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## Adult temperament styles: a network analysis of their relationships with the Big Five Personality Model

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This study investigated the connectivity structure among temperament styles and Big Five personality factors using network analysis. The temporal stability of temperament styles was also investigated. This study utilized two samples of Brazilian participants, the first for the network analysis and the second to investigate the stability of temperament styles. The first sample consists of 149 adults (57% women) ages 18 to 66 ( $M=32$ ;  $SD=9.92$ ), the second of 88 individuals (56% women) ranging from 18 to 41 years-of-age ( $M=23$ ;  $SD=5.79$ ). Results confirmed that temperament styles measured by the Inventory of Adult Temperament Styles formed networks with personality factors measured by the BFP. Community analysis indicated the presence of four clusters. Estimates of test-retest reliability were statistically significant. In conclusion, temperament styles are stable and can be conceived as a network of traits associated with personality.

*Key words:* Personality, temperament, psychological assessment, Big Five, style.

*Estilos de temperamento de adultos: un análisis de redes de sus relaciones con el modelo de cinco grandes factores de personalidad.* Este estudio investigó la estructura de conectividad entre los estilos de temperamento y los cinco grandes factores de la personalidad (Big Five) utilizando análisis de redes. También se investigó la estabilidad temporal de los estilos de temperamento. Se recogieron dos muestras de participantes brasileños, la primera para el análisis de red y la segunda para investigar la estabilidad de los estilos de temperamento. La primera muestra se compone de 149 adultos (57% mujeres) de 18 a 66 años ( $M=32$ ;  $DE=9.92$ ), y la segunda de 88 individuos (56% mujeres) de 18 a 41 años de edad,  $SD=5.79$ ). Los instrumentos fueron el Inventario de Estilos de Personalidad de Adultos (IATS) y la Batería de Factor de Personalidad (BFP). Los resultados confirmaron que los estilos de temperamento medidos por el IATS formaron redes con factores de personalidad medidos por el BFP. El análisis de la comunidad indicó la presencia de cuatro grupos de personalidad. Las estimaciones de la fiabilidad test-retest fueron estadísticamente significativas ( $p \leq 1.0$ ). En conclusión, los estilos de temperamento son estables y pueden ser concebidos como una red de rasgos asociados con la personalidad.

*Palabras clave:* Personalidad, temperamento, evaluación psicológica, estilos.

Interest in defining and assessing temperament stems from its important role in human behavior (Cloninger & Cloninger, 2011; McCrae, 2013; Strelau & Zawadzki, 2011). Contemporary research characterizes temperament as stable traits representing constitutional dispositions that can be observed in childhood and that impact reactions and behaviors throughout the life span (Cassiano & Linhares, 2015; De Pauw, Mervielde, Van Leeuwen, & De Clercq, 2011; Rothbart, Sheese, Rueda, & Posner, 2011; Slobodskaya, & Kozlova, 2016). Temperament underlies behavioral tendencies that are expressed through preferences and personal choices. These behavioral tendencies are believed to have a biological origin, although they may be modified through environmental experience (Callueng & Oakland, 2014; Casalin, Luyten, Vliegens, & Meurs, 2012; Cloninger, 2012; Walters, 2011). Cross-national research confirms that temperament can be observed across different social and cultural environments (Bachert, Wechsler, & Machado, 2016; Barros, Goes, & Pereira, 2015; Canals, Hernández-Martínez, & Fernández-Ballart, 2011; Ito & Guzzo, 2002).

Important distinctions can be made between the terms personality and temperament, although they are often used synonymously in the literature (McCrae et al., 2000). Personality traits or characteristics are acquired patterns of thoughts and behaviors reflecting complex structures, whereas temperament is considered to be the constitutional or biological foundation on which personality develops (McCrae & Costa, 2003; Thomas & Chess, 1977). Temperament is believed to be based on our genetic inheritance and is influenced by our experiences throughout adulthood. In contrast, personality is a broader construct that has been conceptualized as reflecting a wide range of traits beyond temperament, including intelligence, dynamic motivational traits (Cattell & Kline, 1977), and the interaction of environmental events, behavior, and personal factors (McCrae, 2011).

#### *Assessment of Temperament*

Jung (1921/1971) provided an early theory of personality types that considered innate tendencies and dispositions as influences upon behavior. His classification of psychological types was later expanded and used as a theoretical model when developing the Myers-Briggs Type Indicator (MBTI; Myers, McCaulley, Quenk, & Hammer, 1998). The MBTI is believed to reflect four bipolar type dimensions: extraversion/introversion (EI), thinking-feeling (TF), sensing/intuition (SN), and judging/perceiving (JP). The MBTI has been used internationally to identify temperament styles, identify vocational choices, and enhance career success (Atay, 2012; Martin, 2015; Nielson, 2012).

The stability of MBTI scores has been examined using a test-retest approach with a 1 to 2.5 year interval between test administrations.

The results from this analysis, which are reported in the test manual, suggest that scores are adequately stable over time, as indicated by average test-retest correlations ranging from .74 for TF to .84 for SN (Myers & McCaulley, 1985). A more recent study by Salter, Forney and Evans (2005) examined the stability of MBTI scores using the same 1 to 2.5 year interval and obtained similar results for the 4 type scales. A meta-analytic study (Capraro & Capraro, 2002) revealed that out of 210 studies regarding the MBTI, only 14 reported estimates of score reliability, indicating a need for further empirical research.

The external validity of the MBTI scores has been mainly investigated through correlations with other personality measures, such as the Eysenck's or Cattell's personality measures (McCrae & Costa, 2003). The most interesting findings, however, are the relationships between MBTI types and Big Five dimensions of personality, since the Big Five model was empirically constructed whereas the MBTI is theory driven. Researchers have examined relationships among temperament, as measured by the MBTI, and personality, as measured by the NEO Personality Inventory (NEO-PI; Costa & McCrae, 1985). The NEO-PI purports to measure the Big Five personality factors, which are: Neuroticism, Extraversion, Openness to experience, Agreeableness and Conscientiousness. Although some argue that these five factors do not capture the dynamic nature of personality (Raad et al., 2010), the NEO-PI is widely used internationally as a measure of the personality structure (McCrae & Costa, 2003). Comparing NEO-PI with MBTI scores, McCrae & Costa (1989) found significant correlations between these measures: the NEO-PI Extroversion score correlated positively with the MBTI EI score ( $r=.74$ ), the NEO-PI Agreeableness score correlated positively with the MBTI TF score ( $r=.44$ ), and the NEO-PI Openness and Conscientiousness scores correlated positively with the MBTI JP ( $r=.30$ ) and SN scores ( $r=.49$ ). They concluded that, with the exception of Neuroticism, the NEO-PI factors were aspects of healthy personality. Later studies comparing the two instruments (Furham, Moutafi, & Crump, 2003) reached similar results thus indicating that these two measures may be reflecting similar constructs (Reynierse, 2012).

The MBTI model was modified by Oakland, Glutting, and Horton (1996) in their development of the Student Styles Questionnaire-SSQ. These authors considered the model to reflect temperament rather than personality because the dimensions measured are observable in childhood, thus implying that they are biologically based (Callueng & Oakland, 2014). The first two dimensions, Extroversion-Introversion (EI) and Thinking-Feeling (TF), were maintained and the last two were renamed as Practical-Imaginative (PM) and Organized-Flexible (OF). Another modification was to name these dimensions as "styles" rather than types, considering they are reflecting preferences rather than rigid behaviors (Oakland, Stafford, Horton, & Glutting, 2001), which is observed when inspecting the high correlations among the four dimensions,

indicating they are not independent measures (Pittenger, 2005). The four-factor structure of this model has been confirmed cross-nationally as well as across other variables such as gender and race (Benson, Oakland, & Shermis, 2009; Mpofu, Oakland, Mhaka, & Gwirayi, 2010; Rowinski, Ciecuch, & Oakland, 2013).

The Brazilian Temperament Scale for Students (Primi, Wechsler, Nakano, Oakland, & Guzzo, 2014) is a Portuguese-language adaptation of the SSQ. The Inventory of Adult Temperament Styles (IATS; Oakland & Wechsler, 2012) was developed to provide a Portuguese-language measure for adults. The IATS measures four temperament styles: Extroversion-Introversion, Thinking-Feeling, Organized-Flexible, and Practical-Imaginative. Although a structural model with four latent temperament variables was found to provide good fit to IATS data obtained from a sample of Brazilian adults (Wechsler, Oakland, Benson, & Lourenconi, 2014), correlations among the latent temperament variables suggest that they might be measuring similar dimensions. According to Cramer et al. (2012), personality should not be studied under a reductionist model that isolates traits but should instead consider the complex structure of cognitive, affective and behavioral components. That is, these components are connected as a system that can be examined through a network perspective. Thus, the purpose of this study was to explore the relationships of IATS scores to BFP scores using network analyses. An additional goal was investigate the temporal stability of IATS scores.

## METHOD

### *Participants*

Two samples were collected for this study. The first sample consisted of 144 participants (58% women), ranging from 18 to 66 years-of-age ( $M=32$ ,  $SD=9.92$ ), who were working in different Brazilian states (70% from Sao Paulo, 20% from Rio de Janeiro and 10% from Bahia) and hold Bachelor's degrees in Administration, Engineering, Sociology and Psychology. The second sample consisted of 88 individuals (56% women), ranging from 18 to 41 years-of-age ( $M=23$ ;  $SD=5.79$ ), who were majoring in Psychology and Administration at a private university in the State of Sao Paulo.

### *Instruments*

*Inventory of Adult Temperament Styles* (IATS; Oakland & Wechsler, 2012). The IATS consists of 60 forced-choice items. The theoretical basis for the IATS is based on the temperament model proposed by Oakland et al. (1996), which conceptualizes four bipolar temperament styles: Extroversion-Introversion (EI), Practical-Imaginative (PM), Thinking-Feeling (TF), and Organized-Flexible (OF). The first study examining the

structure of the IATS found that the hypothesized confirmatory factor model for Brazilians provided a good fit to the observed data, thus confirming a structure with four dimensional factors (Wechsler, Benson, Oakland, & Lourenconi, 2014). Reliability data for the IATS has not been published.

*Factorial Personality Battery* (BFP; Nunes, Hutz, & Nunes, 2010). This battery was constructed to measure the Big Five personality dimensions. Five factors emerged from an exploratory factor analysis, supporting the intended theoretical structure (Hutz et al., 1998). Cronbach alpha values ranged from .74 (Openness to Experience) to .89 (Neuroticism). Other studies have examined external relations among BFP scores and scores from self-report measures of professional choices, self-efficacy, well-being, extroversion, and socialization. Correlations ranged from .34 to .60 (Nunes & Noronha, 2009; Nunes, Hutz, & Giacomoni, 2009; Zannon, Bastianello, Pacico, & Hutz, 2013). The BFP normative data presented in the test manual were obtained from 6.599 participants, ranging in age from 15 to 60 years old. The reliability and validity studies were approved by the test commission of the Brazilian Federal Council of Psychology (Sistema de Avaliacao de Testes Psicológicos-SATEPSI-2016).

The 5 factors and facets measured by BFP are the following:

- Openness (O), which is comprised of the facets openness to ideas, liberalism, and novelty search.
- Conscientiousness (C), which is comprised of the facets competency, prudence, and commitment.
- Extraversion (E), which is comprised the facets social interaction, arrogance, communication, and dynamism.
- Neuroticism (N), which is comprised of vulnerability, emotional instability, and passivity facets.
- Agreeableness (A), which is comprised of socialization, pro-socialization and confidence.

#### *Procedure*

Participants for the first sample were invited to complete the IATS in a group format during job selection procedures. In the second sample, college students were invited to complete the IATS in a group format during class periods. The second sample was asked to complete the IATS twice during a two-month interval.

Because the IATS is composed of bipolar traits, one dimension of each trait was fixed for comparison with BFP factors: Extroversion (vs Introversion), Flexible (vs Organized), Thinking (vs Feeling), and Imaginative (vs Practical). Network analysis was used to explore relations among temperament traits and personality factors.

Networks are data-based models that enables the representation of complex data patterns (Newman, 2010). Network analysis provide an alternative to more

commonly used factor analytic approaches and, despite previous usage in many academic disciplines, has only recently begun to be used in the study of psychological phenomena (Schmittmann et al., 2013). Rather than conceiving a set of variables to be explained by a single or few latent variables, psychological constructs are viewed as a complex system of causally coupled variables. These systems are evaluated with respect to their structure and connections. This approach has been applied to the study of personality (Costantini et al., 2015) to identify networks which compose personality characteristics and how they affect other components in the personality system.

Network analysis is a machine learning technique that encodes patterns present in actual data (Lauritzen, 1996). In contrast to structural equation models, network analysis does not require specification of the hypothesized structural model. Patterns are represented through spatial representations of variables (vertices) and the pairwise interactions of these variables (edges). Edges can vary in color and thickness, expressing direction and the magnitude of associations. A positioning algorithm enables the variables be portrayed in space relative to their associations (Fruchterman & Reingold, 1991).

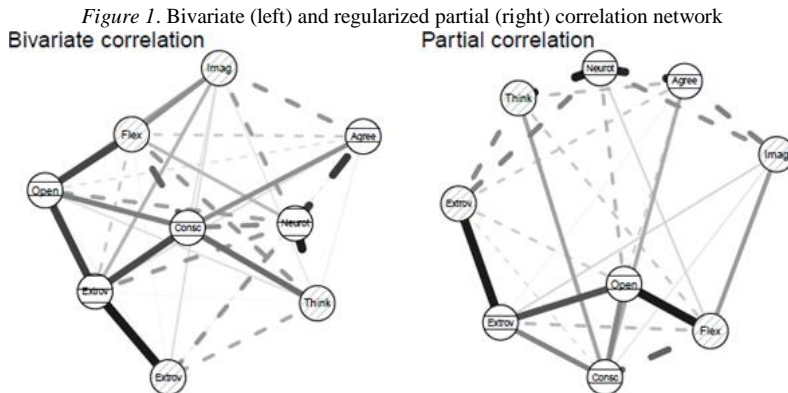
Bivariate correlations were estimated as part of an initial exploration of general patterns. Bivariate correlation networks represent both main and spurious relationships in data, producing dense graphs. In order to produce sparse graphs, encoding the conditional relations (partial correlations), nodewise L1-regularized regression was applied. Partial correlation networks reach partiality through a tuning parameter (Friedman, Hastie, & Tibshirani, 2008) and a model selection hyperparameter based on extended Bayesian information criteria (EBIC; Chen & Chen, 2008). This means that an edge between two vertices only remains if there is a correlation equal to or greater than a given magnitude after controlling for all other covariates. To avoid false negative ratings resulting from the small sample size, the level of the model penalization was decreased.

The hyperparameter  $\gamma$  was set to both zero and .25 and results were compared. It is important to note that partial correlations cannot be interpreted in the same scale of magnitude as bivariate correlations due to rigorous control of covariate effects.

We also applied community analysis (spinglass method) to investigate possible clusters of temperament styles and personality traits. A community in a graph can be defined as a subsets of variables (vertices) with many edges within and few edges between variables from other communities. Positive edges indicate positive links in the community while negative edges indicate links outside of the community (Reichardt & Bornholdt, 2006).

## RESULTS

Bivariate and partial correlation networks reflecting relationships among IATS and BFP traits are presented on the left and right sides of figure 1, respectively. The left network is almost fully connected and represents the main patterns of association. The right network represents the conditioned relations (i.e. partial correlations) between IATS and BFP traits, indicating the relative strength of each connection. Table 1 present the bivariate and regularized partial correlations among IATS and BFP scores. Regularized partial correlation can be interpreted as standardized regression coefficients or betas ("b") in ordinary multivariate regression models, meaning the value that is expected to change in standard deviations for same unit increase in the independent or predictive variable.



Note. Filled edges represent positive associations while dashed edges represent negative ones. Nodes filled with diagonal pattern are IATS temperament subscales and those filled with horizontal pattern are BFP factors. Neurot=Neuroticism, Extrov=Extroversion, Agree=Agreeableness, Consc=Conscientiousness, Open=Openness, Think=Thinking-feeling, Flex=Flexible-organized, Imag=Imaginative-practical, Extrov=Extroversion-introversion.

Table 1. LI-Regularized Partial Correlation for BFP and IATS Traits

	Neurot	Extrov	Agree	Consc	Open	Think	Flex	Imag	Extrv
Neurot	—	.00	-.36	.00	-.13	-.38	.07	-.19	-.21
Extrov	-.18	—	.02	.21	.29	.00	-.12	.07	.38
Agree	-.35	.06	—	.14	-.08	-.12	.00	-.21	-.09
Consc	-.21	.32	.20	—	.20	.16	-.26	.04	-.06
Open	-.17	.34	-.06	.23	—	.00	.38	.00	-.09
Think	-.41	.01	.03	.26	.06	—	-.09	.00	-.20
Flex	.13	-.10	-.09	-.28	.33	-.19	—	.17	.01
Imag	-.17	.14	-.19	.06	.16	.04	.20	—	.00
Extrv	-.19	.41	-.05	-.01	.03	-.15	.02	.07	—

As observed in figure 1, several relationships between IATS temperament traits and BFP personality traits are represented in the right network. The positive



correlations observed between these scales confirm they compose a network of traits. Extroversion is represented by strong relationships among the IATS and BFP extroversion scales (.38).

In addition, the IATS Extroversion-Introversion scale was negatively related to the IATS Thinking-Feeling scale (-.15) and the BFP Neuroticism scale (-.19).

Thus, extroversion appears to be strongly associated with the expression of feelings and weakly associated with the emotional instability that characterizes neurotic persons.

Other notable relationships include the strong positive association of the IATS Flexible-Organized and BFP Openness scales (.33), and a negative association of the IATS Flexible-Organized and BFP Conscientiousness scales (-.28). These associations suggest that flexibility is associated with openness to new ideas rather than the prudence or commitment associated with conscientiousness.

The IATS Imaginative-Practical scale had a weak positive association with the IATS Flexibility scale (.20) and a negative association with the BFP Agreeableness scale (-.19). These associations suggest that imaginative traits are associated with flexibility and liberalism but not with socialization or kindness.

Continuing in the counter clockwise direction, there are the strong negative associations with the BFP Neuroticism scale. As can be observed, Neuroticism was found to be negatively related to both the IATS Thinking-Feeling scale (-.38) and the BFP Agreeableness scale (-.36). These results indicate that neuroticism involves eschewing rational thought in favor of emotions and a tendency to be less kind or even rude to people.

Finally, as previously noted, the IATS Thinking-Feeling scale had a strong negative relationship with the BFP Neuroticism scale (-.41).

Additionally, the IATS Thinking-Feeling scale had a negative relationship with the IATS Extroversion-Introversion scale (-.20) and a positive relationship with the BFP Conscientiousness scale (.26). These results indicate that thinking traits are associated with control of emotions and introversion.

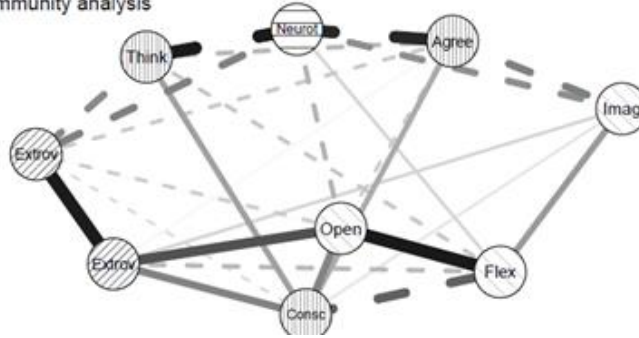
Community analysis indicated the presence of four clusters combining styles and traits. The following clusters can be identified, which are represented by similar colored circles:

- 1) Extroversion (IATS with BFP).
- 2) Thinking (IATS) with Consciousness (BFP) and Agreeableness (BFP).
- 3) Openness (BFP) with Flexibility (IATS) and Imaginative (IATS).
- 4) Neuroticism (BFP).

Test-retest correlations between IATS scores obtained at a two-month interval were all significant ( $p \leq .01$ ), as presented in table 2. The strongest test-retest correlations

were observed for Extroversion-Introversion (.74) and Organized-Flexible (.63). Thus, IATS scores appear to be relatively stable over time.

Figure 2. Community analysis of IATS temperament and BFP personality dimensions



Note. Same pattern nodes form each cluster. Extrov=Extroversion (IATS-BFP); Think=Thinking (IATS); Consc=Conscientiousness (BFP); Agree=Agreeableness (BFP); Open=Openness (BFP); Flex=Flexible (IATS); Imag=Imaginative (IATS); Neurot=Neuroticism (BFP).

Table 2. Test-retest correlation coefficients for the IATS

	EI1	PM1	OL1	TF1	EI2	PM2	OL2	TF2
EI1	1	-.19	-.08	-.12	.74**	-.08	.02	-.2
PM1		--	.43**	.10	-.16	.55**	.31**	-.07
OL1			--	.37**	-.19	.29**	.65**	.04
TF1				--	-.23*	.14	.42**	.57**
EI2					--	-.04	-.14	-.27*
PM2						--	.16	.06
OL2							--	.25*
TF2								--

Note. EI=Extroversion-Introversion, PM=Practical-Imaginative, OF=Organized-Flexible, TF=Thinking-Feeling, 1=First administration, 2=Second administration. \* $p < .05$ , \*\* $p < .01$

## DISCUSSION

Temperament is believed to be the constitutional basis on which personality develops. Oakland and colleagues (1996) re-conceptualized the MBTI temperament types, renaming them based on the view that they represent dimensions of style rather than types. The distinction between dimensions and types is based on the fact that these dimensions are observable early in childhood, suggesting they are biologically based. External relations among adult temperament as measured by the IATS (Oakland & Wechsler, 2012) and Big Five personality factors measured by the BFP (Nunes, Hutz, & Nunes, 2010) were examined in this study. The BFP was utilized based on prior evidence indicating that it measures Big Five personality dimensions (Nunes & Noronha, 2009; Zannon, Bastianello, Pacico, & Hutz, 2013).

Considering that psychological constructs can be viewed as a complex system of causally coupled variables rather than isolated traits, the relationships among temperament styles and personality factors were investigated through network analysis. Network analysis was used to identify clusters of characteristics that compose the personality system (Constantini et al., 2015; Schmittmann et al., 2013). Results confirmed that temperament styles as measured by IATS are related to BFP dimensions. This network of relationships can be viewed as representing the structure of personality.

The Extroversion scales of both measures were found to have a strong positive correlation, suggesting that they measure the same trait. Flexibility was positively connected to Openness and negatively related to Conscientiousness. In addition, the Imaginative scale was positively related to Flexibility and negatively related to Agreeableness. Finally, Neuroticism was negatively related to both Thinking and Agreeableness. The direction of these relations are consistent with what has been found in previous research regarding temperament and the Big Five (e.g., McCrae & Costa, 1989; Furham, Moutafi, & Crump, 2003; Vicent, Inglés, González, Sanmartín, & Fernández, 2016).

Personality can be viewed as complex structure formed by temperament as well as other traits (McCrae & Costa, 2003; Thomas & Chess, 1977). Indeed, four clusters which compose personality factors were identified in our conjoint analysis of the IATS and BFP. The first cluster appears to reflect extroversion and indicates how we express our energy toward the outside world. The second cluster appears to represent our thought processes and values composed by thinking, conscientiousness, and agreeableness. The third cluster represents how we create ideas, and is a combination of flexibility, openness to experiences and imaginative thoughts. Finally, the fourth cluster is represented by neuroticism, which differs from the other clusters in that reflects aspects of maladjustment (e.g., negative affect) rather than stylistic preferences. As multiple traits underlie personality it is important to study these traits simultaneously rather than in isolation (Reichardt & Bornholdt; 2006). Consensus has not been reached regarding the number of personality factors (Raad et al., 2010). The results of this study provide plausible combinations of traits that inform current understanding of and future research regarding the structure of personality. Our findings confirmed relationships among temperament and three factors that seemingly represent healthy aspects of personality. These relationships have been observed in previous research comparing the MBTI with the NEO-PI (McCrae & Costa, 1989, 2003; McCrae, 2013; Reynierse, 2012). The fourth cluster, Neuroticism, had negative relationships with all the IATS dimensions.

This study also builds on previous research by providing evidence of temporal stability for IATS scores over a two-month interval. The results obtained are consistent with findings on the temporal stability of MBTI scores (Myers & McCaulley, 1985; Salter, Forney, & Evans, 2005). In addition, as the MBTI is a qualitative measure it does

not allow inferences regarding the degree to which each one of its components can affect behavior. This information can be obtained using the IATS since it provides a quantitative measure using a scale format.

The results of this study have implications for traditional psychological assessment, as specific characteristics are usually viewed as causing specific behaviors (Cramer et al., 2012). The complex network of relationships among temperament styles and Big Five personality dimensions can contribute to better understanding of individuals' behavior, as influenced by multiple traits. Furthermore, as cross-national research confirms that both temperament as well as personality can be observed across different social and cultural environments, the use of both measures can give important information regarding the complexity of traits that should be considered in personality assessment (McCrae, 2013; Rowinski, Ciecuch, & Oakland, 2013; Slobodskaya & Kozlova, 2016; Wechsler, Oakland, Benson, & Lourenconi, 2014).

The present study confirmed previous findings regarding the measurement of temperament in Brazilian adults. However, additional study involving different samples are needed given the limitation of working mainly with subjects from the state of Sao Paulo. Also, sampling error may have attenuated estimates of stability. Future research should examine test-retest reliability in a sample that is more diverse with respect to age, level of education, and social-economic status. In addition, other measures of personality or temperament can be aggregated to study their network relationships in order to provide a further understanding of the personality dynamics.

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