The influence of neuroticism and psychological symptoms on the assessment of images in three-dimensional emotion space

Psychische Symptomatik und Einschätzung des International Affective Picture Systems im dreidimensionalen Emotionsraum

Abstract

Objective: The present study investigated the influence of neuroticism (NEO Five-Factor Inventory (NEO-FFI)) and psychological symptoms (Brief Symptom Inventory (BSI)) on pleasure, arousal, and dominance (PAD) ratings of the International Affective Picture System (IAPS).

Methods: The subjects (N=131) were presented with images from the IAPS (30 images) and new images (30 images). The influence of neuroticism and BSI (median split: high vs. low) on the assessment of pleasure, arousal and dominance of the images was examined. Correlations of pleasure, arousal and dominance were presented in a 3-D video animation.

Results: Subjects with high scores (compared to subjects with low scores by median split) of neuroticism and psychological symptoms of the BSI rated the presented emotional images more negative in the valence dimension (pleasure), higher in arousal and less dominant.

Conclusion: Neuroticism and psychological symptoms influence the subjective emotional evaluation of emotional images. Therefore the location in the three-dimensional emotion space depends on individual differences. Such differences must be kept in mind, if correlations between emotion ratings and other variables like psychobiological measures are analyzed.

Keywords: emotion space, psychological symptoms, emotion stimuli, personality

Zusammenfassung

Zielsetzung: In der vorliegenden Studie wurde der Einfluss von Neurotizismus (NEO-Five Factor Inventar (NEO-FFI)) und psychischer Symptomatik (Brief Symptom Inventar (BSI)) auf Valenz-, Arousal- und Dominanz-(VAD-) Ratings des International-Affective-Picture-Systems (IAPS) getestet.

Methodik: Den Probanden (N=131) wurde Bildmaterial des IAPS (30 Bilder) sowie neues Bildmaterial (30 Bilder) präsentiert. Der Einfluss von Neurotizismus und BSI (Mediansplit: hoch vs. niedrig) auf die Einschätzung von Valenz, Arousal und Dominanz der Bilder wurde überprüft. Zusammenhänge von Valenz, Arousal und Dominanz wurden in einer 3-D-Video-Animation dargestellt.

Ergebnisse: Personen mit einem höheren Rating-Score (im Vergleich zu einem niedrigen Score; operationalisiert durch Median Split) der Variablen Neurotizismus und psychischer Symptomatik des BSI stuften die Bilder negativer in der Dimension Valenz, höher für Arousal und niedriger für Dominanz ein.

Fazit: Neurotizismus und psychologische Symptomatik beeinflussen die subjektive emotionale Bewertung von emotionalen Bildern. Insofern ist die Lokalisation des dreidimensionalen Emotionsraumes von indivi-

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duellen Unterschieden abhängig. Solche Unterschiede müssen berücksichtigt werden, wenn Korrelationen zwischen emotionalen Ratings und anderen Variablen wie psychobiologische Messungen analysiert werden.

Schlüsselwörter: Emotionsraum, psychologische Symptomatik, Emotionsstimuli, Persönlichkeit

Introduction

This study analysis the influence of neuroticism and psychological symptoms on the subjective assessment of emotional images. Emotional stimuli are selected from the International Affective Picture System (IAPS, [1]). The IAPS is among the most commonly used methods of experimental emotional psychology and psychobiology. This comprehensive set of images (956 images) was developed to visually induce emotions in a standardized and controlled fashion. It has been used, for example, in EEG and fMRI studies [2], [3], [4], [5], [6], [7], [8]. In addition studies with clinical samples used IAPS images for emotional stimulation [9], [10], [11].

Bradley and Lang [8] state that the IAPS images were selected from a broad spectrum of semantic categories (e.g. buildings, landscapes, animals, waterfalls, etc.). Each image was rated by 100 subjects [1] with respect to the three dimensions of pleasure (positive vs. negative), arousal (excited vs. relaxed) and dominance (being controlled vs. being in control). Although the IAPS studies are based on the paradigm of three-dimensional emotion space (originally published by Osgood et al. [12]) quite frequently only the two variables of pleasure and arousal are included in empirical studies. Even the IAPS manuals contain neither a graphical representation of the variable of dominance nor a true three-dimensional illustration [1].

The original IAPS does not capture the entire three-dimensional space. Bradley and Lang [8] represent an U-shaped distribution (between valence and arousal). Drawing on arguments advanced by Tellegen [13], Bradley and Lang consider this U-shaped distribution a consequence of evolutionary development, in as much as negative emotions of high intensity (activating the defensive system) and positive emotions of high intensity (activating the appetitive system) are important for survival. In this respect, Bradley and Lang consider this U-shaped distribution as biologically determined. Nonetheless, to minimize the gaps in the emotion space, we have selected in addition to IAPS stimuli new stock free images from public domains resources for the present study.

Additionally, Libkumann [14] noted that the IAPS images are lower rated in the arousal dimension in contemporary studies compared to the original ratings leading to additional gaps beyond an arousal mean >7.5). It must be kept in mind that the typical gaps of the PAD ratings – particularly the area of arousal 7.5 to 9 – possibly result from the averaging procedure which neglects the original variance within the samples. To our knowledge only few studies measured ratings (PAD) of the experimentally used IAPS stimuli in samples with variance above healthy

subjects. E.g. Duley et al. [15] presented subjects with the IAPS and analyzed the PAD-ratings in and than correlated the scale for "fear of failure" with PAD. This resulted in significant positive correlations with respect to an increased fear of failure and neuroticism for arousal when presented with negative images.

Research question

This study measured the variables of neuroticism (from the NEO-FFI; [16]) and the psychological symptoms from the Brief Symptom Inventory (BSI; [17]) in healthy subjects and examined their influence on IAPS ratings of valence (pleasure), arousal and dominance. Neuroticism represents a personality dimension and BSI measures the extend of psychopathology, both constructs which may influence the processing of emotional stimuli:

At "high" (median split) degrees of neuroticism and psychological symptoms, more negative pleasure is rated than in case of "low" degrees.

At "high" (median split) degrees of neuroticism and psychological symptoms, more arousal is rated than in case of "low" degrees.

At "high" (median split) degrees of neuroticism and psychological symptoms, less dominance is rated than in case of "low" degrees.

It will be explored, in what sector (Category 1: "negative pleasure/low arousal/high dominance", Category 2: "neutral pleasure/low arousal/high dominance", Category 3: "positive pleasure/low arousal/high dominance", Category 4: "positive pleasure/high arousal/high dominance", Category 5: "neutral pleasure/high arousal/neutral dominance", and Category 6: "negative pleasure/high arousal/low dominance) of the PAD space these hypotheses are confirmed. (More about defininition of PAD space sectors in the methods.)

Methods

Subjects

N=141 students participated in the experiment. The subjects signed a consent form for voluntary participation in the study according to the guidelines of the Ethics Committee of Ulm University (245/08-UBB/se). The subjects were between 18 and 40 years old (M=21.6 years; SD=3.3 years); 81 were female (57.0%). Ten people were excluded from the sample because of incomplete questionnaires, leaving a total of N=131 subjects.

Images

Thirty stimuli were selected from the IAPS according to Lang et al. [1], which best matched the "traditional" three areas with regard to rating levels: "positive pleasure/high arousal/high dominance" (n=10; images: 8470, 5470, 5621, 8030, 8080, 8180, 8186, 8370, 8400, 8490), "negative pleasure/high arousal/low dominance" (n=10; images: 6150, 7006, 7009, 7010, 7025, 7035, 7110, 7150, 7161, 7175) and "neutral pleasure/low arousal/high dominance" (n=10; images: 1525, 2730, 3000, 3053, 3120, 3170, 3500, 6300, 9250, 9921).

Thirty images were systematically selected from image databases of the German Press Agency on the basis of the theoretical conceptualizations of the PAD (pleasure, arousal, dominance) dimensions: "positive pleasure/low arousal/high dominance" (n=10), "negative pleasure/low arousal/high dominance" (n=10) and "neutral pleasure/high arousal/neutral dominance" (n=10). According to the descriptions of the dimensions, the images should have the following properties: The dimension of "positive pleasure/low arousal/high dominance" should reflect themes such as harmony, relaxation, peace, quiet, etc. The images should be richly colored. People and animals should be depicted in a relaxed or sleeping state. A typical example would be a couple in white bathrobes, lying head-to-head, smiling with closed eyes. The dimension of "negative pleasure/low arousal/high dominance" should express depression, sadness, passivity, etc. The images should be weakly colored (e.g. winter landscapes). People and animals should be in a rigid state. A typical image would be a gravestone in a winter landscape. The category "neutral pleasure/high arousal/neutral dominance" should include the following aspects: risk, energy, excitement, etc. The mentioned aspects should still be under control, however. The images should be very strongly colored and depict people, animals and other objects in motion. A typical image would be a man on a cliff.

Instructions

The subjects received the German language instructions, which were based on the original instructions by Lang et al. [1], in the form of a PowerPoint presentation. In addition to explanations regarding the procedure, the instructions particularly focused on the three dimensions to be rated, namely pleasure, arousal and dominance, and the Self-Assessment Manikin (SAM; see below) rating method. The authors will gladly make the exact instruction text available upon request.

Procedure

The experiment was conducted with the help of specially developed software. A total of 60 stimulus pictures were presented in random order for a duration of 6 s each. After the presentation of each picture, the image was rated with regard to the degrees of pleasure, arousal and dominance on the basis of the SAM [18] using a scale of 1–9. The rating scale was divided as follows: for pleasure, "1" absolutely negative, "5" neutral, and "9" absolutely positive; for arousal, "1" absolutely relaxed, "5" medium arousal, and "9" highly aroused; for dominance, "1" absolute loss of emotional control, "5" medium emotional control, and "9" absolute control. After completion of the last rating, a fixation cross appeared for 2 seconds, followed by the next image.

The stimuli were presented separately for each participant on a 19" TFT monitor at a resolution of 1024×768 pixels and a color depth of 32 bit. The distance between participant and screen was approximately 60 centimeters. The visual angle between participant and monitor was approximately 24°. The experiment was conducted in a laboratory where light levels were kept constant. One half of the subject group was asked to complete the NEO-FFI and BSI questionnaires before the experiment, and the other half after the experiment.

Questionnaires

NEO-FFI: The NEO-FFI [13] is a factor-analytic questionnaire that captures individual characteristics in the areas of neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Of the 60 questions in the inventory, twelve questions each are related to the following five key areas: Subjects with high neuroticism values tend to be nervous, anxious, sad, insecure, self-conscious and worry about their health. They tend to have unrealistic ideas and are less able to control their needs and respond appropriately to stressful situations. The term neuroticism in this context should not be equated with the homonymous psychiatric category.

BSI: The BSI [14], a short form of the Symptom Check List (SCL-90-R), is an instrument for assessing subjective impairment due to physical and psychological symptoms. The 53 items, which are summarized into 9 scales and three global parameters – analogous to the SCL-90-R – (somatization, obsession-compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, psychoticism, and global severity index), enable statements about the severity of symptoms. The items are formulated in simple language and avoid psychopathological terminology, if they have not yet found their way into the vernacular.

Statistics and graphical representation

Median splits were calculated for neuroticism and symptom expression. It is possibly to distinguish between a group with high vs. low neuroticism and symptom expression. T tests were calculated for the influences of high vs. low symptom expression on pleasure, arousal, and dominance ratings. The test was one-sided; the significance level was α=0.05 (α=0.1 was interpreted as a trend, α=0.01 as highly significant, and α=0.001 as extremely significant). Additionally, effect sizes were determined for total calculation independent of the specific PAD categories (1–6). For this, 30 IAPS image topics were

differentiated that according to Lang et al. fill ideal-typical PAD spaces. The new images were examined regarding the question of whether the ratings of the images had represented the corresponding subspaces. The following categories were distinguished: Category 1: "negative pleasure/low arousal/high dominance", Category 2: "neutral pleasure/low arousal/high dominance", Category 3: "positive pleasure/low arousal/high dominance", Category 4: "positive pleasure/high arousal/high dominance", Category 5: "neutral pleasure/high arousal/neutral dominance", and Category 6: "negative pleasure/high arousal/low dominance."

Due to the technical possibilities available at an online journal we depicted, for the first time, the empirical rating data of the manual by Lang [1] in 3D (Video 1), to illustrate to the reader the configuration of the PAD space. Furthermore, the average of Category 6: "negative pleasure/high arousal/low dominance" for the variable of neuroticism was individually represented in 3D (Video 2). The average ratings of the IAPS and the new images (Video 3) were also rendered in 3D.

Results

Correlations between neuroticism, psychological symptoms and PAD ratings

The following correlations can be found for neuroticism and BSI: somatization ($r=0.21$, $p<0.05$), obsession-compulsion ($r=0.41$, $p<0.001$), interpersonal sensitivity ($r=0.56$, $p<0.001$), depression ($r=0.65$, $p<0.001$), anxiety ($r=0.30$, $p<0.001$), hostility ($r=0.41$, $p=0.001$), phobic anxiety ($r=0.31$, $p=0.001$), paranoid ideation ($r=0.31$, $p<0.001$), psychoticism ($r=0.43$, $p<.001$) and Global Severity Index ($r=0.52$, $p<0.001$).

The comparison for neuroticism high (Nh>2.67, median split) vs neuroticism low (Nl≤2.67, median split) is significant for pleasure ($d=-0.38$) and arousal ($d=0.40$) and not significant for dominance ($d=-0.14$) (see Table 1). Effects were also observed for the categories "positive pleasure/low arousal/high dominance" and "negative pleasure/high arousal/low dominance". The remaining categories show no significant differences.

Table 2 shows the results of the BSI for pleasure, arousal, and dominance. Significant effects were found for arousal ($d=0.36$) and dominance ($d=-0.32$) for the variable of depression, and significant effects in all three dimensions for the variable of anxiety. In addition, effects were found for obsession-compulsion, phobic fear, paranoid ideation, psychoticism and the Global Severity Index. Table 3 shows the results differentiated for each category. There were mostly effects for images in the category "negative pleasure/low arousal/high dominance."

3D representation of the emotion space and correlations between PAD ratings

Video 1 shows the distribution of the original IAPS images in three-dimensional space. This representation can be rotated around a visual axis with VLC-Mediaplayer© or similar software. In the seconds from approx. 0–16, 26–35, and 46–59 one can see the correlation between pleasure and arousal, from approx. 17–25 and 36–45 the correlation between pleasure and dominance, and from approx. 1:06–1:17 min the correlation between arousal and dominance.

In Video 2, the emotion space "negative pleasure/high arousal/low dominance" for low (green) vs. high neuroticism (red) is individually depicted for all subjects. It shows descriptively that subjects with high neuroticism values in the PAD space tended to rate pleasure more negative and arousal higher while viewing the images.

As mentioned in Lang et al. [1], the following gaps are revealed for the relationship between pleasure and arousal: negative pleasure/low arousal, positive pleasure/low arousal and neutral pleasure/high arousal (correlation pleasure/arousal: pleasure ≤ 5: $r=-0.67$; pleasure >5: $r=0.38$). The relationship between pleasure and dominance is graphically a linear relationship, with two large gaps: positive pleasure/low dominance and negative pleasure/high dominance (correlation: pleasure/dominance: $r=.80$). The relationship between arousal and dominance (correlation: arousal/dominance: pleasure ≤5: $r=-0.85$; pleasure >5: $r=-0.34$) shows gaps for low arousal/low dominance and high arousal/high dominance.

Comparison between IAPS and the Ulm images

The average values of the Ulm image rating (Table 4) and the Lang sample [1] were represented in an animation in three-dimensional emotion space independent of the psychological symptoms (Video 3) (scale: IAPS rating Lang [gray]; IAPS rating Ulm [N=30, red]; new image material: negative pleasure/low arousal/high dominance [N=10, blue]; new image material: positive pleasure/low arousal/high dominance [N=10, green]; new image material: neutral pleasure/high arousal/neutral dominance [N=10, pink]). It shows descriptively that the new images will help to fill existing PAD gaps.

The following correlative relationships result between arousal and negative pleasure (pleasure 1–5: $r=-.73$, $p<.001$) and between arousal and positive pleasure (pleasure 5–9: $r=.13$, ns.) for pleasure and dominance ($r=.62$, $p<.001$) and for arousal and dominance ($r=-.89$, $p<.001$). Furthermore, correlations between the two ratings (Lang vs. Ulm) were determined for the 30 IAPS images (pleasure: $r=.94$, $p<.001$; arousal: $r=.96$, $p<.001$; dominance: $r=.92$, $p<.001$).

Table 1: Influence of neuroticism (high vs. low, median split = 2.67) on pleasure (V), arousal- (A), dominance (D) ratings by categories (T test, one-sided, scale: 1–9, N=131, M = means and SD = standard deviation)

V A D	c a t .	neuroticism high M (SD)	neuroticism low M (SD)	p <	cat.	neuroticism high M (SD)	neuroticism low M (SD)	p <
	total	4.85 (0.36)	5.00 (0.42)	0.05	4	6.88 (0.93)	6.97 (0.95)	ns
A	total	4.77 (0.97)	4.39 (0.95)	0.05	4	6.10 (1.59)	6.02 (1.39)	ns
D	total	5.52 (0.90)	5.67 (1.26)	ns	4	5.33 (1.31)	5.33 (1.36)	ns
V	1	3.14 (0.75)	3.42 (0.81)	0.05	5	4.77 (0.82)	4.96 (0.82)	(0.1)
A	1	4.01 (1.49)	3.51 (1.27)	0.05	5	6.03 (1.32)	5.64 (1.20)	0.05
D	1	5.25 (1.45)	5.57 (1.83)	ns	5	4.31 (1.36)	4.74 (1.48)	(0.1)
V	2	4.87 (0.42)	4.99 (0.69)	ns	6	1.79 (0.57)	2.09 (0.77)	0.01
A	2	2.17 (1.26)	1.73 (0.94)	0.05	6	7.19 (1.01)	6.62 (1.37)	0.01
D	2	7.48 (1.78)	7.27 (2.33)	ns	6	3.24 (1.48)	3.93 (1.56)	0.01
V	3	7,64 (0,70)	7.56 (0.79)	ns				
A	3	3.10 (1,46)	2.78 (1.51)	ns				
D	3	7.51 (1.47)	7.17 (2.24)	ns				

Note. Category 1: negative pleasure/ low arousal/ high dominance; Category 2: neutral pleasure/ low arousal/ high dominance; Category 3: positive pleasure/ low arousal/ high dominance; Category 4: positive pleasure/ high arousal/ high dominance; Category 5: neutral pleasure/ high arousal/ neutral dominance; Category 6: negative pleasure/ high arousal/ low dominance

Table 2: Influence of the Brief Symptom Inventory (high vs. low) on pleasure (V), arousal (A), dominance (D) ratings by categories (T test, one-sided, scale: 1–9, N=131, M = mean and SD = standard deviation)

	symptom	high M (SD)	low M (SD)	p <		symptom	high M (SD)	low M (SD)	p <
V	somatization	4.88 (0.35)	4.98 (0.43)	ns	V	hostility	4.93 (0.35)	4.92 (0.42)	ns
A	somatization	4.65 (0.83)	4.5 (1.05)	ns	A	hostility	4.64 (0.84)	4.53 (1.03)	ns
D	somatization	5.40 (0.97)	5.69 (1.16)	ns	D	hostility	5.43 (0.86)	5.65 (1.23)	ns
V	obsession-compulsion	4.88 (0.37)	4.96 (0.42)	ns	V	phobic anxiety	4.89 (0.40)	4.96 (0.39)	ns
A	obsession-compulsion	4.71 (0.87)	4.47 (0.99)	(0.1)	A	phobic anxiety	4.79 (0.98)	4.42 (0.90)	0.05
D	obsession-compulsion	5.32 (0.88)	5.72 (1.19)	0.05	D	phobic anxiety	5.47 (0.95)	5.61 (1.17)	ns
V	interpersonal sensitivity	4.90 (0.38)	4.95 (0.40)	ns	V	paranoid ideation	4.88 (0.37)	4.97 (0.41)	ns
A	interpersonal sensitivity	4.62 (0.92)	4.54 (0.98)	ns	A	paranoid ideation	4.70 (0.93)	4.46 (0.95)	(0.1)
D	interpersonal sensitivity	5.44 (0.97)	5.65 (1.16)	ns	D	paranoid ideation	5.57 (0.95)	5.53 (1.20)	ns
V	depression	4.93 (0.38)	4.92 (0.41)	ns	V	psychoticism	4.88 (0.33)	4.96 (0.44)	ns
A	depression	4.75 (0.92)	4.31 (0.93)	0.01	A	psychoticism	4.83 (0.90)	4.36 (0.93)	0.01
D	depression	5.37 (0.99)	5.82 (1.15)	0.01	D	psychoticism	5.40 (0.77)	5.68 (1.28)	(0.1)
V	anxiety	4..85 (0.37)	4.98 (0.40)	0.05	V	Global Severity Index	4.89 (0.36)	4.96 (0.43)	ns
A	anxiety	4.77 (0.73)	4.45 (1.06)	0.05	A	Global Severity Index	4.74 (0.85)	4.40 (1.02)	0.05
D	anxiety	5.30 (0.81)	5.71 (1.20)	0.05	D	Global Severity Index	5.38 (0.85)	5.73 (1.26)	0.05

Note. median: somatization = 0.14, obsession-compulsion = 1.00, interpersonal sensitivity = 0.50, depression = 0.33, anxiety = 0.50, hostility = 0.40, phobic anxiety = 0.00 (.001), paranoid ideation = 0.20, psychoticism = 0.20, Global Severity Index = 0.45; N = 131

Discussion

Correlations between neuroticism, psychological symptoms and PAD image ratings

The present study showed that the variables of neuroticism and psychological symptoms tend to influence the PAD configuration.

It was demonstrated statistically that significant differences (median split) between the groups of the variables of neuroticism high vs. neuroticism low exist for all variables of the PAD space, particularly for Category 6: "negative pleasure/high arousal/low dominance." This category therefore has the most continuous significant effects concerning the comparison of the degree of neuroticism (high vs. low) in the PAD space (for all three variables). In this respect, the emotional configuration arising from highly excitable negative stimuli and high neuroticism values is found in the "extreme areas" of pleasure/arousal/dominance.

The variable of neuroticism is a measure of the NEO-FFI [16] for the expression of emotional stability and instability, not a clinical measure. It is therefore important how the comparison of symptom expression for the BSI variables – which is a clinical inventory – is represented with regard to the PAD space. The clearest effects occur for anxiety, depression, phobic anxiety, psychoticism and Global Severity Index in Category 1 with the new stimuli for "negative pleasure/low arousal/high dominance. "This illustrates that the paradigm of neuroticism-NEO-FFI vs. BSI exhibits another PAD rating configuration (in the 6 categories). The correlations between neuroticism and BSI variables indeed show significant relationships, but the expression of the correlation is in the mid to low range.

We interpret the significant results of the images in Category 1: "negative pleasure/low arousal/high dominance," particularly in "everyday unpleasant" situations (fear of social decline, death, and loneliness) we expect differences in the PAD configuration, as expressed by the images. However, for anxiety and phobic anxiety, in such a way that it is possible that people with severe symptoms

Table 3: Influence of the Brief Symptom Inventory (detailed, high vs. low) on pleasure (V), arousal (A), dominance (D) ratings by categories (T test, one-sided, scale: 1–9, N=131, M = mean and SD = standard deviation)

VAD	cat.	high M (SD)	low M (SD)	p <	cat.	high M (SD)	low M (SD)	p <
				somatization				
V	1	3.13 (0.77)	3.47 (0.74)	0.05	4	6.95 (0.90)	6.82 (0.98)	ns
A	1	3.85 (1.34)	3.59 (1.38)	ns	4	6.25 (1.38)	5.93 (1.54)	ns
D	1	4.97 (1.52)	5.70 (1.64)	0.05	4	5.17 (1.26)	5.37 (1.37)	ns
V	2	4.78 (0.53)	5.10 (0.53)	0.001	5	4.88 (0.77)	4.90 (0.86)	ns
A	2	2.10 (1.12)	1.85 (1.12)	ns	5	6.00 (1.09)	5.69 (1.38)	(0.1)
D	2	7.27 (1.92)	7.32 (2.31)	ns	5	4.33 (1.38)	4.69 (1.42)	(0.1)
V	3	7.58 (0.72)	7.60 (0.75)	ns	6	1.93 (0.63)	1.96 (0.75)	ns
A	3	2.86 (1.38)	3.11 (1.64)	ns	6	6.85 (1.26)	6.83 (1.34)	ns
D	3	7.29 (1.82)	7.15 (2.13)	ns	6	3.39 (1.53)	3.92 (1.64)	ns
				obsession-compulsion				
V	1	3.19 (0.74)	3.39 (0.79)	ns	4	6.91 (0.91)	6.87 (0.97)	ns
A	1	3.93 (1.34)	3.56 (1.36)	ns	4	6.23 (1.50)	5.99 (1.44)	ns
D	1	4.92 (1.40)	5.66 (1.71)	0.01	4	5.12 (1.18)	5.38 (1.41)	ns
V	2	4.88 (0.41)	5.00 (0.64)	ns	5	4.83 (0.84)	4.94 (0.80)	ns
A	2	2.04 (1.17)	1.92 (1.09)	ns	5	5.94 (1.16)	5.77 (1.32)	ns
D	2	7.08 (2.28)	7.46 (1.98)	ns	5	4.26 (1.11)	4.71 (1.57)	0.05
V	3	7.58 (0.72)	7.59 (0.75)	ns	6	1.87 (0.60)	2.00 (0.76)	ns
A	3	3.11 (1.51)	2.89 (1.53)	ns	6	7.03 (1.29)	6.69 (1.84)	(0.1)
D	3	7.02 (1.97)	7.37 (1.99)	ns	6	3.52 (1.64)	3.76 (1.58)	ns
				interpersonal sensitivity				
V	1	3.22 (0.81)	3.37 (0.73)	ns	4	6.95 (0.87)	6.83 (1.03)	ns
A	1	3.82 (1.38)	3.64 (1.34)	ns	4	6.19 (1.43)	6.01 (1.50)	ns
D	1	5.09 (1.63)	5.55 (1.59)	(0.1)	4	5.06 (1.24)	5.44 (1.36)	(0.1)
V	2	4.84 (0.57)	5.03 (0.53)	0.05	5	4.79 (0.83)	4.98 (0.79)	(0.1)
A	2	2.03 (1.07)	1.93 (1.17)	ns	5	5.85 (1.23)	5.84 (1.28)	ns
D	2	7.36 (1.97)	7.24 (2.24)	ns	5	4.25 (1.31)	4.73 (1.45)	0.05
V	3	7.70 (0.70)	7.49 (0.75)	(0.1)	6	1.88 (0.69)	2.00 (0.70)	ns
A	3	3.03 (1.64)	2.95 (1.42)	ns	6	6.81 (1.43)	6.87 (1.78)	ns
D	3	7.31 (1.94)	7.15 (.2.02)	ns	6	3.54 (1.72)	3.76 (1.50)	ns
				depression				
V	1	3.20 (0.78)	3.45 (0.74)	0.05	4	6.99 (0.87)	6.74 (1.04)	ns
A	1	3.98 (1.44)	3.33 (1.34)	0.01	4	6.30 (1.43)	5.78 (1.48)	0.05
D	1	5.09 (1.54)	5.71 (1.68)	0.05	4	5.09 (1.30)	5.53 (1.30)	0.05
V	2	4.91 (0.41)	4.99 (0.73)	ns	5	4.86 (0.88)	4.94 (0.71)	ns
A	2	2.11 (1.41)	1.77 (1.07)	0.05	5	6.06 (1.24)	5.53 (1.22)	0.01
D	2	7.10 (2.21)	7.59 (1.96)	ns	5	4.25 (1.24)	4.92 (1.55)	0.01
V	3	7.74 (0.70)	7.35 (0.73)	0.01	6	1.90 (0.66)	2.02 (0.74)	ns
A	3	3.08 (1.50)	2.86 (1.56)	ns	6	7.00 (1.27)	6.60 (1.31)	0.05
D	3	7.09 (2.03)	7.42 (1.90)	ns	6	3.59 (1.65)	3.77 (1.54)	ns
				anxiety				
V	1	3.12 (0.81)	3.43 (0.72)	0.05	4	6.97 (0.97)	6.83 (0.92)	ns
A	1	4.07 (1.25)	3.49 (1.39)	0.05	4	6.28 (1.13)	5.97 (0.19)	ns
D	1	4.89 (1.38)	5.64 (1.71)	0.01	4	5.14 (1.07)	5.35 (1.46)	ns
V	2	4.81 (0.60)	5.03 (0.51)	0.05	5	4.80 (0.88)	4.95 (0.77)	ns
A	2	2.00 (1.08)	1.96 (1.56)	ns	5	5.99 (0.90)	5.75 (1.44)	ns
D	2	7.13 (2.14)	7.41 (2.11)	ns	5	4.19 (1.14)	4.73 (1.53)	0.05
V	3	7.52 (0.76)	7.63 (0.72)	ns	6	1.86 (0.71)	2.00 (0.68)	ns
A	3	3.30 (1.45)	2.78 (1.54)	.05	6	6.97 (1.37)	6.76 (1.24)	ns
D	3	7.04 (1.84)	7.34 (2.06)	ns	6	3.43 (1.66)	3.81 (1.55)	ns
				hostility				
V	1	3.24 (0.80)	3.36 (0.75)	ns	4	6.98 (0.89)	6.81 (0.98)	ns
A	1	3.77 (1.38)	3.67 ((1.35)	ns	4	6.31 (1.44)	5.91 (1.47)	(0.1)
D	1	5.06 (1.51)	5.57 (1.87)	0.05	4	5.14 (1.10)	5.37 (1.47)	ns
V	2	4.80 (0.58)	5.07 (0.51)	0.01	5	4.96 (0.73)	4.83 (0.88)	ns
A	2	2.00 (1.07)	1.95 (1.17)	ns	5	5.96 (5.96)	5.76 (1.31)	ns
D	2	7.33 (1.81)	7.27 (2.35)	ns	5	4.21 (1.16)	4.77 (1.54)	0.05
V	3	7.63 (0.71)	7.55 (0.76)	ns	6	1.97 (0.73)	1.93 (0.67)	ns
A	3	2.91 (1.37)	3.05 (1.43)	ns	6	6.86 (1.35)	6.82 (1.26)	ns
D	3	7.30 (1.76)	7.16 (2.15)	ns	6	3.53 (1.61)	3.77 (1.60)	ns

(Continued)

Table 3: Influence of the Brief Symptom Inventory (detailed, high vs. low) on pleasure (V), arousal (A), dominance (D) ratings by categories (T test, one-sided, scale: 1–9, N=131, M = mean and SD = standard deviation)

VAD	cat.	high M (SD)	low M (SD)	p <	cat.	high M (SD)	low M (SD)	p <
phobic anxiety								
V	1	3.11 (0.79)	3.45 (0.73)	0.01	4	6.84 (1.02)	6.92 (0.89)	ns
A	1	3.99 (1.44)	3.52 (1.27)	0.05	4	6.37 (1.36)	5.89 (1.51)	0.05
D	1	5.03 (1.56)	5.56 (1.64)	0.05	4	5.18 (1.25)	5.33 (1.37)	ns
V	2	4.91 (0.44)	4.97 (0.62)	ns	5	4.89 (0.81)	4.89 (0.82)	ns
A	2	2.30 (1.18)	1.74 (1.02)	0.01	5	5.96 (1.14)	5.77 ((1.33)	ns
D	2	7.32 (1.81)	7.28 (2.33)	ns	5	4.38 (1.43)	4.62 (1.39)	ns
V	3	7.61 (0.76)	7.14 (0.72)	ns	6	1.96 (0.72)	1.94 (0.70)	ns
A	3	3.35 ((1.78)	2.72 (1.24)	0.05	6	6.75 (1.41)	6.91 (1.21)	ns
D	3	7.33 (1.57)	7.14 (2.23)	ns	6	3.59 (1.69)	3.71 (1.55)	ns
paranoid ideation								
V	1	3.14 (0.72)	3.46 (0.79)	0.01	4	6.92 (1.02)	6.86 (0.86)	ns
A	1	3.86 (1.43)	3.59 (1.29)	ns	4	6.30 (1.34)	5.90 (1.40)	ns
D	1	5.27 (1.61)	5.40 (1.64)	ns	4	5.24 1.23)	5.29 (1.40)	ns
V	2	4.87 (0.56)	5.02 (0.54)	(0.1)	5	4.83 (0.86)	4.95 (0.77)	ns
A	2	2.07 (1.18)	1.89 (1.02)	ns	5	5.99 (1.08)	5.71 (1.39)	ns
D	2	7.52 (1.79)	7.09 (2.38)	ns	5	4.36 (1.47)	4.66 (1.34)	ns
V	3	7.68 (0.70)	7.49 0.76)	(0.1)	6	1.87 (0.68)	2.02 (0.70)	ns
A	3	3.16 (1.66)	2.82 (1.24)	ns	6	6.85 (1.29)	6.83 (1.31)	ns
D	3	7.47 (1.57)	6.98 (2.31)	(0.1)	6	3.57 (1.65)	3.74 (1.56)	ns
psychoticism								
V	1	3.05 (0.72)	3.52 (0.75)	0.001	4	6.87 (1.02)	6.90 (0.88)	ns
A	1	4.16 (1.42)	3.35 (1.20)	0.001	4	6.40 (1.39)	5.84 (1.49)	0.05
D	1	4.92 (1.36)	5.69 (1.75)	0.001	4	5.13 (1.17)	5.38 (1.43)	ns
V	2	4.80 (0.56)	5.06 (0.52)	0.01	5	4.88 (0.79)	4.90 (0.84)	ns
A	2	2.16 (1.13)	1.82 (1.10)	0.05	5	6.12 (1.16)	5.62 (1.29	ns
D	2	7.24 (1.92)	7.34 (2.28)	ns	5	4.31 (1.29)	4.69 (1.48)	ns
V	3	7.73 (0.71)	7.46 (0.73)	ns	6	1.95 (0.68)	1.94 (0.77)	ns
A	3	3.16 (1.56)	2.85 (1.48)	ns	6	7.01 (1.33)	6.70 (1.26)	ns
D	3	7.25 (1.74)	7.20 (2.16)	ns	6	3.53 (1.61)	3.77 (1.60)	ns
Global Severity Index								
V	1	3.18 (0.71)	3.44 (0.71)	0.05	4	6.95 (0.97)	6.82 (0.92)	ns
A	1	3.98 (1.32)	3.44 (1.35)	0.05	4	6.29 (1.38)	5.89 (1.53)	(0.1)
D	1	4.97 (1.39)	5.73 (1.77)	0.01	4	5.14 (1.18)	5.41 (1.45)	ns
V	2	4.84 (0.54)	5.05 (0.55)	0.05	5	4.86 (0.82)	4.93 (0.81)	ns
A	2	2.06 (1.15)	1.89 (1.09)	ns	5	6.02 (1.14)	5.66 (1.34)	ns
D	2	7.30 (1.99)	7.30 (2.26)	ns	5	4.20 (1.25)	4.85 (1.50)	0.01
V	3	7.64 (0.71)	7.53 (0.76)	ns	6	1.90 (0.64)	1.99 (0.75)	ns
A	3	3.12 (0.19)	2.85 (0.19)	ns	6	6.97 (1.26)	6.70 (1.33)	ns
D	3	7.24 (1.74)	7.20 (2.21)	ns	6	3.41 (1.53)	3.92 (1.64)	0.05

Note. Category 1: negative pleasure/ low arousal/ high dominance; Category 2: neutral pleasure/ low arousal/ high dominance; Category 3: positive pleasure/ low arousal/ high dominance; Category 4: positive pleasure/ high arousal/ high dominance; Category 5: neutral pleasure/ high arousal/ neutral dominance; Category 6: negative pleasure/ high arousal/ low dominance; V: pleasure, A: arousal, D: dominance; median: somatization = 0.14, obsession-compulsion = 1.00, interpersonal sensitivity = 0.50, depression = 0.33, anxiety = 0.50, hostility = 0.40, phobic anxiety = 0.00 (0.001), paranoid ideation = 0.20, psychoticism = 0.20, Global Severity Index = 0.45; N = 131; the effect of V3: interpersonal sensitivity, paranoid and depression is opposite to the prediction

do not differ from people with mild symptoms in extreme conditions (wars and other forms of violence).

All significant effects for the variables of arousal and dominance follow the expected direction of the hypotheses. However, we found a higher positive pleasure rating for severe symptom depression in the category "positive pleasure/low arousal/high dominance" (with new images) – which does not support the hypotheses. This could indicate that depressed persons have a strong need for harmony. This trend can also be seen for other symptoms, although the effects are not significant. The different categories and symptom areas show that it is

also possible that individuals with severe symptoms exhibit a significant difference in dominance (control vs. loss of control), while there are no effects for pleasure and arousal. This indicates that emotions may not be perceived more strongly in case of severe symptoms, but that they are harder to control. As expected, there are only few effects for obsession-compulsion, since this disorder is based on obsessive behavior or thinking rather than on a loss of emotion control.

Overall, the results of the present study can provide information regarding the PAD configuration with respect

Table 4: Ratings of new images (30 images; N=131) for pleasure, arousal, dominance

image	cat.	pleasure M (SD)	arousal M (SD)	dominance M (SD)
01. rundown house	1	3.32 (1.39)	3.49 (1.88)	5.50 (2.14)
02. dead pigeon on gray asphalt	1	3.38 (1.58)	3.62 (2.15)	5.28 (2.63)
03. desolate room in a rundown house	1	2.35 (1.13)	4.29 (1.95)	4.74 (2.22)
04. gravestone in winter scenery	1	2.98 (1.52)	3.85 (2.19)	4.79 (2.76)
05. young woman with depressed expression	1	3.01 (1.24)	3.40 (1.85)	5.58 (2.25)
06. rundown factory buildings	1	4.10 (1.34)	3.04 (1.80)	5.93 (2.18)
07. huddled young woman in a poorly lit stairwell	1	2.99 (1.25)	4.22 (1.93)	5.18 (2.12)
08. people with dreary expressions in a nursery home	1	3.75 (1.65)	3.71 (2.03)	5.72 (2.17)
09. neglected cemetery with dirty river	1	3.43 (1.39)	3.79 (1.84)	5.42 (2.26)
10. neglected backyard with hanging laundry	1	3.83 (1.29)	3.12 (1.70)	5.75 (2.22)
11. couple in the sunrise - sunset	3	7.73 (1.94)	3.01 (1.95)	7.36 (2.12)
12. empty row boat on a sandy beach	3	8.11 (1.20)	3.11 (2.20)	7.40 (2.17)
13. woman with closed eyes in a bath tub	3	7.88 (1.25)	3.21 (2.37)	7.30 (2.28)
14. woman getting a chin massage	3	7.69 (1.34)	2.89 (2.12)	7.04 (2.13)
15. woman lying sleeping in the sun	3	7.86 (1.17)	3.35 (2.36)	7.17 (2.21)
16. two elderly woman lie sleeping covered in a room	3	6.41 (1.54)	2.31 (1.62)	7.24 (2.20)
17. two young men lying on a riverbank in a city	3	7.01 (1.34)	2.67 1.70)	7.15 (2.11)
18. empty deck chairs at a lake in the twilight	3	7.89 (1.12)	2.93 (2.11)	7.45 (2.24)
19. sleeping child with teddy bear	3	7.52 (1.33)	2.77 (2.06)	7.14 (2.18)
20. couple in white bath robes	3	7.79 (1.29)	2.73 (2.04)	7.30 (2.30)
21. house demolition with dust cloud and a crowd of spectators	5	3.54 (1.80)	5.61 (2.08)	4.26 (2.43)
22. worker hanging from a helicopter	5	5.19 (1.42)	5.89 (2.11)	4.77 (2.01)
23. frontal view: car passes car	5	4.52 (1.23)	4.48 (2.12)	5.38 (2.04)
24. painter at work – leaning far out a window	5	4.89 (1.44)	5.70 (2.08)	4.72 (2.10)
25. water rushing down from a dam wall	5	5.38 (1.50)	5.33 (2.02)	4.59 (2.28)
26. volcano eruption with dust cloud	5	4.72 (1.68)	5.67 (1.73)	4.00 (2.14)
27. man sitting at a rocky cliff	5	6.87 (1.62)	6.25 (2.22)	5.25 (2.32)
28. burning bridge with approaching fire-fighting plane	5	4.09 (1.81)	5.57 (2.03)	4.64 (2.22)
29. massive blazing explosion without civilian targets	5	4.15 (1.78)	6.04 (1.88)	3.79 (2.29)
30. man on a cliff	5	5.83 (1.84)	7.31 (1.53)	4.40 (2.23)

Note. Category 1: negative pleasure/ low arousal/ high dominance; Category 3: positive pleasure/ low arousal/ high dominance; Category 5: neutral pleasure/ high arousal/ neutral dominance

to the personality variable of neuroticism and in particular for the specific clinical symptom severity (of the BSI).

Video 2 illustrates that a variety of emotional profiles can be individually represented in the category "negative pleasure/high arousal/low dominance" with respect to the variable of neuroticism. This fills an area of the space that would constitute a gap in typical cases where the IAPS ratings [1] are averaged across the entire sample. This invalidates Libkuman's statement that the area of arousal >7.5 does not exist in the rating of images per se [14].

Limitations

Regarding the limitations of the results it is worth mentioning that the sample was composed solely of medical students from Ulm University. The generalization potential of the results is therefore limited. On the other hand, stronger effects could be expected for clinical samples due to an increase in variance.

It turns out that despite significant differences, the size of the effects are small. No correction for overall type I error was applied.

3D representation of the emotion space

The 3D representation makes an important contribution towards improving the illustration of the PAD rating con-

figuration. In addition, we recommend actually capturing and representing dominance (in print journals: pleasure[y-axis]/dominance[x-axis], arousal[y-axis]/dominance[x-axis]) in future studies (especially in clinical ones).

Comparison between original IAPS and the new Ulm stimuli

The graphical representation of the pleasure, arousal, and dominance rating without consideration of the symptoms shows that the sparsely populated area of "positive pleasure/low arousal/high dominance" can bet better filled by means of a top-down approach. This applies only partially to the gap of "negative pleasure/low arousal/high dominance" and only to one image in the category of "neutral pleasure/high arousal/neutral dominance." Practically this means that additional stimuli can be made available to future studies which intend to induce emotions with the help of images.

A significant correlation was found between pleasure and arousal for negative pleasure (<5) – similar to that observed by Bradley and Lang [8]. This is consistent with Bradley's and Lang's evolutionary approach. There are no significant correlations for positive pleasure (>5). In this respect, the present study can only give limited proof of the dependence on arousal in the pleasure space >5. The result appears plausible, since positive emotions, such as relaxation (e.g., vacation, spa treatments, yoga,

autogenous training, Tai Chi) were presumably of little evolutionary importance compared to negative emotions (e.g. flight). It is noteworthy that the set of Lang et al. [1] does not contain images relating to relaxation. The reason for this could be that the authors [1] gave less attention to these areas of the emotion space because of their evolutionary presuppositions.

Although only a limited number of stimuli exist for the emotion space of "negative pleasure/low arousal/high dominance" (e.g. grief, hopelessness, resignation), it shows that even the sparsely populated area (pleasure 3–4; arousal 3–4; dominance 5–6) can be filled by means of a top-down strategy.

Without fundamentally questioning the evolutionary explanation for the three gaps, this study succeeded in minimizing vacant PAD areas of the emotion space by means of emotional stimuli. These stimuli can be used in future studies that examine emotional responses induced by visual emotion stimuli with low intensity.

Notes

Acknowledgement

Competing interests

The authors declare that they have no competing interests.

Attachments

Available from
http://www.egms.de/en/journals/psm/2011-8/psm000073.shtml

1. Video 1.mp4 (14265 KB)
   Video 1: The empirical rating data of the manual by Lang [1] in 3D

2. Video 2.mp4 (9014 KB)
   Video 2: The average ratings of the pictures from the Category 6 (negative pleasure/high arousal/low dominance) for the variable of neuroticism (low: green vs. high: red) was individually represented in 3D.

3. Video 3.mp4 (10643 KB)
   Video 3: The average ratings of the IAPS (gray) and the new images (red) in 3D

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