Published in final edited form as:

Psychol Assess. 2008 September ; 20(3): 300–304. doi:10.1037/a0012932.

Brain Modules, Personality Layers, Planes of Being, Spiral Structures, and the Equally Implausible Distinction between TCI-R “Temperament” and “Character” Scales: A Reply to Cloninger

Richard F. Farmer and Lewis R. Goldberg

Oregon Research Institute

Abstract

In this reply we address comments by Cloninger (this issue) related to our report (Farmer & Goldberg, this issue) 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 non-linear and dynamic in nature. Several other core assumptions from the psychobiological model, including this most recent iteration, are non-falsifiable, 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, we find little overall support for the differentiation of TCI-R domains into these two 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, this issue), 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 (this issue) 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 non-linear 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.” We address these criticisms and claims in this reply.

Correspondence concerning this article should be addressed to Richard F. Farmer, Oregon Research Institute, 1715 Franklin Blvd., Eugene, Oregon 97403. E-mail: rfarmer@ori.org.

Publisher's Disclaimer: The following manuscript is the final accepted manuscript. It has not been subjected to the final copyediting, fact-checking, and proofreading required for formal publication. It is not the definitive, publisher-authenticated version. The American Psychological Association and its Council of Editors disclaim any responsibility or liabilities for errors or omissions of this manuscript version, any version derived from this manuscript by NIH, or other third parties. The published version is available at <http://www.apa.org/journals/pas/>

The Revised Psychobiological Theory and the TCI-R

Cloninger's (this issue) description of the revised psychobiological theory makes 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, are not clearly described nor are we aware of research on them in relation to his psychobiological theory. Cloninger, for example, posits the existence of 25 brain-based modules that contain "[m]ost of the information about personality." 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).

Non-Linear Dynamics

In an earlier description of the temperament/character distinction, 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 non-linear 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 rejects 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 principle domains of personality, some of which are regarded as "temperament" (novelty seeking [NS], harm avoidance [HA], reward dependence [RD], and persistence [PS]) and others as "character" (self-directedness [SD], cooperativeness [C], and self-transcendence [ST]). A prediction related to the non-linear association of temperament and character is that character traits change with age and maturation whereas temperament traits do not (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 (ESCS) described in our initial report. 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 domains scores did not reveal any non-linear associations. Overall, the assumption that character domains are influenced differently than temperament domains by age is not supported.

The dissociation of HA and SD at higher levels of SD—To illustrate his claim of non-linear dynamics of temperament and character, Cloninger (2004, p. 102) 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."

To test this assertion, we examined all pairwise bivariate scatterplots, and found no evidence of non-linear inter-domain 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 non-linear models. Of the 48 functions fitted, the greatest discrepancy between linear and non-linear 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 non-linear associations among any of the TCI-R temperament and character scale pairs.

Turner et al (2003)—Cloninger cites research by Turner, Hudson, Butler, and Joyce (2003) as illustrative of the limits of applying linear models to tests of his theory. This study initially sought to examine whether the 7 TCI domains predicted regional cerebral blood flow among 20 healthy men. A regression analysis with the 7 personality domains as predictors failed to find any significant associations. Data were then grouped into quartiles for each personality domain (5 subjects 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 non-linear associations with TCI domains.

However, a regression analysis that evaluates 7 predictors with only 20 subjects is severely underpowered. Moreover, the practice of inferring non-linear relations with only 5 subjects 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 our initial article). Finally, not mentioned by Cloninger in his commentary is a similar study by Sugiura et al. (2000). These researchers reported significant (linear) correlations between 3 TCI temperament domains and blood flow in several brain regions. In the aggregate, Turner et al. (2003) provide very weak evidence for non-linearity of TCI-R dimensions.

A 4 + 3 or Seven-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; 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 assertion that factor analytic studies of the TCI-R should analyze temperament and character separately because of “their strongly non-linear relationship.”

¹Output from these analyses is available from the first author upon request.

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" (Svrakic et al., 1996, p. 251).

Heritability—As Cloninger (2004, p. 46) now concedes, "...character was expected to be less heritable than temperament and more influenced by sociocultural learning and environmental influences...twin and genetic association studies now contradict this."

Genetics and neurochemical functions—Cloninger cites 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 (this issue) asserts that "average relations among temperament, neurotransmitter, 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 does 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 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"

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 non-linear 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 ($r_s = .34, -.42, \text{ and } -.27$, respectively). During antidepressant therapy, scores on each domain changed in a normative direction for treatment responders but not non-responders.

²Putting 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.

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 (this issue) assumption that TCI-R temperament scales assess “emotional style” and the character scales assess “rational cognitive processes.”

Temperament versus Character and Treatment Response

Cloninger and his colleagues (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, suggest 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-post treatment 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 (this issue) asserts 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 asserts 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,” and concludes 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.” 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 the Table, 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, this issue). Yet, the TCI and TCI-R are essentially the same measures, with a high proportion of items common to both inventories. Cloninger (2004, p. 101) notes:

“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.”

Overall, several core theoretical assumptions and predictions associated with the psychobiological model and TCI-R assessment are either non-falsifiable, in conflict with each other, or not supported by empirical evidence. As suggested in our initial report (Farmer & Goldberg, this issue) 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) are cited by Cloninger as supportive of his psychobiological model and the theory of TCI-R assessment; at other times, however, such findings are interpreted as irrelevant based on the assumption of non-linear dynamics. Although Cloninger in his commentary is at times critical of the methodology of studies that fail to support the assumptions underlying his theory, he is 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 does the appropriate uses of the TCI-R and its interpretation.

Acknowledgments

Funds for the second author were provided by Grant AG20048 from the National Institute on Aging, National Institutes of Health, U.S. Public Health Service.

References

- Akiskal HS, Mendlowicz MV, Jean-Louis G, Rapaport MH, Kelsoe JR, Gillin JC, et al. TEMPS-A: Validation of a short version of a self-rated instrument designed to measure variations in temperament. *Journal of Affective Disorders* 2005;85:45–52. [PubMed: 15780675]
- Borman PD, Zilberman ML, Tavares H, Surís AM, el-Guebaly N, Foster B. Personality changes in women recovering from substance-related dependence. *Journal of Affective Diseases* 2006;25:59–68.
- Boz C, Gazioglu S, Altunayoglu V, Hacaoglu C. Effect of serotonergic antidepressant therapy on temperament and character scales in patients with chronic tension-type headache. *Psychiatry and Clinical Neurosciences* 2007;61:534–542. [PubMed: 17875033]
- Cloninger CR. A systematic method for clinical description and classification of personality variants: A proposal. *Archives of General Psychiatry* 1987;44:573–588. [PubMed: 3579504]
- Cloninger, CR. *Feeling good: The science of well-being*. New York: Oxford; 2004.
- Cloninger, CR. Differentiating personality deviance, normality, and well-being by the seven-factor psychobiological model. In: Strack, S., editor. *Differentiating normal and abnormal personality*. 2nd. New York: Springer; 2006. p. 65-81.
- Cloninger CR, Svrakic DM, Przybeck TR. A psychobiological model of temperament and character. *Archives of General Psychiatry* 1993;50:975–990. [PubMed: 8250684]
- Cloninger CR, Svrakic NM, Svrakic DM. Role of personality self-organization in development of mental order and disorder. *Development and Psychopathology* 1997;9:881–906. [PubMed: 9449010]
- Dalle Grave R, Calugi S, Brambilla F, Abbate-Daga G, Fassino S, Marchesini G. The effect of inpatient cognitive-behavioral therapy for eating disorders on temperament and character. *Behaviour Research and Therapy* 2007;45:1335–1344. [PubMed: 17074299]
- de la Rie S, Duijsens IJ, Cloninger CR. Temperament, character, and personality disorders. *Journal of Personality Disorders* 1998;12:362–372. [PubMed: 9891290]
- Fossati A, Cloninger CR, Villa D, Borroni S, Grazioli F, Giarolli L, et al. Reliability and validity of the Italian version of the Temperament and Character Inventory-Revised in an outpatient sample. *Comprehensive Psychiatry* 2007;48:380–387. [PubMed: 17560961]

- Gerra G, Avanzini P, Zaimovic A, Sartori R, Bocchi C, Timpano M, et al. Neurotransmitters, neuroendocrine correlates of sensation-seeking temperament in normal humans. *Neuropsychobiology* 1999;39:207–213. [PubMed: 10343186]
- Hamer DH, Greenberg BD, Sabol SZ, Murphy DL. Role of the serotonin transporter gene in temperament and character. *Journal of Personality Disorders* 1999;13:312–328. [PubMed: 10633313]
- Hirano S, Sato T, Narita T, Kusunoki K, Ozaki N, Kimura T, et al. Evaluating the state dependence of the Temperament and Character Inventory dimensions in patients with major depression: A methodological contribution. *Journal of Affective Disorders* 2002;69:31–38. [PubMed: 12103449]
- Kluger AN, Siegfried Z, Ebstein RP. A meta-analysis of the association between DRD4 polymorphism and novelty seeking. *Molecular Psychiatry* 2002;7:712–717. [PubMed: 12192615]
- Luby JL, Svrakic DM, McCallum K, Przybeck TR, Cloninger CR. The Junior Temperament and Character Inventory: Preliminary validation of a child self-report measure. *Psychological Reports* 1999;84:1127–1138. [PubMed: 10477935]
- Panksepp J, Panksepp JB. The seven sins of evolutionary psychology. *Evolution and Cognition* 2000;6:108–131.
- Paris J. Neurobiological dimensional models of personality: A review of the models of Cloninger, Depue, and Siever. *Journal of Personality Disorders* 2005;19:156–170. [PubMed: 15899714]
- Paulhus, DL. Measurement and control of response bias. In: Robinson, JP.; Shaver, PR.; Wrightsman, LS., editors. *Measures of personality and social psychological attitudes*. Vol. 1. San Diego, CA: Academic Press; 1991. p. 17-59.
- Peirson AR, Huchert JW, Thomala L, Berk M, Plein H, Cloninger CR. Relationship between serotonin and the Temperament and Character Inventory. *Psychiatry Research* 1999;89:29–37. [PubMed: 10643875]
- Sugiura M, Kawashima R, Nakagawa M, Okada K, Sato T, Goto R, et al. Correlation between human personality and neural activity in cerebral cortex. *NeuroImage* 2000;11:541–546. [PubMed: 10806039]
- Suzuki A, Fukasawa T, Shiraishi H, Ishii G, Oshino S, Aoshima T, et al. No association between the TPH A218C polymorphism and personality traits in Japanese healthy subjects. *Progress in Neuro-Psychopharmacology & Biological Psychiatry* 2007;31:395–398. [PubMed: 17116352]
- Svrakic DM, Draganic S, Hill K, Bayon C, Przybeck TR, Cloninger CR. Temperament, character, and personality disorders: Etiologic, diagnostic, and treatment issues. *Acta Psychiatrica Scandinavica* 2002;106:189–195. [PubMed: 12197856]
- Svrakic NM, Svrakic DM, Cloninger CR. A general quantitative theory of personality development: Fundamentals of a self-organizing psychobiological complex. *Development and Psychopathology* 1996;8:247–272.
- Tellegen, A. MPQ (Multidimensional Personality Questionnaire): Manual for administration, scoring, and interpretation. Minneapolis, MN: University of Minnesota Press; 1999.
- Turner RM, Hudson IL, Butler PH, Joyce PR. Brain function and personality in normal males: A SPECT study using statistical parametric mapping. *NeuroImage* 2003;19:1145–1162. [PubMed: 12880840]

Table 1
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
<i>Temperament domains</i>			
NS	-.18***	.00	-.32***
HA	-.24***	-.48***	-.10**
RD	.06	-.04	.10**
PS	.34***	.32***	.17***
<i>Character domains</i>			
SD	.24***	.44***	.39***
C	.11**	.09*	.39***
ST	.07	-.03	.07

Notes: MPQ = Multidimensional Personality Questionnaire; BIDR = Balanced Inventory of Desirable Responding. *N*s vary from 651 to 654.

 $p < .001$,

**
 $p < .01$,

*
 $p < .05$