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The psychometrics of the European Portuguese version of the Temperament and Character Inventory-Revised (TCI-R)

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The psychometrics of the European Portuguese version of the Temperament and Character Inventory-Revised (TCI-R)

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Abstract

Cloninger's psychobiological model of personality integrates contributions from behavioral genetics, neurobiology and psychology in the description of the human personality. The Temperament and Character Inventory (TCI) is its assessment instrument. The Brazilian Portuguese version of the TCI has shown good psychometric properties. However, Portuguese spoken in Brazil presents marked and substantial differences to that spoken in Portugal, and no study has yet described the psychometrics of the European Portuguese version. The objective of this study was thus to describe the psychometric properties of the European Portuguese adult version of the TCI (the TCI-R). This study involved 1,400 Portuguese adult participants. The factorial structure of the European Portuguese version was tested using four methods: Exploratory Factor Analysis (EFA), Orthogonal Procrustes Rotation analysis, Confirmatory Factor Analysis (CFA) and Exploratory Structural Equation Modelling (ESEM). The integration of data coming from these methods suggested that the Portuguese version of the TCI-R presented good structural validity (as revealed by the emergence of the Temperament and Character structures predicted by theory) and high levels of congruence between the American and the Portuguese versions. An improvement in the goodness of fit of the models for the Portuguese population was achieved by using ESEM over CFA. Although some facets registered questionable consistency, all dimensions had acceptable to good consistency (all $\geq$ .79). These results confirm the validity of the Portuguese TCI-R and its adequacy for use in European Portuguese samples.

Keywords: personality; psychobiological; TCI-R; psychometric properties; Portuguese.

Introduction

Cloninger's psychobiological model of personality was developed as an integrative approach to human personality, integrating components of different research traditions, including behavioral genetics, neurobiology, psychiatry and psychology (Cloninger & Svrakic, 1997; Cloninger, Svrakic, & Przybeck, 1993; Svrakic, Whitehead, Przybeck, & Cloninger, 1993). It defines personality as a dynamic organization of psychobiological processes, which are conceptualized in terms of two domains: Temperament and Character.

Temperament refers to dispositional and stable tendencies to respond to basic emotional stimuli (e.g. danger, novelty and reward) with automatic habitual reactions such as the inhibition, activation and maintenance of behavior (Cloninger et al., 1993). It comprises four dimensions that remain stable throughout an individual's development. These temperaments are: a) Novelty Seeking (NS) – the propensity to respond intensely to novel stimuli as signals of pleasure by active approach for reward, or active avoidance of punishment. Those high in this temperament are noticeably explorative, impulsive, and dislike rules and regulations; b) Harm Avoidance (HA) – the propensity to respond intensely to signals of punishment or loss of reward by inhibiting behavior. Those high in this temperament so are noticeably anxious, fearful, and shy; c) Reward Dependence (RD) – the propensity to form conditioned signals of reward, especially social approval and attachment cues. Persons with high levels of this temperament are sentimental, sociable, and friendly in attachments; and d) Persistence (PS) – the propensity of the individual to maintain specific behaviors, in spite of frustration and fatigue, with anticipation of delayed success following prior intermittent reinforcement. Such individuals are eager, hard-working, ambitious, and perfectionistic (Cloninger et al., 1993).

Character refers to higher-order self-regulatory cognitive processes involved in individual differences, such as goals, motives, values and standards, and has been described as being composed of three dimensions which refer to the intrapersonal, interpersonal, and transpersonal self (Cloninger, 2004). Self-Directedness (SD) describes individual differences in the intrapersonal self, which refers to the awareness of being an autonomous individual with motives, standards and goals, and functions as self-regulatory processes in goal-oriented behaviors. Those high in this character are responsible, purposeful, resourceful, and self-actualizing. Cooperativeness (CO) refers to individual differences in the interpersonal self, i.e. the awareness of being a member of a group in which each member has both rights and responsibilities. High levels of CO result in tolerance, empathy, helpfulness, principledness, and compassion (Cloninger et al., 1993). Self-Transcendence (ST) refers to individual differences in the transpersonal self, i.e. the awareness of being a member of a larger whole, such as nature or the universe. High levels of ST result in a person who is easily absorbed in what they love to do, altruistic, and spiritual (Cloninger et al., 1993).

All the dimensions of Temperament and Character are moderately heritable (Garcia et al., 2013), and the expression and differentiation of these dimensions can be modified by environmental and cultural influences (Congdon et al., 2012). Temperament and Character traits develop over the lifespan, with Temperament traits remaining moderately stable. The self-regulatory strength of Character traits, on the other hand, increases in response to societal demands (Josefsson et al. 2013; Yang et al., 2015). The psychobiological model of personality is a genetically and neurobiologically informed model rather than a merely empirical descriptive framework of personality, and it therefore provides a testable model of the underlying biological, psychological,

and social causes of personality and its development (Cloninger et al., 1993; Poropat & Corr, 2015).

The psychobiological model of personality was initially developed for clinical assessment in both the general population and clinical settings, and it has proved to be an adequate framework for the description of both normal and abnormal human personality (Cloninger, Zohar & Cloninger, 2010; Lee, Cloninger, Park, & Chae, 2015; Otani et al., 2015; Schneider, Ottoni, Carvalho, Elisabetsky, & Lara, 2015). In particular, recent studies have supported its suitability for describing the personality variables that underlie health behaviors and all components of subjective well-being, as well as ill-being, both in adults (Cloninger & Zohar, 2011; Josefsson et al., 2011; Zaninotto et al., 2016), and adolescents (Garcia et al., 2015; Moreira et al., 2015; Schütz, Archer, & Garcia, 2013).

The Temperament and Character Inventory (TCI) has different age-appropriate measures, including for pre-schoolers (parent and teacher reports), school-children (teacher and parent reports), adolescents (JTCI) and adults (TCI-R). Reflecting the importance of Cloninger's psychobiological model of personality, its assessment instrument (the TCI) has been adapted to over 24 diverse societies including Spain (Gutiérrez-Zotes, Bayon, Montserrat, et al., 2004; Gutiérrez-Zotes, Cortés, Valero, Peña, & Labad, 2005; Gutiérrez-Zotes, Labad, Martorell, et al., 2015), France (Pelissolo et al., 2005), Belgium (Hansenne, Delhez & Cloninger, 2005), Italy (Fossati et al., 2007; Vespa et al., 2015), Brazil (Gonçalves & Cloninger, 2010), Croatia (Jaksic et al., 2015), Greece (Fountoulakis et al., 2015; Giakoumaki et al., 2016), Serbia (Dzamonja-Ignjatovic, Svrakic, Svrakic, Jovanovic, & Cloninger, 2010), Israel (Zohar & Cloninger, 2011) and Hungary (Rózsa, Kó, Andó et al.,under preparation). Age-appropriate versions of the TCI have also been tested in other societies (e.g. Moreira et al., 2012;

Melegari et al., 2014). Studies comparing the concurrent and predictive validity of the TCI and other personality models have systematically shown that the TCI is better, or at least as good as, alternative personality models (Fruyt, Clerq, Wiele & Heeringen, 2006; Grucza & Goldberg, 2007; Gutiérrez-Zotes et al., 2005; Moreira et al., 2012). Altogether, these studies have systematically shown that the TCI is an adequate measure for capturing the dimensions of personality cross-culturally and across the lifespan.

Validity-based studies of the Brazilian Portuguese version of the TCI-R have shown that it presents good psychometric properties (e.g. Schumacker & Beyerlein, 2000). In this study, exploratory factor analyses were performed separately and 4 factors for Temperament, and 3 for Character – as expected – were found in the principal component analysis. Using the Procrustes Rotation correlations method, good congruence was found between the data for the facets of the Brazilian and the American original TCI-R versions (95% or higher). Correlations among the TCI-R dimensions were consistent with what was expected. Internal consistency was satisfactory for the dimensions of Temperament and Character. Finally, correlations between the Brazilian TCI-R's dimensions and gender, age and indicators of both wellbeing and psychopathological symptoms have also been found to be consistent with past research (Gonçalves & Cloninger, 2010).

In spite of the growing interest of Portuguese researchers and practitioners in using the TCI-R, the psychometrics of the European Portuguese version have yet to be documented. The objective of this study was therefore to analyze and examine the psychometric properties of the European Portuguese adult version of the TCI-R.

Method

Participants

In total, 1,400 individuals (583 men and 817 women) aged between 18 and 79 years old (M = 39.71, SD = 14.46) participated in this study. Participants were recruited from a range of different regions of Portugal. Subjects were recruited according to the snowball technique for the selection of non-randomized samples. The individuals presented different levels of academic achievement, with the highest percentage achieving a secondary education: 195 (13.9%) had elementary school (4th grade), 276 (19.7%) finished middle school (9th grade), 470 (33.6%) had high school (12th grade), and 296 (21.1%) had a college or university education degree. Of all contacted individuals, only those who agreed to participate and gave informed consent were included in the study. The research center institutional ethics committee approved the study.

Instruments

Personality was evaluated with the Temperament and Character Inventory – Revised (TCI-R; Cloninger, 1999), a self-report instrument with 240 items. Responses to these items were made on a 5-point-Likert scale (1=*Definitely false*; 2=*Mostly or probably false*; 3=*Neither true nor false, or about equally true or false*; 4=*Most or probably true*; 5=*Definitely true*). The TCI-R is composed of 4 Temperament and 3 Character dimensions. The Temperament dimensions are Novelty Seeking, Harm Avoidance, Reward Dependence and Persistence, each with 4 facets. The Character dimensions are Self-Directedness (with 5 facets), Cooperativeness (5 facets) and Self-Transcendence (3 facets).

Procedures

Adaptation procedures. The translation and adaptation to European Portuguese followed the classical guidelines for these processes (e.g. Hambleton, Merenda, & Spielberger, 2005; Muñiz, Elosua, Padilla, & Hambleton, 2016).

After obtaining authorization from the author of the TCI-R for the adaption and validation of the scale, we followed recommended procedures to verify semantic equivalence in the adaption of questionnaires (Mallinckrodt & Wang, 2004). a) The items from the original American English version of the TCI-R were first translated to the European Portuguese language by two bilingual clinicians. b) The items were then back-translated to English by an experienced professional translator. c) These items were then reviewed by Dr. Cloninger for technical analysis. d) The version of items resulting from this process (including some suggested modifications) were tested in a pilot study involving a group of subjects, and their understanding of the translation was checked. e) Finally, expressions were evaluated in relation to their cultural and semantic equivalence.

Data analysis. Factor structure was assessed using a number of methods: Exploratory Factor Analysis (EFA) and Procrustes Rotation, Confirmatory Factor Analysis (CFA), and a novel analytic method called Exploratory Structural Equation Modeling (ESEM; Asparouhov & Muthén, 2009).

Firstly, the factor structure was assessed by a principal component analysis (EFA) with a Promax Rotation with Kaiser normalization. We considered values equal or greater than .40 as the optimal correlational value. Temperament and Character were analyzed separately, as is recommended with the TCI because of strong non-linear interactions between the two domains. The European Portuguese version of the TCI-R kept the 240 items of the original American version. The principal components analysis was performed on the facets, comprising their respective items, as described in the TCI-R's manual (pag. 12).

Secondly, an Orthogonal Procrustes Rotation analysis was carried out in order to obtain congruence coefficients. This enabled a comparison between results obtained from the Portuguese version and those obtained from the original American version.

Thirdly, because Confirmatory Factor Analysis (CFA) does not allow for cross-loadings among different domains, we also used a relatively new method called Exploratory Structural Equation Modeling (ESEM) to assess the models' goodness of fit. This method fits conceptually between EFA and CFA as it allows for cross-loadings between different domains, as is expected to occur in dynamic personality models. Maximum likelihood confirmatory factor analyses (CFA) were conducted over the covariance matrices of the TCI-R Temperament and Character subscales to test the hypothesized factor structures. ESEM combines features of EFA and CFA in the sense that an EFA measurement model is subjected to a CFA model fit estimation. The ESEM approach differs from the typical CFA approach in that all factor loadings are estimated, subject to constraints, so that the model can be identified (Asparouhov & Muthén, 2009). ESEM was used with an *oblique geomin rotation*.

Finally, we estimated correlations and mean differences. The correlation between domains was assessed using the Pearson correlation test. Means, standard deviations, McDonald's omega coefficients and confidence intervals were calculated for each of the TCI-R dimensions and facets on the whole sample and for males and females separately. Gender differences for all TCI-R domains and facets were examined using a *t test*.

The CFA and ESEM analyses were performed using the MPLUS 7.4 statistical package (Muthén and Muthén, 1998-2015). With the exception of the Orthogonal Procrustes Rotation analysis (which was performed using the Orthosim 2.01 Program), all the other analyses were performed using the Statistical Predictive Analytics

SoftWare (PASW Statistics version 18.0 /SPSS) for Windows, with the exception of the calculation of McDonald's Omega and their respective confidence intervals, which was performed in R (version 3.3.2) using the 'coefficientalpha' package.

Results

The aim of this study was to obtain indicators of validity of the European Portuguese TCI-R, specifically indicators of the factorial structure's validity.

Using Exploratory Factor Analysis (EFA) we identified four factors for Temperament (Table 1) in the principal components analysis (eigenvalues greater than one), accounting for variances of 7.97% in Novelty Seeking (NS), 27.43% in Harm Avoidance (HA), 12.19% in Reward Dependence (RD) and 14.82% in Persistence (PS), with 62.40% cumulative variance. Three factors were identified for Character (Table 2), accounting for variances of 15.21% in Self-Directedness (SD), 33.49% for Cooperativeness (CO) and 10.02% for Self-Transcendence (ST), with 58.72% cumulative variance. All facets in the Portuguese version of the TCI-R version loaded on factors as expected with the exception of NS1 (exploratory excitability) and SD4 (self-acceptance). The facets of NS loaded on component 4 with the exception of NS1 which loaded on component 3 (.50), and showed a low saturation value in component 4 (.23). SD4 loaded on component 1 (.76) while all the other facets of SD loaded on component 2.

Orthogonal Proscrustes rotation analyses comparing each of the facets of the Portuguese version and the original American version were conducted. For all facets we obtained consistency values above 90%. The congruency coefficient for Temperament was .96. For the Temperament dimensions congruency coefficients were .97 for HA, .98 for PS, .98 for RD and .88 for NS. For Character the total coefficient of consistency

was .98, and for the dimensions these coefficients were .99 for CO, .96 for SD, and .97

(ST) (Table 3).

When the 16 temperament subscales of the TCI-R were subjected to a

Confirmatory Factor Analysis (CFA) of its hypothesized four-factor structure, a poor fit

was observed: $\chi^2 = 227.97$; $p < .001$, $\chi^2/df = 22.73$, $CFI = .73$, $TLI = .67$, $RMSEA = .12$.

Modification indices and previous EFA of the 16 temperament subscales suggested a

number of ways fit could be improved. Our solution was to remove NS1 (cross-loaded

highly on HA and RD) and RD1 (cross-loaded highly on HA), and to allow for 7

correlated errors between the subscales. This model showed a marginal fit with the data,

where $\chi^2 = 737.70$; $p < .001$, $\chi^2/df = 11.52$, $CFI = .90$, $TLI = .85$, $RMSEA = .08$. CFA

indicated that the hypothesized three-factor model of TCI-R character subscales

provided a poor fit for the data: $\chi^2 = 805.22$; $p < .001$, $\chi^2/df = 12.98$, $CFI = .87$, $TLI = .84$,

$RMSEA = .09$. Based on modification indices we allowed for 4 correlated errors between

the subscales and this improved model fit: $\chi^2 = 477.75$; $p < .001$, $\chi^2/df = 8.23$, $CFI = .93$,

$TLI = .91$, $RMSEA = .07$.

Findings from the ESEM showed improvement in the Temperament model, but

both models still provided marginal model fit: $\chi^2 = 513.34$, $p < .001$, $CFI = .93$,

$TLI = .87$, $RMSEA = .07$ (Temperament); $\chi^2 = 467.01$, $p < .001$, $CFI = .91$, $TLI = .84$,

$RMSEA = .08$ (Character).

Table 4 presents the McDonald's omega values concerning the internal

consistency of the European Portuguese TCI-R. They ranged from .78(NS) to .88 (HA

and CO). The McDonald's omega coefficients for the facets ranged from .47 (CO3 -

Helpfulness) to .88 (CO4 – Compassion).

The correlations among the four Temperament dimensions of NS, HA, RD and

PS were weak (.05 to -.38) (Table 5). The correlations among the three Character

dimensions (SD, CO, and ST) were weak to moderate (-.17 to .58). The Character

dimension CO was moderately correlated with RD (.57) and SD (.58). All other

dimensions were weakly correlated, except for HA, which was negatively and

moderately correlated with PS (-.41) and with SD (-.43). ST was weakly correlated with

the other dimensions (.03 with NS, -.02 with HA, .29 with RD, .27 with PS, -.02 with

SD, and .22 with CO).

In general, TCI-R dimensions were shown to have an approximate normal

distribution, as suggested by little skewness or kurtosis, with the exception of NS and

HA. The average rating for each facet and dimension was near to the middle option of

the 5-point scale (ranging from 2.8 to 3.5). As described in Table 6, women registered

higher scores in HA, RD, CO and ST.

Discussion

In spite of the cultural differences between America and Portugal, no serious

misunderstandings by the participants seemed to occur during the completion of the

European Portuguese version of TCI-R. Consistent with the theoretical model, the

European Portuguese TCI-R registered a four-factor structure for Temperament and a

three-factor structure for Character. Furthermore, it presented a factorial structure

consistent with the original American version, as showed by *the Orthogonal*

Proscrustes rotation. High levels of consistency between the European Portuguese and

the American versions of the TCI-R for all facets and dimensions (.90) were found,

similarly to the Brazilian Portuguese version, although two exceptions were NS1 and

NS3, which were lower than .90 (Gonçalves & Cloninger, 2010).

All facets of the European Portuguese TCI-R loaded on factors as expected with

the exceptions of NS1 (exploratory excitability) and SD4 (self-acceptance). Similar to

what happened in other cultural versions of the TCI-R (Gonçalves & Cloninger, 2010;

Hansenne et. al., 2005; Martinotti et al., 2008; Pelissolo et al., 2005) the facet NS1 loaded positively on RD and negatively on HA, and SD4 loaded positively in CO. This is consistent with past research, and is a result of the dynamic nature of these personality dimensions which may induce correlations between independent psychobiological processes (Cloninger, 2008). A negative association between NS1 (exploratory excitability) and HA is expected because individuals with high scores in HA are generally reluctant to being engaged in exploratory activities. Also, because self-acceptance is crucial for the acceptance of others, a positive association between SD4 and CO is expected (Gonçalves & Cloninger, 2010). The explained variances in the European Portuguese TCI-R for Temperament (62.40%) and for Character (58.72%) were consistent with those found in other cultural versions, including the Brazilian Portuguese version (58.14% for Temperament and 59.63% for Character; Gonçalves & Cloninger, 2010), the French version (64.2% for Temperament and 55.6% for Character; Pelissolo et al., 2005); the Belgian version (60% for Temperament and 57% for Character; Hansenne et al, 2005); and the Italian version (73.8% for Temperament and 67.5 for Character; Martinotti et al., 2008).

In our study, the CFA revealed poor fit indicators of the factorial structures to our sample, a result which is consistent with a large number of past studies testing the replicability of the structure of personality inventories – from the Big Five to the TCI-R models (Marsh et al, 2010; Cloninger, 2008). The dimensions of the TCI-R were designed to measure specific psychological constructs regardless of the complexity of their interrelationships. This was done in order not to conform to arbitrary assumptions about simple structures, as is arguably done in factor analytic approaches. As a result, factor analysis of the TCI-R is meant only to describe its structure, not to force modification of its content in order to conform to a simple structure. One of the main

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challenges for the quantitative measurement of personality has been the replicability of

the factorial structure of the models and Confirmatory factor analyses (CFAs)

systematically do not support factorial structures of widely validated models. This may

be explained, in part, by the very restrictive assumptions of CFA (Marsh, et al., 2010).

The use of ESEM improved the goodness of fit of the TCI-R structure in the

Portuguese population, but both Temperament and Character models still registered

marginal model fit. This tendency has also been shown in other studies which aimed to

test the replicability of the factor structure of different personality models (Marsh et al.,

2010; Sandór et al, 2017).

We obtained strong internal consistency coefficients for all the dimensions with

McDonald's omega coefficients above .80, except for NS which was 0.78. HA and CO

had the highest McDonald's omegas (.88). The omega values for the facets in the

European Portuguese version varied between .47[.42,.51] (CO3) and .88[.87,.89]

(CO4). These results are similar to those obtained from other cultural versions of the

TCI-R in non-clinical populations (e.g. Hansenne et al., 2005; Pelissolo et al., 2005;

Dzamonja-Ignjatovic et al, 2010; Gonçalves & Cloninger, 2010), although note that past

research has mostly presented Cronbach´s Alpha as a measure of internal consistency

rather than Omega. It has been argued that Omega is superior to Alpha because its

assumptions are more likely to be met, thus reducing the likelihood of overestimating or

underestimating internal consistency (Dunn, Baguley & Brunsden, 2014). Thus one

strength of our analysis is that one can have a greater degree of confidence in the

consistency of the dimensions and facets.

Our findings are in accordance with past research, which has demonstrated the

complex relationship between the Temperament and Character dimensions of

personality, in the sense that they show both equifinality and multifinality (Cloninger,

Svrakic & Svrakic, 1997). In other words, the results show that multiple Temperament dimensions may be associated with a single Character dimension (equifinality), and that one Temperament dimension may be associated with multiple Character dimensions. Cloninger argued that naturally occurring dimensions of personality involve complex adaptive processes, and it was for this reason that he used factor analytic methods only to describe the architecture of his psychobiologically based constructs, not to force them into a simple linear structure (Cloninger, 2004). The correlations between high-order scales observed in the present study (for example, HA was correlated with RD and PS; SD was correlated with CO and ST) provide further evidence of this pattern of complex non-linear relations (Giakoumaki et al., 2015; Josefsson et al., 2013).

The RD and CD, and SD and CO dimensions of the European Portuguese TCI-R were positively correlated. Negative correlations were observed between the HA and PS, and HA and SD dimensions. Although most dimensions are largely independent, some correlations among dimensions are expected since Cloninger´s psychobiological model is based on a dynamic perspective of personality in which development requires interactions among dimensions in order for people to adapt in an integrated manner. In other words, no personality trait exists in isolation, rather each exists as one of several traits that must be integrated to achieve healthy adaptation to challenging situations and opportunities in life. The correlations identified in the present study are identical to those found in the original American version and other cultural adaptations of the TCI-R.

In order to have an understanding of the validity of an assessment's complex constructs, especially in the case of personality, it has been recommend that instead of using an "all or nothing logic" cutoff values for goodness of fit indices should be interpreted with caution (Marsh et al., 2010) and in consideration of the specificities of

the dynamic construct of personality (Cloninger, 2008). Experts on personality measurement research such as Marsh and colleagues recommend, in light of the limitations of analytic methodologies such as CFA, "*an eclectic approach based on a subjective integration of a variety of different indices, detailed evaluations of the actual parameter estimates in relation to theory, a priori predictions, common sense, and a comparison of viable alternative models specifically designed to evaluate goodness of fit in relation to key issues*". (2010, pag.489).

The psychometric properties of the Spanish version of the TCI-R have also been examined. Considering the cultural proximity of Spain and Portugal a discussion of the main results from each of these two studies is of relevance. Firstly, Gutiérrez-Zotes and colleagues (2004) showed that the loadings of the factorial structure of the Spanish version of the TCI-R were consistent with those identified for the European Portuguese version. Further, the correlations between dimensions in the Portuguese version are similar to those identified for the Spanish version (Gutiérrez-Zotes et al., 2015) with the main exception being the correlation between ST and C. Our results indicated a weak positive correlation (.22) whereas for the Spanish version this correlation was shown to be negative (although this correlation was very weak). Some other differences in terms of significance were also apparent although the trend of results were consistent: ST and SD showed a significant negative correlation for the Spanish scale whereas our results failed to reach significance, and PS and SD and C were not significantly correlated for the Spanish scale but did reach significance for the Portuguese version. Gender differences between scores on the dimensions were also mostly consistent. Our study revealed significant differences for the dimensions HA, RD and C, a finding which is consistent with the Spanish study. Our study also identified a significant gender difference for ST, which was not the case for the Spanish study.

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The interpretation of the results of this study presents some limitations. First, the sample of the study used to validate the European Portuguese TCI-R consists of volunteers. Second, it would have been desirable to test the associations between the dimensions of the TCI using other functional indicators. However, because of the robust body of evidence suggesting the validity of the instrument at several levels (including criteria validity, concurrent validity, etc.), and because the main goal of this study was to describe the psychometric properties of the European Portuguese version of the TCI-R, we consider that the results presented here are of scientific importance for two reasons; a) they provide a better understanding of the cross-cultural validity of the model, and b) through demonstrating good psychometric properties of the TCI-R using several different indicators, they enable the use of the model by researchers and practitioners working with European Portuguese speaking people.

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Table 1

Principal component analysis of the TCI-R Temperaments (promax Rotation with Kayser normalization)

Structure matrix	1	2	3	4
NS1	-.31	.15	**.50**	.23
NS2	.01	-.15	-.01	**.71**
NS3	.00	-.11	**.43**	**.62**
NS4	-.07	-.04	-.10	**.76**
HA1	**.82**	.05	-.04	.01
HA2	**.76**	.00	.11	-.19
HA3	**.63**	.00	-.29	-.04
HA4	**.72**	-.18	.01	.14
RD1	**.54**	.35	**.61**	.07
RD2	-.15	.07	**.78**	.01
RD3	-.08	-.11	**.79**	-.08
RD4	-.01	-.39	**.52**	**-.50**
PS1	.17	**.80**	.05	-.03
PS2	-.30	**.64**	.10	-.18
PS3	-.08	**.76**	-.05	.17
PS4	-.09	**.80**	-.04	-.24
Variance Explained	27.43%	14.82%	12.19%	7.97%

Note. NS = novelty seeking; HA = harm avoidance; RD = reward dependence; PS = persistence Loadings with absolute values of .4 or more are shown in bold..

Table 2.

Principal component analysis of the TCI-R Character scales (promax Rotation with

Kayser normalization)

Structure matrix	1	2	3
SD1	.09	**.70**	-.15
SD2	-.12	**.86**	.10
SD3	.02	**.81**	-.09
SD4	**.76**	-.07	-.29
SD5	.12	**.73**	-.03
CO1	**.65**	.17	.02
CO2	**.44**	.20	.27
CO3	**.60**	.21	.08
CO4	**.89**	-.20	.05
CO5	**.57**	.17	.12
ST1	-.28	.13	**.83**
ST2	.14	-.06	**.80**
ST3	.17	-.24	**.63**
Variance Explained	33.49%	15.21%	10.02%

Note. SD **=** self-directedness; CO = cooperativeness; ST = self-transcendence. Loadings with absolute values of .4 or more are shown in bold.

Table 3.

Procrustes Rotation with congruence coefficients for TCI-R facets

Temperament facets	HA	PS	RD	NS	Cong
NS1	.96	.28	.09	.04	.94
NS2	.48	-.60	-.34	.54	.92
NS3	.82	-.36	.10	.44	.97
NS4	.50	-.46	-.49	.55	.99
HA1	-.72	-.19	.48	.55	.99
HA2	-.70	-.09	.66	.26	1.00
HA3	-.89	-.25	.20	.34	.97
HA4	-.60	-.50	.45	.44	.99
RD1	.22	.37	.78	.45	.97
RD2	.80	.29	.51	-.07	.98
RD3	.70	.13	.68	-.17	.98
RD4	.02	-.06	.81	-.58	.92
PS1	.12	.93	.02	.35	.94
PS2	.4	.90	-.14	-.08	.91
PS3	.37	.80	-.32	.34	.93
PS4	.11	.99	-.12	.04	.97
FactCong	.97	.98	.98	.88	.96

Character facets	CO	SD	ST		
SD1	.80	.36	.49		.96
SD2	.80	.01	.61		.96
SD3	.80	.25	.54		.96
SD4	.63	.61	-.49		.99
SD5	.88	.22	.43		1.00
CO1	.92	.23	-.31		1.00
CO2	.96	-.15	-.24		.96
CO3	.95	.16	-.27		.99
CO4	.72	.18	-.67		.98
CO5	.94	.10	-.31		.98
ST1	.24	-.97	.05		1.00
ST2	.46	-.83	-.31		.98
ST3	.29	-.82	-.50		.94
FactCong	.99	.96	.97		.98

Note. NS = novelty seeking; HA = harm avoidance; RD = reward dependence; PS = persistence; SD = self-directedness; CO = cooperativeness; ST = self-transcendence; *FactCong* = Factor congruence.

Table 4.

Omega values and confidence intervals concerning the internal consistency for temperament and character dimensions and facets on total sample and by gender.

	Total Sample (n=1,400)	Male (n=583)	Female (n=817)
	Ω	ω	ω
Novelty seeking (NS)	.78 [.76,.80]	.81 [.80,.84]	.77 [.74,.79]
Exploratory excitability (NS1)	.61 [.58,.64]	.63 [.59,.68]	.60 [.55,.64]
Impulsiveness (NS2)	.63 [.59,.66]	.67 [.62,.72]	.59 [.55,.64]
Extravagance (NS3)	.74 [.71,.76]	.75 [.72,.79]	.73 [.70, .76]
Disorderliness (NS4)	.55 [.51,.59]	.58 [.51,.65]	.52 [.47,.57]
Harm Avoidance (HA)	.88 [.86,.89]	.87 [.85,.90]	.87 [.86,.89]
Anticipatory worry (HA1)	.70 [.67,.73]	.67 [.62,.73]	.71 [.67,.74]
Fear of uncertainty (HA2)	.71 [.68,.64]	.71 [.66,.75]	.68 [.64,.72]
Shyness (HA3)	.78 [.76,.80]	.78 [.75, .81]	.78 [.76,.81]
Fatigability (HA4)	.69, [.67,.72]	.69 [.64,.74]	.68 [.64,.72]
Reward dependence (RD)	.80 [.78,.81]	.79 [.77,.82]	.78 [.76,.81]
Sentimentality (RD1)	.57 [.53,.60]	.53 [.47,.59]	.57 [.52,.61]
Openness to warm communication (RD2)	.69 [.67,.72]	.70 [.65, .74]	.70 [.66,.73]
Attachment (RD3)	.72 [.69,.74]	.70 [.66, .74]	.73 [.70,.76]
Dependence (RD4)	.50 [.46,.55]	.51 [.45,.58]	.49 [.43,.55]
Persistence (PS)	.87 [.85,.88]	.87 [.85,.89]	.86 [.85,.88]
Eagerness of effort (PS1)	.59 [.56,.63]	.59 [.53, .64]	.60 [.55,.64]
Work harm avoidance (PS2)	.70 [.67,.72]	.70 [.65,.75]	.69 [.66,.73]
Ambitious (PS3)	.75 [.73, .77]	.75 [.72,.78]	.74 [.71,.77]
Perfectionist (PS4)	.66 [.63,.69]	.67 [.62,.72]	.65 [.61,.69]
Self-directedness (SD)	.86 [.85,.88]	.86 [.84,.88]	.87 [.85,.88]
Responsibility (SD1)	.61 [.57,.64]	.60 [.54,.65]	.62 [.58,.66]
Purposeful (SD2)	.65 [.62,.68]	.63 [.58,.68]	.67 [.63,.71]
Resourcefulness (SD3)	.64 [.61, .67]	.63 [.57,.68]	.65 [.61,.69]
Self-acceptance (SD4)	.81 [.80,.83]	.82 [.79,.84]	.81 [.79,.83]
Enlightened second nature (SD5)	.63 [.60,.67]	.62 [.56, .67]	.65 [.61,.69]
Cooperativeness (CO)	.88 [.87,.89]	.89 [.87,.90]	.87 [.86,.88]
Social acceptance (CO1)	.77 [.75,.80]	.77 [.74,.80]	.77 [.75,.80]
Empathy (CO2)	.53 [.49,.57]	.50 [.45,.57]	.55 [.49,.60]
Helpfulness (CO3)	.47 [.42,.51]	.47 [.40,.53]	.46 [.40,.51]
Compassion (CO4)	.88 [.87,.89]	.89 [.87,.90]	.87 [.85,.88]
Pure-hearted conscience (CO5)	.56 [.52,.60]	.55 [.48,.62]	.55 [.50,.60]
Self-transcendence (ST)	.83 [.82,.85]	.82 [.80,.85]	.84 [.82,.86]
Self-forgetful (ST1)	.70 [.68, .73]	.71 [.67,.75]	.70 [.67,.73]
Transpersonal identification (ST2)	.71 [.69,.74]	.71 [.67,.75]	.71 [.68,.74]
Spiritual acceptance (ST3)	.80 [.78, .82]	.77 [.74, .81]	.80 [.78,.83]

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Table 5.

Correlation matrices of the seven main dimensions (Pearson correlation)

	NS	HA	RD	PS	SD	CO
Harm Avoidance (HA)	**-.38***					
Reward Dependence (RD)	.18**	-.17*				
Persistence (PS)	.05	**-.41***	.23*			
Self-directedness (SD)	-.18*	**-.43***	.29*	**.32***		
Cooperativeness (CO)	-.13*	-.17*	.57*	.25*	**.58***	
Self-transcendence (ST)	.03	-.02	.29*	.27*	-.02	.22

Note. NS = novelty seeking; HA = harm avoidance; RD = reward dependence; PS = persistence; SD = self-directedness; CO = cooperativeness; ST = self-transcendence.*Pearson correlation coefficients with *p* values <.01; and abs(r) > .30 are shown in bold..

Table 6.

Average of raw scores and ±SD values for TCI-R dimensions and facets on the whole sample and by sex

groups with t test comparing male and female groups.

TCI-R Scale	# Items N	Total Sample (n=1,400)		Male (n=583)		Female (n=817)		t test	p
		M	SD	M	SD	M	SD		
Novelty seeking	35	97.93	12.58	97.95	13.23	97.92	12.11	-.047	.962
NS1	10	32.94	4.64	32.92	4.65	32.95	4.63	.130	.896
NS2	9	22.93	4.27	23.00	4.45	22.88	4.13	-.527	.598
NS3	9	24.92	5.53	24.34	5.67	25.33	5.39	3.324	**.001**
NS4	7	17.15	3.85	17.96	3.99	16.76	3.71	-4.511	**.000**
Harm Avoidance	33	95.99	15.21	92.15	14.84	98.16	14.98	7.432	**.000**
HA1	11	31.19	5.27	30.32	.5.08	31.81	5.33	5.251	**.000**
HA2	7	23.17	4.75	21.77	4.69	24.17	4.53	9.632	**.000**
HA3	7	19.36	4.89	18.99	4.73	19.62	4.99	2.368	**.018**
HA4	8	21.94	4.56	21.06	4.43	22.56	4.56	6.129	**.000**
Reward dependence	30	97.14	11.05	94.99	10.96	98.67	10.87	6.217	**.000**
RD1	8	27.94	3.90	27.01	3.79	28.61	3.83	7.749	**.000**
RD2	10	34.27	5.11	33.76	5.08	34.64	5.10	3.191	**.001**
RD3	6	16.57	3.42	16.15	3.35	16.87	3.43	3.920	**.000**
RD4	6	18.35	3.25	18.08	3.22	18.55	3.25	2.677	**.008**
Persistence	35	122.12	13.85	122.76	13.93	121.66	13.78	-1.47	.142
PS1	9	30.74	4.25	30.28	4.25	31.07	4.22	3.419	**.001**
PS2	8	29.98	3.93	30.20	3.95	29.83	3.91	-1.744	.081
PS3	10	34.03	5.01	34.78	4.95	33.49	4.98	-4.771	**.000**
PS4	8	27.37	4.18	27.50	4.21	27.27	4.16	-1.019	.308
Self-directedness	40	138.40	15.82	137.60	15.43	138.97	16.08	1.601	.110
SD1	8	27.21	3.88	27.00	3.82	27.36	3.92	1.716	.086
SD2	6	23.12	3.35	23.14	3.31	23.11	3.38	-.138	.891
SD3	5	18.32	3.10	18.42	3.00	18.24	3.16	-1.053	.292
SD4	10	30.56	6.94	30.09	6.91	30.89	6.94	2.117	**.034**
SD5	11	39.19	4.79	38.95	4.65	39.37	4.89	1.609	.108
Cooperativeness	36	133.64	15.32	130.66	15.85	135.78	14.56	6.248	**.000**
CO1	8	30.41	4.46	29.90	4.53	30.78	4.37	3.698	**.000**
CO2	5	18.05	2.69	17.67	2.61	18.31	2.71	4.420	**.000**
CO3	8	28.60	3.28	28.21	3.29	28.88	3.25	3.770	**.000**
CO4	7	26.15	5.70	25.25	5.89	26.79	5.47	4.972	**.000**
CO5	8	30.43	4.20	29.63	4.25	31.01	4.07	6.142	**.000**
Self-transcendence	26	79.31	12.18	78.23	11.78	80.09	12.40	2.827	**.005**
ST1	10	32.60	5.29	32.67	5.25	32.54	5.32	-.465	.642
ST2	8	24.28	4.70	24.14	4.71	24.39	4.69	.998	.318

ST3	8	22.43	5.76	21.42	5.54	23.16	5.80	5.636	**.000**

Note. Statistically significant p values lower than .05 ($p<.05$) for the t test are shown in bold.