Meta-Analytic Review of Temperamental Correlates of the Five-Factor Model and Hierarchical Taxonomy of Psychopathology Domains

Azad Hemmati[1] ⓘ, Farzin Rezaei[2] ⓘ, Khaled Rahmani[3] ⓘ, Saeid Komasi[4] ⓘ, Jouko Miettunen[5] ⓘ, Federico Amianto[6] ⓘ and Lee Anna Clark[7] ⓘ

ABSTRACT

Background: There is little and heterogeneous knowledge on the links between the temperamental predispositions of psychopathology and the contemporary dimensional models of psychopathology, such as the Hierarchical Taxonomy of Psychopathology (HiTOP) classification system, which can be aligned with the five-factor model (FFM) of personality. This meta-analysis seeks to expand the temperamental theoretical basis of the HiTOP model by incorporating associations of temperament traits of two temperamental theories measured, respectively, by the Temperament and Character Inventory (TCI) and the Temperament Evaluation of Memphis, Pisa, Paris, and San Diego Autoquestionnaire (TEMPS-A) with (a) the FFM's personality domains and (b) HiTOP's five psychopathological spectra.

Methods: A systematic search was done on Web of Science, Scopus, PubMed, ProQuest, Cochrane Database, and Google Scholar for all articles published in English from January 1990 to August 2020. Because of heterogeneity in the results of almost 70% of studies, pooled estimates of correlation coefficients were calculated using the random-effects method. Risk of bias (low-quality studies) and publication bias are reported.

Results: The pooled correlations obtained from the analysis of 35 studies showed that the temperamental profile associated with each FFM domain and HiTOP spectra is distinct. Specifically, TCI-harm avoidance (HA) and all TEMPS temperaments were more strongly related to neuroticism/internalizing, extraversion/low detachment, and conscientiousness/disinhibition. In contrast, TCI-novelty seeking was more strongly related to both disinhibited/antagonistic externalizing and thought disorder.

Conclusions: A large body of research supports maladaptive variants of all FFM domains and some psychopathological spectra of HiTOP related to the abnormal-range temperaments.

Keywords: Five-factor model, Meta-analysis, Personality, Psychopathology, Temperament

The current dimensional approach in the DSM-5 Alternative Model for Personality Disorders (AMPD) introduces personality pathology as the opposite pole of normal personality on a continuum.[1-3] The dimensional diagnostic system of the DSM-5 AMPD is the result of incorporating the five-factor model (FFM) personality theory.[2,4,5] In this framework, five psychopathological

[1]Dept. of Psychology, University of Kurdistan, Sanandaj, Iran. [2]Dept. of Psychiatry, Roozbeh Hospital, Tehran University of Medical Sciences, Tehran, Iran. [3]Liver and Digestive Research Center, Research Institute for Health Development, Kurdistan University of Medical Sciences, Sanandaj, Iran. [4]Neurosciences Research Center, Research Institute for Health Development, Kurdistan University of Medical Sciences, Sanandaj, Iran. [5]Center for Life Course Health Research, Medical Research Center Oulu, Oulu University Hospital, University of Oulu, Oulu, Finland. [6]Dept. of Neurosciences, Psychiatry Section, Regional Pilot Centre for Eating Disorders, University of Torino, Torino, Italy. [7]Dept. of Psychology, University of Notre Dame, USA.

Address for correspondence: Saeid Komasi, Neurosciences Research Center, Kurdistan University of Medical Sciences, Pasdaran Boulevard, Sanandaj 66135756, Iran.
E-mail: S_komasi63@yahoo.com

domains of the AMPD and the FFM dimensions form two poles of five continua, respectively.[6] Although the DSM-5 AMPD was originally proposed to explain and diagnose personality disorders, this framework was later extended to the broader field of all psychopathology in a newer classification system called the Hierarchical Taxonomy of Psychopathology (HiTOP). The HiTOP is a comprehensive effort to improve the organization, description, and measurement of psychopathology.[7] This classification system addresses the shortcomings of traditional taxonomies, such as arbitrary boundaries between normality and psychopathology, heterogeneity within various disorders, diagnostic instability, comorbidity and co-occurrence, and failure to account for subthreshold cases.[8] The HiTOP classification system combines the primary dimensions of psychopathological signs and symptoms into larger spectra and defines psychological functioning dimensions ranging from normal to abnormal.[8]

According to some evidence,[9,10] the five abnormal spectra of the HiTOP (plus a potential somatoform spectrum) are considered psychopathological expressions of the five normal-range domains of the FFM, together constituting pairs of extremes between which the whole range of human behaviors would manifest: negative affectivity/negative emotionality (internalizing spectrum) versus emotional stability, detachment/low positive emotionality (detachment spectrum) versus extraversion, thought disorder (TD)/psychoticism (TD spectrum) versus openness, antagonism/aggressiveness (antagonistic externalizing spectrum) versus agreeableness, and disinhibition/disconstraint (disinhibited externalizing spectrum) versus conscientiousness. Although the FFM and the HiTOP offer explanations of mental health and psychopathology based on continua, and recent studies have reported validity evidence and discussed the capabilities of the HiTOP classification system in clinical practice,[8,10,11] at least three serious limitations can be considered.

First, too little attention is paid to the cultural context, and almost all the pieces of evidence underlying this model come from Western industrialized countries. Although the FFM shows relatively acceptable cross-cultural structure and validity,[12–14] the HiTOP structure has not yet been studied enough in non-Western countries to generalize to other cultures easily. Second, unlike the FFM,[15,16] serious challenges still need to be solved for the higher-order dimensions of the HiTOP classification system. In particular, validation of some psychopathological dimensions, such as the somatoform spectrum, the mania subfactor, and several dimensions of personality pathology, is far from complete.[7] This limitation in the HiTOP classification system may derive from the relative lack of research on the model due to its recent introduction. It may also be due to its almost singular reliance on factor analysis to extract higher-order independent factors.[2,4,8,17–20]

A third limitation of the HiTOP literature is that there is little to no study of two temperamental theories that are widely used outside the United States, specifically the four temperaments of novelty seeking (NS), harm avoidance (HA), reward dependence (RD), and persistence (PsC) of the psychobiological model of Cloninger, operationalized in the Temperament and Character Inventory (TCI)[21,22] and the five depressive, cyclothymic, hyperthymic, irritable, and anxious temperaments in the affective temperaments model[23,24] operationalized by the Temperament Evaluation of the Memphis, Pisa, Paris, and San Diego Autoquestionnaire (TEMPS-A).[25,26] The affective temperaments, originally introduced concerning affective disorders, predispose traits for psychopathology.[23,24,27] The present review addresses the last limitation, extending the HiTOP model's theoretical basis.

Previous studies not only report intercorrelations among temperament traits[26,28–30] and between temperament traits and psychopathology[31] but also support strong associations of temperament traits with the five higher-order factors of the FFM and HiTOP's spectra.[32,33] This evidence indicates the potential relevance of all these personality factors in explaining the expression of mental health versus psychopathology in human beings. Therefore, the systematic exploration and hierarchical classification of these associations may help refine HiTOP's classification system of psychopathology and suggest a more efficient classification system. For example, the structure of HiTOP relies almost exclusively on factor-analytic approaches,[7] whereas Cloninger[21,22,34] claims that factor-analytical techniques do not limit his temperamental theories and may be able to provide a better explanation for relations between personality and psychopathology. Although many studies based on factor analytical techniques that form the basis of the HiTOP system are inattentive to the etiology of personality and psychopathology, other studies have attempted to extract common factors between traits developed using factor analysis and those in temperamental theories.[35–37] For example, Clark and Ro[35] found that high HA and internalizing spectrum traits in the HiTOP loaded on a common higher-order factor they called negative affectivity. Also, of all the traits examined, high NS had its highest factor loading on a disinhibited externalizing spectrum and low RD on the detachment spectrum. Similar findings have been reported in other studies.[36,37]

Current Study

Summarizing and reporting the broad associations between adaptive and maladaptive personality factors proposed by various theories can provide a coherent body of existing knowledge for mental health researchers and clinicians. It can also help to design new models in psychological sciences and psychiatry. Previous studies in the field of the present review are relatively rare and typically do not include both temperament theories that we examine in this article. Thus, the present review offers a more systematic and complete meta-analysis of the current literature. We included temperamental theories measured using the Tridimensional Personality Questionnaire (TPQ), TCI, and TEMPS-A[23,25,26,34,38,39] and examined associations of these nine temperament traits with the FFM domains and HiTOP spectra. The dimensions of the HiTOP classification system can be assessed using the Personality Inventory for DSM-5 (PID-5) and the Personality Psychopathology Five (PSY-5).[3,40–42] We used studies containing either of these measures to examine the correlations with the FFM domains and HiTOP spectra.

In the current study, we did not intend to focus on the first and second limitations of HiTOP mentioned earlier. In response to these two limitations,

some recent studies have tried to improve knowledge of cross-cultural applicability and higher-order dimensions.[17,18,43] However, more research is needed for pooled estimates by a meta-analysis. Therefore, we focused on the third limitation of HiTOP. The present review aims to answer three main questions. First, what are the correlations between the temperament traits of the two temperamental theories (e.g., HA and depressive temperament) and the five personality domains of the FFM (e.g., extraversion)? Second, what are the correlations between the temperament traits of both theories and the five psychopathological spectra of the HiTOP (e.g., internalizing and TD)? Third, what is the reciprocal hierarchical classification of these correlations? In other words, what are the temperamental triads related to both the FFM domains and the HiTOP spectra? We hypothesize that there are systematic relations among these systems that we will find in our meta-analysis. Therefore, answering these questions will link two temperamental theories to the FFM and HiTOP models, expanding their theoretical networks and those of the two additional temperamental theories.

Methods

The present extensive meta-analysis follows the instructions of the 27-item Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.[44] The process included determining sources and databases, strategies for systematic search, selection criteria, quality assessment of articles, and data extraction.

Sources and Databases

The population of the systematic review and meta-analysis was all articles published in English in the 30 years from January 1990 to August 2020. Systematic searches were performed in PubMed ($n = 1132$), Web of Science ($n = 3484$), Scopus ($n = 187$), ProQuest ($n = 111$), and Google Scholar ($n = 231$). Using a manual search of references, seven additional articles were found, yielding 5152 potential relevant.

Search Strategies and Inclusion Criteria for Studies

Based on previous studies and reviews related to the present study's aims, suitable keywords for searches were determined by two authors (AH and SK). Systematic searches were conducted using the following selected keywords about the temperament traits assessed by the TCI or TEMPS-A, the five personality domains of the FFM, and the psychopathological spectra of the HiTOP system. A list of these terms, conceptual cognates, abbreviations, and related tools can be seen in **Table S1**. The keyword searches were as follows: [*"Temperament"* OR *"TCI"* OR *"TCI-R"* OR *"TPQ"* OR *"novelty seeking"* OR *"harm avoidance"* OR *"reward dependence"* OR *"affective temperament"* OR *"TEMPS-A"*] (AND) [*"big-five model"* OR *"NEO"* OR *"five-factor model"* OR *"FFM"* OR *"NEO-FFI"* OR *"agreeableness"* OR *"conscientiousness"* OR *"openness"* OR *"extraversion"* OR *"neuroticism"*] (OR) [*"Alternative DSM-5 Model"* OR *"AMPD"* OR *"Criterion B"* OR *"PID-5"* OR *"negative affectivity"* OR *"detachment"* OR *"psychoticism"* OR *"antagonism"* OR *"disinhibition"*] (OR) [*"psychopathology-five"* OR *"PSY-5"* OR *"negative emotionality"* OR *"positive emotionality"* OR *"constraint"* OR *"aggressiveness"* OR *"aggression"* OR *"thought disorder"*].

We wanted to include all studies presenting correlations among temperament traits, the domains of the FFM, and HiTOP's psychopathological spectra from 1990 to 2020. Due to many variables and related measurement tools (see **Table S1**), inclusion and exclusion criteria were determined. All English original articles (excluded $n = 3$) published in an academic journal with participants 18 years and older (excluded $n = 1088$) were entered into the review (databases search = 5,145 and manual search = 7). The exclusion criteria were: (a) duplicate records ($n = 1,341$); (b) papers not dealing with temperament traits or the FFM domains and the HiTOP spectra ($n = 1,929$); (c) book and conference abstracts, dissertations, and unpublished papers ($n = 35$); (d) studies with non-original data, previous reviews and meta-analyses, experimental/interventional, longitudinal, or case-control studies, and other studies with an unrelated or unsuitable

design without reported correlations at baseline ($n = 421$); (e) studies containing unrelated temperamental theories ($n = 79$); (f) papers not examining links between temperaments and either personality or psychopathological spectra ($n = 116$); (g) studies containing non-standard self-report instruments without reported validity ($n = 28$); (h) related abstracts without full text ($n = 26$); (i) papers without a human sample ($n = 49$); and (j) low-quality reports ($n = 0$) based on STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) (**Table S2**). Thus, the present systematic review included 37 studies. Finally, two studies were excluded from the meta-analysis because they were not reporting the correlation level between variables. The study selection procedure is shown in **Figure 1**.

## Quality Assessment of the Studies and Data Extraction

The quality of studies was independently conducted by two authors (AH and SK) using the STROBE checklist.[45] This 22-item checklist evaluates the quality of correlation and case-control studies. According to the current objectives, studies with a cutoff point of ≤7 were excluded (**Table S3**). While reviewing the quality of the articles, any disagreement between the two researchers was resolved through discussion with another author (KR).

To extract data, a table was designed to classify and record the collected information. After assessment of the quality of the selected studies (none of the articles was excluded), the data from each study were entered into a table designed for recording the research data and information. The data synthesis process included tabulation and detailed descriptions of the findings of each study. The included studies were organized based on the author list and year of study, participants and their nationality, sample size by gender, range/mean age (standard deviation) of the participants, study design, statistical methods, data gathering tools, findings, including correlations between the variables, limitations, and level of evidence.

FIGURE 1.

A Flow Diagram of the Study Selection Process Based on the PRISMA.
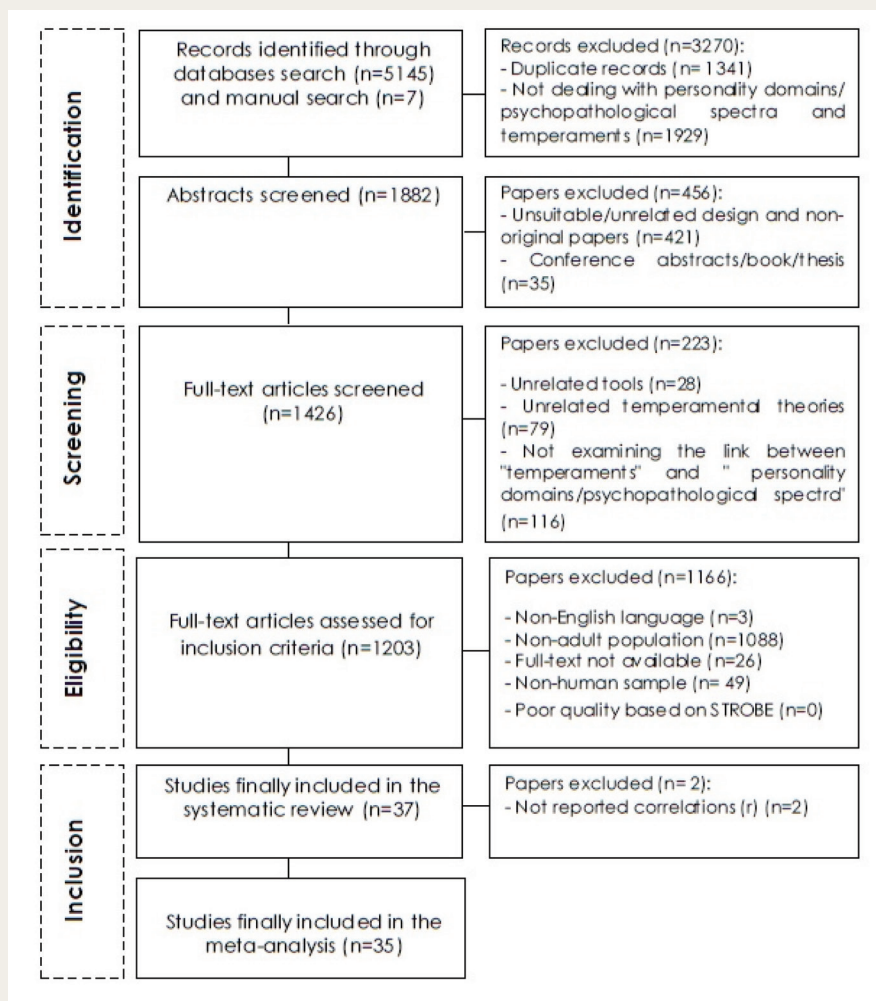
Data Synthesis and Statistical Analysis

Several meta-analyses were performed to calculate pooled correlation coefficients (effect sizes; ES) between each of the temperament traits (NS, HA, RD, PsC, depressive, cyclothymic, hyperthymic, irritable, and anxious temperaments) with the (a) five personality domains of the FFM and (b) five psychopathological spectra of the HiTOP system. The number of studies entered into the meta-analyses in each domain/spectrum is unequal because some studies examined relations between only some temperament traits and five personality domains or five psychopathological spectra. The selected studies were pooled based on sample size and correlation coefficients between variables. The Fisher z-transformation

of correlation coefficients obtained the effect sizes (ESs) in these meta-analyses. For easier interpretation of the results, the obtained z-transformed correlation coefficients were back transformed (z to r transformation) to the level of original correlation coefficients. The estimated correlation coefficients are presented with 95% confidence intervals (CIs) for each temperament trait and personality domain or psychopathological spectrum. Also, the standard z scores for each correlation coefficient are presented.

We studied the heterogeneity of the study samples using the I^2 statistics for a 95% CI. The frequency of heterogeneity in the various meta-analyses was significant (p-value < 0.05 for I^2 in 68% of the studies). Thus, pooled estimates of the correlation coefficients were calculated for all domains and spectra using the

random-effects method.[46] To compare ESs, the obtained correlations were classified according to Cohen's suggestion.[47] So, the present significant correlations are indicated in four categories: $r \geq 0.10$ (small ES), ≥ 0.30 (medium ES), ≥ 0.50 (large ES), and ≥ 0.70 (very large ES). Also, the most important temperamental triads associated with each personality domain and psychopathological spectrum were presented in the form of a figure. Finally, Egger's test was used to detect the possible publication bias. All correlations were tested at the p-value < 0.05 and performed using the Comprehensive Meta-Analysis (CMA.2) software.

Results

Studies Included in the Meta-analysis

The systematic review yielded 37 articles, 35 of which met the criteria for meta-analysis. A total of 37,818 people (male: 11,761, female: 18,243, not specified: 7,814) from 35 individual studies were included in the meta-analysis. Most studies were conducted in Germany, the USA, Spain, the UK, the Netherlands, Australia, and Japan. Fewer studies were performed in Italy, Switzerland, Belgium, Finland, Sweden, Denmark, Poland, Hungary, Canada, China, Taiwan, and Iran. The summary of the methods and results of the studies can be seen in **Table S4**.

Table 1 shows the meta-analysis of the correlations between temperament traits and the FFM domains and HiTOP spectra. As can be seen, most studies have examined correlations between the temperament traits of Cloninger's theory and the FFM domains, and less attention has been paid to other temperamental theories. The studies on the HiTOP spectra, especially the internalizing and detachment spectra, were very few for all temperament traits. Thus, performing a direct meta-analysis on the internalizing and detachment spectra was impossible. However, some studies have tested the relations of temperament theory measures with the FFM domains and the HiTOP spectra, such as neuroticism/internalizing[48–51] and (low) extraversion/detachment.[48,52,53] The number of studies related to each FFM domain or HiTOP spectrum and temperament trait is shown in **Table 1**.

TABLE 1.

The Meta-analysis Results of the Correlations Between Temperament Traits and Personality Domains/ Psychopathological Spectra.

Temperaments and Domains	Study (N)	Sample (n)	Heterogeneity		Correlations (95% CI)	Standard Score		Publication Bias		References
			I²	P		Z	P	Egger	P	
FFM-Neuroticism										[32, 36, 66, 71–74, 76, 80, 85–102]
TEMPS-Anxious	3	940	58.19	0.091	0.71 (0.64, 0.76)	14.92	0.001	0.33	0.797	
TCI-Harm avoidance	24	28,232	92.21	0.001	0.60 (0.56, 0.63)	25.39	0.001	1.17	0.255	
TEMPS-Cyclothymic	5	1,607	24.18	0.260	0.58 (0.54, 0.62)	21.89	0.001	0.23	0.832	
TEMPS-Depressive	5	1,607	52.84	0.075	0.52 (0.46, 0.57)	14.38	0.001	1.15	0.334	
TEMPS-Irritable	5	1,607	84.51	0.001	0.43 (0.31, 0.53)	6.62	0.001	0.05	0.960	
TEMPS-Hyperthymic	5	1,607	31.45	0.212	−0.42 (−0.47, −0.37)	−13.86	0.001	3.19	0.050	
TCI-Reward dependence	21	26,899	75.51	0.001	0.08 (0.04, 0.11)	4.47	0.001	1.02	0.319	
TCI-Persistence	12	17,901	92.92	0.001	−0.06 (−0.15, 0.02)	−1.55	0.122	2.45	0.034	
TCI-Novelty seeking	22	27,335	82.04	0.001	0.02 (−0.02, 0.06)	1.09	0.274	0.24	0.815	
FFM-Extraversion										[32, 36, 66, 70–74, 76, 80, 85–106]
TEMPS-Hyperthymic	6	1,694	54.58	0.051	0.62 (0.57, 0.66)	17.99	0.001	0.58	0.593	
TCI-Harm avoidance	25	29,132	89.51	0.001	−0.50 (−0.53, −0.46)	−23.55	0.001	1.97	0.060	
TCI-Reward dependence	23	27,894	86.58	0.001	0.39 (0.35, 0.43)	18.82	0.001	1.07	0.295	
TCI-Novelty seeking	28	30,149	90.10	0.001	0.37 (0.33, 0.41)	17.05	0.001	2.13	0.043	
TEMPS-Depressive	5	1,607	79.55	0.001	−0.35 (−0.45, −0.24)	−6.04	0.001	1.60	0.208	
TEMPS-Anxious	3	940	62.60	0.069	−0.25 (−0.36, 0.13)	−4.08	0.001	1.45	0.385	
TCI-Persistence	13	18,801	97.85	0.001	0.18 (0.05, 0.31)	2.69	0.007	0.48	0.637	
TEMPS-Irritable	5	1,607	36.56	0.177	−0.12 (−0.18, −0.05)	−3.56	0.001	1.20	0.316	
TEMPS-Cyclothymic	5	1,607	44.65	0.124	−0.11 (−0.18, −0.04)	−3.09	0.002	0.82	0.474	
FFM-Openness										[32, 36, 66, 70, 71, 73, 86, 89, 92, 93, 97, 98, 101, 103]
TCI-Novelty seeking	10	5,394	75.35	0.001	0.27 (0.21, 0.32)	9.19	0.001	1.06	0.318	
TCI-Reward dependence	7	4,386	74.60	0.001	0.26 (0.20, 0.32)	8.06	0.001	0.55	0.603	
TCI-Harm avoidance	8	4,743	82.04	0.001	−0.22 (−0.29, −0.15)	−5.94	0.001	0.60	0.571	
TCI-Persistence	7	4,386	54.40	0.041	0.18 (0.13, 0.22)	7.19	0.001	1.79	0.134	
TEMPS-Hyperthymic	5	1,607	0.00	0.646	0.13 (0.08, 0.18)	5.30	0.001	0.04	0.971	
TEMPS-Cyclothymic	5	1,607	0.00	0.507	0.13 (0.08, 0.18)	5.25	0.001	1.80	0.170	
TEMPS-Depressive	5	1,607	4.40	0.382	−0.10 (−0.15, −0.05)	−3.92	0.001	2.22	0.112	
TEMPS-Anxious	3	940	0.00	0.491	−0.05 (−0.12, 0.01)	−1.68	0.093	2.49	0.014	
TEMPS-Irritable	5	1,607	0.00	0.704	0.03 (−0.02, 0.08)	1.10	0.272	0.55	0.622	
FFM-Agreeableness										[32, 36, 66, 70, 71, 73, 74, 86, 89, 92, 93, 97, 98, 101]
TCI-Reward dependence	8	4,931	87.53	0.001	0.42 (0.35, 0.49)	10.38	0.001	1.11	0.309	
TEMPS-Irritable	5	1,607	68.51	0.013	−0.41 (−0.49, −0.33)	−8.95	0.001	1.06	0.367	
TEMPS-Cyclothymic	5	1,607	67.80	0.014	−0.25 (−0.34, −0.16)	−5.35	0.001	0.35	0.749	
TCI-Novelty seeking	9	5,288	84.10	0.001	−0.14 (−0.21, −0.07)	−3.94	0.001	0.41	0.693	
TEMPS-Depressive	5	1,607	68.37	0.013	0.09 (−0.00, 0.19)	1.95	0.051	0.09	0.935	
TEMPS-Anxious	3	940	58.22	0.091	−0.08 (−0.19, 0.04)	−1.35	0.177	2.36	0.255	
TCI-Harm avoidance	9	5,288	85.26	0.001	−0.08 (−0.15, −0.00)	−1.98	0.048	0.57	0.588	
TCI-Persistence	8	4,931	89.99	0.001	0.08 (−0.02, 0.17)	1.58	0.114	0.89	0.409	
TEMPS-Hyperthymic	5	1,607	0.00	0.695	−0.06 (−0.10, −0.01)	−2.23	0.026	2.64	0.078	

(Table 1 continued)

(Table 1 continued)

Temperaments and Domains	Study (N)	Sample (n)	Heterogeneity		Correlations (95% CI)	Standard Score		Publication Bias		References
			I²	P		Z	P	Egger	P	
FFM-Conscientiousness										[32, 36, 66, 70, 71, 73, 74, 86, 89, 92, 93, 97, 98, 101]
TCI-Persistence	8	4,931	87.39	0.001	**0.49 (0.42, 0.55)**	12.49	0.001	0.27	0.796	
TEMPS-Cyclothymic	5	1,607	0.60	0.403	**−0.37 (−0.42, −0.33)**	−15.61	0.001	3.02	0.057	
TCI-Novelty seeking	9	5,288	85.94	0.001	**−0.35 (−0.42, −0.28)**	−9.34	0.001	1.10	0.309	
TEMPS-Hyperthymic	5	1,607	46.38	0.113	**0.27 (0.20, 0.33)**	7.37	0.001	3.13	0.052	
TCI-Harm avoidance	9	5,288	82.66	0.001	**−0.24 (−0.30, −0.17)**	−6.77	0.001	0.22	0.833	
TEMPS-Irritable	5	1,607	63.45	0.027	**−0.21 (−0.29, −0.12)**	−4.62	0.001	1.40	0.257	
TEMPS-Anxious	3	940	64.83	0.058	−0.12 (−0.24, 0.00)	−1.89	0.059	0.86	0.546	
TCI-Reward dependence	8	4,931	37.55	0.130	0.12 (0.08, 0.16)	6.14	0.001	0.74	0.490	
TEMPS-Depressive	5	1,607	77.70	0.001	−0.08 (−0.19, 0.03)	−1.40	0.160	1.04	0.375	
HiTOP-Thought disorder										[33, 37, 72, 87, 88, 90, 91, 94–96, 99, 102]
TCI-Novelty seeking	13	22,979	91.53	0.001	**0.34 (0.28, 0.39)**	10.84	0.001	0.37	0.721	
TCI-Reward dependence	13	22,979	87.04	0.001	−0.15 (−0.20, −0.10)	−5.56	0.001	1.63	0.131	
TCI-Harm avoidance	11	22,082	94.39	0.001	−0.04 (−0.12, 0.04)	−0.91	0.364	2.99	0.015	
TCI-Persistence	5	13,731	86.51	0.001	−0.03 (−0.14, 0.08)	−0.50	0.618	0.04	0.972	
HiTOP-Disinhibited externalizing										[33, 37, 91, 102, 107]
TCI-Novelty seeking	5	1,951	69.60	0.011	**0.36 (0.28, 0.43)**	8.62	0.001	0.06	0.952	
TCI-Persistence	3	1,591	92.19	0.070	−0.18 (−0.35, −0.01)	−2.04	0.041	0.60	0.656	
TCI-Harm avoidance	5	1,951	95.77	0.170	−0.03 (−0.25, 0.20)	−0.22	0.822	0.03	0.975	
TCI-Reward dependence	5	1,951	84.46	0.001	−0.01 (−0.13, 0.10)	−0.25	0.799	0.18	0.867	
HiTOP-Antagonistic externalizing										[32, 33, 80]
TCI-Novelty seeking	3	1,221	0.00	0.598	**0.28 (0.23, 0.33)**	10.03	0.001	1.08	0.476	
TCI-Reward dependence	3	1,221	69.13	0.039	−0.08 (−0.18, 0.02)	−1.56	0.119	0.09	0.944	
TCI-Harm avoidance	3	1,221	97.91	0.001	−0.06 (−0.42, 0.33)	−0.27	0.784	0.47	0.721	
TCI-Persistence	3	1,221	87.29	0.001	0.04 (−0.12, 0.20)	0.48	0.628	0.48	0.712	

Some psychopathological spectra, including internalizing and detachment, were systematically searched. Although considering the limited number of studies, these were not entered into the meta-analysis.
The studies include two samples.[99,100,103]
Correlations ≥ 0.20 are highlighted in bold. FFM: five-factor model, HiTOP: Hierarchical Taxonomy of Psychopathology, TCI: Temperament and Character Inventory, TEMPS: Temperament Evaluation of Memphis, Pisa, Paris, San Diego Autoquestionnaire.

Table 1 also shows the publication bias associated with each of the correlations. The publication bias was seen for neuroticism, PsC, hyperthymic temperament, extraversion, NS, openness and anxious temperament, and TD and HA (*p*-values < 0.05 for Egger's statistic).

Correlations Between FFM Domains and Temperament Traits

Table 1 presents the meta-analysis of the correlations between the five personality domains and types of temperament traits. The number of studies and participants pooled ESs with 95% CI, the standard *z* score, and *p*-values are presented separately for each domain. As can be seen, neuroticism is correlated with medium or larger ES to HA, depressive, cyclothymic, irritable, anxious (positively), and hyperthymic (negatively) temperaments. Extraversion was correlated positively, with medium or larger ES, to hyperthymic temperament, RD, and NS, and negatively with HA, depressive, and anxious temperaments. It was also correlated, with small ES, with PsC positively, and with irritable and cyclothymic temperaments negatively. Openness correlated with the seven temperament traits, all with small ESs: positively with NS, RD, PsC, cyclothymic, and hyperthymic temperaments; negatively with HA and depressive temperament. Agreeableness correlated, with medium ES, positively with RD and negatively with irritable temperament; it also correlated, with small ES, negatively with cyclothymic temperament and NS. Conscientiousness correlated with medium ES with three temperament traits—positively with PsC and negatively with NS and cyclothymic temperaments; it also correlated, with small ES, positively with hyperthymic temperament and RD and negatively with HA, irritable, and anxious temperaments.

Figure 2 shows the most important temperamental triads related to the FFM domains. The direction of positive and negative correlations highlights the relationships between the FFM domains and

FIGURE 2.

The Temperamental Triads Related to the Five Personality Domains of the Five-Factor Model (FFM) and Five Psychopathological Spectra of the Hierarchical Taxonomy of Psychopathology (HiTOP) Classification System.

The Five Factor Model (FFM) Domains	Temperamental correlates: Novelty Seeking (NS); Harm Avoidance (HA); Reward Dependence (RD); Persistence (PsC); Cyclothymic Temperament (Cyc); Hyperthymic Temperament (Hyp); Irritable Temperament (Irr); Anxious Temperament (Anx)						The Hierarchical Taxonomy of Psychopathology (HiTOP) Spectra
Neuroticism	Anx (+)	HA (+)	Cyc (+)	No data	NS (−)*	HA (+)*	Internalizing
Extraversion	Hyp (+)	HA (−)	RD (+)	No data	RD (−)*	HA (+)*	Detachment
Openness	NS (+)	RD (+)	HA (−)	No data	RD (−)	NS (+)	Thought Disorder
Agreeableness	RD (+)	Irr (−)	Cyc (−)	No data	No data	NS (+)	Antagonistic Externalizing
Conscientiousness	PsC (+)	Cyc (−)	NS (−)	No data	PsC (−)	NS (+)	Disinhibited Externalizing
The highest correlates ←	The mildest correlates					→ The highest correlates	

(The direction of positive and negative correlations are determined using + and − symbols; the boxes highlighted with the symbol (*) are only based on previous evidence, not the current meta-analysis.)

temperamental triads (e.g., NS, RD, and HA for openness). As can be seen in this figure, HA and RD are more frequently associated with the FFM domains.

In **Table 2**, the statistically significant correlations are classified according to Cohen's suggestion[47]: small ES (>.10, one symbol), medium ES (>.30, two symbols), large ES (>.50, three symbols), and very large ES (>.70, four symbols). Based on the present results, the largest ESs were limited to correlations between neuroticism and anxious, HA, cyclothymic, and depressive temperaments, and the correlation between extraversion and hyperthymic temperament.

Correlations Between HiTOP Spectra and Temperament Traits

The correlations between the psychopathological spectra and types of temperament traits can be seen in **Table 1**. We found only a few studies in this area, and they only examined three psychopathological spectrums—TD, disinhibited externalizing, and antagonistic externalizing. Thought disorder was correlated positively with NS ($r = 0.34$, medium ES) and negatively with RD ($r = −0.15$, small ES). Disinhibited externalizing was correlated positively with NS ($r = 0.36$, medium ES) and negatively with the PsC ($r = -0.18$, small ES). Finally, antagonistic externalizing was only correlated positively with NS ($r = 0.28$, small ES).

A summary of the correlation matrix between psychopathological spectra and temperament traits based on Cohen's classification is presented in **Table 2**. As noted previously, although we found no studies that directly examined associations between the nine temperament traits and the HiTOP spectra, we list HiTOP's internalizing and (Low) detachment spectra with FFM Neuroticism and Extraversion, respectively, in **Table 2** based on their established associations in the literature.

Figure 2 shows the most important temperamental triads related to the HiTOP spectra. The direction of positive and negative correlations highlights the relationships between the HiTOP spectra and temperamental triads (e.g., HA and RD for Detachment). As can be seen in this figure, HA and NS are more frequently associated with the HiTOP spectra. The boxes with no data in **Figure 2** also highlight the paucity of research on the relations between temperament traits and the HiTOP spectra.

Discussion

The current review showed that over the last three decades, many studies have examined relations between temperament traits and the five personality domains of the FFM. In contrast, studies on relations between temperament traits and psychopathological spectra of the HiTOP classification system or its conceptual cognates are relatively few, partly because the inaugural HiTOP-focused paper was published just over five years ago.[7] The meta-analytic results from a large body of research support maladaptive variants of the FFM domains related to the abnormal-range temperaments. These analyses provide evidence for the criterion validity of the traditional model (i.e., the FFM) and the more recent dimensional model (i.e., the DSM-5 AMPD) of

TABLE 2.

Schematic Summary of the Correlation Matrix Between Temperament Traits and Personality Domains/Psychopathological Spectra Based on the Meta-analytic Results.

Temperament Traits	Personality Domains of the FFM Plus Associated HiTOP Spectra					Psychopathological Spectra of the HiTOP		
	Neuroticism/ HiTOP Internalizing	Extraversion/ HiTOP Low Detachment	Openness	Agreeableness (HiTOP Low Ant/ Externalizing)	Conscientiousness (HiTOP Low Ant/ Externalizing)	Thought Disorder	Disinhibited Externalizing	Antagonistic Externalizing
TCI-Novelty seeking		+ + (*)	+	−	− −	+ +	+ +	+
TCI-Harm avoidance	+ + +	− −	−		−			
TCI-Reward dependence		+ +	+	+ +	+	−		
TCI-Persistence		+	+		+ +		−	
TEMPS-Depressive	+ + +	− −	−					
TEMPS-Cyclothymic	+ + +	−	+	−	− −			
TEMPS-Hyperthymic	− − (*)	+ + +	+		+			
TEMPS-Irritable	+ +	−		− −	−			
TEMPS-Anxious	+ + + +	−						

(*): Publication bias; (+) Positive correlation; (−) Negative correlation; (a) significant correlation (*r*) ≥ 0.10 (small, one symbol), ≥ 0.30 (medium, two symbols), ≥ 0.50 (large, three symbols), ≥ 0.70 (very large, four symbols). Labels in parentheses indicate established associations between FFM domains and HiTOP spectra for which no meta-analytic studies were found (e.g., Agreeableness and HiTOP's Low Antagonistic Externalizing have been shown to be related, but no meta-analytic studies were found that examined relations between TCI-Reward Dependence and the HiTOP spectra).
FFM: five-factor model, HiTOP: Hierarchical Taxonomy of Psychopathology, TCI: Temperament and Character Inventory, TEMPS: Temperament Evaluation of Memphis, Pisa, Paris, San Diego Autoquestionnaire.

personality disorders. However, the frequency and severity of the associations between the personality and temperament traits address a high overlap that may account for personality pathology. So, temperamental traits are potentially complementary to the AMPD constructs that have been neglected in the conceptualization of this dimensional model of personality. A new research also supports the hypothesis of the complementarity of temperament traits and the AMPD structures.[54] However, we did not have access to sufficient studies (≥3) to calculate the correlations between temperament traits and the spectra of HiTOP. Although NS was correlated strongly with TD and slightly weakly with Externalizing, more evidence is needed to confirm or reject the overlap between temperament traits and the HiTOP constructs.

Associations Between FFM Domains and Temperament Traits

Our meta-analytic findings showed that anxious, HA, cyclothymic, and depressive temperaments from the two temperamental theories are the strongest correlates of neuroticism. Neuroticism is also related positively to irritable temperament and negatively to hyperthymic temperament, with medium ES. From a biological perspective, the behavioral inhibition system (BIS) may be the core[55–58] or complementary structure[56] of all these temperament traits related to neuroticism or the higher-order factor of these temperament traits and neuroticism.[59] The relation between the BIS and the affective temperaments (e.g., depressive, irritable, and anxious temperaments) may explain the correlations reported in previous studies between these temperament traits and neuroticism.[56,60] The BIS helps the organism to identify cues associated with punishment and negative events, and its arousal is related to behaviors of passive avoidance.[61] Thus, a well-regulated BIS may explain normal arousal for punishment and negative events along with adaptive avoidance and serve the higher-order factor of neuroticism and its associated temperaments in the normal range. Concomitantly, an overly sensitive BIS may lead to nonadaptive arousal and pathological avoidance manifest in fear, worry, distress, anxiety, and depression that are disproportionate to the situation or abnormally prolonged, failing to return to baseline levels after a negative event.

Distinct from neuroticism, the current findings showed that hyperthymic temperament, RD, NS, and, to a lesser extent, PsC are positively and HA, depressive, anxious (and, to a lesser extent, irritable and cyclothymic) temperaments are negatively related to extraversion. These correlations may originate from the behavioral activation system (BAS). Previous reports have pointed to relations of BAS with NS and hyperthymic temperament[56,62] and with the extraversion domain and facets.[57,58,63] According to reinforcement sensitivity theory (RST),[64] BAS is a neurobehavioral dopamine-dependent system that mediates individual differences in sensitivity and reactivity to appetitive stimuli.[65] People with high scores on hyperthymic temperament, NS, and RD are expected to have extroverted facets and to seek out and particularly enjoy pleasurable experiences.

The present meta-analysis shows a moderate to small positive correlation between openness and NS, RD, PsC, hyperthymic, and cyclothymic temperaments. Conversely, openness has a small negative relation with HA and depressive temperaments. Like extraversion, compared to BIS, BAS may play a more prominent role in openness. Previous

studies have noted a slight association between openness and BAS.[57,58] Among the big five domains, openness shows the highest correlation with extraversion,[66] and together, extraversion and openness form the higher-order factor of beta,[15] conceptualized as plasticity by De Young et al.[16,67] Thus, these two domains may be a psychological manifestation of temperament traits related to the BAS. Extraversion and openness, along with the correlated temperaments, may also be among the lower-order factors of BAS. However, the ESs related to openness obtained in the present study are much smaller than those found for extraversion. Extraversion is moderately strongly related to RD, and a strong relation has also been reported between BAS and RD.[68] Thus, the BAS may be related to rewards associated with social relationships. This may explain the weaker correlation between BAS and openness compared to extraversion because seeking gratification is mediated by higher-order social cues.

The current findings showed that RD positively, along with irritable and cyclothymic temperaments, and NS negatively are the strongest correlates of agreeableness. RD, the most important factor related to agreeableness, is associated with the anticipation of social reward and sensitivity to social detachment. RD is an independent psychobiological factor that plays a vital role in empathy, intimacy, social attachment, and the need for affirmation.[21,22] There seems to be a significant interaction between some dopamine receptor polymorphisms and serotonin polymorphism.[65] Although a positive correlation has been reported between the BAS and RD,[68] social attachment, unlike the sociability of extraversion, is not a sign of pleasure-seeking but may have a deactivating mechanism for the BIS by using the positive effects of interpersonal relationships. This inference is consistent with the slight correlation reported between agreeableness and BIS.[57] It is consistent with the higher-order factor of alpha[69] or stability,[67] which encompasses (low) neuroticism, agreeableness, and conscientiousness.

According to the present meta-analysis, conscientiousness is most strongly related to PsC and hyperthymic temperament and negatively to NS, HA, cyclothymic, and irritable temperaments. These relations represent a responsible and stable temperament. Jointly, the negative correlations between conscientiousness and NS and HA suggest a balance in BIS and BAS. In support of this inference, two studies reported slightly negative correlations between conscientiousness and BIS.[57,58] Cloninger et al.[34] hypothesized that the character dimensions of their Psychobiological Model represent modulators of temperament; by extension, they also would modulate the BIS and BAS autonomic response systems. Thus, it is noteworthy that the character dimensions of self-directedness and cooperativeness are strongly related to conscientiousness.[36,70,71] Persistence, the strongest correlate of conscientiousness in the present study, is also strongly related to these character dimensions.[72–74] Alternatively, the temperament and character dimensions of Cloninger's model have been shown to have highly similar heritabilities,[75] and—at least in adults—it is not possible to distinguish them empirically, so there may be only a conceptual distinction between temperament and character. This suggests that the role of the BIS and BAS may not be significant in the so-called character traits, or it may indicate that the conceptualization of these systems needs to be modified to encompass them.

Associations Between HiTOP Spectra and Temperament Traits

Despite insufficient studies for a meta-analysis of correlations between internalizing and detachment spectra of the HiTOP and temperament traits, two studies[33,37] found that the internalizing spectrum is positively related to HA. Negative emotions, including anxiety, fear, stress, and distress associated with the BIS, are likely common between this psychopathological spectrum and related temperament traits such as HA. Therefore, as mentioned earlier, given the strong, established relation between neuroticism and internalizing, it is highly likely that internalizing is related to the temperaments with a structure similar to neuroticism (e.g., HA) and, by extension,

BIS is likely to play a key role in this spectrum. Conversely, Detachment is likely the opposite pole of extraversion on a continuum. Researchers[76] found a strong negative relationship between these two variables. Detachment is also negatively associated with RD, one of the stronger correlations of extraversion.[31,33] Thus, like the neuroticism-internalizing relation, and given the evidence of a relation between detachment and extraversion, it is likely that the detachment spectrum relates to the temperaments with a structure similar to extraversion (e.g., RD). Still, the few studies in the present review cannot provide direct evidence for a significant correlation between these psychopathological spectra and temperament traits, so further research is needed.

There is an ongoing debate regarding whether DSM-5 psychoticism (TD spectrum) and openness can be considered two poles of a single continuum.[8,77–79] The present study could not answer whether these two adaptive and maladaptive domains are opposing ends of a continuum. Because a positive correlation was found between openness and NS, we expected a negative correlation between TD and NS. However, the relationship remained positive. Although this finding is consistent with a previous study,[78] this may be due to the analysis of studies containing distinct instruments based on different conceptualizations. However, as expected, a negative correlation was found between RD and TD. This predictable finding may be due to some links between openness and TD. Recently, researchers[79] noted that the two domains are linked in part through their association with connectivity in networks involving experiential simulation and cognitive control. According to the present results, the negative correlation between TD and RD is the difference between openness and TD spectrum.

We could only find and analyze three studies on antagonistic externalizing measured by PSY-5 and TCI temperaments.[32,33,80] Few studies related to this spectrum prevented obtaining reliable results. Nonetheless, the meta-analysis of these studies found a significant positive correlation between antagonistic externalizing and NS. In line with the results of a study that revealed the relationship

between BAS and aggression/hostility,[81] this finding may suggest greater involvement of the BAS than BIS, Also, we found that HiTOP disinhibited externalizing is related positively to NS and negatively to PsC. Despite the few studies included in the analysis, particularly for PsC, and the limitation this places on the reliability and validity of the results, the findings obtained in the present analysis were consistent with expectations based on the literature. Similar to the present results on antagonistic externalizing, a significant positive correlation between disinhibited externalizing and NS may indicate an active BAS. Further, recent studies have supported a link between aspects of disinhibited externalizing (e.g., substance use disorder) and the BAS.[82–84]

Methodological Considerations and Limitations

We analyzed correlations between variables dimensionally without any cutoff point, consistent with the dimensional approach of the DSM-5 AMPD. Of course, significance levels in correlation studies are strongly influenced by sample size. Although we reported standardized (i.e., z) scores, ignoring this problem can challenge the interpretation of the results. Notably, due to the small number of longitudinal studies, the present meta-analysis focused on the cross-sectional correlation between variables. Analysis of longitudinal studies can provide more support for findings regarding causal relationships between variables. Further, the analyses were performed on reported correlations in clinical and non-clinical heterogeneous populations. This may also lead to biased results, depending on the degree of parallelism between the study samples and the general population. Participants in most studies were young college students, who do not represent the population of community adults. The mean age of the sample in no study was more than 50 years. Therefore, overall inference and generalization of the findings must be somewhat circumscribed. Meta-regression of different age and sex populations in future studies may provide valuable results. Although publication bias was

seen in less than 9% of the reported correlations, we presented many tests, so some may be due to chance. Therefore, it is necessary to replicate the analyses related to these target variables. The lack of a large body of studies precluded direct examination of relations between affective temperaments and psychopathological spectra, which was due, in part, to our lack of access to some databases such as PsycInfo, PsycNET, and Cochrane. However, the databases we used were extensive, so it is unclear how much this limitation affected the results. In any case, mental health and personality researchers should conduct future studies based on the limitations reported in the present study.

Conclusion

The present systematic examination of the temperament traits in both Cloninger's theory (i.e., the four temperaments of NS, HA, RD, and PsC) and Akiskal's theory (i.e., the affective temperaments model including the five depressive, cyclothymic, hyperthymic, irritable, and anxious temperaments) identified a relatively large number of studies that reported associations with the FFM personality domains, but fewer studies examined associations with the HiTOP psychopathological spectra. We first intended to calculate the relations between all temperament traits and the five personality domains of the FFM. The meta-analytic results revealed significant associations between the FFM domains, especially neuroticism and temperament traits. So, these results from a large body of research support maladaptive variants of the FFM domains related to the abnormal-range temperaments. Our second goal was to calculate the relations between all temperament traits and the five psychopathological spectra of HiTOP. The meta-analytic results also highlighted the associations of temperaments, especially NS, with some psychopathological spectra of HiTOP, including TD and antagonistic/disinhibited externalizing. The BIS and BAS may be the basis of temperamental responses, and these two systems may be considered higher-order factors of both maladaptive personality traits/temperaments and general psychopathology. We ultimately aimed to identify the

temperamental triads related to the FFM domains and the HiTOP spectra, and the results showed that the most important temperamental triads associated with each FFM domain and HiTOP spectrum differed from the other dimensions. Although the findings of the current meta-analysis partially support the validity of some dimensional models of both personality and psychopathology, including the FFM, the DSM-5 AMPD, and HiTOP, clinicians should consider the overlap between the contemporary dimensional models and temperamental predispositions when diagnosing and treating mental disorders. Future original research may examine the effect of combining these domains, spectra, and temperament traits in explaining general psychopathology.

ORCID iDs

Azad Hemmati https://orcid.org/0000-0002-5863-5987
Farzin Rezaei https://orcid.org/0000-0003-1560-2461
Khaled Rahmani https://orcid.org/0000-0002-0860-8040
Saeid Komasi https://orcid.org/0000-0002-0198-3710
Jouko Miettunen https://orcid.org/0000-0003-0575-2669
Federico Amianto https://orcid.org/0000-0002-7079-8391
Lee Anna Clark https://orcid.org/0000-0002-2571-4347

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