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Brain Modules, Personality Layers, Planes of Being, Spiral Structures, and the Equally Implausible Distinction Between TCI–R "Temperament" and "Character" Scales: Reply to Cloninger (2008)

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In this reply the authors address comments by C. R. Cloninger (2008) related to their report (R. F. Farmer & L. R. Goldberg, 2008) on the psychometric properties of the revised Temperament and Character Inventory (TCI–R) and a short inventory derivative, the TCI–140. Even though Cloninger's psychobiological model has undergone substantial theoretical modifications, the relevance of these changes for the evaluation and use of the TCI–R remains unclear. Aspects of TCI–R assessment also appear to be theoretically and empirically incongruent with Cloninger's assertion that TCI–R personality domains are nonlinear and dynamic in nature. Several other core assumptions from the psychobiological model, including this most recent iteration, are nonfalsifiable, inconsistently supported, or have no apparent empirical basis. Although researchers using the TCI and TCI–R have frequently accepted the temperament–character distinction and associated theoretical ramifications, for example, the authors found little overall support for the differentiation of TCI–R domains into these 2 basic categories. The implications of these observations for TCI–R assessment are briefly discussed.

Keywords: revised Temperament and Character Inventory, TCI–R, TCI–140, psychometrics

In our original report (Farmer & Goldberg, 2008), we evaluated the psychometric properties of the revised Temperament and Character Inventory (TCI–R) and the TCI–140. We found that the TCI–R suffers from many of the same psychometric limitations as the TCI, an unsurprising outcome given the high proportion of common items. In his commentary, Cloninger (2008) criticized our analytic approach and conclusions while suggesting that (a) the theory underlying the TCI–R is different from the theories associated with the development of its predecessors, (b) linear statistical methods are inappropriate for evaluating the nonlinear and dynamic nature of TCI–R domains, and (c) temperament and character scales should be analyzed separately when correlational techniques are used to evaluate the TCI–R. Cloninger concludes by stating that "predictions of the psychobiological theory are strongly validated by extensive data from genetics, neurobiology, longitudinal studies of development, and clinical assessment" (p. 292). We address these criticisms and claims in this reply.

The Revised Psychobiological Theory and the TCI–R

Cloninger's (2008) description of the revised psychobiological theory made liberal use of concepts like matrix structure, five layers of personality, and planes and subplanes of being represented as a "three-dimensional spiral structure." These concepts, however, were not clearly described nor are we aware of research on them in relation to his psychobiological theory. Cloninger, for example, posited the existence of 25 brain-based modules that contain "most of the information about personality" (p. 294). Empirical support for this claim is not provided. Similar formulations in psychobiology and evolutionary psychology are controversial, with some arguing that the module concept is incompatible with known structural and functional aspects of the mammalian brain (Panksepp & Panksepp, 2000).

Nonlinear Dynamics

In an earlier description of the temperament–character distinction, N. M. Svrakic, Svrakic, and Cloninger (1996, p. 251) asserted that character domains mature "in a stepwise manner in incremental shifts from infancy through late adulthood," adding that "the timing and rate of transition between levels of maturity are nonlinear functions of antecedent temperament configurations, sociocultural education, and random life events." Character, then, is assumed to demonstrate nonlinear associations with temperament over the lifespan and is further hypothesized to unfold in a series of steps or "canonical sequences" (Cloninger, Svrakic, & Svrakic, 1997). From these assumptions, Cloninger has rejected the use of statistical approaches based on linear models for evaluating the TCI–R. In this section, we critically evaluate the empirical basis for these assumptions.

Temperament versus character and age. The TCI–R, like the TCI, is based on the assumption that there are seven principal domains of personality, some of which are regarded as *temperament* (Novelty Seeking [NS], Harm Avoidance [HA], Reward

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Dependence [RD], and Persistence [PS]) and others as *character* (Self-Directedness [SD], Cooperativeness [C], and Self-Transcendence [ST]). A prediction related to the nonlinear association of temperament and character is that character traits change with age and maturation, whereas temperament traits do not (D. M. Svrakic et al., 2002). Although moderate linear associations between age and character were initially reported (Cloninger, Svrakic, & Przybeck, 1993), subsequent studies have not demonstrated age-related differences in character. Cloninger (2004, p. 47) recently concluded that "the amounts of increase in character with age are small on average." We also observed this in the Eugene–Springfield community sample described in our initial report (Farmer & Goldberg, 2008). Correlations of age with SD, C, and ST were .14, .13, and .08, respectively. Modest or insignificant correlations were also obtained when age was correlated with the temperament domains: −.17, .00, .03, and −.11 for NS, HA, RD, and PS, respectively. Scatter plots of age with TCI–R domain scores did not reveal any nonlinear associations. Overall, the assumption that character domains are influenced differently than temperament domains by age was not supported.

The dissociation of HA and SD at higher levels of SD. To illustrate his claim of nonlinear dynamics of temperament and character, Cloninger (2004) has suggested

> High Harm Avoidance is closely related to low Self-Directedness . . ., but as Self-Directedness increases the two dimensions are dissociated. Consequently, no adequate theory of personality can be based on models that assume linearity and neglect the nonlinearity and matrix structure of personality development. (p. 102)

To test this assertion, we examined all pairwise bivariate scatterplots and found no evidence of nonlinear interdomain relations. We also fit linear, logarithmic, quadratic, and cubic functions to all joint distributions of temperament and character scale scores. In most instances, the linear function described the data as well or better than nonlinear models. Of the 48 functions fitted, the greatest discrepancy between linear and nonlinear models occurred with the association between HA and ST, where the linear model accounted for 1.2% of the variance and the cubic and quadratic models each accounted for 2.8% of the variance.[1] To specifically address claims about HA–SD relations noted above, we also divided the sample into three groups based on equal intervals of SD scale scores (Group 1 = 88–123; Group 2 = 124–158; Group 3 = 159–194). When HA–SD correlations were computed separately for each group, the obtained coefficients were −.23, −.32, and −.24, respectively. Overall, we found no evidence of nonlinear associations among any of the TCI–R temperament and character scale pairs.

Turner, Hudson, Butler, and Joyce (2003). Cloninger (2008) cited research by Turner et al. (2003) as illustrative of the limits of applying linear models to tests of his theory. This study initially sought to examine whether the seven TCI domains predicted regional cerebral blood flow among 20 healthy men. A regression analysis with the seven personality domains as predictors failed to find any significant associations. Data were then grouped into quartiles for each personality domain (5 participants per quartile). Pairwise post hoc comparisons indicated some significant differences in blood flow across quartile membership within each domain. The authors concluded that blood flow demonstrated nonlinear associations with TCI domains.

However, a regression analysis that evaluates seven predictors with only 20 participants is severely underpowered. Moreover, the practice of inferring nonlinear relations with only 5 participants per quartile grouping is also a risky business, particularly when no a priori predictions based on theory are offered in advance. Similarly, break points for establishing quartile boundaries will vary as a function of sample (particularly among small samples), thus severely limiting the generalizability of this study's findings. Furthermore, the division of data into arbitrary categories (e.g., median splits, quartiles) is theoretically inconsistent with the observation that TCI–R domain scores demonstrate a continuous rather than discontinuous distribution and only a very modest skew (range of skew for TCI–R domains = −.46 to .27; see Table 4 of Farmer & Goldberg, 2008). Finally, not mentioned by Cloninger (2008) in his commentary was a similar study by Sugiura et al. (2000). These researchers reported significant (linear) correlations between three TCI temperament domains and blood flow in several brain regions. In the aggregate, Turner et al. (2003) provided very weak evidence for nonlinearity of TCI–R dimensions.

A 4 + 3 or a 7-Factor Model? The Validity of the Temperament–Character Distinction

In the development of the TCI, the explicit goal was to create a measure of seven separate personality domains: "Studies of natural language provide evidence of seven dimensions of personality" (Cloninger et al., 1993, p. 976). Since 1997, Cloninger and his colleagues continue to refer to the psychobiological theory as "the seven-factor model" (e.g., Cloninger, 2006; D. M. Svrakic et al., 2002). They have also frequently extracted seven factors in tests of the validity of TCI and TCI–R (de la Rie, Duijsens, & Cloninger, 1998; Fossati et al., 2007). In Luby, Svrakic, McCallum, Przybeck, and Cloninger (1999), for example, confirmatory factor analytic methods were used to evaluate a youth version of the TCI based on the hypothesis that "items in each of the seven . . . dimensions constituted single factors" (p. 1132). In this section, we evaluate the validity of the temperament–character distinction and, correspondingly, Cloninger's (2008) assertion that factor analytic studies of the TCI–R should analyze temperament and character separately because of "their strongly nonlinear relationship" (p. 297).

Temperament Versus Character and Etiologic Development

In Cloninger (1987), the NS, HA, and RD temperament domains were theoretically associated with the dopaminergic, serotonergic, and noradrenergic neurotransmitter systems, respectively. Temperament was suggested to be largely biological, heritable, and unmodified by environmental events. Character features in contrast were regarded as "weakly heritable, but moderately influenced by social learning and cultural expectations about personal roles related to age, occupation, and other social circumstances" (N. M. Svrakic et al., 1996, p. 251).

Heritability. As Cloninger (2004, p. 46) now has conceded, "character was expected to be less heritable than temperament and

[1] Output from these analyses is available from Richard F. Farmer upon request.

more influenced by sociocultural learning and environmental influences. . .twin and genetic association studies now contradict this."

Genetics and neurochemical functions. Cloninger (2008) cited research that demonstrated associations among HA, serotonin-related activities, depression, and regional brain reactivity to fear. There are, however, several other studies that failed to support predicted associations between genetics, neurochemical activities, and temperament (Gerra et al., 1999; Kluger, Siegfried, & Ebstein, 2002; Suzuki et al., 2007). Furthermore, Hamer, Greenberg, Sabol, and Murphy (1999) found that the SD and C character domains (and not HA as predicted by theory) were most strongly associated with an inherited polymorphism that modulates serotonin transporter gene expression. In other research, HA and SD have been found to correlate negatively and positively, respectively, with serotonergic activity (Peirson et al., 1999). Cloninger (2008, p. 295) asserted that "average relations among temperament, neurotransmitters, and brain functions are usually weak or inconsistent unless there is careful attention to the specific temperament, specific type of neurotransmitter receptor, and specific location and connections among the brain regions." He did not, however, delineate these specifics nor offer predictions when certain conditions are met. Without such specification, the revised psychobiological model cannot be subjected to tests of empirical falsification, as no precise hypotheses can be formulated.

Summary. Cloninger (2008) has asserted that neurobiology differentiates temperament from character. Research findings, however, frequently fail to support hypothesized temperament and character associations with theoretically relevant neurobiological variables. For this reason, Paris (2005, pp. 160–161) recently concluded that "the claim that the Cloninger model is neurobiological is not justified by the existing evidence." More significantly for the evaluation of the TCI–R, the validity of the temperament–character distinction is not clearly supported by available neurobiological research.[2]

Temperament Versus Character and "Basic Affects"

N. M. Svrakic et al. (1996, p. 252) suggested that "emotions based on temperament are . . . basic because they are stimulated by underlying perceptual processes." In this theoretical paper that established Cloninger's framework for nonlinear dynamics, depressed mood was identified as a basic emotion linked to elevations in HA. Several studies, however, have reported that character scales are influenced by state depressed mood. In Hirano et al. (2002), for example, HA, SD, and C were correlated with depression rating scores, with SD demonstrating the largest association (*r*s = .34, −.42, and −.27, respectively). During antidepressant therapy, scores on each domain changed in a normative direction for treatment responders but not nonresponders.

TCI temperament and character scales often demonstrate similar levels of covariation with other temperament measures. In Akiskal et al. (2005), for example, TCI domain scores had the following median absolute correlations with five "affective temperaments" (cyclothymic, dysthymic, irritable, hyperthymic, and anxious): NS = .26, HA = .49, RD = .19, PS = .07, SD = .48, C = .32, and ST = .20. Such observations challenge Cloninger's (2008) assumption that TCI–R temperament scales assess "emotional style" and the character scales assess "rational cognitive processes."

Temperament Versus Character and Treatment Response

Cloninger et al. (1993, p. 988) suggested that "pharmacological interventions have been proposed in the modification of temperament" and "cognitive–behavioral techniques may facilitate learning self-directed behavior." More recently, however, Cloninger (2004, p. 43) partially conceded: "We found that temperament dimensions . . . changed little . . . with psychotherapy, or with pharmacotherapy!" Several studies, however, have suggested that effective therapies affect both temperament and character scores. Pharmacological interventions for depression (Hirano et al., 2002) or chronic tension headache (Boz, Gazioglu, Altunayoglu, & Hacaoglu, 2007) have produced desirable changes in both of the theoretically different types of scales. Similarly, psychosocial therapies for different conditions have been associated with significant pre- to posttreatment changes in both temperament and character domains (e.g., Borman et al., 2006; Dalle Grave et al., 2007).

Temperament Versus Character and Response Distortion

Cloninger (2008, p. 296) asserted that temperament scales "describe a person's emotional style without any prejudice about what is socially desirable or understandable about a particular individual." He further asserted that character scale means tend to be on the higher end of scale ranges because of "the tendency of people to recognize and endorse socially desirable behaviors" (p. 296) and concluded that the "character scales, but not the temperament scales, are strongly influenced by specific variables related to frequent rare responses, conformity to intermediate cultural norms, or acquiescence" (p.296). On different occasions, the Eugene–Springfield sample was administered the Multidimensional Personality Questionnaire (Tellegen, 1999), which includes a scale to assess response distortion (Unlikely Virtues), as well as the Balanced Inventory of Desirable Responding (Paulhus, 1991), which assesses self-deceptive enhancement and impression management. Table 1 presents the outcomes of a test of Cloninger's hypothesized distinctions between temperament and character in relation to these response-distortion indicators. As is evident from Table 1, we did not find support for his assertions.

Summary

Cloninger's psychobiological theory has undergone extensive revision (Cloninger, 2004), and the theory associated with the TCI–R is purported to be radically different from the theories that aided the development of earlier iterations of this inventory (Cloninger, 2008). Yet, the TCI and TCI–R are essentially the same measure, with a high proportion of items common to both inventories. Cloninger (2004) noted

[2] Putting aside questions concerning the validity of the temperament–character distinction, we separately factor analyzed temperament and character facet scales in the Eugene–Springfield sample. The solution for the character facets revealed that two subscales, SD4 (Self-Acceptance) and C2 (Empathy), loaded predominantly on factors defined by C and ST facets, respectively.

Table 1
Temperament and Character Inventory—Revised (TCI–R) Correlates With Putative Measures of Response Distortion

TCI–R domain	Response distortion indicator: MPQ Unlikely virtues	BIDR Self-deceptive enhancement	BIDR Impression management
Temperament domain			
Novelty Seeking	−.18***	.00	−.32***
Harm Avoidance	−.24***	−.48***	−.10**
Reward Dependence	.06	−.04	.10**
Persistence	.34***	.32***	.17***
Character domain			
Self-Directedness	.24***	.44***	.39***
Cooperativeness	.11**	.09*	.39***
Self-Transcendence	.07	−.03	.07

Note. *N*s vary from 651 to 654. MPQ = Multidimensional Personality Questionnaire; BIDR = Balanced Inventory of Desirable Responding.
* $p < .05$. ** $p < .01$. *** $p < .001$.

> I . . . was shocked to discover that the TCI scales of character provided quantitative measures of the subplanes of thought, even though the scales had been developed in 1993 before I had any idea of the matrix structure or the nonlinear dynamics of self-aware consciousness. Essentially the content of the subplanes of thought corresponded to specific TCI subscales of temperament, and the dynamics of thought in each plane corresponded to specific TCI subscales of character. (p. 101)

Overall, several core theoretical assumptions and predictions associated with the psychobiological model and TCI–R assessment are either nonfalsifiable, in conflict with each other, or not supported by empirical evidence. As suggested in our initial report (Farmer & Goldberg, 2008) and highlighted in this reply, there is little empirical justification for a core assumption of the psychobiological model and TCI–R assessment: the validity of the temperament–character distinction. Theoretical vagaries or inconsistencies place aspects of Cloninger's model in conflict or render them untestable. For example, research findings based on linear modeling (e.g., correlations, factor analysis) were cited by Cloninger (2008) as supportive of his psychobiological model and the theory of TCI–R assessment; at other times, however, such findings were interpreted as irrelevant based on the assumption of nonlinear dynamics. Although Cloninger in his commentary was at times critical of the methodology of studies that fail to support the assumptions underlying his theory, he was nonetheless silent about what would constitute an adequate test of the theory or what would be accepted as evidence in conflict with the theory. Also absent in Cloninger's commentary is (a) any description of how recent theoretical developments correspond to modifications found in the TCI–R; (b) a discussion of the implications of the revised theory for evaluating the reliability, validity, and hypothesized structure of the TCI–R; and (c) a provision of interpretative guidelines for TCI–R scores in light of the revised theory. Without such descriptions, the theory associated with the TCI–R remains unclear, as do the appropriate uses of the TCI–R and its interpretation.

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