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Aptitude Complexes and Trait Complexes

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The origins and development of the concept of *aptitude complexes* are reviewed. Initial empirical success in demonstrating interactions between aptitude complexes and instructional complexes by Richard E. Snow and his students is followed by an inductive approach to finding broader trait complexes. Three empirical studies of college students and adults up to age 62 are described, where trait complexes were correlated with domain knowledge and ability measures. Differentiated profiles of trait complex–knowledge–ability correlations were found and replicated across the 3 studies. Evidence for trait complexes that are supportive or impeding for the development of domain knowledge is reviewed. The aptitude complex–trait complex approach is viewed as an important means toward researching and reevaluating the nature of aptitude–treatment interactions.

One central question addressed in Richard E. Snow's 1963 dissertation was whether "personal variables," such as abilities, attitudes, personality variables, and prior knowledge interacted to affect learning outcome in the context of physics instruction via films. In particular, Snow asked whether there are "combinations of levels of some variables which are particularly appropriate or inappropriate for efficient learning?" (Snow, 1963, p. 120). It is an interesting historical footnote that Snow apparently came to these questions within an industrial psychology program, independent of the aptitude–treatment interaction perspective proposed by Cronbach (1957) 6 years before. A central theme of Snow's perspective, as it developed over the next 3 decades was the notion that one can consider aptitudes in a manner other than as isolated variables. Specifically, even *without* embracing a typological approach to aptitude categorization, Snow was able to conceptualize and investigate how combinations of aptitudes interacted to produce differential educational outcomes.[1]

It would take another 13 years for more general support to be obtained for this concept of aptitude complexes. Two dissertations supervised by Snow in 1976 (one by Penelope Peterson and the other by Ann Porteus) provided important support for Snow's conceptualization. The dissertation by Peterson was a study of ninth-grade students involving a 2-week instructional module in a course called Introduction to Social Science. In that study, interactions were observed with combinations of verbal ability, anxiety, and motivation (as measured by scales of Achievement via Conformance and Achievement via Independence from the California Psychological Inventory). Different results were obtained when groups of participants were identified by both anxiety and ability and paired with classroom structure and participation treatment variables, something Snow (1976) later called the Achievement-via-Independence, Achievement-via-Conformance, and Anxiety [$A_iA_cA_x$] complex in a technical report. According to Snow, the findings indicated that "nonanxious learners who lack sufficient ability, and able learners who are also highly anxious *both* need teacher structure to do well" (p. 10).

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[1]Although much of Snow's later research efforts were subsumed under a larger umbrella of the "aptitude–treatment interaction" research program (e.g., see Cronbach & Snow, 1977), it is not entirely clear that his initial orientation was more or less focused on finding combinations of traits that combined additively in supporting learning or on finding traits that combined in a nonadditive fashion. It is important to note that the treatment of "complexes" described here is agnostic about how various traits combine to influence learning (e.g., whether the traits are independently influential in supporting or impeding learning, or whether there is a nonadditive synergy). Thus, in the discussion of trait complexes, it should be noted that, as identified, they do not necessarily represent true "interactions" in the traditional sense, but they do represent "constellations" of traits that might or might not interact with instructional or learning treatments.

The 1976 dissertation study by Ann Porteus involved a high school investigation in two courses (Introduction to Economics and Philosophy of Education) over an entire academic term. Although there were several differences in the results of the Porteus study, many of the overall findings were similar to those of the Peterson (1976) study—that is, combinations of conative and personality factors interacted with ability level and the outcome of treatments involving high or low structure in the course.

Snow's explication of the concept of aptitude complexes appears to have been uniquely his. Neither of these two dissertations mentioned the term *aptitude complexes*—but Snow's technical report a few months later (Snow, 1976) proposed the specific Achievement–Anxiety ($A_iA_cA_x$) complex as supported by these and previous studies. The second aptitude complex proposed by Snow in his 1976 technical report was a complex of general fluid, crystallized, and visualization aptitudes ($G_fG_cG_v$). Snow admitted that most of the evidence of this complex entering into aptitude–treatment interactions was indirect. Much of the support that Snow cited had to do with an intraindividual difference between Gc and Gv (expressed more simply as a verbal vs. spatial processing advantage). Nonetheless, this orientation appears to have been the theoretical precursor to later studies, such as the Kyllonen, Lohman, and Snow (1984) article on strategy training.

By the late 1980s, Snow (1989) had hypothesized the existence of five different aptitude complexes (shown in the middle of Figure 1) involving abilities (GcGf [crystallized intelligence, fluid intelligence], G_cG_v [crystallized intelligence and general visualization abilities]), motivation and personality (A_iA_c [Achievement via Independence and Achievement via Conformance] and AxAiAc [anxiety with two achievement traits]), and combinations of crystallized intelligence and anxiety (G_cA_x). Snow also suggested that it

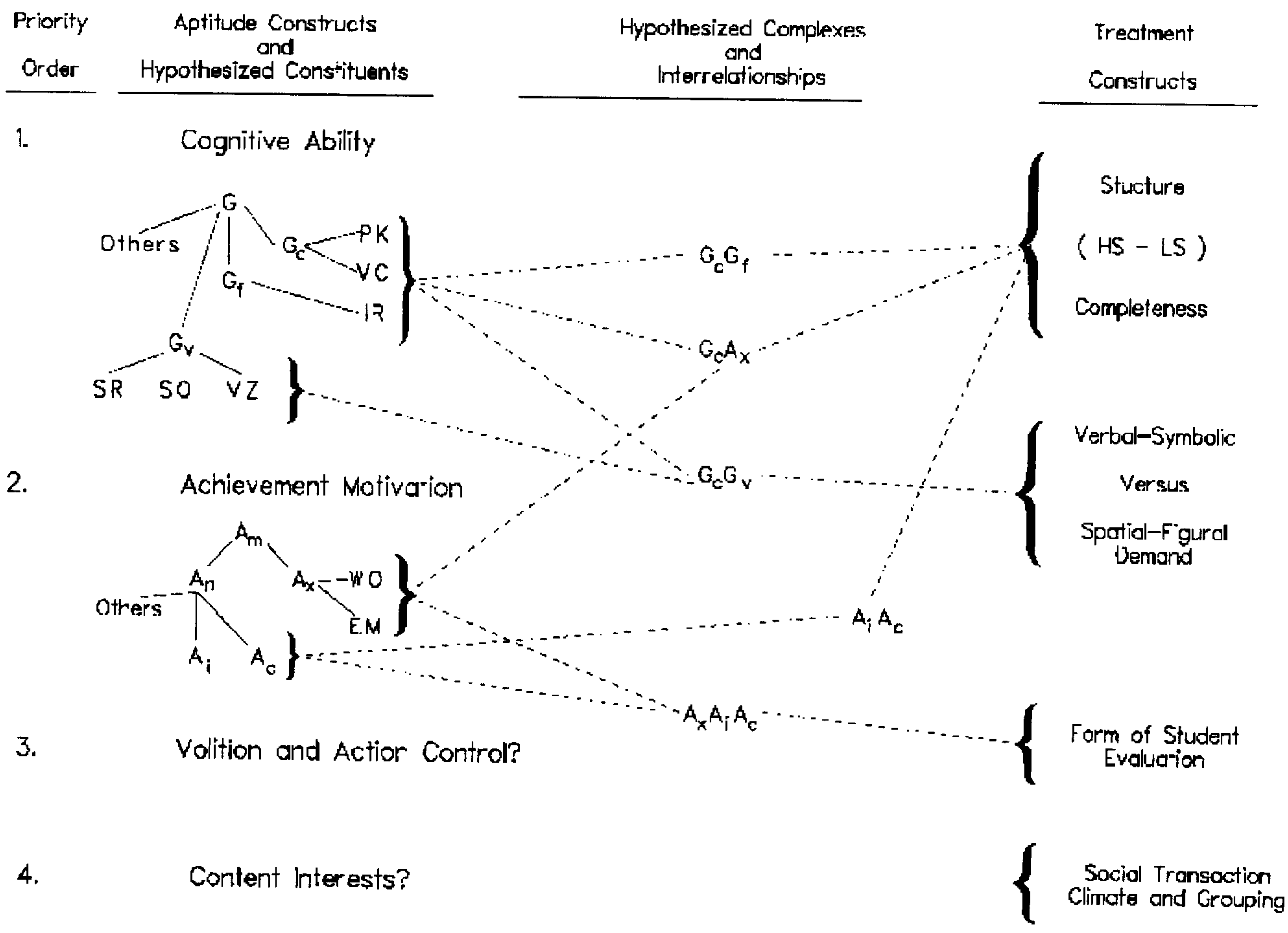

FIGURE 1 "A priority list for analysis of aptitude and treatment constructs, with some hypothesized aptitude constituents and complexes." G = General intelligence, Gc = crystallized intelligence; Gf = fluid intelligence, PK = prior knowledge, VC = verbal comprehension, IR = inductive reasoning, Gv = general visualization, SR = spatial relations; SO = spatial orientation, Vz = spatial visualization; Am = achievement motivation, An = need for achievement, Ax = test anxiety, WO = worry, EM = emotionality, Ai = achievement via independence, Ac = achievement via conformance; and HS–LS = high structure and low structure. From *Learning and Individual Differences: Advances in Theory and Research* (p. 33), by P. L. Ackerman, R. J. Sternberg, and R. Glaser (Eds), 1989, NY: Freeman. Copyright 1989 by Freeman. Reprinted with permission.

might be useful to consider how aptitude complexes could interact with configurations of educational treatments called *treatment complexes.*

A crucial aspect of the aptitude-complex approach proposed by Snow was that one need *not* fall into the quagmire of typologies. Indeed, Snow pointed out in a 1978 article in *Intelligence* that

> Sorting individuals into labeled categories according to boundary conditions or similarities identified in one type of experiment breeds an archaic form of thinking about individual differences. Typologies were discarded by modern psychologists when it was recognized that many dimensions were needed to characterize an individual. No type category ever contains individuals homogeneous in all relevant respects. Typological distinctions may define hypothesized dimensions worth further study; there may even be occasions where the bimodal character of an individual difference distribution supports some form of categorical thinking. *But* multivariate continuous parametric measurement has so far proven to be the most efficient and versatile approach to the problem of studying individual differences of all kinds. Until enough is known about individual differences in cognitive processes to rule out curvilinearity and/or support hypotheses about discontinuities, typological thinking, and the arbitrary cleavage of continuous variables that it promotes, should be avoided in favor of multidimensional conceptualization and multivariate statistical analysis. (Snow, 1978, pp. 228–229)

Snow's (1978) approach to aptitude complexes also differed from Cattell's (1987) integrated "investment hypothesis"—which suggested how abilities, personality, and motivational traits relate to intellectual and achievement outcomes. That is, Cattell's approach to the role of multiple trait influences on learning and knowledge acquisition was to consider traits in isolation, which in turn were incorporated into a multiple-regression framework. The implication of Snow's conceptualization of aptitude complexes is that there is some value added by the combination of the constituent traits that may not be accounted for by consideration of the individual traits. The underlying processes that give rise to the aptitude complexes is less clear, and issues about the development of these configurations suggest many different avenues of developmental research and theory.

TRAIT COMPLEXES INDUCTIVELY DERIVED

Although my initial interests were mainly focused on the ability determinants of individual differences in learning and skill acquisition, a fortuitous collaboration with a psychologist interested in motivational traits and skills started a program of research that proceeded initially down the aptitude–treatment path. Specifically, Ruth Kanfer and I started a collaborative research program that examined how abilities and motivational treatments interacted during the acquisition of skills (e.g., see Kanfer & Ackerman, 1989). With our students and other colleagues, we conducted a series of studies that investigated several aptitude–treatment interactions, including massed versus spaced task practice (Kanfer, Ackerman, Murtha, Dugdale, & Nelson, 1994), self-focus and personality (Ackerman & Woltz, 1994), and part–whole task practice (Goska & Ackerman, 1996). In aggregation, these and other research projects (e.g., Ackerman & Kanfer, 1993) suggested that there was substantially more commonality among families of nonability traits (e.g., personality, interests, motivation, self-concept), and between ability and nonability traits, than was implied by the differentiated domains of extant research. When we conducted a large-scale meta-analysis and review of the personality–ability–interest trait interrelations, Snow's (1978) concept of aptitude complexes became salient.

A few years ago, we (Ackerman & Heggestad, 1997) reviewed a large corpus of studies that reported correlations among three different domains of individual differences: (a) personality, (b) abilities, and (c) interests. In the personality and ability domains, we analyzed a meta-analytic matrix of 19 personality traits by 10 ability traits, for a total of 190 different personality–ability trait pairs. Because of the rather limited literature on personality–interest correlations and interest–ability correlations, our review of these correlations was qualitative, rather than quantitative. We found many significant commonalities among these three trait families. In addition to pervasive correlations (e.g., negative correlations between neuroticism and nearly all ability traits), it appeared that many of the commonalities could be refined down to about four broad sets of traits. That is, this inductive approach to evaluating cross-trait relations seemed to indicate that there were sets of traits that clustered together, even though they represented fundamentally different domains of affect, cognition, and conation. We called these sets *complexes* because we conjectured that they represented the kind of thing that Snow (1963) called aptitude complexes. Because these groups of traits were made up of variables that are not clearly identified as aptitudes—we attempted to avoid the confusion that accompanied the term *aptitude* in Cronbach's original formulation of aptitude–treatment interactions (e.g., see Cronbach, 1957, 1975), and so they were identified as *trait complexes.* The trait complexes identified by Ackerman and Heggestad (1997) are shown in Figure 2 and described in the following sections.

Social Trait Complex

The social trait complex includes enterprising and social interests and also extroversion, social potency, and well-being personality constructs but not any intelligence traits. The social trait complex is relatively uncorrelated with specific intellectual abilities (even though extroversion has ubiquitous small positive correlations across the intellectual ability spec-

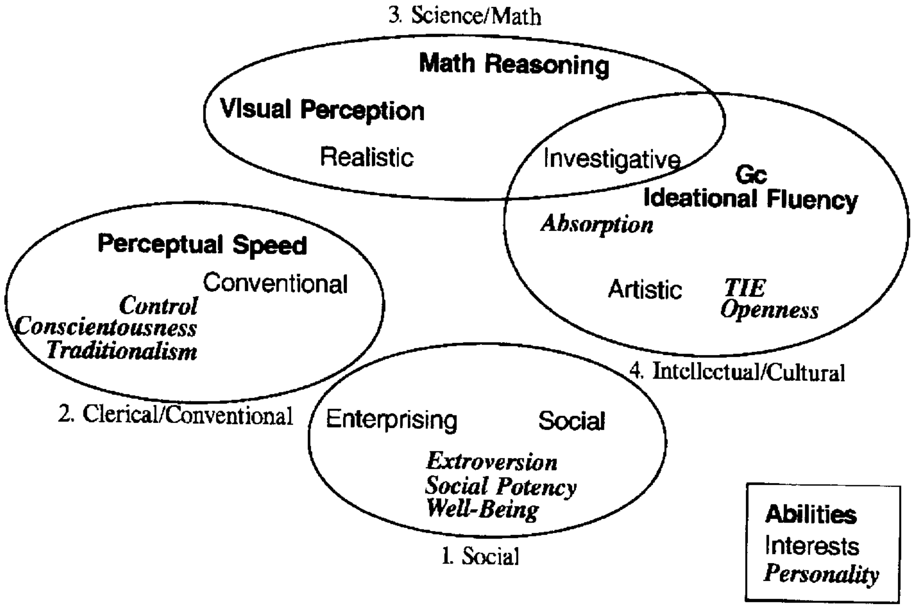

FIGURE 2 Trait complexes, including abilities (bold), interests (regular), and personality (italic) traits showing positive commonalities. Shown are: (1) Social, (2) Clerical/Conventional, (3) Science/Math, and (4) Intellectual/Cultural trait complexes. Gc = Crystallized intelligence; TIE = Typical Intellectual Engagement. From "Intelligence, Personality, and Interests: Evidence for Overlapping Traits,"by P. L. Ackerman and E. D. Heggestad, 1997, *Psychological Bulletin, 121,* p. 239. Copyright 1997 by the American Psychological Association. Reprinted with permission.

trum). One can either interpret these associations as suggesting that persons most closely identified with this trait complex fall across a wide range of intellectual talent or that the corpus of intellectual traits that have been assessed to date do not sufficiently include the domain of "social" abilities or "interpersonal intelligence" (e.g., see Gardner, 1985).

Clerical–Conventional Trait Complex

The clerical–conventional trait complex includes conventional interests (or what Holland, 1959, originally called the "conforming" vocational interest theme) and similar personality traits, such as conscientiousness, traditionalism, and control. This complex also appears to be related to perceptual speed ability (and the computational aspects of numerical abilities)—providing a coherent prototype of an individual who both prefers structure and performs well under structured conditions. An interesting aspect of this trait complex is that perceptual speed–computational math factors are typically those abilities that are the least correlated with standard IQ measures (e.g., see Snow, Kyllonen, & Marshalek, 1984). In some sense, it is fair to ask whether this subdomain of abilities is a significant component of the broader construct of intelligence, per se—even though perceptual speed abilities have been strongly implicated in the development of skilled performance (e.g., see Ackerman, 1988). Moreover, this amalgamation of interest and ability traits may provide support for some additional insights into the meaning of the broad personality construct of conscientiousness (i.e., as a preference for structured environments and situations).

Science–Math Trait Complex

The science–math trait complex and the intellectual–cultural trait complex overlap (see the section that follows) in that both are associated with investigative interests (which Holland, 1959, previously called "intellectual" interests). However, the science–math trait complex is associated with visual perception (i.e., spatial ability) and math reasoning abilities and realistic interests, but the complex is not specifically associated with any particular personality traits (at least as revealed from the data incorporated into the meta-analysis).

Intellectual–Cultural Trait Complex

The intellectual–cultural trait complex, although also associated with investigative interests, is associated with the educational and experiential aspects of intelligence (namely, crystallized intelligence), the artistic interest theme, and the personality traits of openness to experience, absorption, and a measure called *typical intellectual engagement* (TIE)—which is associated with openness (for discussion, see Ackerman & Goff, 1994; Rocklin, 1994). What is fascinating about this particular trait complex is that the measures of openness (and TIE) do not substantially correlate with self-reports of knowledge about physical science and math (Rolfhus & Ackerman, 1996) or with fluid intelligence (Goff & Ackerman, 1992), but rather are associated more with literary–artistic–cultural kinds of interests and abilities.

EMPIRICAL INVESTIGATION OF TRAIT COMPLEXES

Although the fact that measures representing cognitive, affective, and conative traits share variance is in and of itself interesting (see Ackerman, 1997, for a discussion), it remains to be seen whether these groups of traits are influential in determining learning outcomes within Snow's conceptualization of aptitude complexes. That is, to be meaningful for educational contexts, the trait complexes found by Ackerman and Heggestad (1997) must themselves be differentially associated with learning outcomes. The traditional aptitude–treatment interaction study is one way to evaluate the role of trait complexes—where two or more instructional treatments are paired with one or more trait measures to assess whether the regressions between traits and educational outcomes differ as a function of the instructional treatment. However, a more compelling argument can be made for examining learning in less constrained environments because the classroom may be a sufficiently strong situation that attenuates the separate role of traits on outcomes (especially nonability traits; see Cronbach & Snow, 1977). By focusing on individual differences in knowledge and abilities across many different domains, we believed that the role of trait complexes on learning would be more likely to be revealed because the learner has much more control over the knowledge acquired in the workplace or at home than he or she might have in the constrained classroom environment.

The studies that follow were designed to examine the relations among abilities, personality, and interests as they predicted individual differences in domain knowledge across much of the adult life span. Although not specifically designed to examine the role of trait complexes in predicting individual differences in knowledge, the concomitant administration of multiple nonability trait measures made it possible to reanalyze data within the trait-complex framework. Following from the conceptualization that the trait complexes suggested by Ackerman and Heggestad (1997) have differential implications for lifelong acquisition of domain knowledge, the hypothesis is that different patterns or profiles of trait-complex–knowledge correlations will be found when knowledge is assessed across many different domains. For example, one might hypothesize that the science–math trait complex is most highly associated with individual differences in knowledge for physical sciences, such as chemistry, physics, and astronomy but is less associated with individual differences in knowledge in the humanities, such as art, music, and literature. Similarly, individual differences in the verbal–intellectual trait complex should show a pattern that is complementary to the science–math trait complex (i.e., high correlations with knowledge in the humanities but lower correlations with knowledge in the physical sciences). Furthermore, it is possible that some trait complexes are negatively associated with domain knowledge. The social trait complex, for example, may be minimally or negatively associated with knowledge across many academic domains but positively associated with knowledge that is more interpersonal in content.

Study 1

In the first study (which is made up of a combined sample of $N = 143$ university undergraduate students, ages 18 to 27 [see Rolfhus & Ackerman, 1999] and a sample of $N = 135$ adults from the university community, ages 30 to 59 [see Ackerman & Rolfhus, 1999]), 20 domain-knowledge tests were administered. Each of the tests was composed of 35 to 123 multiple-choice items, arranged in order of difficulty (in a power-test format). The tests sampled a wide range of difficulty levels, from basic surface-level knowledge through the content of a 1st-year college course in the topic domain. For summary purposes, the 20 knowledge tests were refined, via factor analysis, to four domain-knowledge composites (physical sciences, civics, humanities, and business). For details on the extensive development, norming, and validation background for these tests, see Rolfhus and Ackerman (1999). A battery of ability tests was administered to provide estimates of math, spatial, and verbal abilities. Finally, personality, self-concept, self-estimates of abilities, and vocational interests scales were administered, which provided the data for assessment of three of the Ackerman and Heggestad (1997) trait complexes, namely social, science–math, and intellectual–cultural. (There were too few measures included in the study to represent the clerical–conventional trait complex.) Assignment of trait measures to respective trait complexes was validated by an exploratory factor analysis, where the dominant factor loading of each trait was compared with the trait complexes derived in the previous meta-analysis and review. The measures aligned with expectations. Specifically, the social trait complex was composed of measures of extroversion, social, and enterprising interests. The science–math trait complex was composed of realistic interests, math self-concept, spatial self-concept, and mechanical self-concept. The intellectual–cultural trait complex was composed of openness to experience, TIE, investigative and artistic interests, and verbal self-concept. Trait-complex scores were obtained by forming *z*-score composites of the individual measures most highly associated with the underlying factors. It is useful to note that unit-weighted *z*-score composites formed from these measures as trait-complex scores were largely uncorrelated with one another (none of the intertrait-complex correlations exceeded .20). Such relative mutual orthogonality suggests that individuals could be high or low on all three trait complexes, yet knowing the score on one trait complex provided no prediction of the score on the other two trait complexes. To determine whether the trait complexes were related to individual differences in knowledge and ability, correlations were computed between trait-complex scores and composite measures of domain knowledge and reference measures of cognitive abilities. These correlations are shown in Figure 3.

The correlations between the three trait complexes on the one hand and both knowledge and ability measures on the other hand present an interesting set of profiles. Individuals who were high on the social trait complex were less knowledgeable on all of the knowledge domains (including business) and lower on the math, spatial, and verbal abilities, suggesting that individuals who are identified with this pattern of nonability traits tend to have lower abilities and concomitant lower levels of knowledge across many different domains. In contrast, the science–math trait complex showed substantial positive correlations with knowledge in physical sciences, spatial ability, and math ability—yet the correlations with other knowledge domains and verbal ability were, although positive, closer to zero. Thus, individuals who had high scores on the science–math trait complex were likely to have acquired more knowledge about the sciences but little more than average knowledge for the domains outside of the sciences. Finally, the intellectual–cultural trait complex showed a small negative correlation with math ability, a near-zero correlation with spatial ability, and a substantial correlation with verbal ability. Although one might expect that individuals who had high scores on the intellectual–cultural trait complex would also score well on humanities knowledge (which they did), it might not be predicted that these individuals also had much higher scores on knowledge in physical sciences, civics, and indeed in business. This pattern of higher levels of knowledge is even more interesting in light of the lower scores on math ability and average scores on

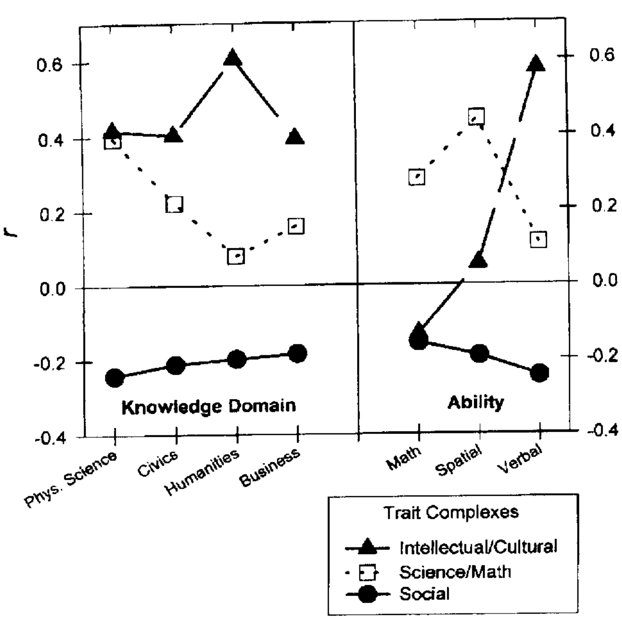

FIGURE 3 Study 1. Correlations between trait complex scores and both knowledge and ability composites. Derived from data reported in Ackerman and Rolfhus (1999) and Rolfhus and Ackerman (1999).

spatial ability. Together the patterns of trait complexes that were "supportive" of knowledge (namely the science–math and intellectual–cultural trait complexes) and "impeding" of knowledge (the social trait complex) provide support for the notion that these trait complexes have the function that Snow (1963) envisioned for his aptitude-complex construct.

Study 2

A second study was conducted that replicated the first study and generalized the findings to a group of participants who had completed more education than the participants in the first study (see Ackerman, 2000). A sample of $N = 228$ participants between the ages of 21 and 62, all of whom had completed at least a baccalaureate level of education, was administered a battery of knowledge, ability, and nonability measures. For this study, although the interest and self-concept measures were unchanged from Study 1, ability measures were selected to represent fluid intelligence (Gf) and crystallized intelligence (Gc), and the personality measures were sampled from the Multidimensional Personality Questionnaire (MPQ; Tellegen, 1982), rather than the NEO Five-Factor Inventory (Costa & McCrae, 1992). A factor analysis of the nonability measures revealed roughly the same three trait complexes found in Study 1, namely social (made up of social and enterprising interests, social potency, and social closeness), math–science (made up of realistic interests and math, spatial, and science self-concepts), and intellectual–cultural (made up of absorption, TIE, and artistic interests). The correlations between trait-complex composites and knowledge composites and abilities are shown in Figure 4.

The magnitude of the correlations between trait-complex scores and knowledge are somewhat different from the results of Study 1, which is most likely a function of the narrower range of talent in the Study 2 sample and the difference in the measures that make up the trait complexes. Nonetheless, the profiles of trait-complex correlations were remarkably similar for the three trait complexes and domain knowledge. The social trait complex was negatively associated with Gf and Gc abilities and with all four domain-knowledge composites. The science–math trait complex was positively associated with Gf and Gc abilities, and it most substantially correlated with physical sciences domain knowledge. The intellectual–cultural trait complex was most highly related to Gc and with humanities domain knowledge. Together, these results support the idea that the identified trait complexes represent combinations of individual characteristics that together influence the level of knowledge acquired in different domains, in contrast to a general association between specific traits and knowledge.

Given the wide range of participant ages in both Study 1 and Study 2, it was not possible to determine whether these trait-complex differences represent the result of an individual's readiness to learn in the different knowledge domains or

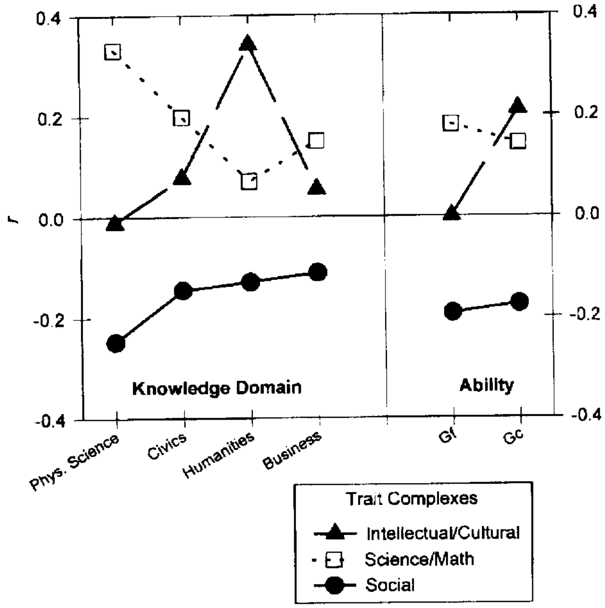

FIGURE 4 Study 2. Correlations between trait complex scores and both knowledge and ability composites. Derived from data reported in Ackerman (2000).

an individual's orientation toward different topic areas for knowledge acquisition—that is, the *direction* of the individual's investment of cognitive effort over time (Cattell, 1987). Study 3 partly addresses this issue by focusing on a sample made up of young adults, who have much more in common, in terms of educational background, than adults who had a wide range of ages and career–avocational experiences.

Study 3

In a follow-up to the previous studies, a sample of university freshmen ($N = 320$) was drawn, where all of the students had completed at least one of the following Advanced Placement courses during high school (English literature, biology, U.S. history)—see Ackerman, Bowen, Beier, and Kanfer (2001) for details. This sample had a restricted range of talent, given that all of the participants were students at selective higher education institutions (average SAT scores for this sample were Verbal = 635; Math = 666; the means were about 1.5 *SD* above the national norms of college-bound high school students). As with Study 2, measures of abilities were administered to provide estimates of Gf and Gc, and a wide range of nonability measures was administered, so that trait-complex measures could be derived. In the nonability battery, a special effort was made to evaluate whether two different aspects of extroversion could be usefully separated in trait complexes, namely, social potency (or dominance) and social closeness (or affiliation). A factor analysis of the nonability trait measures yielded replications of the intellectual–cultural trait complex (called verbal–intellectual in Ackerman et al., 2001), and the science–math trait complex (called science–math–technology). The factor analysis showed that it was possible to separate the different components of extroversion (into a social potency–enterprising trait complex and a social closeness–femininity trait complex). A final trait complex was also found, which included a traditionalism personality trait measure and two measures of motivational traits—worry and emotionality in achievement contexts. The trait complexes derived from these data were broader than those from the previous studies because they were predicated on a wider array of personality, interest, self-concept, and self-estimates of ability and also on measures of motivational traits (e.g., see Kanfer & Ackerman, 2000; Kanfer & Heggestad, 2000), the Bem Sex Role Inventory (Bem, 1974), and several biographical scales regarding activities that the students had participated in over the previous 2 years. Details of the individual scales and factor analysis are beyond the scope of this article but may be found in Ackerman et al. The correlations between the trait-complex scores and domain knowledge and abilities are shown in Figure 5.

For the "supportive" science–math and intellectual–cultural trait complexes, patterns of positive correlations between trait-complex scores and both knowledge and abilities were found, similar to the results of the previous two studies. Science–math trait-complex scores were most highly associated with knowledge in the physical sciences domain and with Gf abilities. The intellectual–cultural trait complex showed a complementary pattern of positive correlations—slightly lower correlations with physical sciences knowledge and Gf but higher correlations with civics, humanities, business knowledge, and Gc. In contrast, the other three "impeding" trait complexes had broadly negative correlations with all of

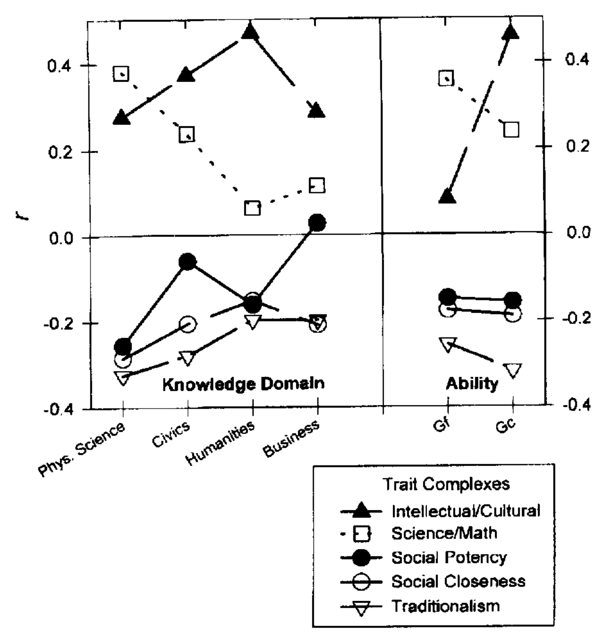

FIGURE 5 Study 3. Correlations between trait complex scores and both knowledge and ability composites. Derived from data reported in Ackerman, Bowen, Beier, and Kanfer (2001).

the domain-knowledge composites and abilities. Only the social potency trait complex showed near-zero correlations with civics and business knowledge—consistent with the notion that persons who are closely identified with high levels of dominance and enterprising interests are drawn more to business domains (or find such domains less aversive) than individuals who are also extroverted but have an orientation toward interpersonal relations in the context of a need for affiliation or supportive interests. It appears that individuals who were closely identified with high levels of traditionalism and with anxiety-related traits of worry and emotionality in school or other performance evaluation contexts have lower ability levels and are also at risk for lower levels of acquired knowledge across a wide array of domains. It is interesting to note that this last trait complex, traditionalism, contains the traits of achievement-related worry and emotionality that were hypothesized by Snow (1989) to enter into an aptitude complex directly relevant to interactions with educational treatments of high versus low structure and the form of student evaluation (see Figure 1).

SUMMARY AND CONCLUSION

The origins and initial developments of aptitude-complex constructs by Snow and his students were reviewed. The inductive derivation of four broad trait complexes was described, and three studies were reviewed. The studies demonstrated that at least three trait complexes could be easily replicated with cross-domain batteries of personality, self-concept, interest, and motivational trait measures. In each study, consistent patterns of supportive trait complexes and impeding trait complexes were found, in the context of individual differences in domain knowledge and abilities. Two trait complexes were found to be positively related to knowledge and ability. Science–math trait complex was most highly associated with physical sciences knowledge, Gf, math, and spatial abilities. Intellectual–cultural trait-complex scores were positively associated with all assessed knowledge domains, and most highly associated with humanities knowledge and with verbal and Gc abilities. In contrast, impeding trait complexes, such as social and traditionalism, were found to have modest magnitude but broad negative associations with knowledge and abilities, even in samples of relatively highly talented study participants.

Historically, most research and theoretical efforts oriented toward discovering the trait determinants of learning and intellectual development have represented isolated or piecemeal investigations of individual traits. The perspective of aptitude complexes or trait complexes represents a fundamentally different conceptualization of the role that cognitive, affective, and conative traits play in determining the outcomes of educational and instructional treatments and on the wider context of intellectual development across the life span. Although isolated traits often have significant and sometimes substantial impact on learning outcomes, it may be that combinations of traits have more predictive power than traits in isolation. Moreover, the combinations of traits described earlier in this article may provide a more substantial explanatory power for understanding how individual characteristics come together to yield different styles of learning and different levels of educational outcomes.

For example, it has often been speculated that high levels of creativity are a function of both ability and nonability traits, in a noncompensatory manner (e.g., see McNemar, 1964). That is, high levels of intellectual ability may be necessary but not sufficient for the expression of creativity. As such, a complex that is made up of supportive cognitive, affective, and conative traits for creativity (such as the intellectual–cultural or science–math trait complexes) may turn out to provide a better prediction of creative achievements than a traditional regression approach (which would usually involve a compensatory formula). Conversely, high levels of impeding trait complexes (such as the social or traditionalism complexes) may indicate individuals with low orientation toward learning in general, even in the presence of average or above average levels of cognitive and intellectual abilities (recall that the studies described here were all conducted on current college students or college graduates, some with advanced degrees).

The cross-domain research aimed at integrating historically differentiated fields of ability, personality, and interests–motivation (e.g., Ackerman, 1997; Snow, 1989) has decisively demonstrated that there is substantial potential for enhancing educational psychology applications of selection, counseling, and instructional treatments. However, the empirical basis of such work is in its infancy. Far more targeted studies are needed that incorporate cross-domain trait assessments and educational outcomes (e.g., see Lubinski, 2000, for a discussion of such issues). It is reasonably clear at this point that trait complexes can be readily determined from extant assessment measures and that trait complexes play an important role in determining the direction and level of effort toward knowledge and skill acquisition. However, it is not clear whether these and other trait complexes are as influential in more tightly constrained educational environments, such as the high school or elementary school environments. It may be, as Snow (1989) suggested, that these amalgamations of traits provide key linkages for interactions with instructional treatments. These may represent the path toward delivering on the early promises of the aptitude–treatment interaction perspective for education.

In the final analysis, it appears that Richard E. Snow showed the way toward conceptualizing multiple-trait interactions as complexes, without falling back on typological thinking. This approach to integrating these three families of Kantian traits—cognition, conation, and affect—may be a fundamentally important approach to understanding development through primary, secondary, and postsecondary education as well as to lifelong learning.

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