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# Neglected Aspects and Truncated Appraisals in Vocational Counseling: Interpreting the Interest–Efficacy Association From a Broader Perspective: Comment on Armstrong and Vogel (2009)

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Invited commentary on Armstrong and Vogel's (2009) article on interpreting the interest–efficacy association stimulated an appraisal from a broader perspective. Like empirical research, scale development, and theorizing emanating from social cognitive career theory (SCCT), their conclusion about the importance of assessing both interests and self-efficacy in applied settings and speculations about the developmental sequencing of these attributes need to be evaluated in the context of what decades of longitudinal research reveal are critical determinants of educational and vocational choice, performance after choice, and persistence. For our interventions to be effective and our theory development to be meaningful, we must ensure that innovative measures possess incremental validity relative to cognitive abilities and educational–vocational interests, which are already well established as salient predictors of long-term educational–vocational outcomes. Broader historical, philosophical, and scientific perspectives are provided to enhance practice, research, and theory development. These broader perspectives reveal how well-positioned vocational counseling is for further advances if it builds on (rather than neglects) its longstanding tradition of developing a cumulative psychological science.

*Keywords:* career assessment, vocational counseling, educational–occupational choice and performance, self-efficacy, total evidence rule

Armstrong and Vogel (2009) proposed that Holland's (1959b, 1966, 1997) theory of RIASEC (Realistic, Investigative, Artistic, Social, Enterprising, Conventional) types can be construed as supporting a model in which both interests and self-efficacy are components of an individual's *vocational identity*. They called attention to an important aspect of Holland's work, namely, that he conceived of RIASEC types as multiattribute complexes, which include not only RIASEC interests but also other personal attributes relevant to development in school and work settings: "Holland (1966) proposed that a number of personal attributes become linked together in the RIASEC types. Furthermore, the emergence of the types is seen as a developmental process influenced by interactions among abilities, interests, and experiences" (Armstrong & Vogel, 2009, p. 393). They contrasted this perspective against that of social cognitive career theory (SCCT), wherein self-efficacy plays a more central role in the development of career-related beliefs and attitudes as well as interests. Although Holland did not explicitly refer to self-efficacy in his theory, Armstrong and Vogel suggested that "RIASEC types" can be used as an alternative framework for interpreting the relations between interest and self-efficacy. They presented data which they interpreted as supportive of a more integrated model of individual differences, wherein both interest and self-efficacy are conceptualized as indicators of RIASEC types, thereby raising questions about the ordering of self-efficacy and interest measures in the SCCT model but, nevertheless, underscoring the importance of assessing both constructs in applied settings.

It is customary for invited commentaries to stay within the lines of the hypothesis under scrutiny and the empirical evidence marshaled in support of the authors' conclusions and recommendations. Do the authors make a compelling case, or don't they? Yet, Armstrong and Vogel (2009) motivated me to study several articles they cited as well as more general SCCT articles and empirical research (e.g., Lent, Brown, & Hackett, 1994; Lent et al., 2003, 2005, 2008; Luzzo, Haspers, Albert, Bibby, & Martinelli, 1999; Nauta & Epperson, 2003; Nauta, Kahn, Angell, & Cantarelli, 2002; Schaefers, Epperson, & Nauta, 1997; among others). As a result, much of this commentary, while clearly germane to Armstrong and Vogel's empirical findings and recommendations, pertains to many other empirical studies in vocational counseling psychology as well. Furthermore, I found myself in a situation familiar to counseling psychologists: As is true when working with many clients, the presenting problem isn't always the deepest or the most psychologically significant. All too frequently, the measures under analysis (self-reports of competencies, confidence, and efficacy) are not evaluated for their unique predictive properties in the context of preexisting measures with appreciable validity for forecasting the educational–vocational phenomena that these new measures purport to explain. So, like the theoretical frameworks resting on them, the unique value of these measures is unknown. To make a scientific advance, investigators need to establish that

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their measures and models give us something that we do not already have; these new measures and models must account for aspects of phenomena that preexisting measures do not explain.

What are the phenomena in this case? Stepping back, Armstrong and Vogel (2009), like SCCT theorists, are ultimately interested in what all practitioners and theorists in vocational psychology are interested in: educational–vocational choice, performance after choice, and persistence. They develop measures, document empirical relationships between innovative and preexisting measures, and build theoretical models in order to understand choice, performance, and persistence in learning and work settings. It would be of little meaning to understand fully what accounts for variance in self-report measures of competencies, confidence, or efficacy if the individual differences they assess are unrelated to long-term behaviors and concrete outcomes in educational and occupational environments. Therefore, they are theorizing about an important domain of human behavior: the behaviors that occur in learning and work settings and the accomplishments achieved as a result of these behaviors.

In this commentary, I argue that much practice, research, and theorizing in vocational counseling neglects relevant measures and empirical findings that need to be taken into account when designing interventions, validating innovative scales, and testing the verisimilitude of theoretical frameworks about educational–vocational choice, performance after choice, and persistence. Cognitive abilities, for example, play a central role in structuring outcomes in educational and vocational settings. Neglecting cognitive abilities when validating measures and building frameworks designed to conceptualize behavior in these important life domains constitutes a violation of Carnap's (1950) total evidence rule and results in misspecified or underdetermined causal models demonstrating the fallacy of the neglected aspect (Castell, 1935; Ellis, 1928). Of course, construct validation is an ongoing process, and all theoretical models leave things out. However, as Jenkins (1981, p. 224) has astutely observed,

> If you are concerned with improving the output of some complex system, you must study the component that produces the largest variance first. Adjusting or correcting smaller sources of variance has no appreciable effect on the output of the system as long as the major source of variance is uncontrolled.

Cognitive abilities are an important source.

To be fair, Armstrong and Vogel (2009), like Holland (1966) and SCCT theorists (e.g., Lent et al., 1994), did acknowledge cognitive abilities in their writing. But they neglected to team them with vocational interests when validating self-report instruments of competence, confidence, and efficacy for their unique psychological import in predicting educational–vocational outcomes. This practice has been a problem for years. In the Centennial Feature of *Journal of Counseling Psychology*, Dawis (1992, p. 16) commented on the sheer number of scales being developed in counseling psychology and wondered how much redundancy they harbored.

Ten years ago, I had the privilege of reviewing a superb edited volume on vocational interests by Savickas and Spokane (1999) for *Contemporary Psychology*. I will repeat what I said about the self-report measures of ability, confidence, and efficacy because essentially nothing has changed over the past decade. In an otherwise glowing review, I was critical of a few chapters:

> With respect to applied applications, it is fine to build subjective (self-report) estimates of confidence or self-efficacy, and these are likely to be helpful in counseling, but it is important to keep in mind the strong shoulders that counseling psychology stands on (Brayfield, [1961], 1962; Dawis, 1992, 1996; Paterson, Schneidler, & Williamson, 1938; Tyler, 1964, 1974; Williamson, 1965). For example, the applied utilities of subjective appraisals need to be assessed in the context of objective indicators of the abilities under analysis, and in conjunction with meaningful outcomes, for empirically documenting the *unique contribution* of these "new kids on the block" (Dawis, 1984, p. 467). I fear that some self-report measures of human capability may not add incremental validity to external criteria, over and above preexisting measures of abilities and interests. Examining this possibility is needed, given the amount of redundancy running through psychological assessment tools (Dawis, 1992, p. 16; Sanders, Lubinski, & Benbow, 1995).
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> Finally, when modeling intervention outcomes, it is important to stress comprehensive assessment to avoid misspecification or errors of underdetermination in purported causal systems. Some writers come perilously close to fostering what Williamson (1965) referred to as a "truncated form of vocational assessment" (p. 140). Surely two students with commensurately low levels of self efficacy for realistic occupations (at the professional level) are approached quite differently by counselors if one has the ability to visualize in three-dimensional space in the top few percentage points, whereas the other is in the bottom quartile of the general population (other things being equal). Of course, all well-trained counselors realize this—Strong (1943, p. vii) stressed this point in the first paragraph of his Preface—but *Vocational Interests* is relevant to a much broader audience of applied and basic scientists. So, I would have liked a bit more caution exercised when psychological appraisals (for something as important as educational or vocational choice) are restricted to one medium. (Lubinski, 2001, pp. 84–85)

To document why counseling psychologists need to incorporate objectively assessed cognitive abilities (rather than relying on subjective estimates) when evaluating measures and models purporting to explain choice, performance, and persistence in educational and occupational settings, I review some important longitudinal findings on the relationships between general and specific abilities and educational–occupational prestige (level) and type (field or domain). Cognitive abilities and interests both have value for longitudinal prediction of educational–vocational life record data; it is curious, therefore, that we have yet to determine whether self-reports of ability, confidence, or efficacy add value to such forecasts. Moreover, criteria for judging scale validation and model testing should place a premium on the use of life record outcomes rather than self-reports of expectations and goals. That is more compelling, albeit long term. Finally, of all the research stimulated by SCCT, STEM (science, technology, engineering, and mathematics) is by far the most active and popular content domain (cf. Armstrong & Vogel, 2009, p. 394; Lent et al., 2008; and references therein). Over the past 2 decades, hundreds of pages in *Journal of Counseling Psychology* and *Journal of Vocational Behavior* have been devoted to SCCT-stimulated research on the determinants of choice, performance after choice, and persistence in STEM. Authors of these articles frequently acknowledge cognitive abilities but have failed to incorporate them along with interests in systematic ways in conjunction with SCCT measures. This practice is particularly hazardous when interventions are developed to enhance confidence or efficacy without taking into account individual differences in learning rates and intellectual orientations assessed by objective abilities. Therefore, empirical

findings and tools for enhancing practice, research, and theorizing about STEM domains are offered to reinforce (a) that broader perspectives are needed and (b) why Armstrong and Vogel (2009, p. 393) maintained that Holland's types are "multifaceted constructs," which involve more than interests.

These considerations give rise to a series of wide-ranging issues addressed in the following five sections (from different perspectives): historical, empirical, philosophical, practical/concrete, and individual differences perspectives.

## A Historical Perspective

In the early development of vocational counseling, objective abilities were as central as any systematic source of individual differences for practice and research, and for good reasons (Dawis, 1992, 1996; Lubinski, 1996; Paterson, 1957; Tyler, 1974, 1992).[1] Over the years, however, utilizing objective ability assessments in counseling psychology (and objective performance criteria more generally) has waned considerably. Yet, such data are essential for practice, scale development, research, and theoretical modeling in educational settings and the world of work (Austin & Hanisch, 1990; Dawis, 1992, 1996; Gottfredson, 2003a). Brayfield (1961) and Williamson (1965) documented how early this trend began by expressing their concerns and calling for broader perspectives.

> I have the impression that vocational counselors neglect to inform themselves on the rich materials and the differing points of view available to them in the study of personnel and industrial psychology. That is, they may be neglecting aspects of reality about which we have at least a modest stock of scientific information. I believe that this has happened in part because vocational counseling, these days, is putting a premium on satisfaction and de-emphasizing performance . . . . it results from a career-planning emphasis, which stresses occupational attachment rather than behavior on the job . . . . We need a healthy antidote of a performance-oriented industrial psychology to balance uncritical acceptance of the self-realization goal of counseling psychology . . . I am impressed (and depressed) by our lack of historical sophistication. I believe that knowledge of our historical antecedents may bring to light important research leads or hypotheses, that it will enhance our discrimination of current important contributions, and finally, that one of the joys of scholarship comes from the feeling of continuity with the past—in short, that an historical feel lends added significance and effectiveness to our daily efforts. (Brayfield, 1961, pp. 40, 42–43)

> We counselors are in grave danger of being indicted as not caring about excellence in intellectual matters. I do not conclude that we are anti-intellectual; but we clearly have been charged with being anti-intellectual, perhaps because we do not explicitly and overtly converse about things intellectual. Rather, we seem to focus our efforts on things affective . . . . In some circles counseling is restricted to psychotherapy with regard to technique and self-perception. This may prove to be but another way of saying that we do not yet deal with the whole child, but only with parts he wants us to deal with . . . . man is not only a feeling animal but a thinking animal, and his thinking can be as distorted as his feelings. (Williamson, 1965, pp. 194–195, 210)

At this point in time, one may justifiably ask, What improvement, if any, do self-report measures developed in vocational counseling in the past 30 years offer over traditional measures of abilities and interests in helping clients gain a realistic appraisal of how they are likely to find and perform in contrasting learning and work environments? A critic may also ask, To what extent has meaningful theoretical development occurred for conceptualizing educational–vocational choice, performance after choice, and persistence with models and validation procedures that do not incorporate objective ability assessments and interests? To be clear, I am not saying that self-report measures of competence, confidence, and efficacy do not assess meaningful individual differences relevant to client understanding and theory development beyond ability and interests in learning and work settings. Rather, I am making the point that we do not know whether they capture criterion variance in meaningful outcomes not already explained by traditional ability and interest measures. Abilities and interests are deeply relevant to educational and occupational outcomes; they denote the familiar "can do" and "will do" aspects of vocational counseling (Dawis, 1992; Gottfredson, 2003a; Tyler, 1974). To judge the value of and place for innovative scales, and how they can be best used, we must measure them against what we already have.

Obviously, people have the ability to do and are confident in their capacity to perform many things that they are not interested in (and vice versa). One goal of counseling is to ensure that clients and students have critical information and realistic appraisals. Moreover, because life is ipsative, it is important to have reliable information on relative strengths (and weaknesses) in capabilities and passions. This is the perspective Strong (1943) had when he launched his outstanding program of research on interest measurement. Aware of the importance of ability measures for understanding behavior in school and work settings, for example, he argued for complementary determinants beyond ability. In the first paragraph of arguably the most important book on vocational interests, Strong (1943, p. vii) stated,

> Time and money are often wasted trying to prepare youths for careers which they or their parents desire today but not tomorrow, and for which too often the young people have no ability. Ability and interest are both involved in vocational choice. The literature is voluminous regarding ability, even though much needs to be added. On the other hand, until just recently there has been very little on the subject of interest.

Subsequently, Strong went on to develop one of the most outstanding research programs in the history of applied psychology.[2]

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[1] Berdie, Layton, Swanson, and Hagenah (1963, p. 9) wrote

> if a priority can be assigned, the topic to receive first place would be "individual differences." . . . Each pupil, regardless of abilities, his current adjustment, or his plans and ambitions, deserves an opportunity to have the fullest possible knowledge concerning his own abilities.

See also Wrenn (1949, 1959). In Hobbs's (1958, p. 598) classic, "The Compleat Counselor," he stressed, "The compleat counselor will also be asked to help in the development of new generations of people trained to levels commensurate with their abilities." Also examine Dawis (1992, 1996, 2001), Pressey (1946, 1955), Roe (1953, 1956), and Tyler (1964, 1974, 1992).

[2] It is worth noting that Strong's (1943) research program was more manageable in that objective assessments of cognitive abilities manifest only small correlations with educational and vocational interests, if any; so when research shows that both abilities and interests predict external accomplishments and choices in education or work, abilities and interests are almost guaranteed to afford incremental validity relative to each other. On the other hand, Armstrong and Vogel (2009, p. 395) reported meta-analytic findings that suggest an overall correlation between interests and self-efficacy of .59; objective and subjective assessments of competencies will covary to the extent that they are reality based, albeit far from unity.

Although the importance of ability is frequently mentioned in SCCT articles and attendant literature (Armstrong & Vogel, 2009, p. 393) and is clearly distinguished from self-reports of competencies (Lent, Brown, & Larkin, 1984, p. 360), studies rarely examine the value added by or unique utility of self-report measures of competencies relative to objective measures of ability and educational–vocational interests (Gottfredson, 2003a; Lubinski, 2001). After years of research, we still do not know what self-report measures of skills competency and self-efficacy afford relative to abilities (objectively assessed) and interests (subjectively assessed). Surely we all know that there is a difference between what people report they can do and what they actually can do? Marked discrepancies (in both directions) underscore one of the many reasons why counseling psychology is needed. Yet, interventions are recommended for teaming interests and self-efficacy appraisals of capability—based on self-reports—without assessing abilities objectively or indicating that doing so might be important. This I found troubling. The literature reviewed by Armstrong and Vogel (2009, pp. 392–395, pp. 404–406) provides the background for why an augmented commentary is needed. Indeed, frequently simply the covariance structure among self-reports of competencies, efficacy, and interests are examined. Or, different self-report instruments are teamed to predict self-reports of educational and vocational intentions (rather than objective accomplishments). When self-reported competencies, efficacy, and interests reveal incremental validity in the prediction of intentions relative to each other, it is argued that all are needed in counseling practice. Neither objective outcomes nor objective abilities are regularly consulted.

## An Empirical Perspective: Predicting Educational–Occupational Level and Type

Following Brayfield's (1961) recommendation to incorporate findings from industrial psychology, occupational classification systems are usefully organized in terms of prestige, and the reliability of people's rankings of occupational level or prestige is in the .95–.98 range across age, sex, socioeconomic status (SES), and even country of the rater (F. L. Schmidt & Hunter, 1998, 2004). These occupational ratings covary in the .90–.95 range with average general intellectual ability scores of people in these occupations. Individual-level correlations drop to the mid .60s but rise to the low .70s when disattenuated (F. L. Schmidt & Hunter, 2004, p. 163). Similarly, for educational level, the number of years of education is correlated with general cognitive ability at .60–.70. Kuncel and Hezlett's (2007) meta-analysis on achievement and persistence outcomes among graduate students as a function of cognitive ability is also impressive.[3] Objectively assessed cognitive abilities account for substantial variance in educational–vocational choice, performance after choice, and persistence to be neglected (Gottfredson, 1997, 2003a).

F. L. Schmidt and Hunter's (1998) meta-analysis is particularly cogent because they assembled 85 years of personnel research, and their analysis shows that general cognitive ability reliably forecasts job performance, with predictive validities ranging from .20 to .60 as a function of job complexity or prestige (see also Judge, Higgens, Thoresen, & Barrick, 1999). Longitudinal findings on the gravitation hypothesis are especially compelling in revealing that employee migration up and down the occupational prestige hierarchy (persistence) is due in large part to individual differences in general cognitive ability (Wilk, Desmarais, & Sackett, 1995; Wilk & Sackett, 1996). These data are solid and require the attention of all psychologists interested in development, learning, and performance in schools and at work.[4]

Furthermore, to support causal inferences based on individual differences, powerful methodologies exist for uncovering the determinants of outcomes like educational attainment, occupational level, and social mobility. For example, by analyzing ability differences among siblings (Jensen, 1980; Lubinski, 2004; Murray, 1998; F. L. Schmidt & Hunter, 2004) and between parents and their children (Waller, 1971), it is possible to ascertain the extent to which family members diverge in educational and occupational outcomes as a function of cognitive ability (while controlling for SES). These designs are compelling because they control for SES without the methodological limitations associated with partial correlations (Humphreys & Parsons, 1977; Kahneman, 1965). Partialing out a third variable from predictor–criterion relationships risks

[3] For further documentation, the following sources are provided: "The general mental test stands today as the most important technical contribution to the practical guidance of human affairs" (Cronbach, 1970, p. 197); "[A general] intelligence test is the single most important test that can be administered for vocational guidance purposes" (Humphreys, 1985, p. 211); and "Almost all human performance (work competence) dispositions, if carefully studied, are saturated to some extent by the general intelligence factor *g*, which for psychodynamic and ideological reasons has been somewhat neglected in recent years but is due for a comeback" (Meehl, 1990, p. 124). Additionally,

> The great preponderance of the prediction that is possible from any set of cognitive tests is attributable to the general ability that they share. What I have called 'empirical *g*' is not merely an interesting psychometric phenomenon, but lies at the heart of the prediction of real-life performances. (Thorndike, 1994)

After reviewing decades of research on Trait × Treatment interactions, Snow (1989, p. 22) concluded,

> Given new evidence and reconsideration of old evidence, [*g*] can indeed be interpreted as "ability to learn" as long as it is clear that these terms refer to complex processes and skills and that a somewhat different mix of these constituents may be required in different learning tasks and settings. The old view that mental tests and learning tasks measure distinctly different abilities should be discarded.

And finally, Campbell (1990, p. 56) stated, "General mental ability is a substantively significant determinant of individual differences in job performance for any job that includes information-processing tasks." Just as many vocational psychologists have conceptualized vocational interests as an aspect of personality, several personality theorists (Cattell, Hathaway, Meehl) have viewed cognitive abilities as aspects of personality, too (cf. Lubinski, 2004).

[4] Frank Schmidt's work has stressed the central importance of general intellectual ability and downplayed specific abilities for predicting work performance. But for the prediction of *group membership* (e.g., conferred educational degrees in specific majors, occupations, and creativity in the humanities vs. STEM), mathematical, spatial, and verbal specific abilities add value to assessments of general cognitive ability, and they also manifest incremental validity relative to each other (Lubinski, 2004; Wai et al., 2009). For a discussion on the complementarities of test validation procedures based on predicting *group membership* versus predicting *individual differences in performance*, see Humphreys et al. (1993).

removing covariance due to a genuine causal relationship, a methodological shortcoming known as the *partialing fallacy* (Meehl, 1970, 1971). Multiple within-family studies suggest that cognitive ability is a dominant determinant in educational and occupational level and achieved SES (Lubinski, 2004; Murray, 1998; Waller, 1971; see also Sackett, Kuncel, Arneson, Cooper, & Waters, 2009).

The magnitude of these educational and occupational outcomes is documented here in the context of powerful methodological tools because, again, "if you are concerned with improving the output of some complex system, you must study the component that produces the largest variance first" (Jenkins, 1981, p. 224).

As these studies illustrate, if the focal aim is ultimately to understand meaningful behaviors and outcomes in education and the world of work, criterion domains outside of self-report appraisals are needed. Cattell (1957) maintained that to approach a comprehensive understanding of human accomplishments and development, data from at least three sources are needed: T-data (tests: cognitive abilities), Q-data (self-report questionnaires: interests), and L-data (life record: educational and occupational outcomes). Utilizing all three types of data, among other things, attenuates the likelihood of misinterpreting covariance due to shared method as substantively meaningful for the focal constructs under analysis (Hoyt, Warbasse, & Chu, 2006). When abilities and interests are combined to forecast educational and occupational outcomes over protracted longitudinal intervals, they not only evince incremental validity, relative to each other, but the results are impressive (Austin & Hanisch, 1990; Gottfredson, 2003a; Lubinski & Benbow, 2006). And these findings provide a baseline for future advances. Not to be overly pessimistic about sorting out Armstrong and Vogel's (2009) speculations about the temporal priority of self-efficacy expectations versus RIASEC interests in the stream of development, but the extensive research programs inspired by Cattell's (1971) investment theory have yet to determine whether individual differences in specific abilities (mathematical, spatial, verbal) are derived from fluid intelligence plus interests, or whether specific abilities have unique antecedents relative to fluid intelligence and interests. Nevertheless, we can still use measures of these attributes meaningfully in applied and basic research settings, because general and specific abilities and interests are relatively stable individual differences, constituting aspects of personality (Bouchard & Loehlin, 2001; Lubinski, 2000, 2004), and each captures unique variance in and holds prophecy for outcomes that matter in life.

There are huge individual differences across and within institutions in terms of student capability (cf. Benbow & Stanley, 1996, p. 251; Williamson, 1965, pp. 112–113). And there are salient ability differences in level and pattern of ability in contrasting educational and occupational pursuits (Corno et al., 2002; Lubinski, 2000, 2004; Gottfredson, 1986, 2003a; Tyler, 1974; Williamson, 1965). Cognitive abilities drive individual differences in learning rates and occupational performance. They need to be assessed to help individuals calibrate realistic expectations and develop meaningful educational–career goals and life plans (Tyler, 1974, 1992). They also need to be assessed for incorporation into realistic models of educational–vocational choice, performance, and persistence.

Self-report measures of competency and self-efficacy may be most useful when students with the ability and interest requisites for a domain do not harbor commensurate competency beliefs or self-efficacy appraisals. In such instances, counselors could marshal normative data and engage in reality testing. Yet, this does not seem to be what is happening (e.g., see Armstrong & Vogel, 2009, pp. 392–395, 402–405; Lent et al., 2008; Luzzo et al., 1999; Nauta et al., 2002; and references therein for counseling and research suggestions).

## A Philosophical Perspective: Neglected Aspects and the Total Evidence Rule

In psychological research, use of complex multivariate statistics can sometimes veil the fact that an important psychological phenomenon is not under analysis; or, more cynically, their use can foster a "soothing illusion of quantitative rigor" (Meehl, 1978, p. 824). Some writers use philosophical jargon in the same way, but I promise that this is not what I am about to do. I shall introduce two concepts: The first is from logic, and the second is from the philosophy of science. Both are quite uncontested and highly germane to this discussion. Ellis (1928, p. 9) introduced psychologists to the *fallacy of the neglected aspect* years ago:

> The logicians point out that a cause of much incorrect thinking is what is known as the fallacy of the neglected aspect. Early students of certain diseases considered them to be due to hot weather or excessive rain—neglecting the activities of the fly or the mosquito in spreading the bacteria. Neglecting aspects of problems often hide variable agencies that must be understood before the problem can be solved.

As Castell (1935, p. 32) pointed out in his introduction of this fallacy, "There is a great difference between advancing irrelevant evidence and omitting relevant evidence." Subsequently, in part because theorists continued to ignore critical evidence, Carnap (1950, p. 211) formalized this fallacy as the total evidence rule: when evaluating the plausibility of a hypothesis or the verisimilitude of a theory, it is imperative to take into account all of the relevant evidence available. As reasonable as this recommendation seems, it frequently is not followed (Bouchard, 2009; Lubinski & Humphreys, 1997). The total evidence rule is a powerful concept, but according to Paul E. Meehl (personal communication, September 1991), it is the most ignored rule of inference among social scientists. It could be utilized more frequently in vocational counseling research, as well as the social sciences more generally (Bouchard, 2009; Lubinski, 2000). A concrete practical example might be useful at this point.

## A Concrete Perspective: Vocational Counseling and STEM Disciplines

Of all the domains targeted by SCCT and its various offshoots, STEM (science, technology, engineering, and mathematics) disciplines appear to be attracting an inordinate amount of attention (Armstrong & Vogel, 2009, pp. 392–395, 404–406; Lent et al., 2003, 2005; Lent, Lopez, & Bieschke, 1991; Nauta & Epperson, 2003; and references therein). This is understandable. Historically, many leaders in vocational counseling stud-

ied the individuality and opportunities required for developing talent in STEM (Holland, 1957; Roe, 1951, 1953; Super & Bachrach, 1957; Wrenn, 1949). Higher numbers of STEM innovators would allow the United States to compete better in world markets (American Competitiveness Initiative, 2006; Friedman, 2005; National Academy of Sciences, 2005). This helps develop my next point, as it underscores the importance of assessing level and pattern of key individual differences attributes when entertaining recommendations for counseling interventions. It also highlights how key individual differences operate (whether or not we choose to measure them).

Years ago, Donald Super chaired an important National Science Foundation (NSF) committee on scientific careers. Super assembled a distinguished team of counseling psychologists (Harold Papinsky, Anne Roe, Leona Tyler, and others) to conduct a literature review and issue recommendations for future research and theory construction on identifying and developing STEM talent. Their report is impressive for multiple reasons. Many of their conclusions and recommendations (Super & Bachrach, 1957), based on the empirical evidence available at the time, are supported by subsequent (Gohm, Humphreys, & Yao, 1998; Humphreys, Lubinski, & Yao, 1993; Humphreys & Yao, 2002; Smith, 1964) and modern longitudinal findings (Lubinski & Benbow, 2006; Park, Lubinski, & Benbow, 2007, 2008; Wai, Lubinski, & Benbow, 2009). Yet, many of their conclusions are neglected by contemporary research programs aimed at developing STEM talent.[5] Although Super and Bachrach (1957) did stress that exceptional general intellectual potential is characteristic of engineers and physical scientists at an early age, they also went on to stress specific abilities: mathematical reasoning and spatial ability. Moreover, they also noted the importance of scientific interests (RIASEC's investigative theme) but called for additional longitudinal research, in particular, following young adolescents over 10 to 15 years to ascertain how these and other personal attributes factor into differential developmental trajectories. Subsequently, John Flanagan launched Project Talent (Flanagan et al., 1962), which was expressly the kind of study that Super's NSF team had in mind.

Project Talent's initial data collection occurred in 1960, and it consisted of a stratified random sample of the nation's high school population. Students in the 9th through 12th grades were assessed on a wide range of tests and questionnaires over a 1-week period, and the entire sample included roughly 50,000 boys and 50,000 girls per grade level, for a total *N* of approximately 400,000. Included in the tests were a number of measures designed to assess cognitive abilities (e.g., general intelligence and specific abilities: mathematical, verbal, and spatial reasoning), information tests (on content areas including art, biology, engineering, journalism, and physics), and attitudes, interests, and personality traits. Project Talent also included longitudinal data taken 1, 5, and 11 years after graduation from high school (Wise, McLaughlin, & Steel, 1979). A recent study examined the 11-year follow-up data in Project Talent (Wai et al., 2009), focusing on those who reported their highest degree received (a bachelor's, master's, or doctorate) and their occupation as a function of general and specific abilities. These findings were then compared to contemporary findings to document the longitudinal stability of the level and pattern of the relationships uncovered over a series of *constructive replications* (Lykken, 1968, 1991).

There is consensus that cognitive abilities are hierarchically organized by a general factor supported by a number of specific abilities (Carroll, 1993; Corno et al., 2002; Snow, Corno, & Jackson, 1996; Snow & Lohman, 1989). Figure 1 graphs the general and specific ability profiles of students earning terminal degrees in various disciplines. Because highly congruent findings were observed for all four Project Talent cohorts (Grades 9 through 12), the cohorts were combined. High general intelligence and an intellectual orientation dominated by high mathematical and spatial abilities, relative to verbal ability, were salient characteristics of individuals who pursued advanced educational credentials in STEM. These participants occupy a region in the intellectual space defined by the dimensions of ability level and ability pattern different from participants who earn undergraduate and graduate degrees in other domains. Some important individual differences in Figure 1 are worth highlighting, because they are relevant to counseling psychologists interested in the development of STEM talent (as well as other talents).

First, there is an important general ability difference between the STEM educational groups and the non-STEM educational groups. In general, students who ultimately secure educational credentials in STEM domains are more able than those earning degrees in other areas, especially in nonverbal intellectual abilities. Moreover, there is another important difference between the STEM and non-STEM groups that relates to a specific ability pattern: For all three STEM educational groupings (and the advanced degrees within these groupings), spatial ability $>$ verbal ability—whereas for all others, ranging from Education to Biology, spatial ability $<$ verbal ability (with one exception: 4-year degrees in business). Adolescents who subsequently earned advanced educational credentials in STEM manifested a spatial–verbal ability pattern opposite that of those who ultimately earned educational credentials in other areas. This is informative for several reasons. Obviously, STEM disciplines place a premium on nonverbal ideation indicative of quantitative and spatial reasoning, but there are other important reasons for examining these differential ability patterns. The ability profiles revealed in Figure 1—namely, the spatial $>$ verbal ability pattern characterizing STEM and the spatial $<$ verbal ability pattern characterizing non-STEM disciplines—covary with motivational proclivities in education and the world of work. And these in turn are likely to have differential implications for commitment to developing expertise and persistence in STEM (Ackerman, 1996; Ackerman & Heggestad, 1997; D. B.

[5] At the most recent American Psychological Association convention (2009), I attended four symposia populated by counseling psychologists addressing the need to develop STEM leaders, and how critical it was to do so for our economic and social well-being. Not one participant mentioned the assessment of objective abilities, and interests were only lightly touched upon. For documentation of the exceptionality found in the ability/interests profiles of top STEM graduate students, see Lubinski, Benbow, Shea, Eftekhari-Sanjani, & Halvorson (2001); the uniformity of the male and female ability/interests/personality profiles stands out. The two-page description of how Microsoft went about building its research center in Beijing is also instructive (Friedman, 2005, pp. 266–267). It mirrors modern findings in the psychological sciences on the individuality and selectivity needed to identify STEM leaders (Lubinski & Benbow, 2006; Park et al., 2007, 2008).

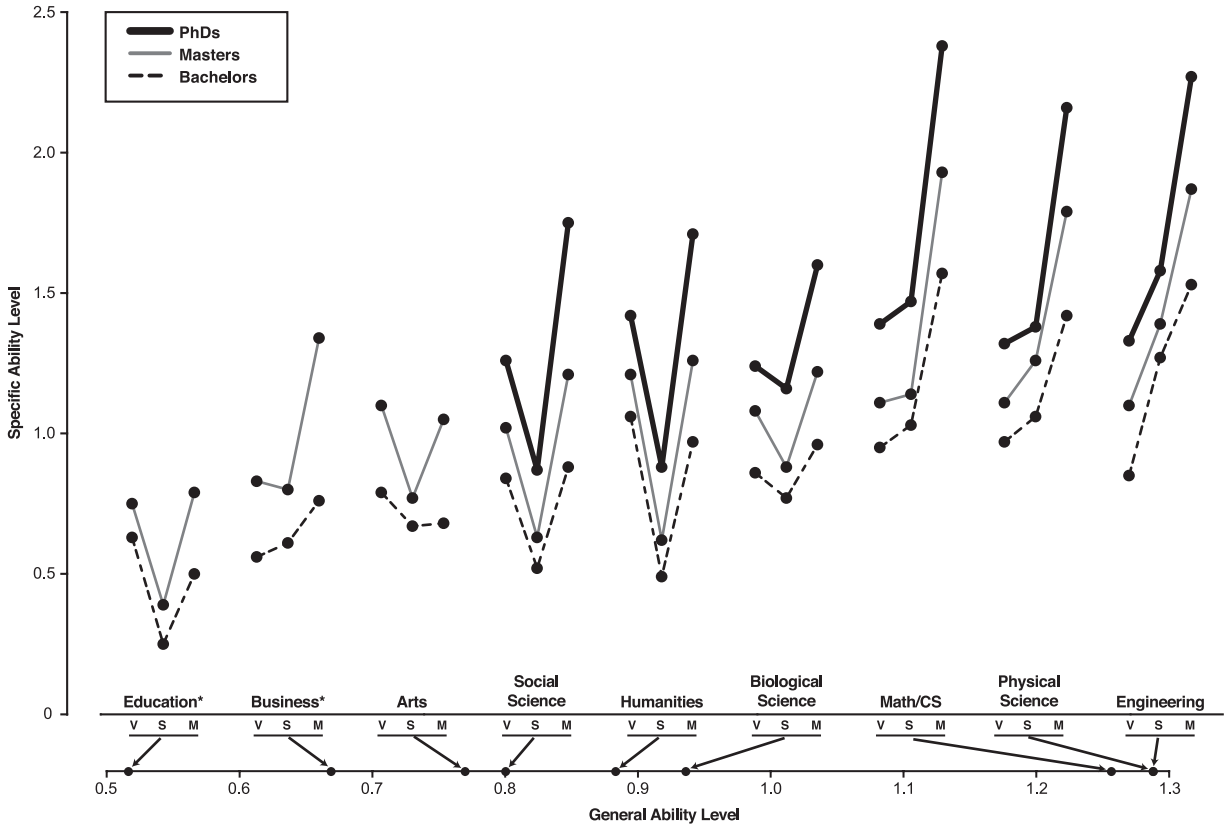


*Figure 1.* Average *z* scores of participants on verbal, spatial, and mathematical ability for terminal bachelor's degrees, terminal master's degrees, and doctoral degrees are plotted by field. The groups are plotted in rank order of their normative standing on *g* (verbal [V] + spatial [S] + mathematical [M]) along the *x*-axis, and the line with the arrows from each field pointing to it indicates on the continuous scale where they are in general mental ability in *z*-score units. This figure is standardized in relation to all participants with complete ability data at the time of initial testing. Respective *N*s for each group (men + women) were as follows for bachelor's, master's, and doctorates, respectively: engineering (1,143, 339, 71), physical science (633, 182, 202), math/computer science (877, 266, 57), biological science (740, 182, 79), humanities (3,226, 695, 82), social science (2,609, 484, 158), arts (615, 171 [master's only]), business (2,386, 191 [master's + doctorate]), and education (3,403, 1,505 [master's + doctorate]). * For education and business, master's degrees and doctorates were combined because the doctorate samples for these groups were too small to obtain stability ($N < 30$). For the specific *N* for each degree by sex that composed the major groupings see Appendix A in Wai et al. (2009).

Schmidt, Lubinski, & Benbow, 1998; Webb, Lubinski, & Benbow, 2007).

Verbal ability, for example, manifests positive correlations around .25 with educational–vocational interests in the humanities and social pursuits, whereas for spatial ability these correlations are of the same magnitude but opposite sign. Similarly, spatial ability manifests positive correlations around .25 with interests in engineering, mechanical, and realistic pursuits, whereas for verbal ability these correlations are of the same magnitude but opposite sign (Ackerman, 1996; Ackerman & Heggestad, 1997; D. B. Schmidt et al., 1998; Webb et al., 2007). Among people and groups who differ markedly in spatial versus verbal ability (viz., spatial ability >> verbal ability, or spatial ability << verbal ability), these small correlations of both signs eventuate in huge motivational differences in orientation toward educational and occupational opportunities for learning about and working with *people versus things* (Su, Rounds, & Armstrong, 2009) or *organic versus inorganic* subject matter (Lubinski & Benbow, 2006). This is only one example of a family of nonintellectual interest/preference/personality attributes that covary with specific abilities: Mathematical, spatial, and verbal abilities all have unique patterns of covariation across interest/preference/personality measures (Ackerman, 1996; Ackerman & Heggestad, 1997).

The point is that these ability/interest "trait complexes" (Ackerman & Heggestad, 1997), "aptitude complexes" (Snow, 1991), or "taxons" (Dawis & Lofquist, 1984) constitute the individuality that educational–vocational opportunities and counseling interventions fall on. They differentially attune individuals to contrasting affordances in education and the work of work (Corno et al., 2002; Lubinski, 1996). To the extent that two groups of individuals vary on specific abilities, distinctive psychological orientations are an-

ticipated. This is based in part on the educational–vocational interests that covary with them. This is highly congruent with Holland's (1966) view of "RIASEC types" as *multiattribute clusters*, which Armstrong and Vogel (2009, p. 393) documented with the following quote from Holland (1966, p. 10):

> Out of his experience, a person develops habitual ways of coping with the tasks presented by his psychological, social, and physical environment, including vocational situations. His biological and social heredity, coupled with his personal history, creates a characteristic set of abilities, perceptual skills and outlook, life goals, values, self-concepts (his image and evaluation of himself), and coping behavior (his typical methods of dealing with the problems of living). A type is then a complex cluster of personal attributes.

Objective ability assessments are critical for both understanding how "RIASEC types" operate as multiattribute clusters and ascertaining the uniqueness of the constituents of each type and how it operates in learning and work environments.[6]

Even with general intellectual ability held constant, different intellectual patterns of specific abilities are associated with different motivational tendencies (Lubinski, Webb, Morelock, & Benbow, 2001; Webb et al., 2007), different passions for personal fulfillment (Ackerman, 1996; Ackerman & Heggestad, 1997; Dawis & Lofquist, 1984), and different requirements for meaningful life (Lubinski, 1996, 2000; Lubinski & Benbow, 2000, 2006). Such groupings are composed of individuals who operate in somewhat different intellectual design spaces from each other (Lubinski, 2004); they see the world a bit differently (Lubinski, 1996; Scarr, 1996). Others have discussed contrasting constellations of personal attributes in the context of Snow's "two cultures" (Cronbach, 1957; Kimble, 1984; Lubinski, 1996, 2000). This might even relate to Dawis's (2001) idea that different constellations of individual differences at the extreme hold different values regarding epistemology (cf. Lubinski, 2000, pp. 433–436). Counseling psychologists interested in the development of STEM talent (and other talents) should not restrict assessments of individuality to general intellectual ability, a specific ability, or one or two of the major interest dimensions (e.g., Lapan, Boggs, & Morrill, 1989). A more comprehensive profiling is needed to understand educational choice, performance, and persistence, as well as how congenial one is likely to find interventions designed to foster affinities toward different learning and work environments (Bouchard, 1997; Scarr, 1996; Scarr & McCartney, 1983). An appreciation of key individual differences is also needed to fully understand the manifestation of optimal states of functioning that co-occur with positive learning experiences and performance.

Pressey's (1955) brilliant treatment of *furtherance*, for example, was designed in part to capture the developmental experiences of talented students operating in environments congruent with their individuality. But furtherance is a more general concept relevant to a broad range of individuals. *Furtherance* appears to anticipate other terms that denote positive emotional states: *peak experiences*, being *in the zone*, and *flow* (Lubinski & Benbow, 2000). These terms all appear to denote experiential happenings that co-occur with positive psychological development, learning, and performance engendered within an environment congruent with one's capabilities and passions: a good fit, an environment responsive to who we are, an environment sensitive to our individuality. This is also in line with White's (1959) classic formulation of efficacy, which was competency based. Among other things, this discussion highlights why, fundamentally, clients and students cannot be given experiences; they can only be given opportunities. Experiences result from the transaction between our environment and our individuality. This constitutes our uniqueness. The multidimensionality and scope of human psychological diversity should never be neglected when dealing with people from a psychological point of view (Cronbach, 1957; Dawis, 2001; Underwood, 1975).

The importance of assessing objective competencies makes Tyler's (1974, p. 5) remarks understandable:

> Engineers must learn mathematics. There are all degrees of ability to accomplish this: some people move with apparent ease from one level of mathematical competence to another and attain the highest levels in a reasonable space of time; some struggle valiantly with the essential concepts and eventually master them; others never get beyond simple arithmetic no matter how hard they try. It would be folly to insist that any boy or girl of eighteen be encouraged to enter and graduate from an engineering school if he or she wishes, without paying some attention to this essential factor of aptitude for advanced mathematical thinking. We need engineers who can design bridges and buildings that will stand.

Another reason that ability differences in level and pattern are reviewed here is because it was unclear to me in reading some SCCT-inspired research whether appropriate samples were being used in the development of self-efficacy interventions meant to enhance the likelihood of pursuing STEM domains. It does no good to design a study in response to the national need to develop more innovators in engineering that involves recruiting and studying samples of students unlikely to earn a degree in engineering

[6] John Holland knew of the importance of teaming general cognitive ability measures with interests. The same year he published his RIASEC theoretical statement (Holland, 1959b), he reported data on a classification of occupations that included three levels of intelligence (Holland, 1959a). Not unlike Roe's (1956) formulation, Holland's report organized the world of work around ability level (prestige) and type (or interests). Aware of this, 15 years ago when I was serving as a Guest Editor for a special issue of *Psychology, Public Policy, and Law*, "Applied Individual Differences Research: Its Quantitative Methods and Its Policy Relevance," I sent Holland an article to review. It was Dawis's (1996) contribution, "Vocational Psychology, Vocational Adjustment, and the Workforce: Some Familiar and Unanticipated Consequences." Holland's review was glowing, and it motivated me to call him personally. Knowing his awareness of the importance of cognitive abilities for vocational choice and performance after choice (Holland, 1957, 1959a), I could not resist asking him why he never incorporated cognitive abilities into his empirical research and modeling. Others who knew the late John Holland better than I did won't be surprised to learn that his response was candid and forthcoming. Paraphrasing, he said, "Well, in terms of a comprehensive theory of vocational development, Dawis and Lofquist's [1984] theory has more going for it than mine; they are closer to the truth, but it will never catch on because it's too complex." Let me stress that Holland simply stated this as a matter of fact; he was not at all self-indulgent or implying that this is how it should be; it was just the way it was. Although I am an admirer of Holland's work and have incorporated it into my own research (Lubinski & Benbow, 2000, 2006), vocational counseling practice, research, and theorizing can handle more complexity (cf. Maier, 1960).

given their interest profile and ability level and pattern.[7] Realistic expectations are sometimes mentioned in this literature (Lent et al., 1994, p. 101), but seldom are they stated explicitly and rarely, if ever, are they documented in longitudinal studies. Outcome expectations should be clearly stated as well. There are profound differences between STEM literacy, STEM expertise, and genuine STEM leadership. What researchers are hoping to accomplish through interventions for enhancing self-efficacy, for example, could be explicated better in future research.[8]

## An Individual Differences Perspective

Counseling psychology is full of strong advocates for various positions. This is understandable because maximizing opportunities for clients and providing them with valid information and models to facilitate their decision making and self-understanding is our business. But to focus on one kind of attribute and to neglect another of proven importance does not constitute application based on sound science. Although cognitive ability assessments have great potential to identify talent in the most unlikely places, they also have the potential to dampen enthusiasm for some pursuits. Should such data be shared with clients (Horst, 1959)? Should it even be collected? When is it reasonable to share with clients multiple lines of evidence from multiple levels of analysis (Meehl, 1974–1975)? These are important issues, because taking an equal-opportunity perspective with a regnant focus on scientific information does not always eventuate in equal outcomes (Ceci & Papierno, 2005).

For example, mathematically gifted (top 1 in 100; Benbow, Lubinski, Shea, & Eftekhari-Sanjani, 2000) and profoundly gifted students (top 1 in 10,000; Lubinski, Webb, et al., 2001) earn doctorates at 25 to 50 times base rate expectations, respectively, for the general population. These men and women earn commensurate proportions of advanced degrees; yet, the women are more represented in the bio-social sciences, medicine, and law, whereas the men are more represented in engineering and the physical sciences. This outcome would be anticipated from gender differences in interests in people versus things (Su et al., 2009) and contrasting differential strengths in verbal versus spatial ability (Deary, Penke, & Johnson, 2010; Geary, 2010; Hedges & Nowell, 1995; Wai et al., 2009). Most importantly, these women have exceptional careers; so do the men. As well, 20-year longitudinal follow-ups reveal that these men and women are equally satisfied with their choices and just as successful on objective and subjective indicators (Benbow et al., 2000; Lubinski, Benbow, Webb, & Bleske-Rechek, 2006). Is this a problem? It is not a scientific problem, because this is not a scientific issue; it is a query concerning values (Dawis, 2001; Wells, 1937). Value suppositions operate in this literature, so it is important that they not be neglected (Scarr, 1993; Webb, Lubinski, & Benbow, 2002). From an individual differences point of view with regard to vocational counseling (Dawis, 1992; Tyler, 1974, 1992; Williamson, 1965), whether mathematically talented individuals invest their intellectual acumen as environmental lawyers to save a precious forest or to publish an article in *Science* about the physical universe is immaterial; what is important is that they have the opportunity to choose.[9] Leona Tyler, arguably the most distinguished counseling psychologist of the past century, offered the following remarks:

> In our haste to abolish the unjust and the obsolete, we cannot afford to ignore the psychological realities that generated such systems in the first place. There are highly significant psychological differences among individuals, and the soundness of our social institutions depends upon how successfully we take them into account . . . . A complex society cannot regard its members as identical interchangeable parts of a social machine. Its complex functioning depends upon the contributions of individuals specializing along different lines, equipped for carrying out different specialized tasks . . . . For this reason we must not be content with any system of universal education that provides identical treatment for all pupils. We must look for ways of diversifying education to make it fit the diverse individuals whose talents should be developed and utilized. (Tyler, 1974, pp. 6–7)

Taking an individual differences perspective of course is only one aspect of a broader perspective:

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[7] Some research with reasonable samples is also noteworthy. For example, Nauta and Epperson (2003) studied a sample of high school girls longitudinally over a 4-year period. They were interested in ascertaining whether STEM outcome expectations were associated with plans to become a STEM leader. In their discussion, they appropriately note that this sample had ACT scores indicating that they were quite talented, and their interest in science surpassed the national average by a wide margin as well. They go on, "Because we studied a select group of high school women, the results of our study cannot be extended to high school girls in general" (Nauta and Epperson, 2003, p. 456). Now, certainly, if you are interested in conducting interventions for enhancing the desire to become a STEM leader, you would not begin by studying average or below average students in intellectual ability, nor students with modest or little interest in science (especially if the students had salient competencies and passion for other pursuits). They were studying the appropriate sample; because their criterion was highly selective (STEM leaders, a small subset of STEM professionals), they were justified in using a select sample in terms of ability and interests (see references in footnote 5). One of the most comprehensive SCCT and best studies I found regarding STEM was by Schaefers et al. (1997); they employed objective ability, interests, and SCCT measures in their investigation. They, too, discussed the significance of spatial ability for STEM domains (p. 181). However, their interest measure forced gender-balanced distributions of RIASEC interests, which suppresses important gender differences relevant to educational–vocational choice in STEM (Su et al., 2009).

[8] Like other experimental manipulations uncovered in the laboratory (Glass, 1968; Sackett, Hardison, & Cullen, 2004; Sackett, Schmitt, Ellingson, & Kabin, 2001), the practical import of innovative psychological concepts and measures needs to be determined in real-world settings before they can be recommended for practice (Hunt, 1999; Lubinski & Benbow, 1995). In addition, differences between experimental and control groups can be huge or miniscule depending on how they reflect base rate expectations in the general population; so, ideally, a normative point of reference is useful for interpreting the importance of experimental effects (both inside and outside the laboratory). For a difference to be a difference it must make a difference on some meaningful outcome. And "it is incumbent upon an investigator who advocates attention to a construct to demonstrate that the characteristic described is not adequately represented already" (Corno et al., 2002, p. 59). All too often innovative ideas such as emotional, multiple, practical, and successful intelligence find appeal but upon empirical scrutiny are found wanting (Brody, 2003a, 2003b; Gottfredson, 2003b, 2003c; Hunt, 1999; Lubinski & Benbow, 1995).

[9] To keep this commentary down to manageable dimensions, I do not address more molecular basic interest scales or the empirically keyed occupational scales available, but these are important aspects of interest measurement and should not be neglected. The literature reviewed herein primarily deals with RIASEC or general interests.

> The intellectual has one prime task to fulfill, first, last, and always. It is his job to search out the truth as best he can and to speak that truth. It is not the intellectual's primary calling, it is not his primary function, to draft political platform . . . . But it is the intellectual's special task—and this is what defines his role or should define it—to pursue the truth without compromise and without regard for his own or anyone else's interests. If intellectuals restrict their function of finding and speaking the whole truth in the service of any program or any political goals, no matter how praiseworthy the program or the goals may be, then those intellectuals are failing in their own unique task and, ultimately, in the most important political task they have. For I feel that political progress depends on how much of the truth we know, how clearly and boldly we speak it, and how great an impression it makes on other people. (Fromm, 1956, p. 116)

## Conclusion

There has been a great deal of activity in generating self-report scales in vocational counseling research, examining their empirical relationships, discussing how they might be teamed in practice, and theorizing about the developmental sequence of the attributes they assess. There have also been moves to erect theoretical frameworks based exclusively on self-report assessments of competencies, interests, and self-efficacy for conceptualizing educational–vocational choice, performance after choice, and persistence. Yet, activity does not always equal productivity in scientific understanding. To truly advance scientific knowledge, researchers need to assimilate the psychological knowledge already available—psychological knowledge that documents the prophecy that abilities and interests harbor for choices that are personally meaningful, for developing genuine competencies, and for identifying satisfying domains wherein positive development is likely to persist over the lifespan. This requires more than empirical research that statistically models how well subjective appraisals of "competencies," "self-efficacy," "outcome expectations," and "interests" in conjunction predict "persistence goals" or "intentions" (Armstrong & Vogel, 2009, p. 404)—all self-reports.

Failing to incorporate relevant empirical findings, measures, and methods and relying on monomethod appraisals (like self-reports of competencies, interests, and self-efficacy to predict educational and career expectations and goals) creates a house of mirrors, or a psychometric "spinning of internal roulette wheels" (Loevinger, 1957, p. 673). What is needed is to step outside of these internally consistent but, quite literally, self-absorbed frameworks and to evaluate innovative measures for what they afford in the prediction of educational and occupational outcomes beyond the teaming of cognitive abilities and interests. I suspect we would learn much because decades of longitudinal research have shown that these two classes of "can do" and "will do" attributes tell an important part of the story of educational–vocational choice, performance after choice, and persistence. Surely what people can do as well as what they feel are both related to their "vocational identity" (Armstrong & Vogel, 2009, p. 393; Holland, 1966, p. 12)? It would be interesting to see how self-efficacy and other more recently developed self-report measures fit into and possibly change this picture.

What better way to mark the 100-year anniversary of Parsons's (1909) *Choosing a Vocation*, the stimulus for psychological research in vocational counseling (Paterson, 1938), than by reinforcing (and reinstating) his first principle for making a wise vocational choice: "a clear understanding of yourself, your aptitudes, abilities, interests, ambitions, resources, limitations, and their causes" (Parsons, 1909, p. 5).

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