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Intelligence and Personality Measurement within the Cattellian Psychometric Model

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Introduction

Intrapersonal psychological variables not only include cognitive abilities, but also enduring personality traits (both normal and abnormal), transitory emotional/mood states, and dynamic motivational traits (which are less stable than either abilities or personality traits, but more stable than mood states (cf. Boyle, 1987a; Cattell & Child, 1975). While ability and personality factors are largely independent with relatively minor overlap/redundancy across modalities (Boyle, 1988b; Boyle, Stanley, & Start, 1985), there are nevertheless, some discernible ability-trait interrelationships.

Indeed, so close is the relationship between certain cognitive abilities and personality that some of these personality traits operate like pseudo-abilities, such that they are often misinterpreted as intellectual abilities (Cattell, 1987).

Within the Cattellian psychometric school, significant multivariate relationships between cognitive ability factors and personality traits (as measured in the Sixteen Personality Factor Questionnaire or 16PF-Cattell, Eber, & Tatsuoka, 1970; and in the Clinical Analysis Questionnaire or CAQ-Cattell & Sells, 1974; Krug, 1980) have been reported, for example, by Cattell (1971), Cattell and Butcher (1968), and by Cattell and Damarin (1968). While the 16PF comprises measures of 16 normal personality traits, the CAQ measures a further 12 abnormal personality trait dimensions, bringing the total 28 traits measured. The 16PF includes primary factors measuring warmth, intelligence, emotional maturity, dominance, impulsivity, superego strength, boldness, sensitivity, trust, imagination, shrewdness, confidence, radicalism, self-sufficiency, self-sentiment, and tension (IPAT, 1991/1992). The CAQ includes additional abnormal primary
factor trait measures (hypochondriasis, suicidal depression, agitated depression, anxious depression, low energy, guilt and resentment, bored depression, paranoia, psychopathic deviation, schizophrenia, psychasthenia, and psychological inadequacy-Krug, 1980). At the Eysenckian (second-order) level of analysis, the 16PF measures five major personality traits as elucidated by Krug and Johns (1986) on over 17000 subjects (extraversion, anxiety/neuroticism, tough poise, independence, and control) while the CAQ adds about another five psychopathological trait dimensions (Boyle, 1987c, 1987d). Using the 16PF as a point of departure, Krug (1984) has devised the Adult Personality Inventory (API), which combines the measurement of seven normal personality traits (including the 16PF second-order factors), eight interpersonal style, and six career/life-style preferences. Use of this factor analytically derived instrument should facilitate the study of ability-personality interactions.

However, as Hakstian and Cattell (1978), and Kline (1979, 1980, 1986) have demonstrated, these significant intermodality correlations generally result in only small multiple correlations, thereby complicating the interpretation of personality trait characteristics from cognitive ability measures such as the Culture Fair Intelligence Tests (CFIT; Cattell & Cattell, 1977), or the Comprehensive Ability Battery (CAB; Hakstian & Cattell, 1982). Nonetheless, such multiple correlations do provide some quantitative assessment of the interaction of intellectual abilities and enduring personality traits (cf. Cattell, 1971, 1982). These interactions include (1) cognitive abilities affecting personality trait development; (2) personality affecting cognitive development; (3) abilities modifying the expression of personality traits; (4) personality traits affecting the utilisation of intellectual abilities (Cattell, 1987).
Generally, the sophistication with which stable intellectual abilities and personality traits (both normal and abnormal) are measured, differs considerably. Cognitive/ability factors (cf. Horn, 1977, 1988) are measured mostly by objective (T-data) performance tests, whereas personality characteristics (traits) are measured predominantly by self-report questionnaire (Q-data) or rating scales (L-data; cf. Cattell & Kline, 1977; Kline, 1986). Self-reports and ratings are particularly unreliable. Although self-reports of cognitive abilities are sometimes included in multidimensional psychological questionnaires (e.g., in Holland's Self-Directed Search or SDS – cf. Campbell, 1985, p. 697), individuals' self-reports of their own intellectual abilities are likely to be biased. So too, in regard to personality measurement, self-report and rating data are prone to numerous response sets (such as social desirability, and ac- quiescence) and response distortion ranging all the way from inadequate self-insight to deliberate dissimulation (either faking good or faking bad, depending on the context in which the measurement takes place). Early work on the intersection of intelligence and personality was undertaken by Hakstian and Cattell (1978). In a study of the inter-battery correlations of 20 ability tests and the 14 subscales of the High School Personality Questionnaire or HSPQ-a downward extension of the 16PF-(Cattell, Cattell, & Johns, 1984), no fewer than 50 correlations out of the total 280 correlations were statistically significant. At the 5 per cent level of significance, only 14 of these correlation coefficients would be expected to have been significant on the basis of chance alone, showing that there is considerable overlap of ability and personality dimensions.

Although the intellectual ability modality is conceptually distinct from the personality trait domain, significant correlations are evident, for example, in
verbal, mathematical, and artistic performances which tend to involve particular
Cattellian personality traits. At the phenotypic level, different intellectual qualities
are probably the result of complex combinations of cognitive and personality traits.
Intelligence tests can discriminate between intellectually bright individuals.
However, many bright individuals may be lacking the personality characteristics
needed to succeed in various contexts. Undoubtedly, personality attributes also
need to be considered in attempting to derive valid behavioural predictions.
Studies with the 16PF and HSPQ have shown a significant increase in the
prediction of performance, over prediction based on intelligence test results alone.
Indeed, Cattell (1987, p. 480) reported an average increase of 42 per cent in
predictive variance by including personality test scores in addition to measures of
abilities, and an average 41 percent increase by including ability measures over
and above personality measures alone, demonstrating unequivocally the
importance of non-ability intrapersonal variables in predicting performance (cf.
Boyle, 1983,
1987a).

Nevertheless, as long as personality is measured by ratings and self-report
questionnaires, the extent of ability-personality interactions will be less readily
discernible since cognitive abilities are nearly always measured by means of
objective (T-data) tests. Thus, the fact that different media of measurement are
employed across the two intrapersonal psychological domains, itself necessarily
limits the degree to which the true extent of ability-personality relationships can be
observed. As Cattell (1987, p. 442) correctly pointed out, "once personality
measurement moved to objective personality factor tests, as in the 0-A batteries, it
became clear that the loading of personality factors on 'miniature situation tests'
sometimes makes a large contribution to what would be called ordinary 'general competence' in much the same areas as those affected by abilities." Under these circumstances, it is clear that ability and personality factors do interact significantly.

**Cattellian psychometric model**

As is evident, behaviour is a complex function of the interactions of several intrapersonal and situational variables. In the Cattellian psychometric model (cf. Kline, 1980, for a detailed review of Cattell's multivariate model), the contribution of personality traits (T), along with cognitive abilities (A), motivational dynamic trait factors (D), and transitory emotional/mood states (S) is shown in the behavioural specification equation (Equation 1). Conceivably, each psychological modality interacts with each of the others in contributing towards behavioural outcomes.

\[
a_{hijk} = \sum b_{hjcw} A_{wi} + \sum b_{hjx} T_{xi} + \sum b_{hjk} D_{yl} + \sum b_{hjkm} S_{mi} \quad (1)
\]

In the above equation, \(a\) represents the behavioural outcome or response of performance \(j\), for individual \(i\), in relation to the focal stimulus \(I_t\), and the ambient situation \(k\) (cf. Cattell, 1983, p. 78). The b's represent the behavioural indices (factor analytic loadings or standardized regression weights). The multiplicative term corresponding to the first-order interaction of intellectual abilities (A) and personality traits (T) is shown in (Equation 2) below. Clearly, there are higher-order curvilinear interactions, making the final behavioural outcome a complex product of numerous interacting variables.
\[ \sum_{j} \sum_{k} b_{hjkwx} A_{wi} T_{xi} \quad (2) \]

In addition, Cattell (1987) has included "modulation indices" into the various versions of the behavioural specification equation. These modulation (s) and (L) terms relate to the situational modulation of traits with respect to each intrapersonal modality (A's, Ts, D's, and S's, respectively—lumped together under T’s—as shown in Cattell, 1983, p. 89)—(Equation 3).

\[ a_{hijk} = \sum b_{hjx} T_{xi} + \sum b_{hky} s_{ky} L_{yi} \quad (3) \]

(3) Clearly, both Equations 2 and 3 need to be integrated into Equation 1, in order to provide a more complete algebraic model of the contribution of ability and personality factors to behaviour. Nevertheless, on the basis of the above psychometric formulations, it would be predicted that there are considerable (and complex) interactions between abilities, on the one hand, and personality traits, on the other hand.

**Application of the general linear model?**

In terms of predicting performance from non-ability intrapersonal variables, the standard use of multiple regression procedures assumes a simple linear-additive model. With regard to the applicability of the general linear model (GLM) upon which virtually all psychometric research to-date (including work based on the Cattellian model) has been prefaced, Rowe (1989, p. 41) commented that, "its widespread use can reflect a justified desire on the part of researchers to describe and account for the relationships among variables of interest in the most parsimonious way... so many omnibus computer software packages containing it
exist. All too frequently, the appropriateness or commensurability of the GLM, in answering research questions about relationships among variables defined by a derived set of data, is merely assumed. Yet the reformulation of such questions in terms of a linear statistical model can fundamentally change the very nature of those questions." It is evident from the work of Bibby (1977) that much of the psychometric research based on the simple linear-additive model is necessarily of questionable validity. Yet, with the development of more refined statistical methods, it is evident that future psychometric studies will be enhanced considerably. For example, non-linear methods of factor analysis have been developed (e.g., Hicks, 1981; McDonald, 1985).

In terms of neuroanatomy, Cattell (1987) speculated that frontal lobe brain injury not only reduces intellectual capacities, but also diminishes associational, relation-perceiving powers associated with the emotional control and impulse deferment-inhibition processes. The means by which intelligence modifies personality, may be partly suggested by this "frontal-lobe" projection of intelligence into a dynamic control system. At extremes of the cognitive ability range, psychological maladjustment is statistically more likely (Eysenck, 1987). In accord with the discussion above regarding the GLM, the relationship between personality and ability is apparently a curvilinear one. Perhaps, higher ability facilitates heightened scores on the development of Factor C (ego control), Factor G (superego), and Factor Q3 (self-sentiment)—(Cattell, 1987). Extremes in cognitive ability are likely to result in frustrations due to restricted interpersonal relationships with peers of similar ability. Consequently, the applicability of the GLM to psychometric research needs to be examined carefully.
Inadequacy of concepts of under- and over-achievement

The traditional concepts of under-achievement and over-achievement (cf. Gaudry & Spielberger, 1971) are premised on the assumption that it is feasible to predict academic performance from cognitive capacity as measured by means of intelligence test scores alone. However, both normal and abnormal personality trait constructs also play a discernible role in modifying performance levels for given individuals. The combined effects of abilities and personality along with the interaction is undoubtedly more important in influencing behavioural outcomes, than is either the effect of abilities or personality traits alone (Cattell & Butcher, 1968). Indeed, Eysenck and Cookson (1969), and also Entwistle and Cunningham (1968) demonstrated unequivocally that the two major personality-type dimensions labelled Extraversion-Introversion, and Neuroticism-Stability (the first two of the second-order 16PF factors-cf. Krug & Johns, 1986) play a very important role in influencing performance outcomes, over and above intelligence alone. From Eysenckian theory (e.g., Eysenck, 1981, 1983; Eysenck & Eysenck, 1984), it is evident that introverted individuals are conditioned more rapidly than extraverts, and it seems likely that decay of conditioned behaviours is slower for introverted than for extraverted individuals.

Eysenck's studies, for example, have shown that at primary school level, stable extraverts tend to achieve better than introverts, whereas in senior secondary and tertiary educational levels, stable introverts (and even neurotic introverts) tend to outperform extraverts. Thus, successful university students tend to be somewhat more neurotic and introverted than are lower achievers. Presumably, at primary school level, the more verbal, outgoing students are perceived by their teachers as more involved and competent in their work. However, at tertiary educational
levels, the introverted students who involve themselves in private reading and study tend to do appreciably better than the more socially oriented and extraverted students, who may find the isolation required for successful study less hedonically satisfying, and consequently, more difficult to handle.

**Cattelian multidimensional personality questionnaires**

Perusal of the psychometric literature reveals that many of the extant, multidimensional personality instruments are based essentially on a priori theoretical conceptualization as to both the number and nature of the major personality trait dimensions (cf. Anastasi, 1988). In contrast, the Cattellian school has attempted to overcome this subjective limitation by empirically structuring the 16PF through the exhaustive use of exploratory factor analytic procedures (cf. Cattell, 1978; Gorsuch, 1983) on as comprehensive a sampling as possible of the normal personality trait domain (as indexed in terms of English language descriptors). Numerous studies of physical plasmoses with known dimensionality (e.g., Cattell & Dickman, 1962) have indicated the usefulness of the factor analytic model for empirically delineating personality traits and ability dimensions (cf. MacCallum, 1985). However, the question must be asked whether the mere fact of having "factor-pure" trait dimensions (as purported to be the case for the Cattellian 16PF, HSPQ, CAQ, CFIT, CAB, etc.) necessarily ensures any greater level of accuracy in prediction, than otherwise would be the case? This is a valid inquiry, as inclusion of subscale scores into a multiple regression prediction equation (regardless of whether or not they represent pure factors as such) adds significantly to prediction of a criterion.
Indeed, Eysenck (1984) pointed out that non-factor-pure personality instruments such as the California Psychological Inventory (CPI) may be partially predictive of performance outcomes. However, Eysenck (1985) also correctly pointed out that it would make sense conceptually to intercorrelate the CPI items and to undertake a methodologically appropriate factor analysis of the resulting intercorrelation matrix, in order to produce actual source trait scales instead of the "folk •concept" scales currently used in the instrument. Inevitably, the resultant enhanced conceptual clarity would enable better testing of various psychological theories. Hence, as Eysenck has shown, factor analytically derived scales such as those included in the Cattellian instruments are to be preferred over non-factored scales (such as those in the CPI).

**Ability-personality interactions under emotionally aroused conditions**

In terms of multiple regression findings, Kline (1979) reported that the addition of personality trait variables to the prediction equation, in addition to ability variables, results in a statistically significant increase in predictable variance (at least within the artificial confines of the school classroom). Academic learning is best predicted from a combination of ability, personality, motivation, and mood-state measures as shown by Cattell et al. (1972), and Dielman et al. (1971, 1973). Cattell and Child (1975, p. 202) suggested that up to one-third of the predictable variance may come from each of these separate modalities. According to Gillis and Lee (1978, p. 241), in regard to reading and mathematics performance, ability and non-ability intrapersonal variables (motivation, personality, mood states) can account for up to 60-75 percent of the achievement variation (Cattell & Kline, 1977). Nevertheless, it is possible that this increase may
be of little practical importance given that the correlations between personality factors and academic performance criteria are generally quite low (30 or less, in the 16PF). This apparently low level of association between personality variables and learning outcomes is obtained under neutral, non-emotional conditions. Studies of personality in relation to academic learning typically have not manipulated emotional intensity levels, thereby leaving doubt as to the actual relationships pertaining under emotionally aroused or stressful conditions.

In view of the apparent gap in knowledge, Boyle (1983, 1987b) addressed this problem and demonstrated that under such circumstances of heightened emotional intensity, the correlations between personality trait variables and learning scores are augmented appreciably. Boyle investigated the effects of emotionally disturbing stimuli on academic learning performance among Australian student teachers. A brief 5-minute film segment portraying actual documentary scenes of automobile accident victims, and also part of a pathologist's post-mortem of a victim was presented to a group of 69 students, while another 66 students comprised a non-treatment control group. The two groups were matched reasonably well across a large number of independent variables covering the ability, personality, motivation, and mood-state domains, respectively. As expected, the emotionally disturbing treatment produced a learning decrement, but resulted in a 36 per cent increase in predictive variance associated with enhanced correlations between the non-ability intrapersonal variables and learning performance, for a prose learning task.

Boyle (1983) reported that whereas only one 16PF subscale (Factor Q2, self-sufficiency) correlated significantly (.25) with academic learning performance under neutral emotional conditions, no fewer than seven of the 16PF factors
correlated significantly with performance under heightened emotional (stressful) conditions. The correlations were Factor B, intelligence (.21), Factor E, dominance (-.29), Factor G, superego strength (.27), Factor L, suspiciousness (-.32), Factor O, insecurity-25, Factor Q1, radicalism (-.20), and Factor Q3, self-sufficiency (.39). These results demonstrate the additional contribution of personality traits over and above intelligence to performance outcomes. Factor B, as measured in both the 16PF and CAQ instruments, is a short power measure of general ability (measuring both crystallized and fluid intelligence combined). Indeed, whereas intelligence as measured by the ACER-AL (a test of general intellectual reasoning with a verbal emphasis) correlated .35 with academic performance in the neutral, non-treatment group (Boyle, 1983), it correlated only .21 with the criterion in the treatment (emotionally aroused) group. Hence, it is evident that personality traits may even predominate over cognitive abilities in influencing academic performance outcomes, under emotionally heightened conditions.

Even under non-emotive conditions, as indicated above, statistically significant ability-personality relationships pertain. Thus, Hakstian and Cattell (1978) reported a three-factor solution based on their inter-battery factor analysis of ability and personality variables. Factor 1 (Academic Achievement Contributors) had significant loadings on abilities labelled: Verbal Ability (.SO), Speed of Closure (.33), Associative Memory (.40), Meaningful Memory (.33), Spelling (.34), Aiming (.41), Crystallized Intelligence (.60), and on HSPQ personality traits: Factor G or superego strength (.40), Factor I or sensitivity (.33), Factor O or insecurity (-.30), Factor Q2 or self-sufficiency (.39), Factor Q3 or self-sentiment (.31), and Factor Q4 or ergic tension (-.30).
Factor 2 (Extraversion) loaded on abilities labelled: Flexibility (.36), Ideational Fluency (.63), Word Fluency (.34), and Originality (.28), and on personality traits: Factor A or warmth (.54)—(social ability is facilitated in individuals high on 16PF Factor A as compared with those who are low on this primary source trait, through encountering greater interpersonal, trial-and-error learning opportunities), Factor F or enthusiasm (.49), and Factor I or sensitivity (.32). Factor 3 (Tough Poise) loaded on abilities labelled: Numerical Ability (.45), Spatial Ability (.39), Perceptual Speed and Accuracy (.39), and Mechanical Ability (.31), and on personality traits: Factor D or excitability (-.30), Factor E or dominance (.32), Factor H or adventurousness (.32), Factor I or sensitivity (-.46), and Factor J or individualism (-.55). Complete definitions for each of these HSPQ factors are provided in the 16PF Handbook (1970, pp.79-109). Evidently, moderate positive correlations exist between intelligence and several personality traits (cf. Boyle, 1986, 1987b).

**Relative variance of personality and ability factors**

Taking into account the variance accounted for, intelligence as measured by Factor B is the second largest of the 16PF primary factors. In accord with the common factor model (Gorsuch, 1983), Factor A (Introversion-Extraversion) accounts for the greatest proportion of variance among the 16PF factors. Birkett-Cattell (1989, p. 30) stated that "This factor is indexed as B, because it is the second largest in the 16PF contingent. That is, with the exception of Factor A, it represents the broadest influence on the total personality of all the factors included in this test." Factor B involves recognition of analogies and similarities, as well as classification ability (Smith, 1988), and consists of verbal and numerical items,
involving familiar vocabulary and contexts. According to Cattell, Eber, and Tatsuoka (1970, pp. 82-83), "the aim in constructing the B measure has been to keep a balance between emphasis on the fluid and crystallized general ability factors (retaining the former by avoiding a large vocabulary). Being unspeeded, it is however, necessarily a "power" measure, and as such, will not correlate quite so highly with the usual speeded intelligence test as with a power test". (cf. Boyle, 1988a).

Given that the minimum number of items needed to measure intelligence reliably is about 40 items, at least four forms of the 16PF (Forms A, B, C, D) need to be administered conjointly (cf. Birkett-Cattell, 1989). One of the often-cited criticisms of the 16PF scales is that they lack adequate reliability because of insufficient numbers of items. However, this criticism is naive, in so far as Cattell has repeatedly advocated the simultaneous administration of at least two forms (and preferably more) of the 16PF. In accord with the Spearman-Brown prophecy formula (Crocker & Algina, 1986, pp. 118-119), virtually any desired level of reliability can be obtained simply by administering additional forms of the instrument (it is quite possible to administer all five forms A, B, C, D, and E, quite apart from the items included in Part 1 of the CAQ). Karson and O'Dell (1976) pointed out that this combined administration probably gives a measure of intelligence comparable to that obtained from many standard intelligence tests. However, they also acknowledged that it is unusual for more than one or two of the 16PF forms to be administered conjointly. Often, only Form A (comprising 13 items) is used, which is undoubtedly less than satisfactory in terms of scale reliability. In view of these considerations, Boyle (1990) has strongly advocated administration of 16PF Forms A and B together, or alternatively Forms C and D
together, in order to satisfy minimal reliability requirements. Karson and O'Dell (p. 39) have also promoted this practice.

Nonetheless, a high score on Factor B, even on a single form is strong evidence of high ability. According to Karson and O'Dell (1976), Factor B is important in interpreting Factor E (dominance). Usually, high scores on Factor B are associated with high scores on Factor E, and vice versa. However, it is quite possible that an individual who exhibits a low Factor E score could obtain a high Factor B score. An interesting example was provided by Karson and O'Dell (p. 45), who pointed out that if one partner in a marriage is high on Factor B, Factor N (shrewdness), Factor E (dominance) and Factor Q1 (rebelliousness), he/she is likely to be dominant and manipulative, especially if the spouse is low on Factor E. In that event, if the low Factor E partner becomes more dominant through some form of psychological intervention, the marriage may become difficult and tortuous. In another example, Karson and O'Dell pointed out that creativity often involves a combination of high Factor M (imagination) in the presence of a high Factor B score.

**Further evidence of correlations between intelligence and personality factors**

Cattell (1987, p. 452) reported that among adolescents there are small, positive correlations between intelligence and 16PF scores superego, Factor G (.18), self-sentiment, Factor Q3 (.23), and sensitivity, Factor I (.12). In university students, intelligence also correlates positively with dominance, Factor E (20), with radicalism, Factor Q1 (.28), and with intensity of inner mental life, Factor M (.20). In terms of ratings (L-data), positive correlations have been reported with conscientiousness, Factor G (.30), self-assuredness, low Factor 0 (.29),
shrewdness, Factor N (.26), and with assertiveness, Factor E (.24). It is possible that more intellectually capable individuals can more readily contemplate the consequences of their actions, and therefore behave in a more socially desirable manner. More successful life experiences may be partly responsible for the apparent association of high ability levels with dominance (E+), radicalism (Q1+), and shrewdness (N+). Individuals with greater intellectual capacity are presumably better organized, persistent, and have more foresight and insight. Cattell (1987) reported that surgent/exuberant (high Factor F) individuals are more able to express intelligence with speed and cleverness rather than with wisdom. The desurgent/lethargic individual (low Factor F) is probably more dependable and prudent than "clever". Wisdom (shrewd judgement) tends to be associated with ego strength (C+)-(involving realism, balance, and self-control), desurgency (F-), superego strength (G+), and high shrewdness (N+). In contrast with general ability, specific abilities often display qualitative differences because of their association with various personality factors. For example, in USA Army recruits, verbal ability has been found to correlate -.25 with Factor A (warmth), -.35 with exuberance (Factor F), and -.35 with sensitivity (Factor I). Possibly, the negative correlation between intelligence Factor B) and extraversion (Factors A and F) might be due the extravert talking more, but reading less (Cattell, 1987).

In regard to the CAQ, several small but significant correlations between Factor B (intelligence) and both the normal and abnormal-psychopathological traits under neutral emotional conditions were reported by Krug (1980) for both normal and clinical samples. For example, among psychologically normal men, intelligence correlated -.20 with Factor D1 (hypochondriasis), -.21 with Factor D2 (suicidal depression), -.28 with Factor Pa (paranoia), -.23 with Factor Sc
(schizophrenia), and -.20 with Factor As (psychasthenia). Likewise, for normal
women (who tend to assent more readily to negative traits and states--cf.
Abramson & Andrews, 1982; Boyle, 1985), intelligence correlated .26 with Factor
C (emotional stability), .23 with Factor F (impulsivity), .27 with Factor M
(imagination), -.21 with Factor 0 (insecurity / guilt proneness), -.26 with Factor D1
(hypochondriasis), -.24 with Factor D2 (suicidal depression), -.24 with Factor D4
(anxious depression), -.21 with Factor D5 (low energy depression), -.27 with Factor
D6 (guilt and resentment), -.23 with Factor D7 (boredom and withdrawal), -.38
with Factor Pa (paranoia), -.29 with Factor Sc (schizophrenia), -.25 with Factor
As (psychasthenia), and -.22 with Factor Ps (psychological inadequacy). Similarly,
a number of small, but significant correlations were reported for clinical samples
of men and women. Most prominent was the correlation of .30 bet­ween Factor B
(intelligence) and Factor 01 (radicalism) for adult males.

**Intelligence-personality findings with the objective-analytic battery**

Ability-Personality interactions have been demonstrated most clearly in the
use of objective, non-questionnaire measures of personality, such as the Objective-
Analytic (0-A) Battery (Cattell & Schuerger, 1978; Schuerger, 1986). The 0-A
Battery is quite unique among multidimensional personality instruments, as it
consists entirely of objective (T-data) tests. Bolton (1988, p. 374) defined an
objective test as "one in which an examinee responds to a miniature situation,
without knowing which personality trait is being evaluated. Unlike conventional
personality measurement strategies, objective tests are not susceptible to self-
report distortion or to the biases of judges".
The 0-A Battery comprises objective/performance measures of 10 major personality source traits. These T-data personality traits appear to "line-up" with the second-order 16PF/CAQ factors (cf. Krug & Johns, 1986). Bolton further stated (p. 377) that "the distinguishing characteristic of the 0-A Batteries is that personality trait structure is assessed at a higher level of generality than through self-report and rating instruments. Because the 0-A source traits encompass both normal and abnormal personality dimensions, the 0-A Batteries are as applicable in nonclinical as well as clinical settings".

Each of the 10 source traits is measured by means of seven or eight subtests taking approximately half an hour to complete (making for a total testing time of about five hours). Each trait is labelled precisely with a Universal Index (U.I.) number, as well as with technical terminology as follows:

1. Ego Standards (U.I. 16)
2. Independence vs. Subduedness (U.I. 19)
3. Evasiveness (U.I. 20)
4. Exuberance (U.I. 21)
5. Capacity to Mobilize vs. Regression (U.I. 23)
6. Anxiety/Neuroticism (U.I. 24)
7. Realism vs. Tensidia (U.I. 25)
8. Asthenia vs. Self-Assurance (U.I. 28)
9. Extraversion vs. Introversion (U.I. 32)
10. Discouragement vs. Sanguininess (V.I. 33)

A full description of these 0-A source traits is provided in Cattell and Schuerger (1978). Test-retest reliabilities (stability estimates) for the 0-A source
traits have been found to range from .61 to .85 (median .71) with a retest interval of three to six weeks, suggesting that the scales are reasonably reliable measures of the 10 source traits. Use of the 0-A Battery has been especially prominent in psychiatric diagnosis, correctly identifying involutional depressives, psychotic depressives, neurotic depressives, schizophrenics, manics, and anxiety neurotics from normal controls (Bolton, p. 379). A summary of the 0-A Battery research concerning psychiatric diagnosis is provided in Cattell and Schuerger (1978, pp. 252-256).

A number of the personality trait factors quantified by means of "miniature situation" or performance tests in the 0-A Battery exhibit interactions with abilities. In line with the common factor analytic model upon which the 0-A Battery was based, the T-data personality trait factors have been indexed in order of diminishing variance according to their order of extraction (Cattell, 1987). This correlation of intelligence with some of the 0-A variables is in line with expectations since T-data tests put more demands on intelligence, than do simple questionnaires. The 0-A Battery personality traits positively correlated with ability include U.I. 16, competitive ego strength, U.L 19, independence, U.I. 21, exuberance, U.I. 22, tough mindedness, U.L 23, capacity to mobilise, and U.I. 25, realism. Those correlated negatively with ability include U.I. 20, evasiveness, and U.I. 28, lack of self-assurance--including only the predominant personality-ability intersections.

Cattell (1987), in noting the resemblance in age curves and heritability between intelligence and U.I. 23 (capacity to mobilise) has suggested an explanation involving brain physiology. Schuerger (p. 280) reported correlations between U.I. 16 and 16PF Factor B of .21, and with the Large-Thorndike (L-T)
intelligence test of .48. U.I. 17 correlated .22 with Factor B. U.I. 19 correlated .46 with Factor B, and .60 with the L-T score. U.L 23 correlated .48 with Factor B, and .59 with L-T. U.I. 24 correlated -.24 with L-T. U.I. 25 correlated 24 with Factor B, and .34 with L-T. U.I. 28 correlated -.38 with Factor B, and -.45 with the L-T test. At the second-order level, Krug (1977, p. 24) reported that intelligence (as a higher-order factor) correlated -.42 with tough poise, -.20 with anxiety, -.45 with socialization, .45 with psychoticism, and -37 with neuroticism.

0-A Battery source traits interacting with intelligence

According to Cattell and Schuerger (1988, p. 244), "appreciable prediction of intelligence test performance, on both crystallized and fluid (culture-fair) tests, can be given by personality primaries U.I. 19, 23, and 25, reaching indeed to .50 in some populations in the case of U.I. 19. Does this mean that performance on these personality test batteries has sufficient demand on cognitive abilities to be contaminated with intelligence? Or, conversely, are we to conclude that performance on intelligence tests, as distinct from the intelligence factor (gr or &) itself, depends partly on personality factors which help the individual effectively to organize his intelligence in actual test-taking situations?" (cf. King, 1976).

U.L. 19 (independence vs. subduedness) influences performance on visual-perceptual tasks including the Gottschalk figures (simple perceptual figures concealed in more complex figures), and Witkin field dependence-independence tasks such as the Embedded Figures Test - EFT). The EFT has been found to correlate substantially (.30 to .60) with field independence. Personality variables correlating with field independence include curiosity, social autonomy, and
healthy body concept (Horn 1977). Although Cattell (1987) claimed that performance on such perceptual tasks is largely a function of this personality factor, Cronbach (1990) maintained that the Witkin field dependence-independence test involves only a specific ability. If Cronbach is correct in hypothesizing no particular personality trait contribution to the performance variance on the Witkin field dependency-independency test, then the conclusion would be that Cattell's U.I. 19 factor is a measure of a specific ability only. What are the correlations between U.I. 19 and the 16PF factors? According to Cattell & Schuerger (1978, p. 28), U.I. 19 correlates positively with 16PF primaries factors: dominance (Factor E), suspiciousness (Factor L), imaginativeness (Factor M), radicalism (Factor Q1), and self-sufficiency (Factor Q2), that is with the 16PF second-order Independence factor (cf. Krug & Johns, 1986). Witkin's perceptual behaviours partly appear to be expressions of this higher-order personality factor. However, U.I. 19 does not merely pertain to perceptual independence, but more broadly to a general temperamental independence.

U.I. 19 has been reported to correlate positively (.26) with academic school grades (cf. Pawlik, 1974; Schuerger, Dielman, & Cattell, 1970). According to Cattell and Schuerger (1988, p. 229), “In questionnaires it is related to low lie scale score (MMPI), general activity and thoughtfulness (G-Z), and to Factor E, dominance, on the 16PF... Wardell and Royce (1975) related it in cognitive performance to Witkin's field independence, to an analytic, independent, rational style, and high 'field articulation'." Cattell and Schuerger concluded that U.I. 19 is highly correlated with psychological health, and intellectual functioning.

U.I. 21 (exuberance) is involved in word fluency and speed of judgement. According to Cattell and Schuerger (1978, p. 29), it is sometimes confounded with
ideational fluency or divergent thinking, but it is broader than just a cognitive
dimension. Manifestations involve high spontaneity, fluency, imaginativeness,
speed of social/perceptual judgment, fast tempo (less accuracy than speed). In
16PF Q-data it is related to exuberance (Factor F), ergic tension/drive (Factor Q4),
guilt proneness (Factor 0), and imagination (Factor M), and in L-data, to ratings of
energetic (Factor F), forceful (Factor E) and excitable (Factor D) behaviour.
Getzels and Jackson (1962) demonstrated a positive relationship between U.I. 21
and creativity, resourcefulness, and imagination. Dielman, Schuerger, and Cattell
(1970) reported a positive correlation (.31) with academic grades (cf. Knapp,
1961). According to Cattell and Schuerger (p. 231), U.I. 21 "has very substantial
hereditary determination and is theoretically best conceived so far as a
temperamental quality of mental energy probably associated with some cortical
chemical pace-maker."

U.I. 23 (capacity to mobilise versus regression) often tends to be confused
with intelligence. This factor apparently corresponds closely to the Eysenckian
Neuroticism dimension. U.I. 23 was defined by Cattell and Schuerger (p. 232) as
the capacity to mobilise one's resources including "skills, motives, memories, and
interests in an integrated way to meet whatever demands the environment makes
for adjustments." U.I. 23 has been associated with a number of intelligence test
tasks, including coding exercises, short-term memory, visuospatial abilities
measures general competence (sometimes simulating intelligence), flexibility,
emotional balance, and stress endurance. U.I. 23 is one of half-a-dozen source
traits equally or more strongly associated with neuroticism. U.I. 23 has some
qualities of the psychoanalytic regression concept, in showing a decline of interest,
and capacity to organize one's thoughts. U.I. 23 is low in psychotic individuals, pointing to much psychological disorganization. Possibly, U.I. 23 may represent an adrenal deficiency following prolonged fatigue, thereby disrupting the individual's hormonal equilibrium (Cattell, 1987). U.I. 23 has positive correlations with academic grades (Dielman et al., 1970, found a correlation of .23 at eighth grade level; Knapp, 1961, reported a correlation of .35 for adults).

Likewise, U.I. 17 (general inhibition) tends to be associated with perceptual slowness, narrowed peripheral visual span, and slowness in dark adaptation. According to Cattell (1982, p. 364), U.I. 17 involves slower speed of gestalt closure, greater GSR reactivity/sensitivity, avoidance of conflict, low ratio of inaccuracy to motor speed, slowing of response speed with increased complexity, reduction of exploration with threat of punishment, and general proneness to inhibition. The tendency of some individuals to "under-perceive" could be associated with this personality characteristic, rather than being an indication of cognitive ability, per se. Seemingly, "low perceptual ability" may in sometimes result from personality characteristics rather than from intellectual attributes.

While only a few 0-A source traits are discussed above in terms of evident ability-personality interactions, Cattell and Schuerger (1988, p. 244) have reported sizeable correlations between virtually all of the T-data factors and intelligence (as measured in terms of reading comprehension and mathematical reasoning ability). Specifically, the obtained correlations ranged from .34 to .41 (for U.I. 16, ego standards), from .52 to .53 (U.I. 19, independence), from -.18 to -.21 (U.I. 20, evasiveness), from .47 to .54 (U.I. 23, mobilisation vs. regression), from -.15 to -.28 (U.I. 24, anxiety), from .29 to .38 (U.I. 25, realism vs. tensidia), from -.28 to -
.40 (U.I. 28, asthenia), from .13 to .18 (U.I. 32, exvia vs. invia), from -.04 to -.16 (U.I. 33, discouragement vs. sanguineness).

**Summary and conclusions**

The psychometric work of the Cattellian school in the fields of personality and intelligence theory and assessment has been prodigious. Cattell and his colleagues have systematically investigated the structure of both normal and psychopathological personality traits side by side with important cognitive/ability dimensions. The major source traits delineated in both intrapersonal psychological domains, via exhaustive exploratory factor analytic investigation, have been incorporated into multidimensional measurement instruments such as the Sixteen Personality Factor Questionnaire (16PF), the Clinical Analysis Questionnaire (CAQ), the High School Personality Questionnaire (HSPQ), the Early School Personality Questionnaire (ESPQ), the Objective-Analytic (0-A) Battery, the Culture Fair Intelligence Tests (CFIT), and the Comprehensive Ability Battery (CAB). It is evident from the research within the Cattellian school, that there is considerable empirical evidence that personality traits and intellectual abilities show appreciable interaction effects. Research (e.g., Boyle, 1983, 1987a) has shown that under non-emotive conditions, intellectual abilities may predominate over personality traits, particularly in the processes involved in cognitive learning. However, under emotionally stressful circumstances, the involvement of some personality factors is augmented so that intelligence per se, is no longer the major determinant of behavioural outcomes.

On the basis of these findings, there seems little doubt that personality traits and intellectual abilities interact profoundly in influencing human behaviour.
Personality and intelligence are clearly interdependent in terms of their associated processes and products. Evidently, it is no longer feasible to regard personality traits and intellectual abilities as completely separate/orthogonal domains.

Cattellian psychology is one of the few psychometric models that attempts to index intelligence along with personality. These findings are most pronounced in the area of objective (T-data) measurement of personality traits and intellectual abilities. Since it is likely that future personality test development will place considerably greater emphasis on T-data measures of personality traits than currently is the case (because of the difficulties and response distortion associated with transparent Q-data items), it would seem probable that the nature and extent of ability-personality interactions will be clarified and elaborated extensively.

However, one of the limitations in this undertaking, as indeed in much of the psychometric research to-date, is the often untested assumption that the simple, linear-additive model is applicable in the field of psychological test construction. The applicability of this general linear model (GLM) to psychosocial research and measurement has been challenged, and it would seem that new developments in statistical software packages (providing advanced curvilinear method of data analysis) are required to cope with the complexities of contemporary psychometric research. Because of the apparent inapplicability of the GLM under many circumstances, it is evident that correlations between cognitive abilities and personal trait dimensions may be attenuated accordingly, thereby giving a quantitative underestimate of the actual degree of association between the two intrapersonal psychological modalities.
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