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RESPONSE

Tinsley on Holland: A Misshapen Argument

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In response to Tinsley (2000) we dispute his conclusions that congruence is a myth and the Holland hexagonal model lacks validity. We suggest that existing meta-analyses on the congruence–satisfaction relationship fail to account for significant sources of error, resulting in inaccurate conclusions. Tinsley's assertions concerning Holland's model are demonstrated to be based on a misunderstanding of Holland's hexagonal model and misrepresentation of Hubert and Arabie's inferential strategy for evaluating order relations. Once it is clear that Holland's model is a RIASEC order model (and not an equilateral hexagon) that enjoys strong support, Tinsley's argument fails.

Tinsley (2000) begins with a series of observations (spuriously called principles) that lead to the argument that there is little evidence to support the congruence–satisfaction relationship. Tinsley develops a litany of what he believes are problems with Holland's theory and the research approaches to Holland's theory that contribute to the congruence myth. His central explanation is that Holland's hexagonal model lacks validity. Because it is premature to dismiss Holland's congruence hypothesis, we first focus on reasons that earlier meta-analyses have failed to find significant congruence–satisfaction relations. We then discuss Tinsley's structural and statistical explanations and assertions concerning Holland's model.

In the present article, we begin by reviewing sources of error that influence congruence–satisfaction research findings. We then outline Tinsley's argument

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that Holland's hexagon is invalid. We show that, as a centerpiece for his assertion that Holland's hexagon is invalid, Tinsley uses a straw man (s/m) strategy, that is, gains an easy victory by first setting up a weak argument and then attacking it (*Webster's New World College Dictionary,* 1997). Next, Tinsley's misrepresentation of Hubert and Arabie's inferential strategy for evaluating order relations is discussed. We end by briefly reviewing research that supports Holland's circular order model. Once it is clear that Holland's model is a RIASEC order model (and not an equilateral hexagon) that enjoys strong support, Tinsley's argument fails.

CONGRUENCE–SATISFACTION: SOURCES OF ERROR

Tinsley argues that hexagonal congruence and satisfaction do not correlate significantly, based on his review of meta-analyses by Assouline and Meir (1987) and Tranberg, Slane, and Ekeberg (1993) as well as several studies published after those meta-analyses were completed. These meta-analyses, however, contain several misapplications of meta-analytic technique and are therefore an inadequate basis for Tinsley's conclusion. For example, Assouline and Meir (1987) included results from investigations that examined congruence and satisfaction in college or high school samples; we argue that such samples are irrelevant in the examination of congruence as it relates to person–environment (P–E) fit, given that for a college or high school student, "environment" is so varied an entity as to be unclassifiable. Tranberg et al. (1993) exclude unpublished studies from their analysis, and Tinsley in fact cites this exclusion as evidence that their results are more valid. Most texts on meta-analysis recommend the opposite tactic, however; the most rigorous meta-analyses are those that include all studies on a topic, regardless of methodological strength or publication status (Hunter & Schmidt, 1990; Rosenthal, 1991). The influence of method artifacts on effect size is then examined following the analysis. While both Assouline and Meir and Tranberg et al. mention the possibility of correcting effect sizes for the influence of artifacts, neither analysis does so.

The possible sources of error in a meta-analysis are many; those cited by Hunter and Schmidt (1990) include sampling error, error of measurement, dichotomization of continuous variables, range variation, and deviation from perfect construct validity. These artifacts can be corrected for at the meta-analysis level. Indeed, certain features present in many studies examining the relationship between congruence and satisfaction warrant such a meta-analytic approach. Several studies have used single-item job satisfaction measures, which have been shown to have reliability significantly lower than scale measures (Wanous, Reichers, & Hudy, 1997). Correcting for reliability in this case will result in increased estimates of effect size.

Moreover, range restriction of congruence and satisfaction is a frequent problem in this literature; Dawis (1991), discussing the prediction of satisfaction, wrote: "A number of explanations can be advanced to account for the mixed results found for interests. If . . . the subjects of follow up studies were survivors of a selection process, one might infer that in this process, the dissatisfied would have tended to leave, whereas the satisfied—and satisfactory—would have tended to remain. The restriction of range that would result could contribute to the lowering of the true correlations" (pp. 851–852). In other words, congruence–satisfaction research studies include people who are very similar to each other in their level of satisfaction. Their lack of variability is what shows in the low correlation statistic, not their lack of congruence.

The area perhaps of greatest concern in terms of the potential influence of artifacts involves the computation of congruence. Where Tinsley disputes the adequacy with which different methods of computing congruence represent Holland's theory, we are concerned with the multiple sources of potential error that are contained within an estimate of congruence. Because, by definition, congruence involves a match between a person and an environment, there are two opportunities for the introduction of error. The classification of individuals and environments into types, Holland or otherwise, is far from a perfect process. We suggest that a significant source of artifactual error in the computation of congruence coefficients may be caused by this classification. As reported by Gottfredson and Holland (1996), when two raters were asked to assign first-letter Holland codes to occupational titles, interrater agreement was at best 80%. Rounds, Smith, Hubert, Lewis, and Rivkin (1999) found that three raters agreed 70% upon the first-letter code of occupational titles and descriptions from the *Enhanced Guide for Occupational Exploration* (Maze & Mayall, 1995). Matching job titles to occupational titles in Holland's system is even more difficult, possibly leading to agreements between two raters of 60%. Researchers in this area typically neglect to report how occupational type assignment is conducted and virtually never investigate how the occupational classification process might influence reported relationships.

Two studies Tinsley cites as appropriate examinations of the congruence–satisfaction relationship, Tokar and Subich (1997) and Young, Tokar, and Subich (1998), demonstrate this problem. Although their sample reported a wide variety of occupational titles, the authors provided no information regarding how these occupational titles were assigned Holland types for use in the determination of congruence or the reliability/interrater agreement of such a coding process. Moreover, in our experience, job titles without a description of required duties often do not accurately represent the occupation (Rounds, 1981), and Holland codes for simple job titles can misrepresent the actual environment. As such, congruence presents a difficult variable for meta-analytic consideration and correction. Future studies should attempt to tease out the influence of these multiple artifacts for a more accurate picture of what the true relationship is between congruence and satisfaction.

TINSLEY'S ARGUMENT: THE HEXAGON IS INVALID

How does Tinsley get from the notion that congruence does not work to the idea that the Holland hexagon is invalid? From an initial misrepresentation of the basic premise, followed by selective representation of research, and clinched by specious statistical reasoning. Tinsley begins with a straw man (s/m) argument by declaring that Holland's model is an equilateral hexagon.

The faulty assumption of an equilateral hexagon is critical to progress toward a conclusion that Holland's structural model is invalid. Tinsley noticed that congruence performed poorly with well-validated instruments, leading to the suggestion that "the theoretical notions underlying the basic P–E fit model are valid, but that Holland's hexagonal model is not" (p. 21). The bases for this leap are a few studies selected by Tinsley that use some form of a congruence index based on the hexagon. Next, inferential statistical methods (a randomization test and confirmatory factor analysis) that are used to evaluate Holland's circular-order model (the calculus assumption) and "circumplex" structure (the equilateral hexagon) are dismissed because they are "biased tests that are conceptually flawed and [based] on subjective interpretations of ambiguous results from opaque multivariate procedures" (p. 25). After summarily rejecting inferential statistical tests, Tinsley recommended that these statistical tests be replaced by descriptive statistical tests.

Because evidence based on inferential statistical tests has now been summarily dismissed, we expected that Tinsley would recommend further structural studies. Surprisingly and with no reason given, he recommended that "further investigations of the hexagonal structure of the RIASEC dimensions are of little theoretical or practical usefulness" (p. 39). But if researchers do investigate RIASEC models, he recommended that we "eyeball" two-dimensional representations of the relations among the observed RIASEC scales to evaluate whether an equilateral hexagon fits the RIASEC data. A more stringent test that does not need quantitative training is Tinsley's "compass" test. The compass test involves centering the pointer of a compass on the point where the axes of a two-dimensional solution cross and then drawing a circle that goes through as many of the RIASEC points as possible. The primary advantage of the compass test seems to be its literal-mindedness. We would insist that a panel of experts should be also assembled to judge the results of the compass test and that interrater reliabilities be reported.

THE S/M ARGUMENT

Early on, Tinsley declares that Holland's model is an exact hexagon, which is his term for an equilateral hexagon or "circumplex" structure: "Holland's (1997) assertion that the relations among the six RIASEC personality (and occupational environment) types form an exact hexagon" (pp. 14–15). But this is an s/m argument that Tinsley sets up to demonstrate lack of supporting evidence.

To ascribe to Holland an equilateral hexagon is just false. Holland has never to our knowledge made an assertion that his RIASEC model is an equilateral hexagon. Holland's structural hypothesis is the calculus assumption stating that "The relationship within and between personality types or environments can be ordered according to a hexagonal model in which the distances among the types or environments are inversely proportional to the theoretical relationships between them" (Holland, 1973, 1985, 1997, p. 5). Dawis (1992) refers to Holland's calculus assumption as the RIASEC order or "circulatory" hypothesis. Similarly, Rounds, Tracey, and Hubert (1992) called Holland's structural hypothesis the circular-order model because types and environments are related to one another in roughly circular fashion according to the order R-I-A-S-E-C.

Nevertheless, Tinsley (2000) takes the same calculus assumption and parenthetically misidentifies it as an equilateral hexagon: "Why should we care if the distance between the six RIASEC types, when plotted in two-dimensional space, is inversely proportional to the theoretical relations between them (i.e., forms an equilateral hexagon)?" (p. 30). Is there room for different interpretations of the calculus assumption? We think not.

Holland has said on a number of occasions that the relations among types and environments form a "misshapen polygon" (e.g., Holland & Gottfredson, 1992). Here is what Holland (1997) recently has said on the topic of the form of the RIASEC model: "The key characteristics of the hexagonal model are the RIASEC order and the implied distances or relationships among the types . . . For instance, the Is and Es should be very different . . . Similarly, the Ss and Es and the other adjacent pairs of types are harder to distinguish from one another because they share some common characteristics" (p. 159).

If Holland never proposed the circumplex hypothesis, who did? Hogan (1983) probably first proposed the circumplex hypothesis. He discussed the theoretical correspondence between Holland's model and personality circumplex models (e.g., Stern, 1970; Wiggins, 1979). Fouad, Cudeck, and Hansen (1984) reported that a circumplex appeared to be a reasonable model accounting for RIASEC relations among types. More recently, Rounds, Tracey, and Hubert (1992) proposed two forms of the RIASEC model, the three- and one-parameter circumplex models. These circumplex models were an extension of Holland's formulations to a more precise model, allowing a more exact test. American College Testing (see Swaney, 1995) has an occupational map that displays occupations with an equilateral hexagon. But the important point is that Holland has never proposed or endorsed an equilateral hexagon. If Tinsley wants to criticize the equilateral hexagon, he should be correct in his attribution, that Hogan, Fouad, Cudeck, Hansen, Rounds, Tracey, Hubert, and Prediger, among others, extended Holland's RIASEC order model to a equilateral hexagon.

Finally, Tinsley goes on to claim that "Only the circumplex hypothesis adequately operationalizes Holland's theory" (p. 15). Tinsley seems to believe there are advantages to the circumplex. He does not explain these advantages. We see no particular advantage of the circumplex model compared to the RIASEC order model and believe that the order model would provide a better template with which to test congruence.

MISREPRESENTATION OF HUBERT AND ARABIE'S (1987) INFERENTIAL STRATEGY

Hubert and Arabie's inferential approach, like any strategy that evaluates model–data fit, has two aspects: (1) the presence of some index of fit (e.g., correspondence index) that assesses the degree to which the data corresponds to the theory and (2) some means (e.g., by randomization or whatever) for assessing the size of the observed index (and typically its nonzeroness). Hubert and Arabie's correspondence index (CI) is the model–data fit measure of the correspondence between Holland's hypothesized order relations and the observed order relations within a RIASEC correlation matrix. The correspondence index has a number of important properties: It is a normalized descriptive statistic indicating the degree to which the ordered predictions are satisfied; it varies from −1 to 1, with 0 indicating chance agreement or disagreement; and it has a probabilistic interpretation. The correspondence index is of the form,

$$\frac{A - D}{A + D + T},$$

where A is the number of order predictions met (agreements), D is the number of violations of the order predictions (disagreements), and T is the number of ties (the denominator, therefore, is the total number of order predictions in the case of the hexagon, 72).

The randomization test produces the exact probability that a correspondence index of the size observed or greater could have been produced by chance (which is operationalized by a random relabeling of the RIASEC objects). This inferential procedure, the calculation of an observed index of relationship and the comparison with randomness to obtain a p value for the index, is what is done all the time in statistics. Two examples should suffice:

a. In the two independent sample problem, the degree of difference is commonly measured by a (normalized) difference between the two sample means (effect size). To assess its nonzeroness we can use a randomization test, an evaluation of how likely the outcome would be given random assignment to the two groups. (Or as an approximation, the independent sample t test could be used.)

b. In relating two variables (x and y), the degree of association may be measured by the correlation (or its square). To assess nonzeroness (independence) we can do so by a randomization test and possibly reject the random assignment of the x's against the y's or the converse. (Or as an approximation to the latter, we might use the usual t test for a correlation.)

Tinsley confuses the use of a correspondence index with the randomization test for evaluating its significance, stating that "This is readily apparent in Figure 3, which depicts a two-dimensional representation of a RIASEC matrix judged by the randomization test to fit a circular order (see Fouad, Harmon & Borgen, 1997)" (p. 22). The randomization test does not assess "fit." We reject randomness, but the "fit" is measured by correspondence index. Tinsley again makes the same mistake, confusing the two aspects of a statistical test: "The finding that the model fits the observed correlation matrix better than most randomly generated correlation matrices provides no information about the absolute fit of the model to the data, nor does it test whether an alternative model would fit the data better than the hypothesized model" (p. 23). We agree. The randomization test is only intended for the "nonzero evaluation" or the rejection of nullity—not to measure absolute fit; that measure is represented by the correspondence index itself. But then, Tinsley reasons that "The conclusion is inescapable; the randomization test does not provide an adequate test of Holland's theory" (p. 23). The conceptual logic underlying the randomization test is not flawed; rather, it seems that Tinsley may misunderstand it.

CALCULUS ASSUMPTION: EVIDENCE

Holland's calculus assumption is supported overwhelmingly by research based on multiple methods. Here is a sample of that evidence:

1. The first demonstrations of Holland's RIASEC circular arrangement were based on principal components (Cole, Whitney, & Holland, 1971; Cole, 1973). Later, Prediger (1982) applied a principal components technique that extracts factors to fit a specified target matrix to 24 published correlation matrices from seven different RIASEC inventories. Prediger reported that the RIASEC circular arrangement was found for 23 of the 24 data sets.

2. Numerous RIASEC data sets have been evaluated with multidimensional scaling (e.g., Rounds, Davison, & Dawis, 1979; Swanson, 1992) and discriminant analysis (e.g., Donnay & Borgen, 1996; Tokar & Swanson, 1995). It is rare to find a spatial arrangement that does not support Holland's calculus assumption.

3. Rounds (1995) used a meta-structural analysis to integrate 60 RIASEC correlation matrices. A three-way multidimensional scaling yielded a two-dimensional representation showing that a RIASEC circular arrangement existed over the 60 matrices and that the interpoint distances among the six types met *all* 72 of Holland's order predictions.

4. Day, Rounds, and Swaney (1998) studied a sample of college-bound students who completed the UNIACT (Swaney, 1995). The sample included African Americans ($N = 2745$), Mexican Americans ($N = 1809$), Native Americans ($N = 2643$), Asian Americans ($N = 1959$), and White Americans ($N = 2454$). A three-way multidimensional scaling yielded a plot shown in Fig. 1 (also see Rounds & Day, 1999). The melting-pot plot is overlaid on a plot derived from a three-way multidimensional scaling of 77 U.S. RIASEC matrices (Rounds & Tracey, 1993). For purposes of the present paper, these MDS configurations show an R-I-A-S-E-C circular order with the plots close to

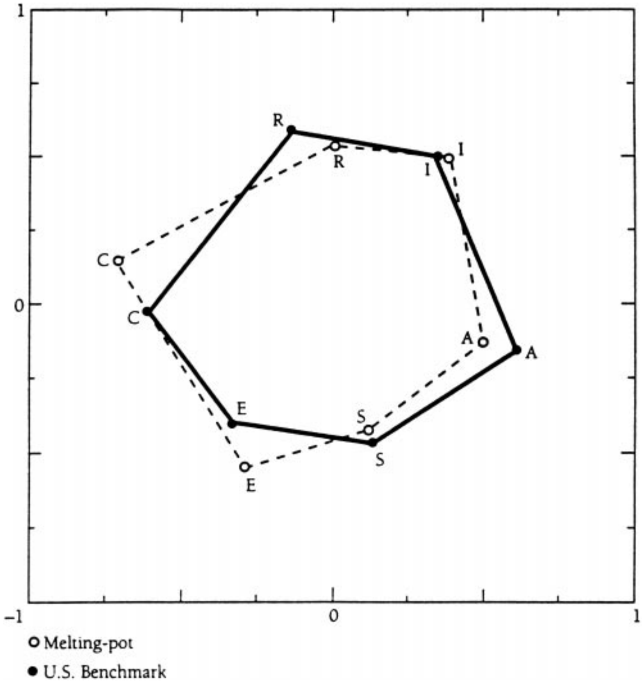

FIG. 1. Melting pot plot (Day, Rounds, & Swaney, 1998) and U.S. Benchmark plot; R, Realistic; I, Investigative; A, Artistic; S, Social; E, Enterprising; C, Conventional. (From "Prediger's dimensional representation of Holland's RIASEC circumplex." By J. Rounds and T. J. Tracey, 1993, *Journal of Applied Psychology,* **78,** p. 882. Copyright 1993 by the American Psychological Association. Also from "The structure of vocational interests for diverse racial ethnic groups." By S. X. Day, J. Rounds, and K. Swaney, 1998, *Psychological Science,* **9,** p. 44. Copyright 1998 by the American Psychological Society. Adapted with permission of the authors.)

representing an equilateral hexagon. Deviation from the equilateral hexagon occurs with a gap between the Conventional and the Realistic types.

In sum, Holland's calculus assumption shows a good fit to RIASEC correlation matrices. In fact, it is rare, as Dawis (1992) notes, to find a RIASEC matrix that does not display the circular ordering. This has also been our experience applying Hubert and Arabie's inferential strategy to U.S. matrices (e.g., Tracey & Rounds, 1993) but not to international samples (Rounds & Tracey, 1996).

CONCLUDING REMARKS

Tinsley's argument that congruence is a myth reminds us of the situation back in the 1970s when researchers argued that cognitive ability measures have small and nonsignificant relations with job performance (see Schmidt, 1988). Not until observed validities were adjusted for restriction of range, sampling error, and criterion unreliability were researchers able to have true estimates of ability–job performance relationships. We suggest that similar methods should be applied to the congruence–satisfaction relationship before dismissing congruence entirely as a useless concept.

What if the congruence–satisfaction relationship is trivial? If so, models using variables that mediate the link between congruence and satisfaction could be developed. We envision efforts similar to models that link attitudes to behavior (e.g., Ajzen & Fishbein, 1980). Another approach considering the value of the congruence concept is contained in Hoeglund and Hansen's (1999) suggestion that workers "have largely self-selected into fairly congruent occupations leaving other factors accountable for their satisfaction" (p. 181). They suggest that congruence–satisfaction is most important for initial selection into occupations rather than long-tenured jobs. Finally, a more radical approach would be to consider vocational interests (Holland types) as one of a number of work values related to satisfaction (Rounds, 1990). Nevertheless, the structural explanation offered by Tinsley for the lack of relationship between congruence and satisfaction is without merit.

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