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ORIGINAL ARTICLE

Anxiety-Related Coping Styles and Individual Differences in Primary Emotional Systems Against the Background of Affective Neuroscience Theory: a Study Using Samples from Germany and China

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Abstract

Scientific literature suggests that Neuroticism is an important predictor in understanding individual differences in anxiety-related coping styles such as vigilance (positive association) and cognitive avoidance (negative association). Considering Pankseppian Affective Neuroscience (AN) theory could contribute to understand these relationships more in-depth, because the evolutionary old subcortical brain systems of FEAR, SADNESS, and ANGER might represent brain-anatomical bottom-up drivers of Neuroticism. $N=594$ German participants ($n=170$ males; mostly student background) and $N=332$ Chinese participants ($n=72$ males; mostly student background) completed the Affective Neuroscience Personality Scales (ANPS) and the Mainz Coping Inventory (Angstbewältigungsinventar; ABI) to assess individual differences in primary emotional traits and anxiety-related coping styles, respectively. As hypothesized, associations between the three emotional systems and the two coping styles cognitive avoidance and vigilance were observed. There were some differences in correlations between the Chinese and German samples, mainly regarding associations between ANGER and cognitive avoidance. Moreover, linear regression analyses revealed FEAR as a main predictor of vigilance (positive) and cognitive avoidance (negative) in the German sample. In the Chinese sample, FEAR was the main predictor of cognitive avoidance (negative), only; for vigilance SADNESS (positive) was the main predictor. Theoretical assumptions behind primary emotional traits indicate that the brain systems underlying FEAR and SADNESS indeed influence anxiety-related coping styles in a bottom-up fashion.

Keywords Anxiety-related coping style · Angstbewältigungsinventar · Primary emotional systems · ANPS · Affective Neuroscience Personality Scales · Personality

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Introduction

One of the most influential emotion theories has been proposed by Jaak Panksepp, who also coined the term "Affective Neuroscience" (Panksepp, 1991). Panksepp used deep brain stimulation, lesion studies, and pharmacological challenge tests to understand emotions from inside the brain (Montag & Panksepp, 2016). Pankseppian Affective Neuroscience (AN) theory (e.g., Panksepp, 1992, 2004, 2011) proposes seven primary emotional brain systems driving mammalian behavior in a bottom-up fashion. In AN theory, bottom-up means that primary emotional systems are rooted in ancient subcortical brain areas influencing more recently evolved cortical brain layers (Davis & Montag, 2019). The seven primary emotional systems are called SEEKING, LUST, CARE, PLAY (positive emotional systems) and FEAR, ANGER/RAGE, SADNESS/PANIC (negative emotional systems; e.g., Panksepp, 2007, 2011; for an introduction see Montag and Davis, 2020). The primary emotional systems endow mammals with important tools for survival. The negative emotional systems are focused in the present work. The SADNESS (or PANIC) system is triggered by separation distress, because in groups mammals are stronger. This is easy to understand, when one imagines reactions of a young child losing eye contact with his/her parents (Montag et al., 2017; Panksepp and Watt, 2011). The FEAR system helps mammals to evade danger. ANGER helps both to fight for limited resources and to endow energy when being cornered. Although all mammals have these seven primal emotional systems built into their brains, individual differences in brain anatomy and functionality can be observed across individuals explaining why (i) these systems operate with different strength (e.g., Deris et al., 2017; Montag et al., 2013; Reuter et al., 2009) and therefore (ii) could be seen as evolutionary oldest part of personality (Montag & Panksepp, 2017, p. 2).

In order to provide psychological scientists with an easy-to-administer self-report tool assessing individual differences in primary emotional systems against the background of AN theory, the Affective Neuroscience Personality Scales (ANPS) (Davis et al., 2003) were constructed to measure six primary emotional traits (PETs) based on the primary emotional brain systems: PLAY, SADNESS, SEEKING, CARING, FEAR, and ANGER (LUST is not included as described in the Supplementary Material). For an overview on ANPS research see the recent work Montag, Elhai and Davis (2021).

The ANPS have been abundantly investigated in relation to the well-known Big Five Personality Traits (Openness (to Experience), Conscientiousness, Extraversion, Agreeableness, and Neuroticism) (Costa & McCrae, 1985; for cites on ANPS-Big-Five studies see below), perhaps presenting the current gold standard to describe individual differences in human personality (for an extension of the Big Five model see the HEXACO model by Lee & Ashton, 2004). Although the Big Five are of high relevance to measure individual differences in personality, its lexical background prevents answering questions on why humans differ in personality (for a short history of the Big Five see Montag & Elhai, 2019). As AN theory proposes seven primary emotional systems rooted in subcortical brain areas, links between PETs (which are based on the primary emotional systems) and the Big Five make it very likely that the primary emtotional systems are biological drivers of the Big Five. Indeed, abundant research provides evidence for robust associations between PETs and each Big Five factor (Abella et al., 2011; Barrett et al., 2013; Davis et al., 2003; Marengo et al., 2021; Montag et al., 2019).

Of interest for the present work are observations providing evidence for FEAR, SADNESS, and ANGER being bottom-up drivers of Neuroticism (see, e.g., Montag & Davis, 2018). More tonic activity of the negative primary emotional systems might in part explain why some individuals report greater trait Neuroticism.

Neuroticism and its biological underpinnings are relevant for the present work, because high scores on this personality dimension go along with a higher probability of suffering from a mood disorder such as major depression (Lahey, 2009; Saklofske et al., 1995). For example, Montag et al. (2017) observed that high FEAR and high SADNESS (together with low SEEKING) might be at heart of depression (for similar results see Fuchshuber et al., 2019). Also in the context of affective and other mental disorders, AN theory helps to understand why a person is suffering from a mental disorder by studying imbalances of ancient brain-based systems (Panksepp, 2006).

It is well-known that not only Neuroticism and its underlying primary emotional systems are of relevance to understand the nature of negative affect, but also individual differences in coping styles when facing a threatening situation. According to the Model of Coping Modes (e.g., Egloff & Krohne, 1998; Krohne, 1996), one can distinguish between a cognitive avoidant and vigilant coping style: vigilance describes enhanced processing of threatening material and even enforced focus of attention on the anxiety-provoking parts of the situation, whereas cognitive avoidance describes removal of attention from threatening information in the anxiety-provoking situation (Egloff & Krohne, 1998; Krohne, 2001). Of interest for the present work, higher tendencies towards depression symptoms have been associated both with a vigilant coping style (Krohne et al., 2002) and with higher FEAR and SADNESS scores, when considering Panksepp's AN theory (Fuchshuber et al., 2019; Montag et al., 2017). As can be seen in Fig. 1, the literature provides evidence for a link between FEAR/SADNESS and anxiety-related coping styles (vigilant+; cognitive avoidant−), since all of these constructs are also related to Neuroticism.

The link between primary emotional systems according to AN theory and anxiety-related coping styles has not been investigated thus far. From our perspective, such a research endeavor would be highly interesting, because it might shed light on the biological basis of the often-observed link between higher Neuroticism and vigilant coping (Egloff & Krohne, 1998; Jung et al., 2019), because the same biological basis might underly both Neuroticism and vigilant coping style. And this basis can, in turn, be examined more in-depth by investigating PETs (and primary emotional systems, accordingly) underlying both Neuroticism and vigilant coping style. Further support for the idea of a potential similar biological underpinning for Neuroticism and vigilance recently came from a study by Jung et al. (2019). They observed a single nucleotide polymorphism (SNP) associated with both Neuroticism and vigilance but not cognitive avoidance (Jung et al., 2019).

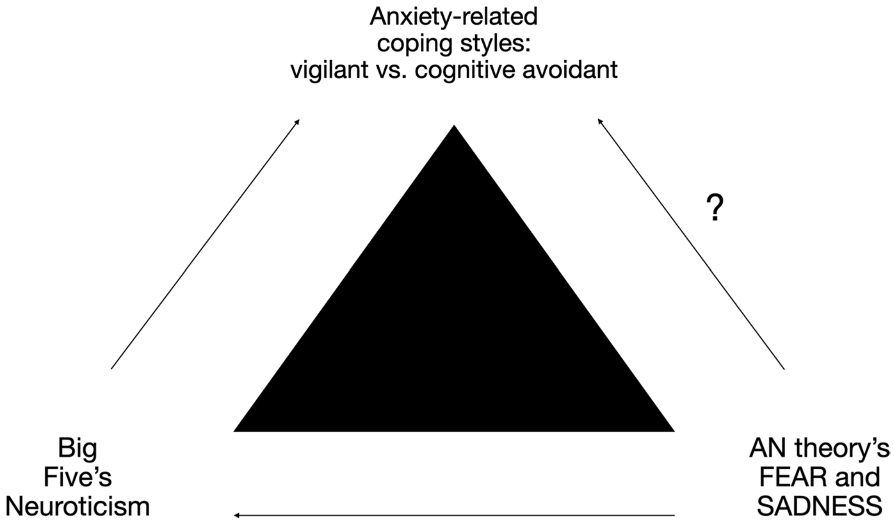

Fig. 1 Previously detected associations between personality traits and anxiety-related coping styles and the indirect associations to be explored

As Neuroticism has been robustly linked to a vigilant coping style, and the primary emotional systems of SADNESS/FEAR/ANGER seem to be bottom-up drivers of Neuroticism, we propose that especially SADNESS and FEAR would also be linked to a vigilant coping style in a positive way and inversely to a cognitive avoidant coping style. For ANGER, such associations are also likely, but probably smaller in size because ANGER associations with Neuroticism are usually weaker than those between SADNESS/FEAR and Neuroticism (Montag & Panksepp, 2017).[1] The present work investigated the associations between the aforementinoed PETs and anxiety-related coping styles in German and Chinese samples. This strategy was chosen, because we believe such associations are culturally independent, in particular if they are rooted in ancient mammalian brain systems. Moreover, observing similar associations in samples recruited in different cultural settings can be a strategy to foster reproducible science (Montag, 2018). Following the idea of Montag (2018) the cross-cultural approach offers the possibility to underline the global validity of a result. We propose that the association between the PETs and vigilance and cognitive avoidance is independent of cultural differences and therefore we expect similar results in the Chinese and German samples in the following way: we expect the three PETs of ANGER, FEAR, and SADNESS to be significant positive predictors of vigilance and significant negative predictors of cognitive avoidance.

[1] Note that the focus of the current work is on associations between vigilance/cognitive avoidance and the three PETs, rather than Neuroticism. Correlations between Neuroticism, ABI variables, and three PETs are therefore only presented in the Supplementary Material.

Methods and Materials

Participants

German Sample

The initial German sample consisted of $N = 603$ participants ($n = 170$ males and $n = 433$ females; M_{age}: 23.096; $SD_{age} = 8.126$). Most of the participants had a student background (86.070%) and were recruited at Ulm University, Ulm, Germany via classes and on campus. They provided electronic informed consent and completed among others the following self-report questionnaires: Angstbewältigungsinventar (ABI, Egloff & Krohne, 1998) and Affective Neuroscience Personality Scales (ANPS). Information on data cleaning can be found in the Supplementary Material. The German part of the study was approved by the ethics committee, of Ulm University, Ulm, Germany.

Chinese Sample

The initial Chinese sample consisted of $N = 444$ participants ($n = 120$ males and $n = 324$ females; M_{age}: 22.579; $SD_{age} = 15.332$) recruited at Tianjin Normal University, Tianjin, China, where the Chinese part of the study was also approved by the ethics committee of the Tianjin Normal University, Tianjin, China. Participants were invited via "WeChat" a popular Chinese social media application (Montag et al., 2018). First, informed consent was given online. Afterwards, the web survey was conducted on a platform hosted by a Chinese web survey platform (wjx.cn). All measures were administered in Mandarin Chinese. 91.216% of the participants had a student background.

Questionnaires and Statistical Analysis

Information on the questionnaires and on statistical analysis can be found in the Supplementary Material.

Results

Descriptive Statistics, Associations with Age and Gender Differences in the German and Chinese Samples

Mean scores, standard deviations, and the observed range of age, the ANPS (3 PETs) and ABI scores for the total German and Chinese samples and male and female subsamples are presented in Table 1. *t*-Tests revealed gender differences in all ABI variables in the German and the Chinese sample except vigilance in the ego-threat scenario in the Chinese sample. Women showed significantly higher vigilance scores

Table 1 Means (SDs), [observed range], and results of *t*-tests on gender differences, for age, ANPS FEAR, ANGER, SADNESS scales, and ABI variables, separately for the German and Chinese samples

ANPS/ABI	German sample ($N = 594$)			Chinese sample ($N = 332$)		
	Total ($N = 594$)	Male ($n = 170$)	Female ($n = 424$)	Total ($N = 332$)	Male ($n = 72$)	Female ($n = 260$)
Age	23.160 (8.169) [16; 82]	24.200 (9.459) [16; 82]	22.743 (7.563) [16; 62]	21.196 (4.392) [18; 49]	23.111 (5.772) [18; 46]	20.665 (3.771) [18; 49]
		$t(592) = 1.970; p = .049; d = .178$			**$t(88.444) = 3.400; p = .001; d = .557$**	
FEAR	2.642 (0.465) [1.214; 3.857]	2.495 (0.467) [1.429; 3.714]	2.701 (0.452) [1.214; 3.857]	2.688 (0.371) [1.429; 3.857]	2.559 (0.275) [2.000; 3.143]	2.723 (0.386) [1.429; 3.857]
		$t(592) = -4.968; p < .001; d = .443$			**$t(157.160) = -4.095; p < .001; d = .442$**	
ANGER	2.575 (0.465) [1.214; 4.000]	2.556 (0.480) [1.214; 4.000]	2.583 (0.459) [1.357; 3.857]	2.598 (0.383) [1.286; 4.000]	2.471 (0.263) [1.786; 3.286]	2.633 (0.404) [1.286; 4.000]
		$t(592) = -0.625; p = .532; d = .058$			**$t(173.646) = -4.062; p < .001; d = .423$**	
SADNESS	2.481 (0.385) [1.429; 3.857]	2.332 (0.366) [1.571; 3.286]	2.540 (0.377) [1.429; 3.857]	2.683 (0.345) [1.429; 3.786]	2.605 (0.289) [2.000; 3.286]	2.705 (0.357) [1.429; 3.786]
		$t(592) = -6.158; p < .001; d = .540$			**$t(330) = -2.183; p = .030; d = .290$**	
CAV-E	10.113 (4.018) [0.000; 20.000]	11.400 (3.908) [2.000; 20.000]	9.597 (3.950) [0.000; 20.000]	10.834 (4.166) [1; 20]	12.681 (3.989) [4.000; 20.000]	10.323 (4.076) [1.000; 20.000]
		$t(592) = 5.044; p < .001; d = .449$			**$t(330) = 4.363; p < .001; d = .556$**	
CAV-P	12.131 (3.609) [0.000; 20.000]	13.000 (3.365) [3.000; 20.000]	11.783 (3.648) [0.000; 20.000]	11.349 (3.791) [0; 20]	12.889 (3.844) [4.000; 20.000]	10.923 (3.671) [0.000; 20.000]
		$t(592) = 3.756; p < .001; d = .337$			**$t(330) = 3.980; p < .001; d = .472$**	
CAV-T	22.244 (6.558) [1.000; 40.000]	24.400 (6.358) [5.000; 40.000]	21.380 (6.444) [1.000; 40.000]	22.184 (7.144) [7; 40]	25.569 (7.209) [10.000; 40.000]	21.246 (6.849) [7.000; 40.000]
		$t(592) = 5.183; p < .001; d = .461$			**$t(330) = 4.686; p < .001; d = .605$**	
VIG-E	13.687 (3.909) [1.000; 20.000]	12.559 (4.128) [2.000; 20.000]	14.139 (3.727) [1.000; 20.000]	15.485 (3.543) [2; 20]	14.764 (3.648) [5.000; 20.000]	15.685 (3.494) [2.000; 20.000]
		$t(592) = -4.526; p < .001; d = .404$			**$t(330) = -1.960; p = .051; d = .260$**	

Table 1 (continued)

ANPS/ABI	German sample ($N=594$)			Chinese sample ($N=332$)		
	Total ($N=594$)	Male ($n=170$)	Female ($n=424$)	Total ($N=332$)	Male ($n=72$)	Female ($n=260$)
VIG-P	10.441 (4.032) [0.000; 20.000]	8.924 (3.887) [0.000; 20.000]	11.050 (3.931) [1.000; 20.000]	14.467 (4.060) [2; 20]	13.236 (4.191) [5.000; 20.000]	14.808 (3.964) [2.000; 20.000]
		$t(592)=-5.976$; $p<.001$; $d=.527$			**$t(330)=-2.940$; $p=.004$; $d=.387$**	
VIG-T	24.128 (6.978) [3.000; 40.000]	21.482 (7.175) [3.000; 40.000]	25.189 (6.615) [4.000; 40.000]	29.952 (6.904) [6; 40]	28.000 (7.199) [13.000; 40.000]	30.492 (6.735) [6.000; 40.000]
		$t(592)=-6.022$; $p<.001$; $d=.531$			**$t(330)=-2.737$; $p=.007$; $d=.361$**	

Abbreviations: *CAV-E*, cognitive avoidance (ego-threat); *CAV-P*, cognitive avoidance (physical threat); *CAV-T*, cognitive avoidance (total score); *VIG-E*, vigilance (ego-threat); *VIG-P*, vigilance (physical threat); *VIG-T*, vigilance (total score)

Note: gender differences in age two-tailed tested, all other variables one-tailed tested, significant results are bolded and lower cognitive avoidance scores than men in both samples. Different results were found for the ANPS variables of interest. Significant gender differences were found for the three PETs (FEAR, ANGER, SADNESS) in the Chinese sample with higher scores for women in all three PETs. In the German sample, significant gender differences were only observed for SADNESS and FEAR with higher scores for women. Mean age of the female and male subsamples differed significantly in both cultural samples with males being slightly older. Results are presented in Table 1.

To assess potential associations of age with the variables of interest, Pearson correlations were calculated. Age was significantly negatively correlated (after bootstrapping) with the three PETs: FEAR ($r = -0.152$, $p < 0.001$, CI: [−0.217; −0.084]), ANGER ($r = -0.096$, $p = 0.019$, CI: [−0.157; −0.040]), and SADNESS ($r = -0.130$, $p = 0.001$, CI: [−0.201; −0.064]) in the German sample. Age was negatively correlated with FEAR ($r = -0.162$, $p = 0.003$, CI: [−0.263; −0.039]) and SADNESS ($r = -0.170$, $p = 0.002$, CI: [−0.268; −0.068]) and positively with cognitive avoidance in ego-threat scenarios: CAV-E ($r = 0.129$, $p = 0.018$, CI: [0.007; 0.248]), cognitive avoidance in the physical threat scenarios: CAV-P ($r = 0.174$, $p = 0.001$, CI: [0.072; 0.278]), and the total score of cognitive avoidance: CAV-T ($r = 0.168$, $p = 0.002$, CI: [0.046; 0.287]) in the Chinese sample.

Differences in the three PETs and the ABI variables Between the German and Chinese Samples

MANCOVA revealed a significant difference between the two samples on the combined dependent variables (FEAR, ANGER, SADNESS, CAV-E, CAV-P, CAV-T, VIG-E, VIG-P, VIG-T): $F(7, 915) = 36.878$, $p < 0.001$, partial $\eta^2 = 0.220$, Roy's largest root = 0.282. Due to heterogeneity in variances between groups for FEAR ($F(3, 922) = 9.465$, $p < 0.001$) and ANGER ($F(3, 922) = 8.747$, $p < 0.001$) tested via Levene's test, Roy's largest root is reported (Ateş et al., 2019). Significant differences on the combined variables were also found for gender ($F(7, 915) = 11.390$, $p < 0.001$, partial $\eta^2 = 0.080$, Roy's largest root = 0.087), the interaction term of gender and culture ($F(7, 915) = 2.146$, $p = 0.037$, partial $\eta^2 = 0.016$, Roy's largest root = 0.016), and age ($F(7, 915) = 4.282$, $p < 0.001$, partial $\eta^2 = 0.032$, Roy's largest root = 0.033).

Univariate ANCOVAs were conducted for every dependent variable. Culture, gender, and the interaction term of gender and culture were included as independent variables and age was included as covariate. Results showed statistically significant differences between the two cultures in SADNESS ($F(1, 921) = 51.438$, $p < 0.001$, partial $\eta^2 = 0.053$), CAV-E ($F(1, 921) = 9.986$, $p = 0.002$, partial $\eta^2 = 0.011$), and all vigilance variables: VIG-E ($F(1, 921) = 39.380$, $p < 0.001$, partial $\eta^2 = 0.041$), VIG-P ($F(1, 921) = 161.837$, $p < 0.001$, partial $\eta^2 = 0.149$), and VIG-T ($F(1, 921) = 117.580$, $p < 0.001$, partial $\eta^2 = 0.113$). Significant gender differences were found in all dependent variables: FEAR ($F(1, 921) = 24.450$, $p < 0.001$, partial $\eta^2 = 0.026$), ANGER ($F(1, 921) = 5.672$, $p = 0.017$, partial $\eta^2 = 0.006$), SADNESS ($F(1, 921) = 23.687$, $p < 0.001$, partial $\eta^2 = 0.025$), CAV-E ($F(1, 921) = 40.743$, $p < 0.001$, partial $\eta^2 = 0.042$), CAV-P ($F(1, 921) = 29.671$, $p < 0.001$, partial $\eta^2 = 0.031$), CAV-T ($F(1, 921) = 46.667$, $p < 0.001$, partial $\eta^2 = 0.048$), VIG-E (F(1,

Table 2 Partial Pearson correlations (controlled for age) and bootstrap-CIs between the three PETs and ABI variables in the Chinese sample (lower left side) and German sample (upper right side)

Correlation coefficients

	FEAR	ANGER	SADNESS	CAV-E	CAV-P	CAV-T	VIG-E	VIG-P	VIG-T
FEAR		**.262***** [.176; .355]	**.694***** [.647; .736]	**−.382***** [−.450; −.308]	**−.221***** [−.295; −.144]	**−.356***** [−.424; −.279]	**.440***** [.375; .509]	**.356***** [.284; .426]	**.452***** [.388; .516]
ANGER	**.549***** [.446; .638]		**.298***** [.215; .382]	−.052 [−.137; .033]	−.068 [−.146; .019]	−.070 [−.148; .016]	**.138***** [.050; .224]	**.195***** [.116; .272]	**.190***** [.111; .274]
SADNESS	**.688***** [.618; .752]	**.469***** [.350; .567]		**−.324***** [−.397; −.247]	**−.196***** [−.268; −.119]	**−.306***** [−.376; −.236]	**.308***** [.236; .375]	**.292***** [.212; .358]	**.341***** [.268; .408]
CAV-E	**−.340***** [−.425; −.245]	**−.186***** [−.286; −.083]	**−.256***** [−.349; −.157]		**.478***** [.403; .545]	**.876***** [.854; .894]	**−.367***** [−.444; −.284]	**−.176***** [−.266; −.087]	**−.307***** [−.390; −.221]
CAV-P	**−.279***** [−.378; −.178]	**−.224***** [−.315; −.120]	**−.186***** [−.286; −.087]	**.603***** [.524; .670]		**.843***** [.815; .868]	**−.110**** [−.196; −.023]	**−.391***** [−.469; −.302]	**−.287***** [−.370; −.195]
CAV-T	**−.347***** [−.431; −.257]	**−.228***** [−.323; −.125]	**−.249***** [−.336; −.154]	**.906***** [.882; .924]	**.884***** [.858; .906]		**−.285***** [−.366; −.200]	**−.323***** [−.411; −.231]	**−.346***** [−.431; −.255]
VIG-E	**.263***** [.164; .360]	**.148**** [.031; .256]	**.290***** [.191; .384]	.072 [−.034; .178]	**.160**** [.038; .274]	**.127*** [.010; .236]		**.544**** [.480; .599]	**.875***** [.854; .891]
VIG-P	**.232***** [.139; .328]	**.223***** [.125; .317]	**.288***** [.169; .395]	**.164**** [.053; .269]	**.140*** [.004; .256]	**.170**** [.052; .275]	**.648***** [.569; .716]		**.883***** [.863; .900]
VIG-T	**.271***** [.176; .366]	**.207***** [.100; .303]	**.318***** [.212; .415]	**.134*** [.023; .237]	**.164**** [.031; .283]	**.166**** [.050; .274]	**.894***** [.868; .915]	**.920***** [.900; .938]	

Abbreviations: *CAV-E*, cognitive avoidance (ego-threat); *CAV-P*, cognitive avoidance (physical threat); *CAV-T*, cognitive avoidance (total score); *VIG-E*, vigilance (ego-threat); *VIG-P*, vigilance (physical threat); *VIG-T*, vigilance (total score)

Note: *$p < .05$; **$p < .01$; ***$p < .001$ (one-tailed tested), significant correlations after bootstrapping are bolded

Table 3 Comparisons of correlations between Chinese and German samples via Fisher's z-tests

Fisher's z-tests

	FEAR	ANGER	SAD-NESS	CAV-E	CAV-P	CAV-T	VIG-E	VIG-P	VIG-T
FEAR		**$z=5.069$ $p<.001$**	$z=0.167$ $p=.867$	$z=0.702$ $p=.483$	$z=0.900$ $p=.368$	$z=0.149$ $p=.881$	**$z=2.950$ $p=.003$**	**$z=1.977$ $p=.048$**	**$z=3.042$ $p=.002$**
ANGER			**$z=2.929$ $p=.003$**	**$z=1.979$ $p=.048$**	**$z=2.323$ $p=.020$**	**$z=2.355$ $p=.019$**	$z=0.148$ $p=.882$	$z=0.426$ $p=.670$	$z=0.257$ $p=.797$
SAD-NESS				$z=1.080$ $p=.280$	$z=0.151$ $p=.880$	$z=0.898$ $p=.369$	$z=0.287$ $p=.774$	$z=0.063$ $p=.949$	$z=0.375$ $p=.708$
CAV-E					**$z=2.580$ $p=.010$**	**$z=2.129$ $p=.033$**	**$z=6.645$ $p<.001$**	**$z=4.991$ $p<.001$**	**$z=6.572$ $p<.001$**
CAV-P						**$z=2.360$ $p=.018$**	**$z=3.952$ $p<.001$**	**$z=8.053$ $p<.001$**	**$z=6.699$ $p<.001$**
CAV-T							**$z=6.118$ $p<.001$**	**$z=7.366$ $p<.001$**	**$z=7.682$ $p<.001$**
VIG-E								**$z=2.355$ $p=.018$**	$z=1.272$ $p=.203$
VIG-P									**$z=2.905$ $p=.004$**
VIG-T									

Abbreviations: *CAV-E*, cognitive avoidance (ego-threat); *CAV-P*, cognitive avoidance (physical threat); *CAV-T*, cognitive avoidance (total score); *VIG-E*, vigilance (ego-threat); *VIG-P*, vigilance (physical threat); *VIG-T*, vigilance (total score)

Note: comparisons of correlations are presented in this matrix, conducted with correlations rounded to three decimals; significant differences in correlations are bolded (two-tailed tested)

921) = 17.781, $p<0.001$, partial $\eta^2=0.019$), VIG-P ($F(1, 921)=34.779$, $p<0.001$, partial $\eta^2=0.036$), and VIG-T ($F(1, 921)=33.008$, $p<0.001$, partial $\eta^2=0.035$). For the interaction term between gender and culture, significant effects were only found for SADNESS ($F(1, 921)=3.922$, $p=0.048$, partial $\eta^2=0.004$) with the highest SADNESS scores for females in the Chinese sample (mean = 2.705) and the lowest SADNESS scores for males in the German sample (mean = 2.332) (for a better understanding of the directions of the results see Table 1).

Correlations

Correlation patterns between ABI variables and the three PETs corrected for age are presented in Table 2 for both samples.

Significant negative correlations were found between all cognitive avoidance variables and the PETs FEAR and SADNESS but not for the PET ANGER in the German sample. Significant positive correlations were found between all vigilance variables and all three PETs in the German sample.

In the Chinese sample, the three PETs were significantly negatively correlated with all cognitive avoidance variables and significantly positively with all vigilance

Table 4 Regression analysis 1: hierarchical linear regression with the total score of cognitive avoidance as criterion, and age, gender, and the three PETs as potential predictors in the German sample

Variable	*B*	*SE of B*	*Beta*	*p*	*CI*
Gender	−.302	.087	−.137	<.001	[−.474; −.128]
Age	−.074	.039	−.074	.054	[−.148; .008]
FEAR	−.276	.054	−.276	<.001	[−.378; −.173]
ANGER	.033	.040	.033	.416	[−.047; .112]
SADNESS	−.095	.055	−.095	.083	[−.199; .010]

Note: *B*, unstandardized coefficients; *Beta*, standardized coefficients. All variables except gender in *z*-standardized form, gender coded: 1 = male, 2 = female, bold letters indicate significance after bootstrapping

variables. Correlations for German/Chinese males and females separately are presented in the Supplementary Material.

Fisher's z-test revealed significant differences in correlations between the Chinese and German samples for correlations between FEAR and the ABI variables and between ANGER and the ABI variables in the following way: differences were found for associations of FEAR with all vigilance variables, and of ANGER with all cognitive avoidance variables. Results are presented in Table 3.

Hierarchical Linear Regression

German Sample

Regression Analysis 1 with the Total Score of Cognitive Avoidance (CAV-T) as the Criterion Variable.

Hierarchical linear regression showed the highest adjusted R^2 for the second model including all potential predictors ($R^2 = 0.145$, $F = 21.129$, $p < 0.001$). The first model including only gender and age showed a smaller adjusted $R^2 = 0.041$ and, therefore, a minor association with CAV-T. The changes in R^2 between the first and the second model ($p < 0.001$) were significant. Results for each potential predictor in the second model are listed in Table 4. Only gender and FEAR were significant predictors in the regression model.

Regression Analysis 2 with the Total Score of Vigilance (VIG-T) as Criterion Variable.

Again, hierarchical linear regression showed the highest adjusted R^2 for the second model including all potential predictors ($R^2 = 0.230$, $F = 36.337$, $p < 0.001$). The first model including gender and age showed a smaller adjusted $R^2 = 0.056$. The changes in R^2 between the first and the second model ($p < 0.001$) were significant. The results for each potential predictor in the second model are listed in Table 5. Gender, age, and again FEAR were significant predictors after bootstrapping.

Table 5 Regression analysis 2: hierarchical linear regression with the total score of vigilance as criterion and age, gender, and the three PETS as potential predictors in the German sample

Variable	*B*	*SE of B*	*Beta*	*p*	*CI*
Gender	.365	.083	.165	< .001	[.212; .529]
Age	.099	.037	.099	.007	[.013; .179]
FEAR	.403	.051	.403	< .001	[.303; .501]
ANGER	.082	.038	.082	.031	[− .007; .159]
SADNESS	.001	.052	.001	.992	[− .102; .101]

Note: *B*, unstandardized coefficients; *Beta*, standardized coefficients. All variables except gender in *z*-standardized form, gender coded: 1 = male, 2 = female, bold letters indicate significance after bootstrapping

Table 6 Regression analysis 1: hierarchical linear regression with the total score of cognitive avoidance as criterion and age, gender, and the three PETS as potential predictors in the Chinese sample

Variable	*B*	*SE of B*	*Beta*	*p*	*CI*
Gender	− .415	.127	− .171	.001	[− .662; − .146]
Age	.075	.052	.075	.151	[− .023; .205]
FEAR	− .289	.075	− .289	< .001	[− .423; − .152]
ANGER	− .032	.061	− .032	.607	[− .143; .086]
SADNESS	− .021	.071	− .021	.772	[− .152; .110]

Note: *B*, unstandardized coefficients; *Beta*, standardized coefficients. All variables except gender in *z*-standardized form, gender coded: 1 = male, 2 = female, bold letters indicate significance after bootstrapping

Chinese Sample

Regression Analysis 1 with the Total Score of Cognitive Avoidance (CAV-T) as Criterion Variable.

Hierarchical linear regression showed the highest adjusted R^2 for the second model including all potential predictors ($R^2 = 0.161$, $F = 13.749$, $p < 0.001$). The first model including only gender and age showed a smaller adjusted $R^2 = 0.070$ and therefore a minor prediction of CAV-T. The changes in R^2 between the first and the second model ($p < 0.001$) were significant. The results for each potential predictor in the second model are listed in Table 6. Only gender and FEAR were significant predictors in the regression model.

Regression Analysis 2 with the Total Score of Vigilance (VIG-T) as Criterion Variable.

Again, hierarchical linear regression showed the highest adjusted R^2 for the second model including all potential predictors ($R^2 = 0.108$, $F = 9.042$, $p < 0.001$). The first model including gender and age showed a smaller adjusted $R^2 = 0.018$. The changes in R^2 between the first and the second model ($p < 0.001$) were significant. The results for each potential predictor in the second model are listed in Table 7. Gender and SADNESS, but not FEAR, were significant predictors after bootstrapping.

Table 7 Regression analysis 2: hierarchical linear regression with the total score of vigilance as criterion and age, gender, and the three PETS as potential predictors in the Chinese sample

Variable	*B*	*SE of B*	*Beta*	*p*	*CI*
Gender	.294	.131	.121	.026	[.025; .584]
Age	.090	.054	.090	.098	[− .008; .200]
FEAR	.063	.078	.063	.420	[− .098; .212]
ANGER	.038	.063	.038	.547	[− .095; .164]
SADNESS	.251	.074	.251	< .001	[.087; .422]

Note: *B*, unstandardized coefficients; *Beta*, standardized coefficients. All variables except gender in *z*-standardized form, gender coded: 1 = male, 2 = female, bold letters indicate significance after bootstrapping

Please note that we administered the complete ANPS in the present study. However, given the strict hypotheses, we only present associations between negative primary emotional systems and anxiety-related coping style in the main body of this work. Researchers interested in associations with positive emotional traits can obtain these from the Supplementary Material.

Discussion

In line with our hypotheses, we observed that both FEAR and SADNESS were robustly correlated with anxiety-related coping styles in both Germany and China. As expected, in both countries higher FEAR and higher SADNESS were associated with an elevated vigilant and reduced cognitive avoidant coping style. In terms of observed effect sizes, the associations were in the moderate area (Cohen, 1992). We believe that our findings speak for globally valid associations, because similar correlations appeared in two independent samples stemming from different ethnic and cultural backgrounds. We observed some associations between ANGER and anxiety-related coping in both samples, but these where much lower and less robust than those observed with FEAR/SADNESS and anxiety-related coping. With the many studies showing that FEAR/SADNESS (and ANGER to be discussed in the Supplementary Material) represent the bottom-up drivers of Neuroticism, it makes senses that high tonic activity of the FEAR and SADNESS system might play an important role in the development of vigilant coping as well. One could conclude that individuals with tendencies towards higher activity in these brain areas are more easily flooded with negative affect making them more anxious—hence, leading to higher monitoring of the environment. However, one also needs to take into account results from the regression analysis. Hierarchical linear regression underlined the particular importance of FEAR as a predictor of anxiety-related coping. In the German sample, FEAR was the only significant predictor out of the three PETs both for cognitive avoidance (negatively) and vigilance (positively; total scores). In the Chinese sample, FEAR was the main predictor for cognitive avoidance (negatively; total score), as well, but not for vigilance. For vigilance (total score), the only significant predictor out of the three investigated PETs was SADNESS (positive) in the Chinese sample. This is noteworthy, because FEAR and SADNESS substantially overlap ($r = 0.694$ in Germany and $r = 0.688$ in China), and FEAR seems to be sufficient in predicting cognitive avoidance in both countries, but vigilance in Germany only.

The difference between the Chinese and German samples (verified by significant interaction terms of FEAR and culture and SADNESS and culture on vigilance in a further hierarchical regression, presented in the Supplementary Material) in predictors of vigilance is interesting. How can this finding be explained? We know from AN theory that the SADNESS system is triggered by situations of separation distress (e.g., a child being separated from the mother, loss of a romantic partner, or separation from relevant peers). China has a more collectivistic culture where fitting and belonging to a group seems more important than in an individualistic culture such as the German one (e.g., Hofstede et al., 2005). Therefore, the SADNESS system may be more active (as a vigilant monitoring mechanism towards potential break from a group). Indeed, we find evidence for higher trait SADNESS in our Chinese compared to German sample in the present data, something we observed also in other works (Sindermann et al., 2018; Wernicke et al., 2018). Hence, SADNESS differences between the German and Chinese samples seem to be robust. One could expect that separation from a group is not only accompanied by an unpleasant emotional state but also with detrimental and even dangerous consequences against an evolutionary background such as social ostracism. The results of the MANCOVA in the current work revealing significant cultural differences between China and Germany in the datasets support this idea. Significant cultural differences were also found for cognitive avoidance (ego-threat) and all vigilance variables perhaps also highlighting the special culturally different link between vigilance and SADNESS/FEAR.

However, when interpreting the present findings, one should be careful because of measurement invariance issues. In the present study, CFAs (results are presented in the Supplementary Material) reveal that neither the ABI nor the ANPS proposed models fitted very well in the German or Chinese sample. Therefore, no measurement invariance can be assumed for any scale in the present study. Nevertheless, we want to again highlight the similar correlational patterns found in the two samples that underline correctness of the questionnaire translations.

Moreover, the correlational nature of the study is a limitation as we cannot claim to make causal predictions with the current results. Beyond that, a slightly larger Chinese sample and more gender balanced samples in China and Germany would have been desirable to even better consider potential cultural and gender differences. Additionally, the present study is also limited due to its self-report nature. In future work, it will be highly interesting to directly investigate individual differences in individualistic/collectivistic thinking and relate it to individual differences in SADNESS and FEAR to back up our interpretation of the data (see above).

Despite the described limitations, we feel confident that our study can advance the understanding of predicting factors of individual differences in anxiety-related coping styles, especially vigilant coping.

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Author Contribution SJ and CM designed the present study. SJ drafted the first version of the manuscript, which was revised by CM and CS. SJ carried out all statistical analyses, which independently were checked by CS. The German sample was collected by SJ, CS, and CM. The Chinese sample was collected by HY. All authors, in particular also JDE, revised the paper before submission again. All authors approved the final version of the manuscript.

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Availability of Data and Material The authors present data open science, when it is possible. In this case, the datasets have been generated already some years ago (German part) and therefore the data cannot be made publicly available—not all participants gave consent for sharing the data. Upon reasonable requests, the authors will provide other scientists access to the anonymized data to check on statistics and/or run additional analysis.

Code Availability Not applicable.

Declarations

Conflict of Interest The authors declare no competing interests.

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