, given the large number of significant correlations found in the reviews and meta-analysis, it is difficult (and not particularly useful from a heuristic perspective) to represent all the significant relations. As such, we limited the depictions to the largest correlations (i.e., illustrations are presented with the highest respective communalities among the trait measures, typically above .20) and those that provide the most coherent sets of relationships (i.e., we do not extensively discuss associations that do not appear to have some consistency in the matrix of results).

From an ability-based perspective, personality traits of Openness to Experience, TIE, Intellectence, and Alienation, as well as Test Anxiety, were found to have substantial communality. Similarly, Realistic, Investigative, and Artistic interests were found to be related to particular abilities. These relationships are shown in Figure 6. Clearly, the relationships are complex, but a pattern does indeed emerge. Test Anxiety has pervasive negative associations on abilities, as do Enterprising and Conventional interests (with the exception of Conventional interests and Perceptual Speed). Positive associations are found with Openness to Experience, TIE, and Intellectence personality constructs and Investigative, Realistic, and Artistic interests. Although it is not possible to portray all the significant relations between these three sets of traits into the same configural representation, a sense of the various interrelations is shown in Figure 7, where four trait complexes (similar to Snow's "aptitude complexes"; see Snow, 1989; and Snow, Corno, & Jackson, 1996) have been drawn that illuminate positive communalities among personality, interest, and ability traits. We should note that this is an abstraction and reduction of the data, but this approach refines the results into a single, generally coherent framework.

The first trait complex shows no positive communality with ability measures and is made up of a broad social trait complex. It includes Social and Enterprising interests, along with Extroversion, Social Potency, and Well-Being personality traits. The remaining trait complexes include ability traits. The clerical/conventional trait complex includes Perceptual Speed abilities, Conventional interests, and Control, Conscientiousness, and Traditionalism personality traits. The remaining trait complexes overlap to a degree; the third trait complex, science/math, is not positively associated substantially with any personality traits but includes Visual Perception and Math Reasoning abilities and Realistic and Investigative interests. The last trait complex, intellectual/cultural, includes abilities of Gc and Ideational Fluency; personality traits of Absorption, TIE, and Openness to Experience; and Artistic and Investigative interests.

Discussion and Conclusions

In this article, we started with a review of intelligence testing as a paradigm. From the developments of intelligence assessment for children at the beginning of this century, the stage was set to mainly consider intellectual abilities as maximal performance and as far removed as possible from experiences and background of the examinee. With a focus on these aspects of intellectual life, intelligence assessment and theory develop-

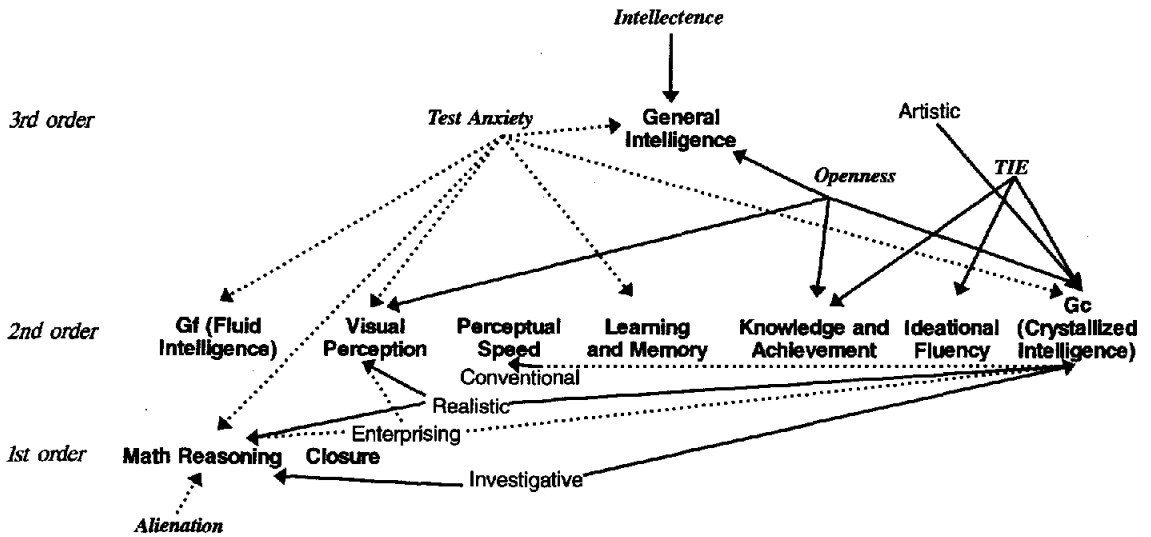

Figure 6. Associations between abilities (bold), interests (regular), and personality (italic) traits. Solid lines = positive correlations; dotted lines = negative correlations. TIE = typical intellectual engagement.

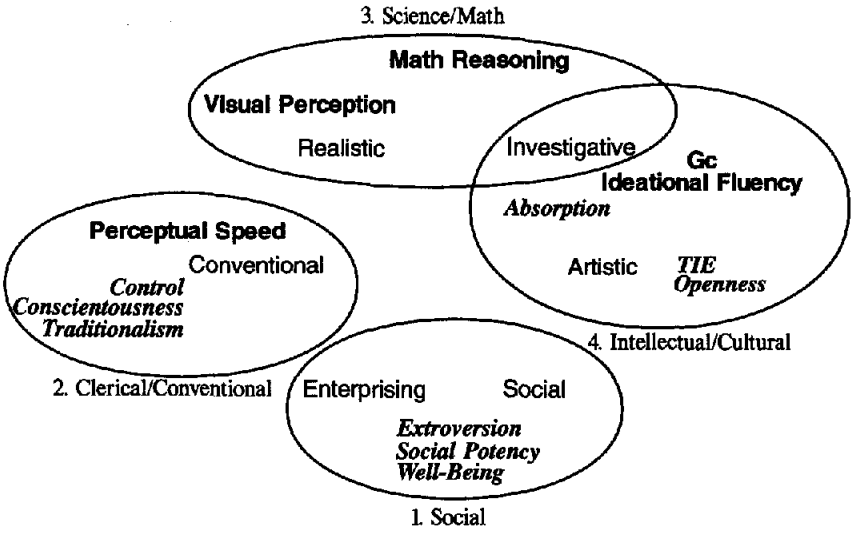

Figure 7. Trait complexes, including abilities (bold), interests (regular), and personality (italic) traits, showing positive commonalities. Number categories are trait complexes. Gc = Crystallized Intelligence; TIE = typical intellectual engagement.

ments over this century have mainly proceeded along a separate path from personality and interest theory and assessment. However, a consideration of adults, rather than children, and aspects of TIE provide a basis to investigate common variance among measures of intellectual ability, personality traits, and interests. We reviewed theories of abilities that provide additional bases for an integrated viewpoint, that is, a viewpoint that is much more inclusive of other traits than the intelligence–assessment paradigm. Personality theories and interest theories were reviewed, and an extensive meta-analysis of personality–ability relations was conducted, along with a review of interest–ability relations. From the meta-analysis, it was determined that many sources of common variance could be found between personality and ability measures. Many of these personality–ability relations were pervasive, namely, negative relations between personality traits falling under the Neuroticism/NEM and Psychoticism/Constraint factors and Test Anxiety and positive relations between personality traits of Extroversion and abilities. Other personality–ability relations were more specific, such as the relations among Openness to Experience and measures of Gc, Gf, and Knowledge and Achievement and among TIE and Gc, Ideational Fluency, and Knowledge and Achievement. Interest measures also showed substantial positive relations with ability measures, mainly in the domains of Realistic, Investigative, and Artistic interests, whereas Enterprising and Conventional interests tend to be negatively associated with abilities.

From this review, we highlighted four trait complexes across the three trait domains: social, clerical/conventional, science/math, and intellectual/cultural. Although it is not possible to determine causal connections with the corpus of data we reviewed, the communality among these traits suggests directions for future investigations of enabling and moderating influences. It seems to be reasonable to propose (as Holland, 1973, did; see also Sorenson, 1933, 1938) that development of personality–interest–intelligence traits proceeds along mutually causal lines. That is, abilities, interests, and personality develop in tandem, such that ability level and personality dispositions determine the probability of success in a particular task domain, and interests determine the motivation to attempt the task. Thus, subsequent to successful attempts at task performance, interest in the task domain may increase. Conversely, unsuccessful attempts at task performance may result in a decrement in interest for that domain. Later adult development also appears to be interactive (abilities, personality, and interests), as demonstrated by Kohn and Schooler (1973, 1978; see reviews by Schooler, 1987; and Willis & Tosti-Vasey, 1990). Ultimately, the malleability of individual differences in these trait complexes might be investigated—but, given the common variance among the various traits, it appears that new approaches might best be constructed as multiply determined interventions—such as an effort that could be devoted to raise Artistic and Investigative interests, expand Openness to Experience and TIE, and provide instruction in the content area of culture or verbal knowledge. In the final analysis, it appears that Cronbach (1957) was initially too restrictive by only suggesting that there are two types of scientific psychologists, the correlational and the experimental. Within the correlational discipline, theory has been too restrictive along major trait domains. Investigations of higher order interactions (e.g., Cronbach, 1975) and trait complexes (see Snow, 1989) may provide for substantially improved understanding of the nature of individual differences in each of these traditionally separated domains of cognition, affect, and conation (interests) and the development of intellect across the life span (e.g., see Ackerman, 1996).

Finally, note the three specific limitations to this investigation. First, we only considered linear Pearson product–moment correlations among ability, personality, and interest trait families. Thus, our analysis was insensitive, to the degree that linear correlations are not sufficiently robust, to any possible nonlinear relations that might exist between trait families (e.g., see Ent-

wistle & Cunningham, 1968; and Snow et al., 1996). However, meta-analytic examination of nonlinear hypotheses is impractical when multiple types of measures and samples are used, mainly because it is necessary to construct models of where inflection points should occur on the particular variables of interest. Other approaches to the corpus of data would be necessary for such an evaluation. Second, we have not considered the nature of potential gender differences among the various trait relations, even though significant gender differences are often found among all three of the trait families under consideration. Finally, we reiterate that we limited our discussion to nonpathological samples of participants—evaluation of the relations between the trait families across the full range of personality trait levels (as well as extremes on ability and interest traits) would require a different approach (e.g., see H. J. Eysenck, 1995) or a larger sample of investigations than could be located in the literature.

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