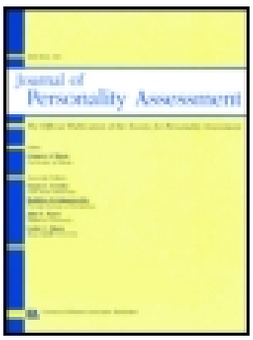

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Relations Between Lexical and Biological Perspectives on Personality: New Evidence Based on HEXACO and Affective Neuroscience Theory

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ABSTRACT

We provide evidence on the convergence of language-based questionnaire and biological perspectives on personality traits. The first study, conducted on Serbian students, provided evidence on the position of Panksepp's Affective Neuroscience Personality Scales (ANPS) in the personality space defined by HEXACO facets. The second, replicatory study was conducted on a sample of German young adults. Results show that the instruments based on these 2 approaches target highly similar personality phenomena, which is revealed in the high canonical correlations between them (the first 3 being above .70 in both samples). Despite the overlap, the scales measuring emotional systems do not map onto HEXACO factors one-to-one, and mostly have substantial loading on more than 1 HEXACO factor. The pattern of correlations between HEXACO and ANPS scales was highly similar in the 2 samples. The importance of the findings for the personality taxonomy and theory is discussed.

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The lexical paradigm, based on descriptive adjectives, turned out to be one of the most fruitful approaches in the quest for an adequate personality taxonomy (Digman, 1990; Goldberg, 1990; Saucier & Goldberg, 1996) and has been followed by similar assessments using the traditional sentence-based approach (Costa & McCrae, 1992; Lee & Ashton, 2012). Although *per definitionem* sensitive to social and cultural influences, these approaches revealed cross-cultural similarities in the personality structure (Aghababaei, Wasserman, & Nannini, 2014; Ashton & Lee, 2007; Ion et al., 2017; McCrae & Costa, 1997; McCrae, Terracciano, & 79 Members of the Personality Profiles of Cultures Project, 2005; McCrae, Terracciano, & 78 Members of the Personality Profiles of Cultures Project, 2005; Paunonen et al., 1996; Wasti, Lee, Ashton, & Somer, 2008). Even though the problem of the number of basic personality factors derived from the lexically based approach seems not to be yet definitively resolved (Saucier, 2008, 2009), psychological meaning and the structure of the basic personality traits proposed by various models within these language approaches appear to be highly similar and cross-culturally robust (Ashton & Lee, 2007; McCrae & Costa, 1997; Wasti et al., 2008). Strong evidence on the heritability and developmental trajectories of these lexically derived factors also point to the possibility that the individual differences in them reflect, at least to some extent, differences in underlying biological systems (Bouchard & Loehlin, 2001; Jang, McCrae, Angleitner, Riemann, & Livesley, 1998; Yamagata et al., 2006).

Based on these considerations, the comparisons between lexical and biologically oriented models of personality might reveal similarities not initially expected given such conspicuous conceptual differences between them. The main goal of this study is to explore the relations based on the two well-known conceptualizations and operationalizations of lexical and biological approach to personality: the HEXACO model rooted in the lexical tradition, and the affective neuroscience theory (ANT) model representing the biological approach to personality. These conceptualizations and their questionnaire-based measures are elaborated in the continuation of the text.

Affective neuroscience theory and the Affective Neuroscience Personality Scale

Panksepp's ANT provided compelling evidence for seven emotional and motivational survival tools that he referred to as basic affective/emotional action systems (Panksepp, 1998, 2011). These evolved brain systems represent instinctual responses to life challenges that were readily observable in the behavior of all mammalian species, including humans, and likely function as the biological basis of personality (Davis & Panksepp, 2018). To the best of our knowledge, ANT is the most elaborate, refined, and persuasive theory of

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the biological foundations of personality based on the available neuroanatomical, neurochemical, and neurophysiological data (e.g., Montag & Panksepp, 2017).

It was argued elsewhere that these affective foundations of personality arise from subcortical brain regions; that is, evolutionally older parts of the brain, more ancient than "neomammalian" cortex (Davis & Panksepp, 2011; Montag & Panksepp, 2017; Panksepp, 1998). These brain systems—generating instinctual behavior (unconditioned responses)—are homologous in all mammals and have similar chemistry. Their integrity can be shown by the ability to elicit coherent specific emotional responses with localized brain stimulation. These primary systems are elaborated during human development by secondary conditioning and tertiary thoughts and self-reflections, but the evolutionary origin and foundational power of these discrete, persistent systems are prehuman. Panksepp documented seven basic emotional systems: SEEKING, FEAR, SADNESS, ANGER, PLAY, CARE, and LUST. The Affective Neuroscience Personality Scales (ANPS) are designed to capture each of these systems except LUST because the authors assumed that it might be an affective factor that people would not wish to be frank about (Davis & Panksepp, 2011; Davis, Panksepp, & Normansell, 2003). Therefore, LUST, as a primary emotion defined by Panksepp's model, is not tapped by ANPS due to its proneness to elicit socially desirable responding with possible negative carry-over effects on answers to other items on the ANPS. The authors added the Spirituality scale to capture what they considered to potentially be the highest human emotion. This scale was included to acknowledge its importance in drug addiction treatment (Panksepp, Nocjar, Burgdorf, Panksepp, & Huber, 2004). However, it is obvious that whatever the emotion behind spirituality might be, it was never considered a primary emotion.

On the emotional systems

The SEEKING system promotes exploration, investigation, and foraging, and it energizes all basic emotional systems with appetitive and anticipatory arousal. It includes anticipation of new positive experiences, curiosity, and liking to find solutions to problems. Although generally avoiding connecting particular aspects of mental functioning to only one emotional system, Panksepp pointed to the ascending dopaminergic tracts and lateral hypothalamus as the core of the powerful, affectively valenced neural system producing feelings of engagement and excitement when seeking resources needed for survival or pursuing cognitive interests (Panksepp, 1998). The FEAR system is related to anxiety, worrying, difficulty in making decisions, ruminating, and feeling tense. Capacity to experience fear originates in the circuits and connections between the central amygdala and periaqueductal gray of the midbrain. Neurochemicals involved are excitatory amino acids such as glutamate and various neuropeptides such as corticotrophin-releasing factor (CRF), ACTH, and alpha-MSH. ANGER is derived from the potential loss of resources or being physically restricted and includes being easily irritated and frustrated and expressing anger both verbally and physically. The core of this system runs from the medial amygdala downward, via stria terminalis to the medial hypothalamus, and further down to the specific areas of the periaqueductal gray. Decreased levels of serotonin, GABA, and opioids facilitate it, and a neuropeptide—substance P—appears to be a key modulator of the ANGER system. SADNESS is related to social separation distress, crying, feeling lonely, and thinking about loved ones and past relationships (see also the link to depression; Montag, Widenhorn-Müller, Panksepp, & Kiefer, 2017). The circuitries involved in stress vocalizations related to separation and panic attacks arise from midbrain periaqueductal gray, close to where physical pain responses are generated, but they are also present in the medial diencephalon (especially dorsomedial thalamus), ventral septal area, preoptic area, and many sites in the bed nucleus of the stria terminalis, even anterior cingulate gyrus, amygdala, and hypothalamus in some higher species. It seems that beyond the central role of glutamate and CRF, the decreased levels of acetylcholine, opioids, oxytocin, and serotonin have a mostly modulatory role in the SADNESS system. The PLAY system is related to laughter and humor, and it also includes playing social games with physical contact. Expectedly, the PLAY system calls into action many neural circuits (e.g., areas controlling movements, such as cerebellar, vestibular, and basal ganglia systems), and parafascicular and posterior thalamic nuclei seem to be crucial in mediating play urges. Modest opioid arousal and the muscarinic cholinergic receptor system promote play, whereas the contribution of biogenic amines and various types of their receptors seem to be more complex and not yet understood in details. CARE is about nurturing tendencies such as caring for others, being drawn to young children and pets, and being soft-hearted toward people in need. Part of the circuitry controlling this system descends from the preoptic areas along the dorsal route to the brain stem, and part through a hypothalamic route to ventral tegmental areas. Although several hormones are implicated in CARE behavior, the central role is played by the neuropeptide oxytocin (for a detailed overview see also the appendix in the work by Montag & Davis, 2018). Spirituality assumes feelings of connectedness with all forms of life and being one with creation (Davis & Panksepp, 2011; Davis et al., 2003; Panksepp, 1998).

ANT and the Big Five

Based on the description of these emotional and motivational systems, it is not difficult to recognize similarities between emotional systems and Big Five traits. Namely, one would expect to find substantial relations between the SEEKING system and Openness and Extraversion, between the FEAR and SADNESS systems and Neuroticism, between the (low) ANGER and CARE systems and Agreeableness, and between the PLAY system and Extraversion. The similarities between Big Five traits and emotional and motivational systems can be expected based already on what can be extracted from various definitions of personality traits, emphasizing stable individual differences in cognitive,

emotional, and motivational aspects of mental states resulting in stable behavioral patterns. Constructs proposed by Panksepp are predominantly related to emotional and motivational aspects of these behavioral regularities; that is, evolutionary older systems mostly isomorphic across mammalian species, located in the phylogenetically oldest layers of reptilian and mammalian brains (Montag & Panksepp, 2017), but having an impact on cognitive aspects of information processing, too (Panksepp, 1998). Indeed, aforementioned expectations on the overlap between the personality traits and these systems were supported by the evidence obtained on U.S. (Davis & Panksepp, 2011; Davis et al., 2003), German and Chinese (Montag & Panksepp, 2017), and Serbian samples (Montag, Davis, Lazarević, & Knežević, 2018). These studies demonstrated that four out of five Big Five/Five-Factor Model (FFM) traits can be substantially related to the basic emotional systems. The only exception was Conscientiousness, which seems to be a more cerebral dimension emerging late in mammalian evolution (appearing in chimpanzees and humans [Gosling, Kwan, & John, 2003; Gosling & John, 1999; King & Figueredo, 1997] and brown capuchin monkeys [Morton et al., 2013]). It likely provides a top-down behavioral inhibition involving the inferior frontal cortex and subthalamic nucleus (Congdon & Canli, 2008). Obviously, the case of Conscientiousness shows that there is at least one substantial dimension of personality that is not related to any of the primary emotional systems. It also suggests the possibility that—from a biological perspective—there is a heterogeneity in the nature of personality traits belonging to the same level of personality assessment hierarchy (C vs. all other traits).

The HEXACO model

In recent years, significant empirical evidence accumulated in favor of HEXACO/Big Six (B6) comparing to the FFM/Big Five (B5). Recent lexical studies indicated better cross-cultural replication of the HEXACO/B6 models especially outside the languages of northern European origin. Namely, in Italian, Hungarian, and Chinese languages the B5 were not found in the five-factor solutions because the factor including content related to personal integrity versus taking advantage of others was extracted instead of one of the B5 factors (Intellect/Openness). All five B5 factors were found only in the six-factor solutions. Besides, the B6 solution proved superior to B5 not only under standard lexical variable selection but also under less restrictive ones, for example, those including evaluative descriptors (cf. Ashton et al., 2004; Lee & Ashton, 2008; Saucier, 2008, 2009; Saucier & Srivastava, 2015). In this study, the HEXACO model was chosen to represent the lexical approach to personality assessment because available evidence suggests that it might be a more accurate taxonomy of the basic personality traits than B5.

Three of the six HEXACO dimensions closely resemble the dimensions of the FFM/B5: Extraversion (X), Openness (O), and Conscientiousness (C). For two of the other factors, Neuroticism and Agreeableness (A), the relations between FFM/B5 domains and the HEXACO space are more complex. Specifically, compared to the FFM/B5 Emotional Stability-Neuroticism factor, labeled Emotionality (E) in the HEXACO, HEXACO E excludes anger as well as including sentimentality items that partly define FFM/B5 Agreeableness (Ashton & Lee, 2007). The HEXACO A trait also departs from the FFM/B5 Agreeableness by excluding sentimentality and including the lack of anger and anger-related behaviors such as being too critical, too stubborn, and holding a grudge. Although Ashton and Lee (2007) argued that the content of the HEXACO A (i.e., patience, flexibility, gentleness, and forgivingness) better resembles the true nature of the trait than FFM/B5 Agreeableness, in fact, they might have created redefined scales (including E) but used the same labels. What markedly differentiates the HEXACO model from FFM/B5 is the inclusion of a new domain—Honesty/Humility (H)—featuring fairness, greed avoidance, and two FFM facets of Agreeableness (i.e., sincerity [straightforwardness] and modesty) as its core characteristics. In addition to 24 facet scales loading onto six higher order domains, HEXACO contains interstitial facet scales designed to assess important traits that load moderately on two or more personality domains (Lee & Ashton, 2006). Altruism, as one of those interstitial traits, was developed to assess sympathy and soft-heartedness. Previous studies have shown that altruism tends to "migrate" between the H, A, and E domains (Ashton & Lee, 2007). It seems that accumulated empirical evidence speaks in favor of the HEXACO model in its theoretical comprehensiveness and practical value (Ashton & Lee, 2007).

The goals of the study

Based on the theoretical grounds and previous empirical evidence based on the B5 models, we expect to find substantial relations between the ANT emotional systems and HEXACO E, X, O, and A. The HEXACO model includes the H trait, which does not exist in the B5 model. This trait—entailing a sense of fairness—does not seem to reflect a primary emotional system. Like C, it also appears to reflect a more cerebral dimension. However, it should not be equated with the highly complex, uniquely human cognitive processes of moral reasoning. H might have much in common with the moral behavior understood as bounded rationality (Gigerenzer, 2010), assuming rudimentary cognitive processing such as imitate-your-peers, equality, tit-for-tat, and default heuristics. It was shown that this sense of fairness was present in nonhuman primates, which is nicely documented in the experiments with inequality aversion manifested by brown capuchin monkeys (e.g., Brosnan & de Waal, 2003, 2014). Therefore, similar to C, we do not expect the substantial correlations of H with any of the emotional systems but do expect moderate correlations with several of them. Small to moderate correlations are expected because H, as explained, does not reflect complex moral reasoning (expected to be unrelated to emotional systems) but rudimentary cognitive schemas having the characteristic of a trait-like tendency that is likely to be to a certain extent

triggered by, facilitated, or some other way connected to the emotional systems such as CARE or ANGER. If this expectation proves to be correct it will be the second basic personality trait not corresponding to any of the primary emotional systems.

To the best of our knowledge, this is the first study to explore the relations between lexically derived HEXACO traits and primary emotional systems conceptualized by ANT. To investigate these relations, we have conducted two studies. The first study reported in this article is exploratory and aims to investigate the relationship between ANT and HEXACO traits in a university student sample from Serbia. The second study was confirmatory and aimed to evaluate the robustness of the relations found in the first study on a new, larger, and more heterogeneous sample. The second study was conducted on a larger German sample consisting of both students and persons recruited from the general population (mostly young adults) from the country with slightly different cultural characteristics. As in Davis et al. (2003), correlations higher than .45 accounting for at least 20% of the shared variance were used as the cutoff criterion for the substantial overlap between the traits defined by the lexical and biological framework in both studies.

Study 1: The position of ANT emotional primary systems within the basic personality space—Exploratory study

The main goal of the first study was to explore the relations between basic personality space defined by HEXACO personality traits and emotional systems proposed by the ANT. The main hypothesis is that all emotional systems (except Spirituality) will be related to HEXACO traits, except for C and H. The expectations are that the correspondences between ANT emotional systems and HEXACO traits will be to a considerable extent similar to those obtained between the ANPS and FFM/B5 assessments, although certain differences should be expected. One should bear in mind that there are differences between the variants of the B5 model. For example, it had been demonstrated that there was only partial overlapping between the B5 adjective-based lexical assessments (Saucier's mini markers) and the questionnaire-based lexical measures (FFM, NEO Five-Factor Inventory) of the same constructs (Mooradian & Nezlek, 1996). Having in mind considerable restructuring of the personality space within the HEXACO model (e.g., two facets belonging to the domain of Agreeableness in FFM—straightforwardness [sincerity] and modesty—were moved to the domain of H in HEXACO), a somewhat different pattern of correlations with ANPS scales should be expected.

Method

Sample

The sample for Study 1 consisted of 229 respondents, students of psychology at the University of Belgrade, Serbia. To collect a sample of sufficient size, three consecutive cohorts of students (sophomore) participated in the study. The average age was 20.24 years ($SD = 2.05$), and 80.3% of participants were female. The study was approved by the Ethics Committee of the Serbian Psychological Association at the Faculty of Philosophy, University of Belgrade. Instruments were administered via an online Moodle platform, not allowing participants to skip the answers. There were no missing data. The participants filled in personality inventories during regular practicals. Respondents received course credit for participation in the study. All participants signed informed consent and all procedures adhered to the principles of the Declaration of Helsinki.

Instruments

The ANPS 2.4 consists of 112 items with a joint 4-point Likert-type scale ranging from 0 (*strongly disagree*) to 3 (*strongly agree*). Respondents completed the Serbian version of the ANPS (Montag et al., 2018). The ANPS taps three positive primary systems (SEEKING, CARE, PLAY), and three negative primary systems (FEAR, ANGER, SADNESS). Each of these scales contains 14 items. In addition, 12 items assess Spirituality. The theoretical range of scores from Spirituality is 0 to 36, and the remaining six scales can have values of 0 to 42.[1]

The HEXACO Personality Inventory–Revised (HEXACO PI–R; Lee & Ashton, 2016) consists of 100 items with a joint 5-point Likert type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). It measures six domain traits: Honesty/Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness, but also 25 lower level personality dimensions (four facets per domain, and one interstitial facet, altruism). The Serbian version of the HEXACO PI–R was administered to the respondents (Međedović, Čolović, Dinić, & Smederevac, 2017). The scores are calculated as the average values of the scale items; that is, they can have values 1 to 5.

Analytic strategy

To explore the relationship between basic personality traits and the primary emotional systems, extension analysis and correlation analysis were employed. We used extension analysis to locate ANT primary systems in the six-factor personality space defined with HEXACO traits. The extension analysis is a form of factor analysis that allows conducting first a factor analysis using one set of variables, named core variables. Another set of variables, named extension variables, is then added. This analysis allows researchers to investigate how the extension variables fit into the space defined only by the core variables (Gorsuch, 1997). In this study, 25 HEXACO PI–R facet scales were used as the core variables,

[1]Score on Spirituality is calculated the following way: Spirituality score = (+18 − ans7 − ans23 − ans39 − ans55 − ans71 − ans87 + ans15 + ans31 + ans47 + ans63 + ans79 + ans95). The scores on the other scales are calculated the following way: for example, SEEK score = (+21 − ans1 − ans17 − ans33 − ans49 − ans65 − ans81 − ans97 + ans9 + ans25 + ans41 + ans57 + ans73 + ans89 + ans105) (Davis & Panksepp, 2011).

Table 1. Descriptive statistics for Affective Neuroscience Personality Scales and HEXACO scores: Serbian sample.

	M	*SD*	h_2	Cronbach's α
Honesty/Humility	3.58	.64	.59	.84
Emotionality	3.42	.65	.58	.84
Extraversion	3.31	.82	.77	.92
Agreeableness	3.02	.64	.66	.86
Conscientiousness	3.71	.63	.64	.86
Openness	4.00	.55	.62	.81
SEEKING	29.09	5.85	.73	.79
FEAR	24.61	9.07	.74	.91
CARE	29.11	6.46	.48	.79
ANGER	19.45	7.46	.78	.85
PLAY	26.24	7.07	.67	.84
SADNESS	25.33	6.83	.62	.82
Spirituality	19.14	7.40	.74	.88

Note. $N = 229$. h_2 = Momirovic's coefficient of homogeneity, which shows the proportion of the true item variance; that is, variance from which the error variance has been removed, accounted for by the first principal component (Knežević & Momirović, 1996).

and the seven ANPS scales were used as extension variables. HEXACO variables are treated here as core variables because this model is elaborated at the facet level, with the well-established factorial structure based on these facets (e.g., Ashton & Lee, 2007). The extraction procedure was a maximum likelihood. The extracted factors were Promax rotated.

To assess the level of overlap between ANPS and HEXACO PI–R scales, canonical correlation analysis (CCA; Hotelling, 1936; Knežević & Momirović, 1996) and redundancy analysis (Stewart & Love, 1968) were conducted. The CCA that is defined as the maximization of correlations of orthogonal linear combinations of two sets of variables is the most appropriate method to assess the level of overlap in information on a personality that these two instruments capture. Redundancy analysis corrects for the fact the canonical correlations reflect the level of overlap between the canonical variates extracted in the two sets, not original variables: Redundancy analysis will tell to what extent canonical variates extracted in HEXACO space explain the variance in the ANPS original seven scales, or, alternatively, what is the average squared multiple correlation between HEXACO scales and every ANT scale.

Results and discussion

Descriptives for the ANPS and the HEXACO PI–R scales obtained in the Serbian sample are displayed in Table 1. Results show that the internal consistencies of the ANPS obtained in Study 1 are good, with Cronbach's alpha ranging from .79 (for SEEKING and CARE) to .91 (for FEAR). These coefficients are in line with the previously obtained reliability coefficients (Davis & Panksepp, 2011; Davis et al., 2003). Internal consistencies of the HEXACO PI–R domains obtained in Study 1 are also good and range from .81 (for Openness) to .92 (for Extraversion). Homogeneity varies across HEXACO PI–R domain scales and ANPS scales (Table 1), pointing to the fact that they differ in the complexity (Momirović's coefficient of homogeneity h_2 can be interpreted as an index of unidimensionality; the higher the coefficient is, the lesser is the departure from unidimensionality).

Table 2. Correlations between HEXACO PI and Affective Neuroscience Personality Scales domain-level scales: Serbian sample.

	SEEKING	FEAR	CARE	ANGER	PLAY	SADNESS	Spirituality
Honesty/Humility	−.04	.04	.20*	−.33**	−.24**	−.03	.05
Emotionality	−.07	**.58****	.42**	.17*	−.06	**.61****	.10
Extraversion	**.48****	**−.56****	.20**	−.06	**.63****	−.37**	.20**
Agreeableness	.07	−.12	.12	**−.73****	.03	−.16*	.16*
Conscientiousness	.12	−.01	.06	−.13	−.06	.00	−.02
Openness	**.47****	−.06	.10	−.03	.08	−.05	.34**

Note. $N = 229$. Correlations with absolute values of .45 or above are shown in bold.
*Correlation is significant at the .05 level (2-tailed). **Correlation is significant at the .01 level (2-tailed).

Table 2 displays the results of the correlation analysis between HEXACO PI–R domain scales and ANPS scales obtained in the Serbian student sample (correlations between HEXACO PI–R facets and ANPS scales are given in Appendix A in the supplementary materials at https://osf.io/5b4uk/). The SEEKING system correlates with HEXACO X and O. The FEAR system is related to E and low X. CARE has the highest correlation with E. ANGER correlates with low A and moderately with low H. PLAY is predominantly related to X. SADNESS correlates with E and low X, and Spirituality moderately correlates with O.

The six factors with eigenvalues above 1, using 25 HEXACO facets, were extracted and Promax rotated. They explained 62% of the total variance. These factors, explaining 15%, 13%, 12%, 9%, 8%, and 6% of variance were interpreted as X, C, A, O, E, and H, respectively.

As expected, all facets of the HEXACO traits loaded on corresponding traits (upper part of Table 3). ANPS scales were then projected onto the six factors defining the HEXACO personality space and their extended loadings (i.e., loadings on the factors to which extraction ANPS scales did not contribute) can be seen in the lower part of Table 3. The SEEKING scale loaded on X and O almost equally. Primary loading of the FEAR scale was on low X and secondary on E. The CARE scale had primary loading on E. ANGER loaded primarily on low A. The PLAY scale loaded on the X factor, and SADNESS primarily loaded on E. Spirituality did not have high loadings on any of the latent traits (the highest one was on O, reaching .32).

Results of the CCA nicely illustrate the level of the overlap between information on personality tapped by these two instruments: Seven canonical correlations were found to be statistically significant, the first three being .91, .83, and .78, respectively. The remaining four were .63, .59, .52, and .39 (all significant at $p < .05$). The first canonical correlation reflects the relation between E and low X with FEAR and SADNESS; the second represents the relation of E and H with CARE and low ANGER; the third indicates relations of E and low A with the ANGER, PLAY, and SEEKING systems; the fourth reflects relations between agreeable aspects of E and low O with CARE and low SEEKING; the fifth indicates relations between X, low H, and low C with PLAY and to a smaller extent Spirituality; the sixth represents relations between low O, E, and X with low Spirituality, PLAY, CARE, and SADNESS; and the seventh indicates distant

relations between predominantly low H and low A with SADNESS and Spirituality. Redundancy analysis showed that canonical variates extracted from HEXACO PI–R facet scales reproduced 58% of the variance in the seven original ANPS scales (full canonical correlation output is given in Appendix 2 in the supplementary materials at https://osf.io/bk5wg/).

Study 2: Cross-cultural robustness of the relations between ANPS and lexical personality traits—Replication on German general population

The main purpose of Study 2 was to investigate the robustness of the findings regarding the relations between lexical HEXACO PI–R and ANPS scales by using a large sample of younger people recruited from both a student background as well as persons from the general population with a culturally different background (i.e., German).

Method

Sample

The sample of Study 2 consisted of 702 respondents (all participating in the Ulm Gene Brain Behavior Project), with an average age 23.68 years ($SD = 6.06$), 69.8% of whom were female. The study was approved by the local ethics committee of Ulm University, Ulm, Germany. There were no missing data because the instruments were administered via an online platform, not allowing participants to skip the answers. All participants signed informed consent and all procedures adhered to the principles of the Declaration of Helsinki.

Instruments

The same instruments administered to Serbian sample were used here. Respondents completed the German version of the ANPS (Reuter, Panksepp, Davis, & Montag, 2017) and the German version of the HEXACO PI–R (Ashton, Lee, Marcus, & De Vries, 2007; the German version was taken from the official HEXACO Web site at http://hexaco.org/hexaco-inventory).

Analytic strategy

As in Study 1, we explored correlations between ANPS and domain scales from the HEXACO PI–R. Extension analysis was performed again to test whether the results obtained in Study 1 would replicate on the new sample. The extraction procedure was a maximum likelihood. The extracted factors were Promax rotated. Finally, to explore the magnitude of the associations between dimensions defined by the ANPS and HEXACO PI–R, we again employed CCA and redundancy analysis.

Results and discussion

Descriptives for the ANPS and the HEXACO PI–R scales obtained on the German sample are presented in Table 4.

Table 3. Extension loadings of the Affective Neuroscience Personality Scales (ANPS) on lexical factors of personality: Serbian sample.

	Factor loadings of core variables					
HEXACO	X	C	A	O	E	H
Honesty						
Sincerity	−0.03	0.16	0.20	−0.10	−0.03	**0.57**
Fairness	0.01	**0.37**	0.23	−0.14	0.25	**0.58**
Greed avoidance	−0.12	0.00	0.23	0.14	0.03	**0.67**
Modesty	−0.19	0.00	0.29	−0.08	0.18	**0.63**
Emotionality						
Fearfulness	−0.26	0.09	−0.12	**−0.30**	**0.47**	0.03
Anxiety	**−0.37**	0.14	−0.20	−0.17	**0.55**	0.01
Dependability	0.04	−0.05	−0.06	−0.10	**0.65**	0.00
Sentiment	0.18	0.18	0.08	−0.01	**0.70**	0.19
Extraversion						
Social self-esteem	**0.79**	0.11	0.04	0.00	−0.10	−0.12
Social boldness	**0.71**	−0.09	−0.06	0.24	0.02	−0.20
Sociability	**0.73**	0.04	0.10	0.07	0.29	−0.05
Liveliness	**0.89**	0.04	0.10	0.03	−0.02	−0.11
Agreeableness						
Forgiveness	0.14	−0.09	**0.74**	0.16	0.07	0.24
Gentleness	−0.08	−0.08	**0.61**	−0.11	0.15	**0.44**
Flexibility	0.08	−0.05	**0.65**	−0.07	−0.03	**0.35**
Patience	0.05	0.16	**0.75**	0.02	−0.16	0.25
Conscientiousness						
Organization	0.20	**0.70**	0.02	−0.27	0.12	0.14
Diligence	**0.47**	**0.62**	0.00	0.16	0.10	0.06
Perfectionism	−0.16	**0.72**	−0.05	0.06	0.17	0.13
Prudence	0.01	**0.71**	0.05	−0.16	0.04	0.09
Openness						
Aesthetic appreciation	−0.06	−0.03	0.13	**0.52**	−0.03	0.13
Inquisitiveness	−0.01	−0.05	0.05	**0.43**	−0.10	−0.03
Creativity	0.13	−0.01	0.02	**0.67**	0.01	0.04
Unconventionality	0.05	−0.11	−0.01	**0.80**	−0.18	−0.11
Altruism	**0.37**	0.26	**0.31**	0.03	**0.51**	0.23
	Factor loadings of extension variables					
	X	C	A	O	E	H
ANPS						
SEEKING	*0.47*	0.09	0.10	*0.45*	0.04	−0.03
FEAR	*−0.60*	0.02	−0.16	−0.11	0.43	0.03
CARE	0.21	0.06	0.15	0.06	*0.49*	0.22
ANGER	−0.11	−0.13	*−0.68*	0.00	0.09	−0.37
PLAY	*0.59*	−0.10	0.05	0.12	0.04	−0.20
SADNESS	−0.39	0.03	−0.16	−0.08	*0.51*	−0.01
Spirituality	0.18	−0.02	0.16	0.32	0.18	0.08

Note. $N = 229$. H = Honesty/Humility; E = Emotionality; X = Extraversion; A = Agreeableness; C = Conscientiousness; O = Openness to Experience. All variables without a prefix are facet-level scales of the HEXACO Personality Inventory–Revised. Factor loadings of core variables with absolute values of .30 or above are shown in bold. Extension loadings with absolute values of .45 or above are shown in italics.

Results show that the internal consistencies of the ANPS obtained in this study are good, with Cronbach's alphas ranging from .72 (for SEEKING) to .86 (for FEAR). Internal consistencies of the HEXACO PI–R domains obtained in Study 1 are also good and range from .78 to .86.

Table 5 displays the results of correlation analysis (correlations between HEXACO PI–R facet scales and ANPS scales are given in Appendix 3 of the supplementary materials at https://osf.io/m5nv4/). Overall, results are highly similar and the patterns of correlations show high consistency across the Serbian and German samples.

Table 6 shows the results of the extension analysis. The upper part of Table 6 displays the results of the exploratory factor analysis involving the core variables. Again, six factors with eigenvalues above 1 were extracted from the 25 HEXACO PI–R facet scales, explaining 60% of the variance. The first factor (explaining 15% of the variance) was interpreted as E, the second (13%) was A, the third (10%) X, the

Table 4. Descriptive statistics for Affective Neuroscience Personality Scales and HEXACO scores: German general population sample.

	M	*SD*	h_2	Cronbach's α
Honesty/Humility	3.35	.57	.60	.83
Emotionality	3.29	.59	.69	.86
Extraversion	3.45	.55	.69	.85
Agreeableness	3.09	.51	.81	.82
Conscientiousness	3.52	.50	.65	.82
Openness	3.28	.54	.69	.78
SEEKING	25.87	4.43	.71	.72
FEAR	22.65	6.72	.79	.88
CARE	27.23	5.96	.59	.81
ANGER	21.67	5.89	.81	.82
PLAY	28.19	5.57	.67	.80
SADNESS	20.88	5.16	.62	.74
Spirituality	12.96	6.38	.86	.85

Note. $N = 702$. h_2 = Momirović's coefficient of homogeneity, which shows the proportion of the true item variance (i.e., variance from which the error variance has been removed), accounted for by the first principal component (Knežević & Momirović,1996).

Table 5. Correlations between HEXACO PI and Affective Neuroscience Personality Scales domain-level scales: German general population sample.

	SEEKING	FEAR	CARE	ANGER	PLAY	SADNESS	Spirituality
Honesty/Humility	.04	−.05	.31**	−.34**	−.01	.02	.16**
Emotionality	−.05	**.62****	**.52****	.24**	−.06	**.60****	.21**
Extraversion	.42**	**−.53****	.19**	−.19**	**.64****	−.41**	.15**
Agreeableness	.13**	−.28**	.16**	**−.71****	.25**	−.25**	.11**
Conscientiousness	.29**	.09*	.07	−.05	−.07	.04	−.07
Openness	.41**	−.06	.20**	−.04	.04	.09*	.31**

Note. $N = 702$. Correlations with absolute values of .45 or above are shown in bold.
*Correlation is significant at the .05 level (2-tailed). **Correlation is significant at the .01 level (2-tailed).

fourth (9%) C, the fifth (8%) O, and the sixth (5%) H. The lower part of Table 6 shows the extension loadings of the ANPS scales.

When extension analysis was conducted on the German sample, results demonstrated consistency with the ones obtained on the sample of Serbian students. All facets of the HEXACO model loaded on corresponding higher order factors as expected. ANPS scales loaded on the HEXACO latent factors as in Study 1, patterns of loadings being remarkably similar.

Finally, results of the CCA closely resembled the findings obtained on the Serbian student sample: All seven canonical correlations were significant at $p < .01$, the first three being .90, .81, and .75, and the remaining four being .60, .52, .34, and .29. These correlations reflect correspondences between the two spaces similar to those found in the Serbian sample with the first three pairs of canonical variates being especially high. For example, what the first canonical correlation in both samples reveals is that almost identical information captured by the combination of E and low X in case of the HEXACO approach is tapped by the combination of the ANT FEAR and SADNESS systems. The higher overlap reflected in the first three canonical correlations concerns mostly personality phenomena related to E, X, and A, whereas the lower level of overlap is present in the case of the phenomena related to O, H, and C or, in ANT terminology, to SEEKING and Spirituality. The redundancy analysis showed that 54% of the variance in the ANPS original scales was reproduced by the canonical variates extracted from HEXACO PI–R scales. In other words, the average squared multiple correlation predicting each of the seven ANPS scale scores from the HEXACO PI–R facet scale scores is .54, indicating a substantial overlap of the two sets of variables. Full canonical correlation output is given in Appendix 4 of the supplementary materials at https://osf.io/pj398/.

Table 6. Extension loadings of the Affective Neuroscience Personality Scales (ANPS) on lexical factors of personality: German general population sample.

	Factor loadings of core variables					
HEXACO	E	A	X	C	O	H
Honesty						
Sincerity	−0.09	0.20	−0.07	0.03	0.15	**0.52**
Fairness	0.22	0.24	0.04	0.27	−0.03	**0.58**
Greed avoidance	0.10	**0.31**	0.06	−0.05	0.18	**0.64**
Modesty	0.20	0.37	−0.02	−0.01	−0.03	**0.63**
Emotionality						
Fearfulness	**0.56**	−0.13	−0.30	0.11	−0.14	0.05
Anxiety	**0.55**	0.23	−0.50	0.17	−0.08	−0.08
Dependability	**0.73**	−0.09	0.06	0.02	0.11	0.10
Sentiment	**0.78**	0.05	0.07	0.10	0.18	0.22
Extraversion						
Social self-esteem	−0.09	0.21	**0.71**	0.12	0.06	0.10
Social boldness	−0.01	−0.05	**0.59**	0.01	0.23	−0.13
Sociability	**0.32**	0.21	**0.59**	−0.07	0.19	0.05
Liveliness	−0.07	0.26	**0.77**	0.00	0.11	0.08
Agreeableness						
Forgiveness	−0.12	**0.60**	0.30	−0.16	0.12	**0.36**
Gentleness	0.10	**0.67**	0.19	−0.13	0.08	**0.32**
Flexibility	−0.01	**0.61**	0.13	−0.12	0.00	**0.31**
Patience	−0.24	**0.70**	0.18	0.03	0.10	**0.33**
Conscientiousness						
Organization	0.03	−0.03	0.04	**0.61**	−0.13	0.10
Diligence	0.15	−0.09	0.24	**0.66**	0.13	0.07
Perfectionism	0.18	−0.18	−0.09	**0.70**	0.05	−0.05
Prudence	−0.13	0.07	−0.09	**0.55**	−0.17	0.11
Openness						
Aesthetic appreciation	0.19	0.15	0.03	0.01	**0.73**	0.24
Inquisitiveness	−0.16	0.05	0.09	0.09	**0.40**	0.10
Creativity	0.15	0.07	0.19	0.01	**0.64**	0.11
Unconventionality	0.01	−0.05	0.19	−0.16	**0.65**	−0.03
Altruism	**0.54**	**0.37**	0.18	0.10	0.28	**0.58**
	Factor loadings of extension variables					
	E	A	X	C	O	H
ANPS						
SEEKING	0.04	0.11	0.41	0.23	0.38	0.08
FEAR	*0.48*	−0.24	*−0.58*	0.13	−0.10	−0.09
CARE	*0.57*	0.19	0.15	0.07	0.21	0.33
ANGER	0.21	*−0.65*	−0.22	−0.03	−0.03	−0.39
PLAY	0.08	0.24	*0.59*	−0.10	0.08	0.04
SADNESS	*0.50*	−0.21	−0.44	0.06	0.07	−0.02
Spirituality	0.23	0.09	0.15	−0.05	0.31	0.16

Note. $N = 702$. X = Extraversion; E = Emotionality; A = Agreeableness; O = Openness to Experience; C = Conscientiousness; H = Honesty/Humility. All variables without a prefix are facet-level scales of the HEXACO Personality Inventory–Revised. Factor loadings of core variables with absolute values of .30 or above are shown in bold. Extension loadings with absolute values of .45 or above are shown in italics.

General discussion

We found a substantial overlap in information on personality assessed by ANPS and HEXACO PI–R. However, despite the overlap, our results demonstrate that personality phenomena are differently structured at the latent level by the ANT biological and the HEXACO lexical approaches. Still, the pattern of correlations and the extension loadings of

ANT systems on the six HEXACO factors were strikingly similar in two populations, Serbian and German.

Although the two instruments are rooted in the different approaches to personality (biological and lexical), they target highly similar personality phenomena, especially those related to X and E. Actually, these two traits were expected to show substantial relations with five out of the six primary emotional systems: X with PLAY and SEEKING and E with FEAR, SADNESS, and ANGER. From Eysenck's early conceptualization of personality structure, these two dimensions were postulated to reflect differences in the latent biological systems (Eysenck, 1990; Eysenck & Eysenck, 1976). Being connected to positive and negative emotions, motivational systems, alimentary functions, sexual drive, circadian rhythms, and psychopathology, it is no surprise that these traits turned out to be closely related to the basic emotional regulations. Slightly higher correlations of X with the emotional systems are a likely result of the presence of the contents such as social self-esteem expecting to increase negative correlations with fears, anxieties, and negative moods.

This overlap is less intense in the case of phenomena related to O, and minimal in the case of those connected to H, C, and Spirituality. The absence of the notable relations between affective neuroscience emotional systems on one hand and C and H, on the other hand, is expected. Entailing top-down behavioral inhibition in the case of C and a higher order sense of fairness in the case of H, they do not have a counterpart among the primary emotional systems (Davis & Panksepp, 2011).

The case of ANPS Spirituality

The case of Spirituality is somewhat unique. It is least represented in HEXACO, and is clearly different from Panksepp's emotional systems; namely, it is not a primary emotional system and is not clearly connected to any of the neuroanatomical structures on which these primary emotional systems are based. Interestingly, it also seems to be outside the scope of the lexical approach as well. Having in mind the arguments that authors of the ANPS gave for the inclusion of Spirituality (mostly practical, not theoretical; Davis & Panksepp, 2011), our opinion is that it reflects their awareness that some important phenomena of individual differences are missing from the dominant personality models. Their attempt is in line with the suggestion of Piedmont (1999) considering the possibility that religiosity becomes the sixth personality trait, or Cloninger and his associates (Cloninger, Svrakic, & Przybeck, 1993; Svrakic et al., 2002) assuming that the dimension of self-transcendence is important to capture and explain various phenomena related to personality disorders. Our thesis (to be empirically evaluated in the near future) is that these three constructs at least partially emanate from what should be included in the taxonomy of the basic personality traits: psychosis proneness or disintegration (Knežević, Savić, Kutlešić, & Opačić, 2017); that is, a broad dimension of individual differences not captured by any of the most influential personality models (Knežević et al., 2016; Knežević et al., 2017; Lazarević et al., 2016; Međedović, 2014) that includes a broad range of disintegrative, apophenic, or psychotic-like phenomena. The question of the exact content of this disposition is not of primary concern here (i.e., whether Eysenck's or Krueger's psychoticism or Knežević's disintegration model represent the domain the most accurately). The point is that there is a recognizable need of many personality theorists to understand dispositional roots of such phenomena as a consequence of the difficulties in explaining them by the existing trait taxonomies (B5 or HEXACO; Ashton & Lee, 2012; Ashton, Lee, De Vries, Hendrickse, & Born, 2012; Watson, Clark, & Chmielewski, 2008). Our thesis is that the inclusion of Spirituality, self-transcendence, or religiosity into the personality space reflects a need to include some of these psychotic-like, apophenic, disintegrative phenomena—mostly those contents assuming to characterize a general, nonclinical population. In other words, our expectation is that if HEXACO is complemented by disintegration, a substantial amount of Spirituality variance would be explained by the combination of O and disintegration (although E and A could incrementally contribute), especially by disintegration facets magical thinking and enhanced awareness.

Personality phenomena are differently structured by HEXACO and ANT at the latent level

Notwithstanding the fact that ANPS and HEXACO PI–R scales capture similar information on personality phenomena, this information is differently structured at the latent level; that is, mapping emotional systems onto these lexically derived personality traits are not one to one. Namely, four out of six emotional systems are mapped onto more than one lexical factor. In our extension analyses the SEEKING system appears linked to E and O (see that X was also robustly linked with SEEKING in the Chinese and German samples investigated in Montag & Panksepp, 2017, which is further discussed in Montag & Panksepp, in press), FEAR and SADNESS to low X and E, and ANGER to low A and low H. Unfortunately, different overlapping patterns between the ANT (representing Panksepp's primary-process brain emotional systems) and lexical personality models are observed depending on which lexically based model is used. Cross-cultural data from the United States, France, and Turkey comparing the ANPS to B5 assessments using Goldberg adjectives have not revealed strong correlations between SEEKING and Extraversion (Davis et al., 2003; Ozkarar-Gradwohl et al., 2014; Pahlavan, Mouchiroud, Zenasni, & Panksepp, 2008), which stand in contrast to comparisons using the NEO PI–R (Montag & Panksepp, 2017) and now the HEXACO PI–R. Indeed, there is substantial disagreement among the lexical models themselves beyond the classical B5 and HEXACO models (Saucier, 2009), which suggests there might be no quick resolution to how Panksepp's brain-based primary emotions as biological foundations of personality should be mapped onto factor analytically derived personality models.

Why there are differences between HEXACO and ANT taxonomies of basic traits?

These differences do not automatically assume that one taxonomy is correct and that the other is wrong. It might be that the latent structures of the covariances among the indices based on various lexically based approaches do not entirely reflect their biological underpinnings, but some other systematic influences. For example, one might speculate that O and E have a common input from the SEEKING system, but then diverge during childhood and stabilize as separate dispositional tendencies due to interactions of some aspects of the SEEKING system with the cognitive capacities of an individual. If two lexical traits are linked to the SEEKING system, it is plausible to expect a certain level of connectedness between them, although we believe the SEEKING system is linked to and energizes all primary emotions as well as homeostatic and sensory survival systems (Montag & Panksepp, 2017). Thus, common links to the same emotional system might explain robust connectedness between some pairs of domain-level personality traits. If it is really the case, then personality theory should explain why, for example, X and O—despite having a common biological origin—diverge from each other and stabilize as more or less separate but correlated dispositional tendencies. Indeed, the data are not against such an interpretation; for example, there are systematic correlations between O and X in questionnaire-based personality models (meta-analytically estimated $r = .45$; Mount, Barrick, Scullen, & Rounds, 2005), A and H ($rs = .28$–$.42$ for various samples; Lee & Ashton, 2016), and Neuroticism and low E (meta-analytically estimated $r = .24$; Mount et al., 2005). In fact, these systematic correlations between basic traits already gave rise to the postulation of, for example, a two-factor model of personality assuming the existence of the broader personality factors located above FFM or HEXACO dimensions (cf. Cieciuch & Strus, 2017; DeYoung, Peterson, & Higgins, 2002; Digman, 1990). One higher order factor was found to reflect the shared variance of Neuroticism, Conscientiousness, and Agreeableness, and the other one the shared variance of Extraversion and Openness. These higher order dimensions are known as alpha and beta (Digman, 1990), stability and plasticity (DeYoung, Peterson, & Higgins, 2002), or social self-regulation and dynamism (Saucier et al., 2014). ANT offers mechanisms that might explain the covariances among the traits, mechanisms more specific and precise than just broad biological characterizations in terms of the common neurotransmitter implicated in these trait covariances (serotonin and dopamine, respectively) that have been previously offered (DeYoung et al., 2002).

The second possibility is that the measurement model on which one of these inventories (or both) were based is not entirely correct. The slightly lower reliability and homogeneity of CARE and SADNESS scales from the ANPS and Honesty from the HEXACO inventory might indicate that allocations of the items in these scales are not entirely justified. It is not quite unlikely that the further improvements of the measurement models of these two approaches (primarily the ANT model, because it is not primarily factorially derived) might lead to the stronger convergent-discriminant correlations between the dispositions these models assume to constitute personality space.

There are other potential problems that can cast doubt on the taxonomic validity and precision of the biologically based personality models such as ANT. First, it is highly probable that, with the advances in neuroscience, slightly different biological architecture might be suggested, perhaps with the potential to match the factorially derived models even better. For example, based on the strong evidence on the relation between schizophrenia and the dopaminergic system ("schizophrenia as dopamine disorder"), Panksepp tried to understand and explain psychotic-like experiences as a consequence of the dysfunction of the SEEKING system (the integrity of the dopaminergic system was postulated to be crucial for the SEEKING system; Montag & Panksepp, 2017; Panksepp, 1998). However, as the empirical evidence that accumulated emphasized the equally important role of another neural system (integrity of the NMDA receptor system in psychosis, or "schizophrenia as glutamate disorder" [Insel, 2010]), it is not unimaginable that in the future this neural system becomes critically connected to psychotic-like experiences. This outcome would be more in line with the findings on the behavioral separateness of psychotic-like phenomena from the phenomena generated by the SEEKING system (i.e., Openness and Extraversion; Knežević et al., 2017). Second, one should bear in mind that ANPS is a questionnaire operationalization of constructs developed within the theory of neuroaffective systems, leaving the possibility that there could be some inherent limitations of self-report measures to adequately capture functions of these neural systems. What we have here assessed is not the functioning of the emotional systems per se, but the self-report of the sample of their behavioral consequences. The authors of the ANPS scales were entirely aware of the fact when they wrote, "Although ANPS items attempt to address primary affects directly, since all self-report assessments must include cognitive reflection, we interpret the ANPS scales as tertiary (thought-mediated) approximations of the influence of the various primary emotional systems in people's lives" (Davis & Panksepp, 2011, p. 1952). For example, the extraction of the Neuroticism factor having high correlations with three emotional systems, FEAR, SADNESS, and ANGER, these authors tend to interpret as an artificial, statistical lumping, caused by the limitations of the tertiary processing system—based on thoughts and self-reflections—in differentiating between the various distressful feelings rooted in different emotional systems. Although the self-report approach to the assessment of emotional systems has inherent limitations, for example, regarding the possibility to reflect the relations among them precisely, it seems that there are no reasons to believe that it cannot capture a range of behavioral consequences of these emotional systems and that it precludes testing the coherence of various behavioral indicators of these systems, that is hypothesized by the ANT. It seems that self-report measures could be useful in testing many aspects of neurobiological theories of human personality, but to test correctness of these taxonomies in a more

precise and rigorous manner, self-report data should be complemented by the methods such as observer ratings, cross-species electric stimulation of the brain, pharmacological, experiential, or brain damage studies. Fortunately, the cross-species evidence exists, and it gives rise to ANT independently from the measurement based on questionnaires (Davis & Panksepp, 2011; Panksepp, 1998).

The differences between lexical models and their relations with ANT

As there is no competing personality model based on emotional systems but there are competing lexical models, it is easy to analyze how variations in the conceptualization of the latter influence their correlations with the former. For example, some unexpectedly high overlap between the constructs such as HEXACO E and the ANT CARE system could be ascribed to the conceptualization of the former. Namely, it appears that conceptual closeness of the HEXACO E factor to some sort of tender-mindedness such as the E scale sentimentality facet (reflected also in high loadings of altruism on E) lead to the unusually high loadings of the CARE system on the E factor, loadings even higher than those of the FEAR system. Previously obtained low correlations between FFM/B5 Neuroticism and the CARE system ($r = -.07$ in Davis & Panksepp, 2011; $r = -.12$ in Pahlavan, Mouchiroud, Zenasni, & Panksepp, 2008; $r = .11$ in Ozkarar-Gradwohl et al., 2014; or $r = -.01$ in Montag et al., 2018) suggest that the conceptualization of E within the HEXACO framework is the primary reason for such an increase in this correlation. Similarly, the reconceptualization of A within the HEXACO framework—turning it mostly into low ANGER—led to the loss of its correlation with the CARE system (present in the case of Agreeableness from the FFM; Montag & Panksepp, 2017). Indeed, moving modesty from FFM Agreeableness to HEXACO H and inclusion of flexibility as a facet of HEXACO A seem to be the primary causes of the correlation between CARE and H, loss of the correlation between CARE and A, and an increase of the correlation between low ANGER and A (see supplementary material, Appendices A and B).

It does not mean that conceptualization of—for example—a higher order E construct within the HEXACO model is not correct, or that it is less correct than the conceptualization of B5 Emotional Stability or FFM Neuroticism: It means that certain emphasis and conceptualizations of the traits within a lexical paradigm can have consequences on the levels of their resemblance to the more biologically conceptualized dispositions, such as primary emotional systems. In that sense, FFM/B5 Neuroticism bears a stronger resemblance to the emotional systems of ANGER, FEAR, and SADNESS than HEXACO E, which largely moves ANGER to A. Moreover, all correlations of ANT systems with the corresponding FFM/B5 factors appear to be slightly higher than the correlations with the corresponding HEXACO factors (Davis & Panksepp, 2011; Montag et al., 2018). In other words, factorially correct HEXACO personality structure seems to correspond to Panksepp's primary emotional system less than another factorially correct lexical structure—FFM/B5—based on a slightly different pool of indicators and trait contents. Our opinion is that the correspondences between various lexically based assessment models and models based on different paradigms, such as ANT, can be very useful in our quest for the most "natural" taxonomy of personality traits. Once again, it does not automatically mean that one model being more similar to the ANT model is the correct one, but understanding the reasons for the convergences and discrepancies between the personality models that are based on different paradigms could be potentially informative for personality theory. It is difficult to see other ways to improved and more precise trait taxonomies beyond these constant calibrations and adjustments based on the new evidence prompted by the different theoretical perspectives.

What remains outside the scope of the ANT are C and H. These traits have not yet been mapped onto the primary emotional systems, neither conceptually nor empirically. Because these variables of individual differences are unlikely to be primary emotional systems, it is of theoretical and practical interest to find out the neuroanatomical structures on which they are based because this might have important behavioral consequences (e.g., differences in their malleability).

Replicability of the findings across the Serbian and German samples

The finding of equal importance is that the patterns of loadings and correlations between HEXACO PI–R and ANPS scales are highly similar in Serbian and German samples. Given the cultural, historical, and linguistic differences between the two nations (the Serbian language belongs to the Slavic branch, whereas German belongs to the Germanic family of languages), such an outcome would be less expected if the factors based on the lexical approach to personality structure reflect these cultural and historical idiosyncrasies to an important degree. Therefore, it appears that both biological and lexical approaches to personality discern universals of human behavior, the dispositions that behavioral manifestations and biological architecture seem to be cross-culturally robust.

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This article has earned the Center for Open science badges for Open Data. The data and materials are openly accessible at https://osf.io/m5nv4/.

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