



## Universidades Lusíada

Moreira, Paulo  
Inman, Richard A.  
Cloninger, Robert

### **Personality networks and emotional and behavioral problems : integrating temperament and character using Latent Profile and Latent Class Analyses**

<https://doi.org/10.1007/s10578-020-01063-9>  
<http://hdl.handle.net/11067/6349>

#### **Metadados**

<b>Data de Publicação</b>	2020
<b>Resumo</b>	Recent research indicates that adaptive functioning and well-being depends on the integration of three dissociable systems of learning and memory that regulate associative conditioning, intentionality and self-awareness. Our study objective was to describe how different integrated configurations of these systems (i.e. different expressions of personality) relate to the presence of internalizing, externalizing and total problems. In total, 699 adolescents completed the JTCI and Achenbach's YSR. L...
<b>Editor</b>	Springer
<b>Palavras Chave</b>	Temperament, Character, Personality networks, Behavioral and emotional problems.
<b>Tipo</b>	article
<b>Revisão de Pares</b>	yes
<b>Coleções</b>	[ILID-CIPD] Artigos

Esta página foi gerada automaticamente em 2024-04-17T02:05:51Z com informação proveniente do Repositório

Personality networks and emotional and behavioral problems:  
Integrating temperament and character using Latent Profile and Latent  
Class Analyses

Paulo A.S. Moreira<sup>1, 2</sup>

Richard A. Inman,<sup>2</sup>

C. Robert Cloninger<sup>3</sup>

<sup>1</sup>*Instituto de Psicologia e de Ciências da Educação [Institute of Psychology and Education],  
Universidade Lusíada-Norte (Porto), Portugal*

<sup>2</sup>*Centro de Investigação em Psicologia para o Desenvolvimento (CIPD) [The Psychology for  
Positive Development Research Center], Portugal*

<sup>3</sup>*Washington University, Department of Psychiatry, and Anthropedia Foundation, St. Louis,  
MO, USA*

**Note. This document is the authors' version of the final accepted manuscript,  
published 28.09.2019 by *Child Psychiatry and Human Development*  
doi: 10.1007/s10578-020-01063-9**

**<https://link.springer.com/article/10.1007/s10578-020-01063-9>**

**Corresponding author:** Paulo Moreira, Centro de Investigação em Psicologia para o  
Desenvolvimento, Universidade Lusíada - Porto, Rua Dr. Lopo de Carvalho, 4369-006, Porto,  
Portugal, email: [paulomoreira@por.ulusiada.pt](mailto:paulomoreira@por.ulusiada.pt). Phone: +351 213 611 538  
ORCID: 0000-0002-5454-7971

**Funding:** Support for this research comes from national funds from the Fundação para a Ciência e  
Tecnologia I.P. (FCT) [*Portuguese Foundation for Science and Technology*], under the Projects  
CIPD-BI-UID/PSI/04375/2016 and PTDC/MHC-CED/2224/2014.

### Abstract

Recent research indicates that adaptive functioning and well-being depends on the integration of three dissociable systems of learning and memory that regulate associative conditioning, intentionality and self-awareness. Our study objective was to describe how different integrated configurations of these systems (i.e. different expressions of personality) relate to the presence of internalizing, externalizing and total problems. In total, 699 adolescents completed the JTCI and Achenbach's YSR. Latent profile analyses revealed two temperament profiles and six character profiles. Adolescents with a steady temperament, and those with healthy characters, were significantly less likely to present clinical levels of problems. The integration of a steady temperament and healthy character profiles in a *Mature-Steady* joint temperament-character network was also associated with significantly less clinical problems. In sum, our person-centered study indicates that adaptive expressions of associative conditioning, intentionality, and self-awareness (i.e. integrated personalities) are critical for mental health.

**Keywords:** Temperament, character, personality networks, behavioral and emotional problems.

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

### Personality networks and emotional and behavioral problems: Integrating temperament and character using Latent Profile and Latent Class Analyses

There is now a large body of evidence that suggests personality (one's characteristic way of thinking, feeling, and behaving) exists on the same spectrum of functioning as psychopathology (Widiger, 2011; Widiger & Trull, 2007). According to this perspective, psychopathology is a manifestation of extreme/maladaptive variants of normal personality. Thus, to improve the diagnoses, treatments and prognoses of patients with mental disorders it is vital to have an accurate model of how psychopathology relates to personality structure. As we shall make clear, a critical task in this endeavor is conducting research using models that integrate two components of personality that have traditionally been considered within different literatures: temperament traits and higher-order sociocognitive processes.

There is considerable evidence that certain temperament traits pose a risk for psychopathology (Krueger & Tackett, 2003). Cross-sectional (Vazsonyi et al., 2006) and longitudinal (White et al., 2001) studies have shown that temperament traits related to impulsivity are associated with behavioral symptoms such as delinquency, antisocial behavior, and drug use. Trait negative emotionality has also been linked to this type of symptoms (James & Taylor, 2007). Other temperament traits, such as behavioral inhibition, are linked to symptoms such as anxiety (Muris et al., 2011). Specific, multi-trait temperament profiles, have also been linked to impaired functioning and psychopathology (Althoff et al., 2012; Caspi & Silva, 1995; Rettew et al., 2008).

Sociocognitive perspectives of personality assume self-regulation is a locus for understanding the influence of distal factors (e.g. environmental influences) on emotion, cognition, behavior, and motivation (Strauman, 2017). Self-regulation involves the higher-order sociocognitive processes relevant to initiating, maintaining and controlling thoughts,

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

behaviors and emotions in the pursuit of goals and effective social functionality. Failures in self-regulation (resulting in dysregulation) are widely acknowledged to be linked to maladaptive functioning and psychopathology (Althoff, 2010; Althoff et al., 2010).

Dysregulation has been implicated in a range of health problems and incorporated into models of major depressive disorder (Nolen-Hoeksema et al., 2008), generalized anxiety disorder (Mennin et al., 2007), and alcohol- and substance-related disorders (Sher & Grekin, 2007).

Despite these independent literatures, researchers have argued that the complex interactions between sociocognitive dimensions and temperamental dispositions are critical for fully understanding within-individual variation in personality (Cervone, 2005; Cloninger, 2004; Mischel & Shoda, 1995). Indeed, temperament traits can predict disorders at a global level, but are, by themselves are insufficient for predicting which specific individuals are at risk of developing psychopathology (Cloninger, 2004; Cloninger et al., 1993; Cloninger & Svrakic, 1997). For example, research shows that harm avoidance is correlated with anxiety problems (Bierderman et al., 1993), but not all people with high harm avoidance will develop these issues. Thus, to advance the current understanding of psychopathology as a manifestation of extreme/maladaptive variants of normal personality, it is necessary to study personality-psychopathology associations adopting a personality framework that integrates temperament and sociocognitive dimensions.

### **Cloninger's Psychobiological Model of Personality**

The psychobiological model conceptualizes personality as the dynamic organizations that regulate the way individuals learn to shape and adapt to internal and external environments. At its core, this model integrates two distinct personality domains that have traditionally been labelled *temperament* and *character* (Cloninger, 2004; Cloninger et al., 1993, 2019). The temperament dimensions of this model reflect innate dispositions that

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

influence how individuals automatically, spontaneously and unconsciously learn to behave, react emotionally and form attachments (Cloninger et al., 2019). The character dimensions of the psychobiological model correspond to organizations of higher-order cognitive processes that shape what people make of themselves intentionally and/or creatively (Cloninger, 2004; Cloninger & Cloninger, 2020). This self-government involves two systems that regulate intentional self-control (*what* am I going to do?) and self-awareness (*why, where, and when* am I going to do it?) (Zwir et al., 2019). Thus, according to this model, the structure of human personality corresponds to the expression of three interacting yet dissociable systems of learning and memory: the procedural memory system (associative conditioning), the prepositional memory system (logical and semantic), and the episodic memory system (capacity for self-awareness and introspection).

Recent evidence indicates human personality can be considered at varying levels of descriptive complexity (Zwir et al., 2019). Specifically, this complexity rises from (a) the individual temperament and character dimensions, to (b) sets of genes linked to these dimensions (Zwir et al., 2018a, 2018b), (c) genetically independent multi-trait temperament and character profiles (Cloninger & Zwir, 2018; Zwir et al., 2018b, 2018a), and finally (d) joint networks of temperament and character profiles (Zwir et al., 2019). We shall consider individual dimensions, multi-trait profiles, and joint temperament-character networks in turn.

***Temperament and Character Dimensions.*** The psychobiological model defines four temperament and three character dimensions, each with numerous facets, which are measured by the scales of Cloninger's Temperament and Character Inventory (TCI) (Cloninger, 1999). The four temperamental traits correspond to dissociable brain subsystems and organizations of psychobiological processes that influence individual differences in responses to basic emotional stimuli. The first two of these dimensions, *novelty seeking* and *harm avoidance*, describe dispositional tendencies to respond to reward versus threat and are theoretically

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

related to two brain/behavior systems implicated in goal-directed behavior: the behavioral activation system (BAS) and behavioral inhibition system (BIS) (Mardaga & Hansenne, 2007). The third temperament dimension, *reward dependence*, describes sensitivity to reward (particularly social approval). The final temperament dimension, *persistence*, describes the tendency to resist behavioral extinction after the removal of reward. The three character dimensions correspond to organizations of higher-order sociocognitive processes that regulate the temperamental dimensions and their conflicts in life situations. Such regulation occurs in relation to different concepts of the self: the self as an autonomous individual with values and standards (*self-directedness*), as a part of a society/community (*cooperativeness*) and as part of a wider reality that transcends the individual (*self-transcendence*).

***Temperament and Character Profiles.*** There is now robust evidence that the heritability of temperament and character is determined by sets of genes that are specific to distinct multi-trait profiles, and not individual dimensions (Cloninger & Zvir, 2018; Zvir et al., 2018b, 2018a, 2019). Studies have shown that individuals can be grouped according to various genetically-distinct configurations of temperament (Zvir et al., 2018b) and character dimensions (Zvir et al., 2018a). Moreover, most genes encoding variability in these temperament profiles were found to be associated with molecular processes that regulate associative conditioning (Zvir et al., 2018b), while most genes encoding variability in character profiles were associated with self-regulation via the processes of self-control, empathy and episodic memory (Zvir et al., 2018a).

***Joint temperament-character networks.*** The genetically independent temperament and character profiles described above are related in complex, yet systematic, ways. Zvir et al. (Zvir et al., 2019) found that temperament and character profiles are integrated via genetic-environment interactions to form three joint temperament-character networks, each representing individuals with specific integrated configurations of the three major systems of

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

learning and memory. These networks were the *Creative-Reliable* network (those who were more creative, prosocial, and insightful in appraisal of values and theories), the *Organized-Reliable* network (those able to regulate the expression of temperament, but with little creativity), and the *Emotional-Unreliable* network (those who are emotionally reactive with little regulation or creativity) (Cloninger & Cloninger, 2020). Individuals occupying the creative-reliable network were typically superior in terms of physical and mental wellbeing. Conversely, individuals occupying the emotional-unreliable network had the highest illbeing. Finally, those in the organized-reliable network had roughly average levels of wellbeing (Zwir et al., 2019).

### **The Psychobiological Model and Psychopathology: Current Research**

Various studies have established that temperament and character dimensions have independent associations with psychopathology (Svrakic et al., 1993). Internalizing problems (including anxiety, depression, and somatic symptoms) have been consistently linked to high harm avoidance (Cloninger et al., 2006; Goncalves & Cloninger, 2010; Kim et al., 2006; Lee et al., 2018) and low self-directedness (Cloninger et al., 2006; Goncalves & Cloninger, 2010; Kim et al., 2006; Lee et al., 2018). Harm avoidance has also been found to be predictive of anxiety disorders from childhood into adulthood (Bierderman et al., 1993). Anxiety and depression have also been shown to have weaker negative correlations with persistence and cooperativeness (Goncalves & Cloninger, 2010), although this has not been consistently observed across studies. Other psychobiological dimensions are relevant for understanding externalizing problems (e.g. prominent impulsiveness, disruptiveness, and substance abuse). High novelty seeking temperament in particular has been linked to disruptive behavior, substance abuse (Wills et al., 1994), and other externalizing symptoms such as aggression (Lee et al., 2018). Other studies have highlighted that low self-directedness and low cooperativeness are an indicator of mental disorders (Lee et al., 2018; Svrakic et al., 1993).



## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

A smaller and newer body of work has shown that multi-trait personality profiles also present differences in psychopathology. Individuals with temperament profiles characterized by high novelty seeking and low persistence (referred to variously across studies as an “antisocial”, “disengaged”, or “slow to warm up” profile) were shown to have elevated levels of emotional and behavioral problems (Rettew et al., 2008) and more ill-being (Zwir et al., 2018b) relative to other profiles. Studies have also shown that two unhealthy character profiles (the “apathetic” and “dependent” character profiles, which are defined by low self-directedness and low self-transcendence, and generally low character integration) are typically associated with more illbeing and psychopathology than healthy character profiles (Cloninger et al., 1998; Cloninger & Zohar, 2011; Josefsson et al., 2011; Moreira et al., 2015; Zwir et al., 2018a). In contrast, the most healthy and integrated character profiles (e.g. creative and organized profiles) are linked to the highest levels of wellbeing (Zwir et al., 2018a) and lowest prevalence of psychopathology (Cloninger et al., 1998).

This body of research has several limitations. Most studies adopted variable-centered methods; that is, they tested linear associations between individual personality variables and indicators of psychopathology. Such studies thus neglect the non-linear nature of human personality and human functioning (Cloninger, 2008) and are, as a result, largely uninformative about which specific individuals are at risk of developing disorders. Moreover, of the small number of studies that used person-centered methods to study multi-trait profiles, most focused on temperament or character profiles *separately* (Althoff et al., 2012; Cloninger & Zohar, 2011; Josefsson et al., 2011; Moreira et al., 2015; Rettew et al., 2008), and/or on illbeing rather than specific indicators of psychopathology (Zwir et al., 2018b, 2018a, 2019). As such, these studies neglect the fact that genetically independent temperament and character profiles are organized in complex yet systematic networks via genetic-

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

environmental interactions, and that positive functioning is influenced by these interactions (Zwir et al., 2019).

To address this gap in the literature, the study objective was to investigate the role of interacting temperament and character profiles in psychopathology (internalizing, externalizing and total problems) using a person-centered approach. Because personality has a hierarchical structure (Zwir et al., 2019), with joint temperament-character networks resulting from the integration of genetically independent temperament and character profiles, our chosen approach was to classify adolescents into temperament and character profiles, and then to further classify them based on combinations of temperament and character profiles. At each step, we explored differences in emotional and behavioral problems as a function of personality. Based on prior works, we anticipated the emergence of multiple distinct temperament and character profiles (Zwir et al., 2018b, 2018a) and that these would be differentially linked to emotional and behavioral problems. We also anticipated that temperament and character profiles would tend to co-occur in systematic ways, resulting in distinct joint temperament-character networks (Zwir et al., 2019). Given current understanding about the personality features linked to happiness, health and well-being (Cloninger & Cloninger, 2020), we expected individuals high in creativity (integrated configurations of the three systems of learning and memory expressing as high self-awareness and intentionality) to have fewer emotional and behavioral problems than those who are emotionally reactive and with little self-control or creativity.

### **Method**

#### **Participants**

For this article, we used data from the same sample reported by Moreira et al. (2020). Briefly, we recruited four schools in the north of Portugal (three middle schools and one vocational secondary school) using a convenience sampling strategy, and invited all students

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

in each school to participate. Middle schools in Portugal include the seventh, eighth, and ninth grades. Vocational secondary schools also have three years that are equivalent to the 10<sup>th</sup>, 11<sup>th</sup>, and 12<sup>th</sup> grades. After excluding respondents who were adults ( $\geq 18$  years), we had data for 873 adolescents<sup>1</sup>.

From this sample, we excluded 174 participants for having 100% missing data for at least one study measure. This included a small number of 17-year-olds ( $n = 12$ ), who completed the TCI-R rather than the JTCI. Thus, the final study sample comprised 699 adolescents (47.6% male; 48.9% female; 3.4% missing). Adolescents attending the middle schools were in the seventh ( $n = 215$ ;  $M_{age} = 12.9$  years), eighth ( $n = 183$ ;  $M_{age} = 13.9$  years), or ninth ( $n = 137$ ;  $M_{age} = 14.7$  years) grade. From the vocational secondary school, adolescents were enrolled in the first ( $n = 153$ ;  $M_{age} = 16.1$  years) or second year ( $n = 11$ ;  $M_{age} = 16.3$  years).

### Measures

As part of the broader cross-sectional study, participants completed a battery of self-report paper-based questionnaires. This included:

**Junior Temperament and Character Inventory (JTCI).** We used the Portuguese JTCI (Moreira et al., 2012) to measure the temperament and character dimensions of Cloninger's psychobiological model. The version of the JTCI used had 124 items<sup>2</sup>, each scored on a five-point scale from 1 (*completely false*) to 5 (*completely true*). In the study sample, values for ordinal omega (based on polychoric correlations) were good across the seven dimensions, ranging from self-transcendence ( $\omega = .66$ ) to cooperativeness ( $\omega = .89$ ) (See Table 1).

---

<sup>1</sup> In total, 1044 individuals aged (12-24 years) completed the study protocol. However, we excluded adults (almost all attending the vocational school) because (a) our principal interest was in adolescents, and (b) because individuals aged 18+ completed the adult measure (TCI-R) rather than the JTCI.

<sup>2</sup> There has since been a more recent 127-item version of the Portuguese JTCI with modifications made to the self-transcendence scale. These modifications are described in (Moreira et al., 2012).

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

**Youth Self Report (YSR).** The YSR (T.M. Achenbach, 1991) is a 112-item assessment of the presence of eight syndromes. Items are rated on a three-point scale from 0 (*not true*) to 2 (*frequently true*). The eight syndrome scales of the YSR were combined into two distinct higher-order scales that reflect *internalizing* (the sum of the anxious/depressed, withdrawn/depressed and somatic complaints scales) and *externalizing* (the sum of the rule-breaking behavior and aggressive behavior scales) problems. We also calculated a global indicator of *total problems*. In US samples, these higher-order scales have been shown to have excellent internal consistency and test-retest reliability (coefficients  $> .85$ ) (Thomas M. Achenbach et al., 2008). In our sample, indices of ordinal omega were also excellent for internalizing problems ( $\omega = .93$ ), externalizing problems ( $\omega = .94$ ), and total problems ( $\omega = .98$ ) (See Table 1).

**Additional Measures.** Participants completed several other questionnaires that were not considered in the present study. This included measures of psychological distress, affective and non-affective wellbeing, student approaches to learning, patterns of adaptive learning, and student engagement.

### Procedures

**Data collection.** Ethical approval was granted from the ethics committee of Lusíada University. After obtaining informed consent from students' parents and school administrations, students completed the questionnaires in a classroom setting under the supervision of a teacher and graduate student.

**Statistical analyses.** Our analytical plan involved using a person-centered approach to assess differences in internalizing, externalizing and total problems as a function of personality. Person-centered methods are useful for exploring how emergent subgroups (such as individuals with shared personality characteristics) differ or relate on a given variable (Howard & Hoffman, 2018). Person-centered approaches are warranted in personality

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

research where the interest is in understanding how intra-individual organizations of dynamic psychobiological processes relate to relevant life outcomes (Asendorpf, 2015).

All analyses were conducted using R (version 3.6.1 (R Core Team, 2019)). We analyzed the missing data mechanism for the JTCI and YSR using the *MissMech* package (Jamshidian et al., 2014) and did not find sufficient evidence to reject the hypothesis that data were missing completely at random. We thus, replaced missing values using a median imputation. Data were then tested in three stages to describe how student personality, described at ascending levels of complexity, relates to emotional and behavioral problems.

For the first stage, we calculated zero-order correlations between JTCI and YSR dimensions. For the second stage, we used Latent Profile Analysis (LPA) to identify and classify the study sample into a) temperament profiles, and b) character profiles. These models were estimated using standardized student mean scores for each of the four temperament and three character dimensions, respectively (continuous variables). For the third stage, we used Latent Class Analysis (LCA) to classify the study sample into joint temperament-character networks. This model was estimated using students' assigned temperament and character profiles (categorical variables). For both the LPA and LCA, we determined the optimum number of latent classes by comparing the fit of a series of models with increasing numbers of classes. Model fit was compared using the Akaike Information Criterion (Akaike, 1974), Bayesian Information Criterion (Schwarz, 1978) (BIC; Schwarz, 1978), sample-size adjusted BIC (Sclove, 1987), and entropy (Celeux & Soromenho, 1996). For LPA, we also used an Analytic Hierarchy Process (Akogul & Erisoglu, 2017) to help determine the number of classes.

At both the second and third stages, we used MANCOVAs to test differences in internalizing and externalizing problems simultaneously after controlling for age and gender.

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

At each of these stages, we also conducted an independent ANCOVA to test if the emergent profiles and networks differed in total problems.

After performing these analyses, we noted that group differences were mostly small and postulated this may be a result of positively skewed data and consequent floor effects (see Discussion). Hence, we engaged in a post hoc analysis testing whether personality profiles/networks differed in the proportion of class members with clinical presentations of internalizing, externalizing and total problems. For the YSR, scores between the 82<sup>nd</sup> and 90<sup>th</sup> percentiles ( $> 1 SD$ ) are the most efficient discriminators between normal and disturbed behavior (T.M. Achenbach, 1991), and we therefore defined individuals with Z scores  $> 1$  as clinical cases. These analyses included the Chi-squared test and, in the cases of  $2 \times 2$  contingency tables, the calculation of Odds Ratios (OR). Odds should not be interpreted as true risk, but are similar to risk when the event is rare (which we argue is the case with disturbed behavior).

### Results

#### Descriptive statistics

Table 1 presents the descriptive statistics for our study variables. It was noteworthy that adolescents' tended to report low levels of problems, as clear by the moderate to strong positive skewness of YSR scales. Considering YSR scores  $> 1 SD$  as an indicator of clinical behavior, it was evident that 14% – 18% of adolescents had clinical levels of the eight syndromes.

#### TABLE 1

Zero-order correlations between JTCI dimensions and YSR scales are shown in Table 2. From this table it was evident that emotional and behavioral problems were consistently positively correlated with novelty seeking and harm avoidance, and negatively correlated with persistence and self-directedness.

TABLE 2

**Temperament profiles and emotional/behavioral problems.**

Values for AIC, BIC and SABIC favored different models (Table 3, Panel A). Consequently, because the analytic hierarchy process (Akogul & Erisoglu, 2017) favored the two-class model, we chose to extract two classes. Figure 1a shows the temperament z scores for these two classes.

TABLE 3

FIGURE 1

Adolescents in class one ( $n = 501$ ) had a temperament profile characterized by moderately high novelty seeking, and moderately low reward dependence and persistence. Because these features were similar to a profile identified by Zwir et al (Zwir et al., 2018b), we used the same label: the antisocial profile. The adolescents in class two ( $n = 198$ ) had low novelty seeking (reduced by approximately 1 SD), high reward dependence, and high persistence (elevated by approximately 1 SD). Given its similarity to one of the profiles identified by Rettew et al (Rettew et al., 2008), we gave it the same label: the steady profile. These profiles had significantly different gender compositions,  $p < .001$ , and differed significantly in age  $p < .001$ ,  $\omega^2 = .023$  (see Table 4).

TABLE 4

Figures 1B-D indicate that the steady profile had fewer emotional and behavioral problems than the antisocial profile. The multivariate analysis using Pillai's trace indicated the covariates age,  $V = .06$ ,  $F(2, 669) = 13.50$ ,  $p < .001$ , and gender,  $V = .04$ ,  $F(2, 669) = 9.73$ ,  $p < .001$ , were significantly related to temperament profile. There was also a significant effect of temperament profile on the number of internalizing and externalizing problems after controlling for age and gender,  $V = .05$ ,  $F(2, 669) = 12.39$ ,  $p < .001$ . Separate univariate ANCOVAs on the outcome variables revealed significant effects on internalizing problems,

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

$F(1, 671) = 9.86, p = .002, \omega^2 = .013$ , and externalizing problems,  $F(1, 671) = 30.21, p < .001, \omega^2 = .040$ , after controlling for age and gender. An independent ANCOVA on the outcome variable total problems also revealed a significant effect of temperament profile after controlling for age and gender,  $F(1, 671) = 22.60, p < .001, \omega^2 = .030$ .

Table 3 shows that a larger proportion of individuals with an antisocial temperament profile had clinical levels of internalizing, externalizing and total problems compared to those with a steady temperament profile. These differences were significant for internalizing problems,  $\chi^2(1) = 6.35, p = .012, \phi = .10, OR = 1.99, 95\% CI [1.20, 3.47]$ , externalizing problems,  $\chi^2(1) = 29.22, p < .001, \phi = .21, OR = 6.25, 95\% CI [3.17, 14.28]$ , and total problems,  $\chi^2(1) = 18.37, p < .001, \phi = .17, OR = 3.87, 95\% CI [2.11, 7.85]$ .

### **Character profiles and emotional/behavioral problems.**

As with the temperament profiles, LPA fit indices favored a range of different models (Table 3, Panel B). Consequently, we extracted a six-class solution in accordance with the analytic hierarchical process. Character z scores across the six classes are shown in Figure 2.

#### FIGURE 2

Adolescents in the first class ( $n = 161$ ) had low values for all three character dimensions, and we therefore labelled this profile the ‘apathetic’ profile. The few adolescents with a ‘disorganized’ profile ( $n = 6$ ) were characterized by low self-directedness and cooperativeness, but a high elevation in self-transcendence. Most adolescents ( $n = 257$ ) were characterized by average levels of all three dimensions and were thus described as having a ‘diffuse’ character profile. Adolescents with a ‘moody’ profile ( $n = 88$ ) were characterized by average self-directedness and elevated cooperativeness and self-transcendence. Adolescents with an ‘organized’ profile ( $n = 105$ ) were defined by high self-directedness, slightly elevated cooperativeness, and low self-transcendence. Finally, adolescents with elevations across all three dimensions ( $n = 82$ ) were described as having a ‘creative’ profile. These character



## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

profiles differed significantly in terms of their gender composition,  $p < .001$ , and age,  $p < .001$ ,  $\omega^2 = .024$ .

Figure 2 presents the differences in emotional/behavioral problems across the six character profiles. The multivariate analysis indicated the covariates age,  $V = .03$ ,  $F(2, 666) = 11.10$ ,  $p < .001$ , and gender,  $V = .04$ ,  $F(2, 666) = 14.58$ ,  $p < .001$ , were significantly related to character profile. There was also a significant effect of character profile on the number of internalizing and externalizing problems after controlling for age and gender,  $V = .10$ ,  $F(2, 1334) = 7.05$ ,  $p < .001$ . Separate univariate ANCOVAs on the outcome variables revealed significant effects, after controlling for age and gender, on internalizing problems,  $F(5, 667) = 13.52$ ,  $p < .001$ ,  $\omega^2 = .082$ , and externalizing problems,  $F(5, 667) = 11.11$ ,  $p < .001$ ,  $\omega^2 = .068$ . An independent ANCOVA on the outcome variable total problems also revealed a significant effect of character profile after controlling for age and gender,  $F(1, 667) = 14.62$ ,  $p < .001$ ,  $\omega^2 = .088$ .

Table 4 presents the number of clinical presentations of internalizing, externalizing, and total problems across the character profiles. Individuals with the unhealthy apathetic and disorganized character profiles were the most likely to have clinical levels of behavioral and emotional problems. In contrast, individuals with the organized and creative character profiles were the least likely to have clinical levels of emotional and behavioral problems. These differences were significant for internalizing,  $\chi^2(5) = 51.70$ ,  $p < .001$ , Cramer's  $V = .27$ , externalizing,  $\chi^2(5) = 64.85$ ,  $p < .001$ , Cramer's  $V = .30$ , and total problems,  $\chi^2(5) = 58.63$ ,  $p < .001$ , Cramer's  $V = .29$ .

### **Joint temperament-character networks and emotional/behavioral problems.**

Model fit indices for the LCA consistently favored a two-class model (Table 3, Panel C). All adolescents in the first class ( $n = 485$ ) had an antisocial temperament profile, and the

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

majority had either an apathetic (33%) or diffuse (44%) character profile (see Figure 3). The relationship between temperament and character profiles was complex, as indicated by the number of adolescents who had either a moody or organized character profile (9% and 13% respectively). Because these adolescents had an antisocial temperament and underdeveloped character, leading them to be more emotionally driven, we labelled this the *Emotional-Antisocial* network. Most adolescents in the second class ( $n = 214$ ) had a steady temperament profile (93%), and none of these adolescents had an apathetic or disorganized character profile. Instead, the largest proportion of these adolescents had a creative profile (38%), with smaller proportions for the organized (21%), moody (20%), and diffuse (21%) profiles. Because most of these adolescents had a steady temperament and a healthy character, we labelled this the *Mature-Steady* network. These integrated profiles differed significantly in terms of their gender composition,  $p < .001$ , and in terms of age,  $p < .001$ ,  $\omega^2 = .021$  (Table 4).

### FIGURE 3

The multivariate analysis indicated the covariates age,  $V = .03$ ,  $F(2, 670) = 10.48$ ,  $p < .001$ , and gender,  $V = .04$ ,  $F(2, 670) = 14.56$ ,  $p < .001$ , were significantly related to joint temperament-character network. There was also a significant effect of network on the number of internalizing and externalizing problems after controlling for age and gender,  $V = .04$ ,  $F(2, 670) = 15.60$ ,  $p < .001$ . Separate univariate ANCOVAs on the outcome variables revealed significant effects on internalizing problems,  $F(1, 671) = 11.52$ ,  $p < .001$ ,  $\omega^2 = .015$ , and externalizing problems,  $F(1, 671) = 29.20$ ,  $p < .001$ ,  $\omega^2 = .039$ , after controlling for age and gender. An independent ANCOVA on the outcome variable total problems also revealed a significant effect of character profile after controlling for age and gender,  $F(1, 671) = 22.75$ ,  $p < .001$ ,  $\omega^2 = .030$ .

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

The proportions of these joint temperament-character networks with clinical levels of behavioral and emotional problems were similar to the temperament profiles. There were significantly higher proportions of clinical cases in the emotional-antisocial network for internalizing,  $\chi^2(1) = 9.13, p = .003$ , Cramer's  $V = .12$ , OR = 2.26, 95% CI [1.36, 3.93], externalizing,  $\chi^2(1) = 21.02, p < .001$ , Cramer's  $V = .20$ , OR = 4.91, 95% CI [2.68, 9.91], and total problems,  $\chi^2(1) = 20.36, p < .001$ , Cramer's  $V = .18$ , OR = 3.94, 95% CI [2.19, 7.76].

### Discussion

A first finding of the current study was the identification of two latent temperament profiles and six latent character profiles. This finding is noteworthy because these were broadly consistent with various temperament and character profiles identified in prior person-centered studies using Cloninger's personality model.

Of the two emergent temperament profiles, one describes adolescents with a tendency to be more impulsive, social detached and easily discouraged (the antisocial profile), and the second described those with a tendency to be more controlled, calm and friendly (the steady profile). The fact that these profiles shared a strong similarity with the steady and disengaged profiles identified by Rettew et al (Rettew et al., 2008), the reliable and antisocial profiles identified by Zwir et al (Zwir et al., 2018b), and the easy and slow to warm up profiles of Thomas and Chess (Thomas et al., 1968) was evidence of their validity within adolescent samples. Overall, we found that the steady profile was associated with fewer emotional and behavioral problems than the antisocial profile, and this difference was largest for externalizing problems (although as we shall consider below, all effect sizes were small). These findings are consistent with the studies by Rettew et al (Rettew et al., 2008), and Zwir et al (Zwir et al., 2018b), which showed individuals with steady/reliable-type profiles typically have reduced ill-being, higher wellbeing, and fewer diagnosed psychiatric disorders. Considering these findings, our study suggests that the manner in which individuals tend to

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

express themselves spontaneously as an expression of individual differences in associative conditioning is a relevant factor to understanding risk for the development of emotional/behavioral problems.

Adolescents were also members of six distinct character profiles that are theoretically consistent (Cloninger, 2004) and often identified in research on character (Cloninger & Zohar, 2011; Zwir et al., 2018a). Of the six character profiles identified, two (the organized and creative profiles) were consistent with what have been considered as “healthy” personalities (defined by high self-directedness and high cooperativeness). Three others (the apathetic, disorganized and moody profiles) were consistent with “unhealthy” personalities. People in the largest profile – the diffuse profile -- had roughly average levels of all three character dimensions, which implies they have qualities of a creative character, but are not fully integrated (Cloninger et al., 1998). A robust body of research on character profiles provides evidence that healthy characters, and particularly creative characters, are fundamental for adaptive human functioning, wellbeing and health (Cloninger, 2013; Cloninger & Zohar, 2011; Josefsson et al., 2011; Moreira et al., 2015). Consistent with this literature, we found that adolescents with healthy characters had the lowest levels of emotional and behavioral problems, with most members of these classes having lower than average levels. Specifically, a closer inspection of our results suggested a specific linear effect of self-directedness on the prevalence of problems with the least healthy characters (lowest self-directedness) having the highest problems; the diffuse character (average self-directedness) having average problems; and the healthy characters (highest self-directedness) having the fewest problems. Thus, this set of findings aligns with current understanding of the critical role of self-directedness and self-regulatory ability, as well as overall character integration, in predicting psychopathology (Svrakic et al., 1993).

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

The primary contribution of the present study is that it recognizes personality can be organized in levels of ascending descriptive complexity with genetically-independent temperament and character profiles being integrated into complex adaptive networks via genetic-environment interactions (Zwir et al., 2019). These joint networks capture differences in how individuals learn to shape and adapt to their internal and external environments via the integrated configuration of three systems of learning and memory. The first joint temperament-character network we identified consisted of adolescents with an antisocial temperament profile and unhealthy/diffuse character. This combination was a close match to the emotional-unreliable network identified by Zwir et al (Zwir et al., 2019) and indicated these individuals were poorly regulated and low in creativity. The second joint network was made up of steady temperament and healthy (mature) characters. Because this cluster included individuals with a creative character profile and those with an organized character profile, we suggest that it represents a combination of the distinct creative-reliable and organized-reliable profiles identified by Zwir et al (Zwir et al., 2019). In other words, this network included individuals who had greater capacity for mental self-government (and some individuals with high creativity). Comparing the two networks, we found that the mature-steady network had lower levels of emotional/behavioral problems, and particularly externalizing problems, than the emotional-antisocial network. As such, our study findings align with theory on what constitutes a healthy personality (Cloninger, 2004, 2013; Cloninger & Cloninger, 2020; Zwir et al., 2019) and indicate that the healthy integration of associative conditioning, intentionality and self-awareness – enabling self-actualization and identity formation -- serves to reduce risk for the development of psychopathology.

### **Small Effects and Odds Ratios**

While our overall finding was that there were differences in YSR scale scores as a function of personality profiles and networks, it was clear that the magnitudes of these

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

differences were small. Indeed, in the cases of temperament profiles and joint temperament-character networks these effects (measured as  $\omega^2$ ,  $\phi$ , or Cramer's V) were sufficiently small that they might not be considered practically or clinically significant (Ferguson, 2009). One explanation for these small effects was that we measured emotional and behavioral problems, using a self-report scale, in a non-clinical sample, which unsurprisingly resulting in a large proportion of individuals scoring at the lower limits of the scales. Thus, it is possible that the limited number of emergent profiles (particularly in the cases of temperament and joint temperament-character networks), each with a level of heterogeneity, were not sensitive to the subtle differences in non-clinical levels of problems. However, we also showed via the calculation of odds ratios that the various personality profiles and networks differed in their probability of disturbed behavior (versus normal behavior), which is critical information for those working in clinical practice. For example, we found that 18% of the emotional-antisocial network (88 individuals) had clinical levels of internalizing problems compared to 9% of the mature-steady network (19 individuals). The effect size calculated from this analysis indicated that the absolute difference in probability of disturbed behavior between the networks was small. However, the odds ratio analysis indicate that adolescents with the emotional-antisocial network were more than twice as likely to have clinical levels of internalizing problems. The same group of individuals was almost five times more likely to have clinical levels of externalizing problems. In short, we found; a) that the emergent profiles and networks were linked to measurable, yet ultimately small, differences in non-clinical levels of emotional and behavioral problems, but also (b) that these profiles and networks were differentiated by their relative odds for disturbed behavior.

### **Limitations**

The study has several limitations. First, we recruited the adolescents from a small number of schools using a convenience non-probabilistic strategy. Therefore, it is possible

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

that this sample is not fully representative of adolescents in Portugal, meaning there is a threat to the external validity of the study. Direct replications of this study using more sophisticated sampling techniques (e.g. stratified random sampling to select representative schools, and representative students within each school) are required to enhance the validity of our findings. Second, it is important to acknowledge that the data were collected entirely using self-report instruments; a methodological choice that is commonly criticized in terms of construct validity (adolescents may be biased in their presentation of sensitive information, such as emotional/behavioral problems) and common method variance (although some researchers believe these critiques are overblown (Chan, 2009)). Future studies on this topic ought to incorporate parent- or teacher-report measures to validate our main findings.

### **Conclusions**

A full understanding of how normal variants of personality manifest as behavioral and emotional problems requires an acknowledgment that personality is organized in a hierarchy of descriptive complexity ascending from individual traits, to genetically independent multi-trait profiles, to complex networks of interacting temperament and character profiles. We found that an antisocial temperament profile and unhealthy character profiles were linked to increased odds for developing clinical levels of internalizing, externalizing, and total problems. We also found that an emotional-antisocial network (implying emotional reactivity and low self-control and creativity) was linked to increased odds for developing clinical levels of problems. Based on our findings, and in alignment with the recommendations made by others (Cloninger & Zvir, 2018) we suggest that clinicians wanting to understand specific individuals' risks for psychopathology should focus on multi-trait temperament and character profiles and their complex interactions, rather than individual personality dimensions.

### **Summary**

## PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

Recent genetic and epidemiological studies have uncovered three genetic-environmental networks underlying the integrated expression of human personality: associative conditioning, intentionality, and self-awareness. In this study, we described how different combinations of these systems are associated with emotional and behavioral problems in adolescents. Latent profile analyses showed the adolescents could be classified into one of two distinct temperament profiles and, simultaneously, one of six distinct character profiles. Individuals with a ‘steady’ temperament profile tended to have reduced emotional and behavioral problems. Individuals with more mature character profiles also had decreased psychopathology. A latent class analysis showed individuals with a ‘steady’ temperament profile tended to have a more developed character. Conversely, individuals with an ‘antisocial’ temperament profile tended to have underdeveloped character. The combination of a steady temperament and developed character was associated with reduced emotional and behavioral problems. Adaptive expressions of the dissociable but interacting brain systems for associative conditioning, intentionality and self-awareness are linked to fewer emotional and behavioral problems, particularly at clinical levels. These findings contribute to deepening current understanding about the personality-psychopathology associations in adolescents by using a genetically informed personality framework and person-centered approach.

**Ethical Standards Statement:** This study has been approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Additionally, national laws have been observed.

**Conflict of Interests:** On behalf of all authors, the corresponding author states that there is no conflict of interests.

### References



PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

Achenbach, T.M. (1991). *Integrative guide for the 1991 CBCL/4-18, YSR and TRF profiles*.

Department of Psychiatry, University of Vermont.

Achenbach, Thomas M., Becker, A., Döpfner, M., Heiervang, E., Roessner, V., Steinhausen,

H. C., & Rothenberger, A. (2008). Multicultural assessment of child and adolescent psychopathology with ASEBA and SDQ instruments: Research findings, applications, and future directions. *Journal of Child Psychology and Psychiatry and Allied*

*Disciplines*, 49(3), 251–275. <https://doi.org/10.1111/j.1469-7610.2007.01867.x>

Akaike, H. (1974). A new look at the statistical model identification. In *Selected Papers of*

*Hirotsugu Akaike* (pp. 215–222). Springer.

Akogul, S., & Erisoglu, M. (2017). An approach for determining the number of clusters in a

model-based cluster analysis. *Entropy*, 19(9), 1–15. <https://doi.org/10.3390/e19090452>

Althoff, R. R. (2010). Dysregulated children reconsidered. *Journal of the American Academy*

*of Child and Adolescent Psychiatry*, 49(4), 302–305. <https://doi.org/10.1097/00004583-201004000-00004>

Althoff, R. R., Ayer, L. A., Crehan, E. T., Rettew, D. C., Baer, J. R., & Hudziak, J. J. (2012).

Temperamental profiles of dysregulated children. *Child Psychiatry and Human Development*, 43(4), 511–522. <https://doi.org/10.1007/s10578-012-0280-7>

Althoff, R. R., Ayer, L. A., Rettew, D. C., & Hudziak, J. J. (2010). Assessment of

dysregulated children using the Child Behavior Checklist: A receiver operating characteristic curve analysis. *Psychological Assessment*, 22(3), 609–617.

<https://doi.org/10.1037/a0019699>

Asendorpf, J. B. (2015). Person-centered approaches to personality. In M. Mikulincer, P. R.

Shaver, M. L. Cooper, & R. J. Larsen (Eds.), *APA handbook of personality and social psychology, Vol. 4. Personality processes and individual differences* (pp. 403–424).

American Psychological Association.

PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

- Bierderman, J., Rosenbaum, J. F., Bolduc-Murphy, E. A., Faraone, S. V., Chaloff, J., Hirshfeld, D. R., & Kagan, J. (1993). A 3-Year Follow-up of Children with and without Behavioral Inhibition. *Journal of the American Academy of Child and Adolescent Psychiatry*, 32(4), 814–821. <https://doi.org/10.1097/00004583-199307000-00016>
- Caspi, A., & Silva, P. A. (1995). Temperamental Qualities at Age Three Predict Personality Traits in Young Adulthood: Longitudinal Evidence from a Birth Cohort. In *Source: Child Development* (Vol. 66, Issue 2).
- Celeux, G., & Soromenho, G. (1996). An entropy criterion for assessing the number of clusters in a mixture model. *Journal of Classification*, 13, 195–212. [https://doi.org/10.1016/S0167-8655\(98\)00144-5](https://doi.org/10.1016/S0167-8655(98)00144-5)
- Cervone, D. (2005). Personality architecture: Within-person structures and processes. *Annual Review of Psychology*, 56, 423–452. <https://doi.org/10.1146/annurev.psych.56.091103.070133>
- Chan, D. (2009). So why ask me? Are self-report data really that bad? In C. E. Lance & R. J. Vandenberg (Eds.), *Statistical and methodological myths and urban legends: Doctrine, verity and fable in the organizational and social sciences* (pp. 309–336). Routledge/Taylor & Francis Group.
- Cloninger, C. R. (1999). *The Temperament and Character Inventory - Revised*. Center for Psychobiology of Personality, Washington University.
- Cloninger, C. R. (2004). *Feeling Good: The Science of Well-Being*.
- Cloninger, C. R. (2008). The psychobiological theory of temperament and character: Comment on Farmer and Goldberg (2008). *Psychological Assessment*, 20(3), 292–299. <https://doi.org/10.1037/a0012933>
- Cloninger, C. R. (2013). What makes people healthy, happy, and fulfilled in the face of current world challenges? *Mens Sana Monographs*, 11(1), 16–24.

PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

<https://doi.org/10.4103/0973-1229.109288>

Cloninger, C. R., Bayon, C., & Svrakic, D. M. (1998). Measurement of temperament and character in mood disorders: a model of fundamental states as personality types. *Journal of Affective Disorders*, *51*(1), 21–32.

Cloninger, C. R., Cloninger, K. M., Zwir, I., & Keltikangas-Järvinen, L. (2019). The complex genetics and biology of human temperament: a review of traditional concepts in relation to new molecular findings. In *Translational Psychiatry* (Vol. 9, Issue 1). Nature Publishing Group. <https://doi.org/10.1038/s41398-019-0621-4>

Cloninger, C. R., & Svrakic, D. M. (1997). Integrative Psychobiological Approach to Psychiatric Assessment and Treatment. *Psychiatry*, *60*(2), 120–141.

<https://doi.org/10.1080/00332747.1997.11024793>

Cloninger, C. R., Svrakic, D. M., & Przybeck, T. R. (1993). A psychobiological model of temperament and character. *Archives of General Psychiatry*, *50*(12), 975–990.

Cloninger, C. R., Svrakic, D. M., & Przybeck, T. R. (2006). Can personality assessment predict future depression? A twelve-month follow-up of 631 subjects. *Journal of Affective Disorders*, *92*(1), 35–44. <https://doi.org/10.1016/j.jad.2005.12.034>

Cloninger, C. R., & Zohar, A. H. (2011). Personality and the perception of health and happiness. *Journal of Affective Disorders*, *128*(1–2), 24–32.

<https://doi.org/10.1016/j.jad.2010.06.012>

Cloninger, C. R., & Zwir, I. (2018). What is the natural measurement unit of temperament: Single traits or profiles? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*. <https://doi.org/10.1098/rstb.2017.0163>

Cloninger, K. M., & Cloninger, C. R. (2020). The Psychobiology of the Path to a Joyful Life: Implications for Future Research and Practice. *Journal of Positive Psychology*, *15*(1), 74–83. <https://doi.org/10.1080/17439760.2019.1685579>

PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

Ferguson, C. J. (2009). An Effect Size Primer: A Guide for Clinicians and Researchers.

*Professional Psychology: Research and Practice*, 40(5), 532–538.

<https://doi.org/10.1037/a0015808>

Goncalves, D. M., & Cloninger, C. R. (2010). Validation and normative studies of the

Brazilian Portuguese and American versions of the Temperament and Character

Inventory - Revised (TCI-R). *Journal of Affective Disorders*, 124, 126–133.

<https://doi.org/10.1016/j.jad.2009.11.007>

Howard, M. C., & Hoffman, M. E. (2018). Variable-Centered, Person-Centered, and Person-

Specific Approaches: Where Theory Meets the Method. *Organizational Research*

*Methods*, 21(4), 846–876. <https://doi.org/10.1177/1094428117744021>

James, L. M., & Taylor, J. (2007). Impulsivity and negative emotionality associated with

substance use problems and Cluster B personality in college students. *Addictive*

*Behaviors*, 32(4), 714–727. <https://doi.org/10.1016/j.addbeh.2006.06.012>

Jamshidian, M., Jalal, S., & Jansen, C. (2014). MissMech: An R Package for Testing

Homoscedasticity, Multivariate Normality, and Missing Completely at Random

(MCAR). In *JSS Journal of Statistical Software* (Vol. 56, Issue 6).

<http://www.jstatsoft.org/>

Josefsson, K., Cloninger, C. R., Hintsanen, M., Jokela, M., Pulkki-Råback, L., &

Keltikangas-Järvinen, L. (2011). Associations of personality profiles with various

aspects of well-being: A population-based study. *Journal of Affective Disorders*, 133(1–

2), 265–273. <https://doi.org/10.1016/j.jad.2011.03.023>

Kim, S. J., Lee, S. J., Yune, S. K., Sung, Y. H., Bae, S. C., Chung, A., Kim, J., & Lyoo, I. K.

(2006). The relationship between the biogenetic temperament and character and

psychopathology in adolescents. *Psychopathology*, 39(2), 80–86.

<https://doi.org/10.1159/000090597>

PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

- Krueger, R. F., & Tackett, J. L. (2003). Personality and psychopathology: Working toward the bigger picture. *Journal of Personality Disorders, 17*(2), 109–128.  
<https://doi.org/10.1521/pedi.17.2.109.23986>
- Lee, S. J., Park, S. H., Cloninger, C. R., & Chae, H. (2018). Behavior problems and personality in Korean high school students. *PeerJ, 2018*(12).  
<https://doi.org/10.7717/peerj.6106>
- Mardaga, S., & Hansenne, M. (2007). Relationships between Cloninger's biosocial model of personality and the behavioral inhibition/approach systems (BIS/BAS). *Personality and Individual Differences, 42*(4), 715–722. <https://doi.org/10.1016/j.paid.2006.08.013>
- Mennin, D. S., Holaway, R., Fresco, D. ., Moore, M. T., & Heimberg, R. G. (2007). Delineating components of emotion and its dysregulation in anxiety and mood psychopathology. *Behavior Therapy, 38*, 284–302.
- Mischel, W., & Shoda, Y. (1995). A cognitive-affective system theory of personality: Reconceptualizing situations, dispositions, dynamics, and invariance in personality structure. *Psychological Review, 102*(2), 246–268. <https://doi.org/10.1037/0033-295X.102.2.246>
- Moreira, P. A. S., Cloninger, C. R., Dinis, L., Sá, L., Oliveira, J. T., Dias, A., & Oliveira, J. (2015). Personality and well-being in adolescents. *Frontiers in Psychology, 5*, 1494.  
<https://doi.org/10.3389/fpsyg.2014.01494>
- Moreira, P. A. S., Oliveira, J. T., Cloninger, K. M., Azevedo, C., Sousa, A., Castro, J., & Cloninger, C. R. (2012). The psychometrics and validity of the Junior Temperament and Character Inventory in Portuguese adolescents. *Comprehensive Psychiatry, 53*(8), 1227–1236. <https://doi.org/10.1016/j.comppsy.2012.04.014>
- Muris, P., van Brakel, A. M. L., Arntz, A., & Schouten, E. (2011). Behavioral Inhibition as a Risk Factor for the Development of Childhood Anxiety Disorders: A Longitudinal

PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

Study. *Journal of Child and Family Studies*, 20(2), 157–170.

<https://doi.org/10.1007/s10826-010-9365-8>

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination.

*Perspectives on Psychological Science*, 3(5), 400–424.

R Core Team. (2019). *R: A language and environment for statistical computing*. R Core Team.

Rettew, D. C., Althoff, R. R., Dumenci, L., Ayer, L., & Hudziak, J. J. (2008). Latent profiles of temperament and their relations to psychopathology and wellness. *Journal of the American Academy of Child and Adolescent Psychiatry*, 47(3), 273–281.

<https://doi.org/10.1097/CHI.0b013e318160b403>

Schwarz, G. E. (1978). Estimating the dimension of a model. *Annals of Statistics*, 6(2), 461–464. <https://doi.org/10.1214/aos/1176344136>

Sclove, S. L. (1987). Application of model-selection criteria to some problems in multivariate analysis. *Psychometrika*, 52(3), 333–343. <https://doi.org/10.1007/BF02294360>

Sher, K. J., & Grekin, E. R. (2007). Alcohol and affect regulation. In J. J. Gross (Ed.), *Handbook of Emotion Regulation* (pp. 560–580). Guilford Press.

Strauman, T. J. (2017). Self-Regulation and Psychopathology: Toward an Integrative Translational Research Paradigm. *Annual Review of Clinical Psychology*, 13(8), 8.1-8.27. <https://doi.org/10.1146/annurev-clinpsy-032816>

Svrakic, D. M., Whitehead, C., Przybeck, T. R., & Cloninger, C. R. (1993). Differential diagnosis of personality disorders by the seven-factor model of temperament and character. *Archives of General Psychiatry*, 50, 991–999.

Thomas, A., Chess, S., & Birch, H. G. (1968). *Temperament and behavior disorders in children*. New York University Press.

Vazsonyi, A. T., Cleveland, H. H., & Wiebe, R. P. (2006). Does the effect of impulsivity on

PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

- delinquency vary by level of neighborhood disadvantage? *Criminal Justice and Behavior*, 33(4), 511–541. <https://doi.org/10.1177/0093854806287318>
- White, H. R., Bates, M. E., & Buyske, S. (2001). Adolescence-limited versus persistent delinquency: Extending moffitt's hypothesis into adulthood. *Journal of Abnormal Psychology*, 110(4), 600–609. <https://doi.org/10.1037/0021-843X.110.4.600>
- Widiger, T. A. (2011). Personality and psychopathology. *World Psychiatry*, 10(2), 103–106. <https://doi.org/10.1002/j.2051-5545.2011.tb00024.x>
- Widiger, T. A., & Trull, T. J. (2007). Plate tectonics in the classification of personality disorder: Shifting to a dimensional model. *American Psychologist*, 62(2), 71–83. <https://doi.org/10.1037/0003-066X.62.2.71>
- Wills, T. A., Vaccaro, D., & McNamara, G. (1994). Novelty seeking, risk taking, and related constructs as predictors of adolescent substance use: An application of Cloninger's theory. *Journal of Substance Abuse*, 6(1), 1–20. [https://doi.org/10.1016/S0899-3289\(94\)90039-6](https://doi.org/10.1016/S0899-3289(94)90039-6)
- Zwir, I., Arnedo, J., Del-Val, C., Pulkki-Råback, L., Konte, B., Yang, S. S., Romero-Zaliz, R., Hintsanen, M., Cloninger, K. M., Garcia, D., Svrakic, D. M., Rozsa, S., Martinez, M., Lyytikäinen, L. P., Giegling, I., Kähönen, M., Hernandez-Cuervo, H., Seppälä, I., Raitoharju, E., ... Cloninger, C. R. (2018a). Uncovering the complex genetics of human character. *Molecular Psychiatry*. <https://doi.org/10.1038/s41380-018-0263-6>
- Zwir, I., Arnedo, J., Del-Val, C., Pulkki-Råback, L., Konte, B., Yang, S. S., Romero-Zaliz, R., Hintsanen, M., Cloninger, K. M., Garcia, D., Svrakic, D. M., Rozsa, S., Martinez, M., Lyytikäinen, L. P., Giegling, I., Kähönen, M., Hernandez-Cuervo, H., Seppälä, I., Raitoharju, E., ... Cloninger, C. R. (2018b). Uncovering the complex genetics of human temperament. *Molecular Psychiatry*. <https://doi.org/10.1038/s41380-018-0264-5>
- Zwir, I., Del-Val, C., Arnedo, J., Pulkki-Råback, L., Konte, B., Yang, S. S., Romero-Zaliz,

PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN  
ADOLESCENTS

R., Hintsanen, M., Cloninger, K. M., Garcia, D., Svrakic, D. M., Lester, N., Rozsa, S.,  
Mesa, A., Lyytikäinen, L.-P., Giegling, I., Kähönen, M., Martinez, M., Seppälä, I., ...

Cloninger, C. R. (2019). Three genetic-environmental networks for human personality.

*Molecular Psychiatry*. <https://doi.org/10.1038/s41380-019-0579-x>



PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

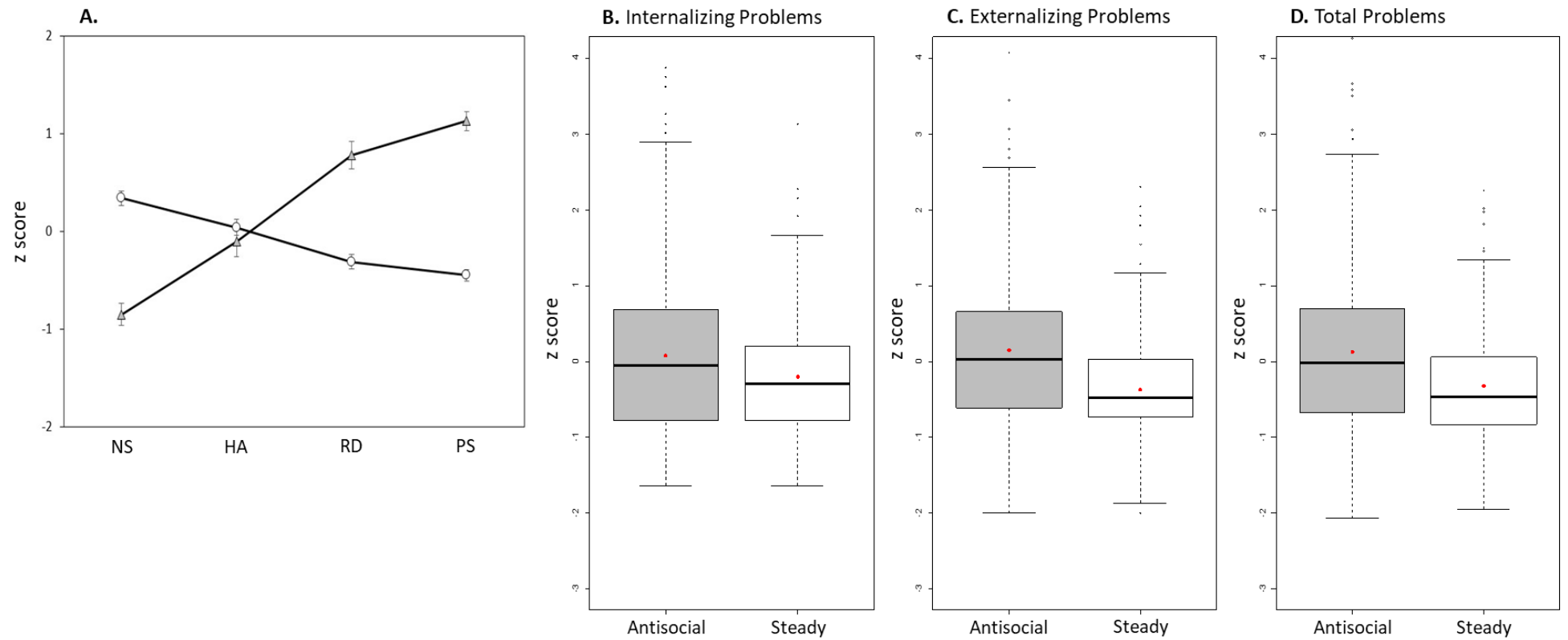


Figure 1. (A) Temperament dimension z scores for the two latent temperament profiles revealed by Latent Profile Analysis. Error bars correspond to 95% CIs. NS = novelty seeking. HA = harm avoidance. RD = reward dependence. PS = persistence. Box plots of internalizing (B), externalizing problems (C), and total problems (D) z scores for the two temperament profiles.

PERSONALITY NETWORKS AND BEHAVIOR AND EMOTIONAL PROBLEMS IN ADOLESCENTS

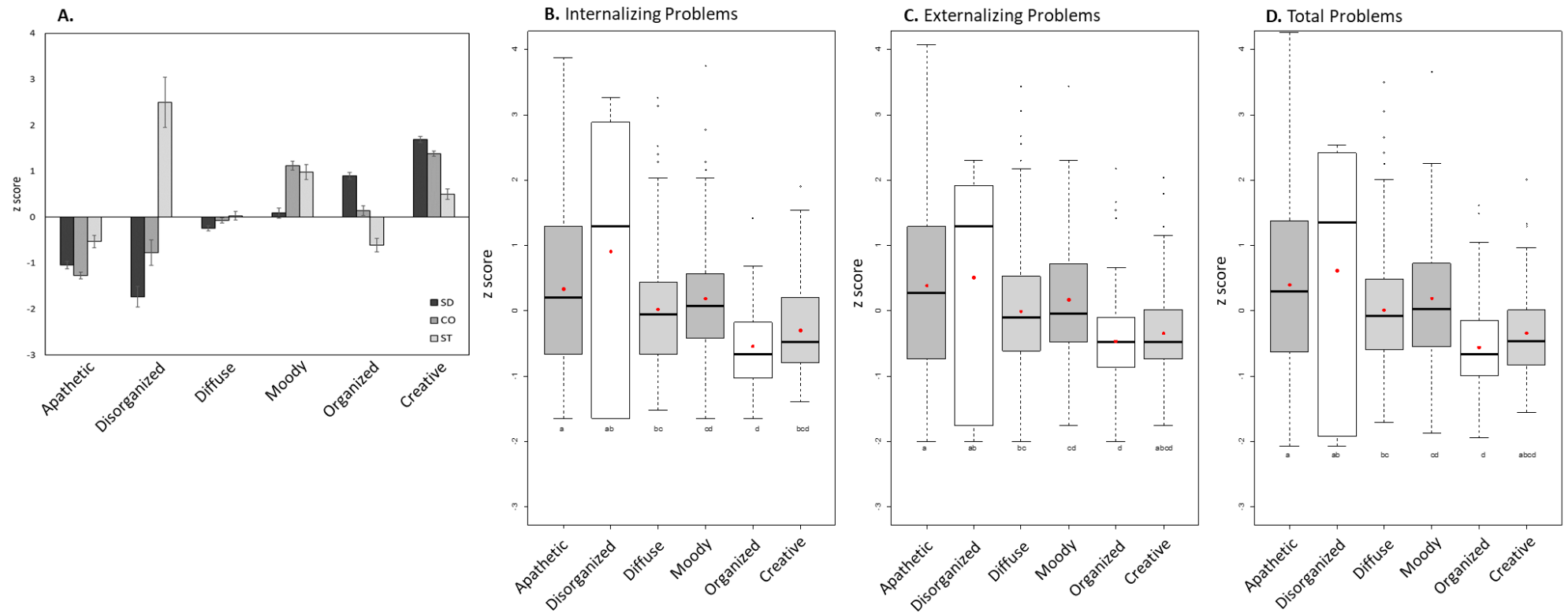


Figure 2. (A). Character dimension z scores for the six character profiles extracted via Latent Profile Analysis. Error bars correspond to 95% CIs.

SD = self-directedness. CO = cooperativeness. ST = self-transcendence. Box plots of internalizing (B), externalizing problems (C), and total problems (D) z scores for the six character profiles. Profile s sharing the same letter are not significantly different (alpha = .05, Tukey-adjusted).

PERSONALITY NETWORKS AND BEHAVIORAL AND EMOTIONAL PROBLEMS IN ADOLESCENTS

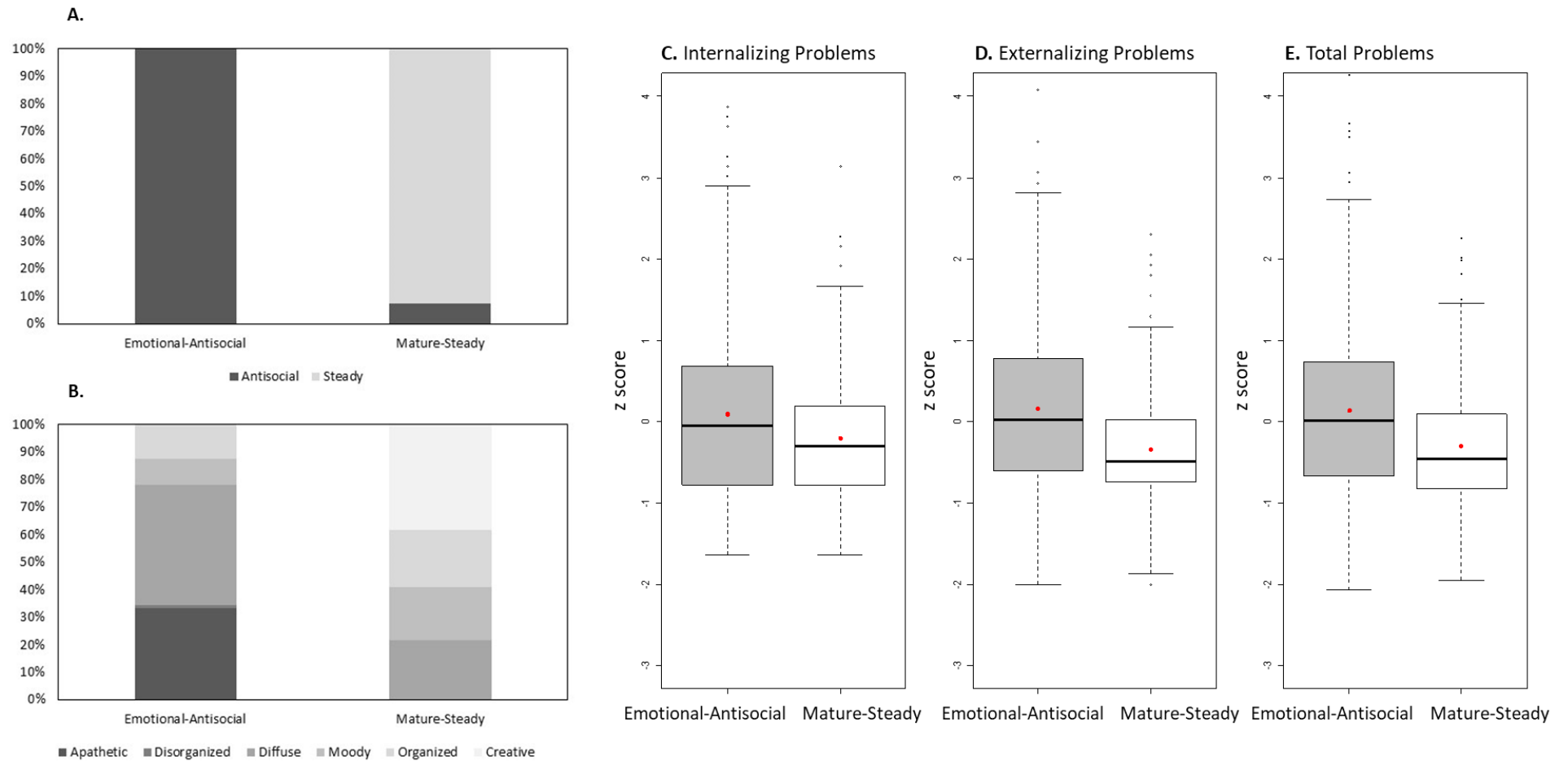


Figure 3. (A). Temperament composition of integrated temperament-character profiles. (B) Character composition of integrated temperament-character profiles. Box plots of internalizing (C), externalizing (D), and total problem (E) z scores for the two integrated temperament-character profiles.

PERSONALITY NETWORKS AND BEHAVIORAL AND EMOTIONAL PROBLEMS IN ADOLESCENTS

Table 1.

*Descriptive statistics for psychobiological personality dimensions and indicators of emotional and behavioral problems (n = 699).*

		<i>M</i>	<i>SD</i>	Min	Max	Skewness	Kurtosis	$\omega$	% high scorers (> 1 SD)
JTCI	Novelty seeking	2.87	0.45	1.35	4.09	-0.05	-0.02	.82	-
	Harm avoidance	2.78	0.42	1.47	4.05	-0.22	0.02	.73	-
	Reward dependence	3.41	0.42	2.20	4.93	0.55	0.36	.70	-
	Persistence	3.45	0.41	2.28	4.83	0.32	-0.04	.76	-
	Self-directedness	3.51	0.42	2.52	4.96	0.35	-0.16	.84	-
	Cooperativeness	3.79	0.45	2.16	4.95	-0.03	-0.40	.89	-
	Self-transcendence	3.51	0.48	2.00	5.00	0.04	0.18	.66	-
YSR	Total problems	51.68	24.95	0.00	158.00	0.86	0.79	.98	15.0%
	Internalizing problems	13.41	8.15	0.00	45.00	0.94	0.89	.93	15.3%
	Externalizing problems	15.81	7.90	0.00	48.00	0.82	0.62	.94	16.3%
	Anxious/depressed <sup>a</sup>	6.29	3.60	0.00	10.00	0.71	0.43	.82	18.3%
	Withdrawn/depressed <sup>a</sup>	3.07	2.34	0.00	12.00	0.88	0.52	.80	14.6%
	Somatic complaints <sup>a</sup>	4.04	3.33	0.00	20.00	1.13	1.65	.88	15.0%
	Social problems	4.63	3.35	0.00	18.00	0.94	0.59	.88	17.7%
	Thought problems	5.22	3.53	0.00	17.00	0.81	0.20	.88	18.0%
	Attention problems	6.32	2.91	0.00	17.00	0.31	0.08	.75	13.7%
	Delinquent behavior <sup>b</sup>	7.47	3.81	0.00	23.00	0.67	0.40	.86	15.6%
Aggressive behavior <sup>b</sup>	8.34	4.54	0.00	25.00	0.81	0.40	.90	17.7%	

*Note.* Scores between 82<sup>nd</sup> and 90<sup>th</sup> percentile have been shown to be most efficient discriminators between normal and disturbed behavior. We thus used scores > 1 SD as the cutoff for high scorers. <sup>a</sup>Internalizing syndromes. <sup>b</sup>Externalizing syndromes.

PERSONALITY NETWORKS AND BEHAVIORAL AND EMOTIONAL PROBLEMS IN ADOLESCENTS

Table 2

*Zero-order correlations between JTCI dimensions and indicators of emotional and behavioral problems.*

	NS	HA	RD	PS	SD	CO	ST
Total problems	<b>.32</b>	<b>.22</b>	-.12	<b>-.23</b>	<b>-.35</b>	-.17	.14
Internalizing problems	<b>.21</b>	<b>.29</b>		-.15	<b>-.34</b>	-.14	.16
Externalizing problems	<b>.39</b>	.09	-.12	<b>-.24</b>	<b>-.30</b>	-.18	.11
Syndromes							
Anxious/depressed <sup>a</sup>	.17	<b>.26</b>		-.07	<b>-.27</b>		<b>.20</b>
Withdrawn/depressed <sup>a</sup>	<b>.25</b>	<b>.20</b>	-.16	<b>-.24</b>	<b>-.35</b>	<b>-.21</b>	.10
Somatic complaints <sup>a</sup>	.16	<b>.28</b>		-.11	<b>-.29</b>	-.11	.12
Social problems	<b>.25</b>	<b>.28</b>	-.19	<b>-.26</b>	<b>-.43</b>	<b>-.26</b>	.08
Thought problems	<b>.22</b>	<b>.26</b>	-.16	<b>-.20</b>	<b>-.31</b>	-.14	.13
Attention problems	<b>.33</b>	.12	-.08	<b>-.29</b>	<b>-.29</b>	-.14	.07
Delinquent behavior <sup>b</sup>	<b>.33</b>	.11	-.10	<b>-.20</b>	<b>-.24</b>	-.11	.13
Aggressive behavior <sup>b</sup>	<b>.41</b>		-.13	<b>-.26</b>	<b>-.31</b>	<b>-.22</b>	.09

*Note.* Only values significant at  $p < .05$  are presented. Values in **bold** correspond to ‘practically’ significant effect  $r > |.20|$ . <sup>a</sup>Internalizing syndromes.

<sup>b</sup>Externalizing syndromes. NS = Novelty Seeking. HA = Harm Avoidance. RD = Reward Dependence. PS = Persistence. SD = Self-Directedness. CO = Cooperativeness. ST = Self-Transcendence

PERSONALITY NETWORKS AND BEHAVIORAL AND EMOTIONAL PROBLEMS IN ADOLESCENTS

Table 3.

*Fit indices for Latent Profile Analysis based on students' mean scores for each of the temperament dimensions (Panel A) and each of the character dimensions (Panel B), and for Latent Class Analysis based on students temperament and character profiles (Panel C).*

Classes	AIC	BIC	SABIC	Entropy
<b>Panel A.</b> LPA based on temperament dimensions				
1	7946.70	7983.10	7957.70	1.00
2	7712.77	7771.92*	7730.64	0.66
3	7700.77	7782.67	7725.51	0.66
4	7701.53	7806.17	7733.14	0.72
5	7681.33*	7808.72	7719.82*	0.66
<b>Panel B.</b> LPA based on character dimensions				
1	5960.03	5987.32	5968.27	1.00
2	5714.59	5760.09	5728.33	0.60
3	5593.21	5656.90	5612.45	0.73
4	5569.17	5651.06*	5593.91	0.66
5	5560.88	5660.97	5591.12	0.63
6	5539.87	5658.16	5575.60	0.67
7	5547.18	5683.67	5588.41	0.58
8	5521.56*	5676.25	5568.29*	0.74
<b>Panel C.</b> LCA based on temperament and character profiles				
1	3003.65	3030.95	2993.83	1.00
2	2771.49*	2830.63*	2749.58*	0.79
3	2785.49	2876.48	2751.49	0.51
4	2799.49	2922.33	2753.40	0.46
5	2813.49	2968.18	2755.31	0.44

*Note.* AIC = Akaike Information Criterion. BIC = Bayesian Information Criterion. SABIC = Size Adjusted BIC. \* = The minimum value of information criterion

PERSONALITY NETWORKS AND BEHAVIORAL AND EMOTIONAL PROBLEMS IN ADOLESCENTS

Table 4.  
Class characteristics.

	Age (years)	Gender			Clinical behavior (high scorers)		
	<i>M</i> (SD)	Male	Female	Missing	Internalizing Problems	Externalizing Problems	Total Problems
<b>Temperament Profiles</b>							
Antisocial ( <i>n</i> = 501)	14.42 (1.44)	267 (53)	212 (42)	22 (4)	88 (18)	106 (21)	94 (19)
Steady ( <i>n</i> = 198)	13.92 (1.34)	66 (33)	130 (66)	2 (1)	19 (10)	8 (4)	11 (6)
<b>Character Profiles</b>							
Apathetic ( <i>n</i> = 161)	14.67 (1.37)	112 (70)	42 (26)	7 (4)	48 (30)	54 (34)	49 (30)
Disorganized ( <i>n</i> = 6)	15.50 (0.55)	3 (50)	3 (50)	0 (0)	3 (50)	3 (50)	3 (50)
Diffuse ( <i>n</i> = 257)	14.19 (1.51)	112 (44)	133 (52)	12 (5)	33 (13)	29 (11)	31 (12)
Moody ( <i>n</i> = 88)	14.07 (1.44)	20 (23)	67 (76)	1 (1)	15 (17)	19 (22)	16 (18)
Organized ( <i>n</i> = 105)	14.08 (1.32)	55 (52)	48 (46)	2 (2)	2 (2)	4 (4)	3 (3)
Creative ( <i>n</i> = 82)	14.17 (1.29)	31 (38)	49 (60)	2 (2)	6 (7)	5 (6)	3 (4)
<b>Joint Temperament-Character Networks</b>							
Emotional-Antisocial ( <i>n</i> = 485)	14.42 (1.45)	261 (54)	203 (42)	21 (4)	88 (18)	103 (21)	93 (19)
Mature-Steady ( <i>n</i> = 214)	13.96 (1.34)	72 (34)	139 (65)	3 (1)	19 (9)	11 (5)	12 (6)