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Personality and Cognitive Performance[1]

The two experiments reported here are concerned with the influence of trait anxiety and other individual differences on cognitive performance using the face-in-the-crowd procedure. Participants completed questionnaires (EPQ-R; STAI; Marlowe-Crowne Social Desirability Scale) and across two experiments searched for discrepant faces in matrices of otherwise identical faces (in Experiment 1: threatening, happy, neutral targets against emotional or neutral backgrounds, and in Experiment 2: threatening, happy, sad and scheming targets against neutral distractors). The key findings from this study indicated that anxiety enhanced processing efficiency of positive emotional material when interacts with high psychoticism. Additionally, the vigilance for threatening and neutral faces was a characteristic of sanguine individuals with repressive coping while inefficient processing of threatening and neutral stimuli of non-defensive melancholic subjects. These results are discussed with reference to attentional control theory (Eysenck, Derakshan, Santos, & Calvo, 2007).

Keywords: *anxiety, PEN, personality coherence vs. incoherence, attentional control theory, facial stimuli*

Introduction

A more recent line of research is concerned with the biasing effects of anxiety on cognitive processes, leading to enhanced awareness of threat (see Eysenck, 2006). It is now commonplace to relate anxiety to the attentional resources and working memory (e.g., Eysenck, Derakshan, Santos & Calvo, 2007). However, cognitive psychological accounts of anxiety are not necessarily conclusive and consistent (see Fajkowska & Krejtz, 2007, for a review). We have suggested that promising as an approach to better understanding cognitive functioning in anxiety is to study a group of trait anxious individuals as heterogeneous. Recent research from a number of fields led us to believe, that the heterogeneity of high-anxious group is mainly formed by differentiation in individual properties related to effort and arousal (e.g., Fajkowska & Krejtz, 2006; 2007) and by differentiation in style of coping (e.g., Weinberger, Schwartz & Davidson, 1979; Asendorpf & Scherer, 1983; Eysenck, 2000; 2006).

The purpose of this article is to describe within the frame of the attentional control theory (Eysenck et al., 2007) an initial study, which tested the hypothesis that anxious individuals process facial threat and other facial emotional stimuli in a manner associated with their style of coping and the level of extraversion, neuroticism and psychoticism.

The attentional control theory is an approach to anxiety and cognition representing a major development of Eysenck (1979) and Eysenck and Calvo's (1992) processing efficiency theory. The central focus of the processing efficiency theory was on a distinction between effectiveness and efficiency. Effectiveness refers to the quality of task performance, which is conventionally assessed by various behavioural measures (e.g., speed of performance; accuracy of performance). In contrast, efficiency refers to the relationship between the effectiveness of performance and the effort or processing resources invested in that performance. According to the theory, anxiety generally impairs processing efficiency on complex tasks to a greater extent than performance effectiveness.

The original processing efficiency theory rested on two major assumptions. First, worry is the component of state anxiety responsible for effects of anxiety on performance effectiveness and efficiency. Worry or self-preoccupation is characterised by concerns over evaluation and failure and

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expectations of aversive consequences (e.g., Borkovec, 1994). It is activated in stressful situations, and is most likely to occur in individuals high in trait anxiety (e.g., see Eysenck, 1992, for a review). Worry has two effects. One effect involves cognitive interference by pre-empting the processing and temporary storage capacity of working memory. The worrisome thoughts consume the limited attentional resources of working memory, which are therefore less available for concurrent task processing. The other effect involves increased motivation to minimise the aversive anxiety state. This function is accomplished by promoting enhanced effort. Thus, potential performance impairments caused by the pre-emption of working memory resources can be compensated for.

The second assumption concerns the mechanisms and components of working memory affected by anxiety. Processing efficiency theory is based on the working memory model (Baddeley, 1986; 2001). It is assumed that the main effects of worry (and more generally anxiety) are on the central executive (a modality-free system resembling attention). Accordingly, adverse effects of anxiety on performance and efficiency should be greater on tasks imposing substantial demands on the central executive. There is much empirical support for these predictions (see Eysenck et al., 2007, for a review).

Attentional control theory (Eysenck et al., 2007) represents a major development of the previous processing efficiency theory building on its strengths and addressing its limitations. It is assumed that anxiety impairs efficient functioning of the goal-directed attentional system and increases the extent to which processing is influenced by the stimulus-driven attentional system (Corbetta & Shulman, 2002). In addition to decreasing attentional control, anxiety increases attention to threat-related stimuli. Unfavourable adverse effects of anxiety on processing efficiency depend on two central executive functions involving attentional control: inhibition (avoiding distracting stimuli) and shifting (flexible shifting of attention). However, anxiety may not impair performance effectiveness (quality of performance) when it leads to the utilisation of compensatory strategies (e.g., enhanced effort; increased use of processing resources).

Accordingly, there is a question if compensatory strategies used by anxious individuals to regain attentional control might be associated with other personality or temperament characteristics? We can make the assumption that attentional mechanisms may be modulated directly (*via e*nhancing) or indirectly (*via* facilitation) by variations of a range of personality and temperamental traits. We can expect that related to arousal and effort personality traits might be particularly important in terms of attentional system functioning. Various forms of arousal can serve to alert the organism and activate the anterior or posterior attentional systems (see Fox, 2008). Moreover, effort invested in attentional processing comes from the momentary arousal activated by the task but also from the individual arousability (e.g., Pavłov, 1938/1952; Eysenck, 1967; 1981; Humphreys & Revelle, 1984; Mathews & Margetts, 1991; Nęcka, 2000; Fajkowska & Krejtz, 2007).

Personality traits such as extraversion or neuroticism are connected with arousal and effort (Eysenck, 1981) and indeed, they are associated with attentional biases to process different classes of information (Fox, 2008). Relatively stable, constitutional arousal is connected with the extroversion - introversion dimension, but visceral activation with the neuroticism- emotional stability dimension. In extroverts, non-specific, cortical arousal is lower than in introverts. The tendency to anxious reactions is reflected in neurotics, because the visceral activation is lower in that group than in emotionally stable individuals (Eysenck & Eysenck, 1985). An important part of this picture is psychoticism. It relates to ineffective attentional control caused by poor inhibition processes (Eysenck, 1967; 1992; Szymura & Smigasiewicz, 2004), what is associated with different performance level of attentional task being automatic or demanding the effortful control (see Szymura, 2007).

Thus, one can assume that the extroversion, neuroticism and psychoticism dimensions influence the level of arousal and amount of effort invested in performance and predispose individuals to preferentially process facial emotional information that is congruent with these traits, respectively. Three components of the attentional system –disengage, move, engage- should be biased in a way that is congruent with a particular personality trait (see Fox, 2008). For example, individuals with anxious personalities (high in trait anxiety or neuroticism) are especially efficient at detecting threatening faces (Byrne & Eysenck, 1995; Juth, Lunqvist, Karlsson & Őhman, 2005). In similar fashion, extraverts are friendly, outgoing individuals who experience higher levels of positive affect than introverts (Diener, Oishi, & Lucas, 2003). As a result, extraverts may be more efficient than introverts at detecting happy faces but not threatening faces. Individuals high in psychoticism have a lack of involvement with other people, and are characterised as impersonal, antisocial, and unempathic. Thus, they may be especially unresponsive to the emotions displayed on faces regardless of whether those emotions are negative or positive. On the other hand, individuals high in psychoticism experience high levels of hostility and anger. For example, Spielberger (1988) reported a significant (but small) positive correlation between psychoticism and trait anger. As a consequence, those high in psychoticism may be especially vigilant in terms of detecting angry faces. Potentially relevant evidence was reported by van Honk et al. (2001). They found that individuals scoring high on trait anger had an attentional bias for angry faces.

However, there is another possibility then postulated by the hypothesis of personality congruent cognitive biases. It is also likely that these personality traits will interact

or intercorrelate with each other and produce attentional biases being specific for this interaction or intercorrelation. This is an important point and means that we can extend the attentional control theory by considering additional factors over and above anxiety such as the effect of interaction between anxiety and extraversion, introversion and psychoticism on processing efficiency of facial emotional stimuli.

It is predicted theoretically that the differentiation in processing efficiency of emotional material is related to interactions or inrecorrelations between those properties and the level of trait anxiety (Eysenck & Eysenck, 1975; Eysenck, 1981; 1992; Szymura, 2007). The interaction or intercorrelation can be described in terms of the individual coherence, what is seen as the consistency of temperamental traits (associated with one's need for stimulation) with other personality characteristics (e.g., anxiety, depressive mood) linked with a self –providing, appropriate dose of stimulation, fulfilling one's need for stimulation, determined by the physiological mechanisms of temperament (see Eliasz, 1981; 1985; 1992; Fajkowska-Stanik & Marszał-Wiśniewska, 2003). Thus, individuals with coherent or incoherent structures of personalities which involve the particular level of anxiety might be found among sanguine, phlegmatic, melancholic or choleric temperamental types (Fajkowska & Krejtz, 2007). For instance, coherent sanguine structure of personality is low on anxiety trait, high on extraversion and low on neuroticism (Eysenck, 1981) or according to the Regulative Theory of Temperament by Strelau (2008) low on anxiety trait, emotional reactivity, perseveration, very high on endurance and activity and high on sensory sensitivity and briskness.

Temperamental components of personality, based on mechanisms that are responsible for individual differencesin level of arousal contribute to the processing stimulation. They can either increase or reduce stimulation input or discharge level of arousal to a greater or lesser extent. Moreover, depending on the configuration of these traits the processing stimulation (regulation) may have different level of effectiveness. What in turn depends on activity as temperamental trait, which serves as the regulator of need for stimulation (see Strelau, 2008).

Enumerated above traits composing the sanguine type indicate a high capacities of processing stimulation in this temperamental structure (similar to phlegmatic type and contrary to melancholic or choleric types; see Strelau, 2008). Distinguished in the organization of personality sanguine traits of temperament and high anxiety (e.g., as the response to the environmental influence) constitute the incoherent personality structure. (see Fajkowska & Krejtz, 2006; 2007). Generally, it is assumed that incoherent personality structure is a result of discrepancies between the stimulative value of activity and capacities of processing stimulation (see Eliasz, 1981) what is accompanied by non-effective performance and non-adequate reactions and behaviours (see Fajkowska & Krejtz, 2007). Considering the incoherent sanguine individual as an example, anxiety may potentially block his/her high need for stimulation (e.g., by lowering number of activities) what is not adequate to his/her high capacities of processing stimulation. Consequently, he/she is exposed to negative effects of understimulation. However, it not might be always the case. To make matters even more complicated, it also needs to be kept in mind that the final effect of performance of individuals with incoherent structure of personality depends on the wide range of factors, e.g. the nature of task or activity, social influence or strategies of coping. The latest factor seems to be very important when anxiety is involved in coherent or incoherent structure of personality. Why? It has been explained below.

The group of high trait anxious individuals is not homogeneous. It is important to consider coping styles relating to defensiveness, which has often been assessed by the Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1960). Weinberger, Schwartz, and Davidson (1979) identified three groups on the basis of defensiveness and trait anxiety scores. Individuals scoring low in trait anxiety and defensiveness were classified as truly low anxious, those low in trait anxiety but high in defensiveness as repressors, and those high in trait anxiety and low in defensiveness as high-anxious. A fourth group of defensive high anxious (high trait anxiety; high defensiveness) was subsequently identified (e.g., Asendorpf & Scherer, 1983).

Little is known of cognitive processing in defensive high anxious individuals. In turn, much of such research has been dedicated to repressive coping, which a key characteristic is dissociation between self-report (indicative of low anxiety) and physiological response (indicative of high anxiety). Decades of studies have shown that the repressive coping style may serve a protective function (see Coifman, Bonanno, Ray & Gross, 2007, for a review). For instance, individuals with repressive coping tend to avoid threat and negative emotions what is not a deliberate avoidance of negative affect, which actually increases negative affectivity (e.g., Fox, 1993; Myers & Derakshan, 2004). On the other hand, in a series of studies repressive coping is associated with a number of maladaptive consequences (see Hoge, Austin & Pollack, 2007, for a review). Interesting differences have been found between low-anxious individuals and repressors with respect to attentional bias. Evidence for an opposite attentional bias in repressors (systematic avoidance of attending to threat-related stimuli) coupled with no attentional bias in low-anxious individuals has been reported (e.g., Fox, 1993; Myers & McKenna, 1996; Newman & McKinney, 2002; Mogg et al., 2000). There is much evidence that high-anxious individuals have an attentional bias favouring the processing of threat-related stimuli over neutral ones (e.g., Eysenck, Macleod, & Mathews, 1987; MacLeod & Mathews, 1988). However, this more detailed analysis of

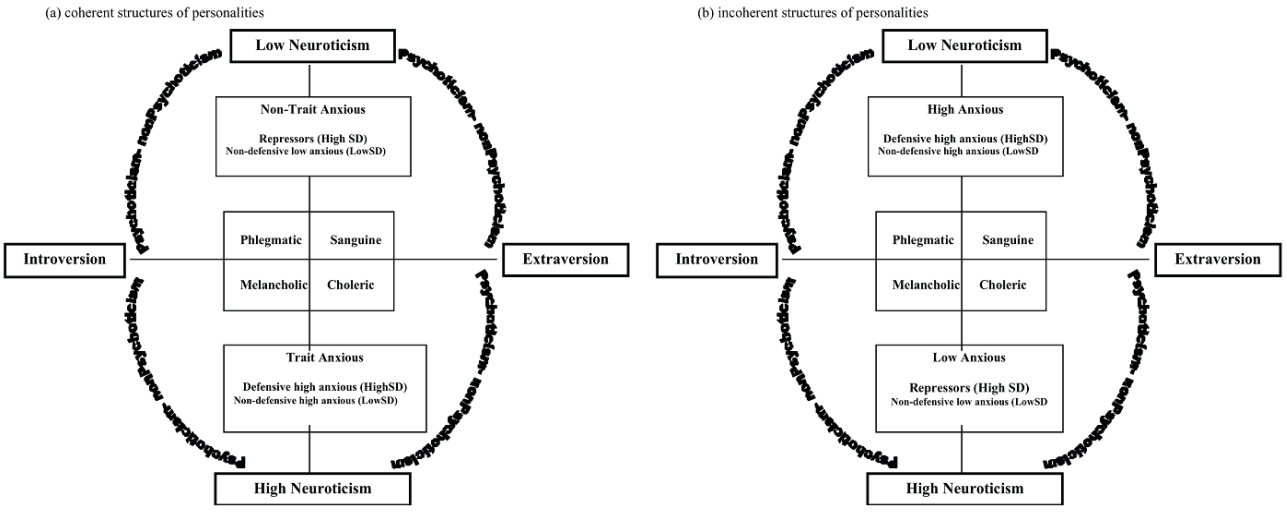


Figure 1. Model of inter-relationships between extraversion, neuroticism, psychoticism, anxiety and repressive coping styles in: (a) coherent structures of personalities and (b) incoherent structures of personalities.

attentional allocation indicates that the attentional bias found in high-anxious individuals depends in large measure on the difficulty that they have in disengaging from threat-related stimuli (Fox, Russo, & Dutton, 2002; Yiend & Mathews, 2001). Overall, several studies have illustrated that the avoidance of negative affect in repressive coping is automatic and may operates as a protective mechanism serving to keep levels of anxiety low in stressful situations (e.g., Derakshan et al., 2007).

Figure 1 (a) and (b) indicates the range of personality and coping style variables considered in the study presented here, and provides the theoretical speculations of their inter-relationships. As demonstrated in Figure 1, it is more likely that the repressive coping style will occur in two coherent structures of personalities: sanguine (low-anxious emotionally stable extraverts) and phlegmatic (low-anxious emotionally stable introverts) and in two incoherent structures of personalities: melancholic (low-anxious neurotic introverts) and choleric (low-anxious neurotic extraverts).

If all of this is correct then it may be a case that repressive coping style attached to the aforementioned incoherent structures of personalities can promote the resilience to aversive events by means of the automatic avoidance of the more negative aspects of stress. Hypothetically, the repressive coping style may restrict access to negative affect and not intensify the overstimulation in these incoherent individuals with low capacities of processing stimulation. But what is a function of repressive coping in described above coherent types of personalities? One possible explanation is that the repressive coping has been developed in coherent types of personalities to intensify their vigilance for threat and eliminate a potential neglecting of significant information. The logic behind that explanation is that high capacities of processing stimulation and positive emotions typical for those types of personalities broaden their attentional focus (see Fox, 2008) what potentially does not allow them to detect accurately significant threatening signals and protect themselves against negative or painful outcomes. Such a situation we can easily explain by the affect-as information account (e.g., Clore, Gasper & Garvin, 2001).

However, given what we have learned about temperamental differences so far, we would expect that associated with repressing coping threat avoidance or vigilance will be more beneficial for those temperamental types which actively encourage effective stimulation processing. That is by reason of threat and other corresponding emotions are usually seen as the very arousing or stimulating affects (e.g., Robinson & Compton, 2006). For instance, that is more likely to happen that intensified by repressive coping vigilance for threat in coherent sanguine individuals will be rather adaptative on account of their effective stimulation processing. In contrast, the repressive coping might not facilitate the functional reactions to threat in coherent phlegmatic types due to their noneffective processing stimulation.

The presented above theoretical analysis and evidence from research lead us to formulate the following questions: How extraversion, neuroticism, and psychoticism differentiate attentional processing efficiency of emotional facial stimuli, respectively? How styles of coping differentiate attentional processing efficiency of emotional facial stimuli? How interactions among these personality dimensions and styles of coping influence attentional processing efficiency of emotional facial stimuli?

Adequately to hypothesis and questions have been posed above a broad range of personality dimensions and of coping styles is considered in the two experiments reported here.

Most studies are designed to examine the relation between only one personality dimension and performance (e.g., Byrne & Eysenck, 1995; Eysenck, 1997, for a review; Juth et al., 2005; Hadwin, Brogan & Stevenson, 2005). As

yet, there are relatively few relevant studies, nearly all of which have focused only on interactions among personality dimensions, involving anxiety, and processing of facial emotional stimuli. Nearly all of these studies are based on the face-in-the-crowd procedure (Fajkowska & Krejtz, 2007; Fajkowska & Marszał-Wiśniewska, 2006) and the computer test of emotional DIVA (divided attention test, dual-task procedure; Fajkowska & Krejtz, 2006).

The greatest relevance to the experiments reported here is the face-in-the-crowd procedure originally demonstrated by Hansen and Hansen (1988). With this procedure they found consistently that angry faces were more readily detected in happy crowds than were happy faces in angry crowds and they referred to this as the face-in-the-crowd effect. According to Hansen and Hansen (1988), this is a "pop-out" effect based on a parallel, preattentive search. However, subsequent research has typically found generally failed to replicate these key findings reported by Hansen and Hansen (1988) with the typical finding being that happy faces are processed more efficiently than threatening ones (see Purcell, Stewart, & Skov, 1996; Öhman, Flykt & Esteves 2001a; Őhman, Lundqvist, & Esteves, 2001b, for a review; Öhman, 2005a; 2005b). As Őhman et al. (2001a; 2001b) pointed out, the results suggesting that happy or friendly faces are processed more efficiently than threatening ones may involve a confounding between the type of facial emotion and familiarity. Őhman et al. (2001b) eliminated this; they used schematic faces to the procedure that were equally unfamiliar to all of their participants. With these schematic faces, they consistently found that threatening angry faces were detected more rapidly and accurately than were other negative faces (sad or scheming). Juth et al. (2005; see also Őhman et al. 2001a; 2001b) established with schematic faces that angry faces were detected more efficiently than happy ones. Folk, Remington, and Johnston (1992) showed that the probability of any given stimulus capturing attention depends in part on its relevance to the individual's current goals. Thus, stimuli inconsistent with his/her current goals tend to be ignored and not processed thoroughly. In view of the functional and evolutionary significance of the face, it seems reasonable to assume that face perception involves specialised modules and that the production and decoding of emotional facial expressions have their origins in biological evolution and serve as important social signals (Lundqvist, Esteves, & Őhman, 1999).

The effects of anxiety on central executive processing can be examined with the face-in-the-crowd procedure. There is some evidence that the effects should be greater on tasks imposing substantial demands on the attentional control (Eysenck et al., 2007). Here, high demands are formed by the prolonged visual search design (see Mackworth, 1948; 1957) potentially affecting selective attention (vigilance) and inhibition functions. The session lasts approximately 80 minutes, targets are randomly presented on only 50% of trials, and time pressure is present. Additionally, type of material – emotional and social - lifts a level of complexity of experiments (e.g., Fox, Russo, Bowles & Dutton, 2001; 2002; Mogg, Philippot & Bradley, 2004; Pishyar, Harris & Menzies, 2004; Mogg & Bradley, 2005; Fox, Russo & Georgiou, 2005; Fajkowska & Krejtz, 2003). Moreover, the high stimulative value of the prolonged visual search task engages individual's capacities of processing stimulation and effectiveness of processing stimulation based on the stimulation reduction or augmentation mechanisms (Strelau, 2008). Consequently, the prolonged tasks performance is effortful and stimulative thus, consumes attentional resources and temperamental ‚energy'.

Thus, the processing efficiency might be reflected in reaction times for the correct responses to the particular emotional signal. It could be the case for anxious individuals that tasks demands, described above, potentially reduced their attentional control, leading to decreased processing efficiency and longer reaction times for correct responses to the specific emotional targets. But under the same circumstances the attentional control might be not impaired in some of them. What does allow them to put effort and operate efficiently? Perhaps, the answer is that particular structure of temperamental traits and coping styles. The two studies more detailed reported below provide a convincing support for this line of thinking.

With the face-in-the-crowd paradigm, Fajkowska and Marszał-Wiśniewska (2006) studied the effects of depression on detection of sad faces. The predicted 'sad –face-in the-crowd effect' was not confirmed. Depressed mood differentiated the attentional processing of positive stimuli but not negative ones. Happy faces were detected slower than angry, sad and scheming ones. Moreover, the lower accuracy in detection of all faces was associated with temperamental properties (low level of capacities of processing stimulation) in clinically depressive and high-anxious individuals.

Across two experiments based on the face-in-the-crowd procedure was found the positive effect of coherent types of personalities (interaction between level of anxiety and temperamental traits) on processing efficiency of emotional material (Fajkowska & Krejtz, 2007). The effect remained when anxiety was omitted from the analysis. Thus, it was assumed that effect was not related mainly to trait anxiety but to temperamental traits (emotional reactivity, perseveration and activity). Moreover, the increased processing efficiency of the emotional material was connected with the emotional reactivity (in coherent personality). Under some circumstances, anxious individuals out-performed non-anxious ones. The increased processing efficiency of threatening faces was observed in coherent, high anxious individuals with low level of endurance and activity but with high level of perseveration.

In line with these results, it is predicted theoretically that resistance to distractors (inhibitory functions of central

Figure 2. Samples of 3x3 matrices with targets used in the Experiment 1, adapted from Öhman, Lundqvist, and Esteves (2001).

executive) and processing efficiency are not generally impaired in high-anxious individuals. In addition, some temperamental traits seem to play more a crucial role than anxiety in processing the emotional material. As yet, however, there is not enough evidence relevant to this prediction and to extend these results we designed the studies being reported here.

Experiment 1

Method

Participants

A total of 97 psychology undergraduate students took part in this study. There were 80 females and 17 males with a mean age of 20.86 years and SD = 2.91 years. They completed three questionnaires: extraversion, neuroticism, and psychoticism were assessed by the Revised Eysenck Personality Questionnaire (EPQ-R; Eysenck & Eysenck, 1994); trait anxiety by the Spielberger State-Trait Anxiety Inventory (STAI; Wrześniewski & Sosnowski, 1996), and defensiveness by the Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1960; Drwal & Wilczyńska, 1980). Median splits on the trait anxiety and defensiveness scales produced four groups: (1) low-anxious (low anxiety, low defensiveness); (2) repressors (low anxiety, high defensiveness); (3) high-anxious (high anxiety, low defensiveness), and (4) defensive high anxious (high anxiety, high defensiveness).

The experimental session took place approximately one week after administration of questionnaires.

Procedure

The experiment replicated the design of Öhman et al. (2001b) with the measurement of personality traits added.

The visual stimuli were presented on a computer screen and programmed in *E-Prime 1.0* to initiate trials, and record reaction times (RTs) and false responses (FRs).

The stimuli were arranged in matrices consisting of nine individual schematic faces, drawn in black against a white background, arranged in 3 x 3 blocks (see Figure 2).

The outline of the face and the nose were drawn in with 1-pixel lines, and the eyebrows, eyes, and mouth were drawn with lines of 2 pixels. The individual faces were 84 X 98 pixels, and the size of the faces on the screen was approximately 3° X 3.5°, and the stimulus matrix was 10° X 11.5° (see Öhman et al., 2001b).

All participants were tested individually and asked to follow the written instructions presented on the computer screen. The instructions explained that the task was to detect a discrepant face in the display of faces. It was also mentioned that some displays contained a target whereas others did not. They were instructed to press the appropriate key as rapidly as possible to indicate whether the discrepant target was present in the display or not. Before the task began, participants went through a series of training trials, responding by pressing two different keys on the computer keyboard. A target present decision was indicated with the right index finger, and a target absent decision with the left index finger.

Each trial started with the presentation of a fixation point (0.4 cm in diameter) for 2 s at the centre of the screen in the location at which the central face of the matrix later appeared. The duration of the matrix was either 1 s or 2 s. On half of the trials one face was the target and had a different emotional expression from that of the background distractors. The other half of the trials were non-target trials and consisted of nine faces all displaying the same emotion (neutral, threatening, or friendly).

All distractor expressions were combined with all target expressions, and so there were six different possible target-distractor combinations. Target faces could occur at any of the nine positions in the matrix. Overall, there were 54 different matrices that contained a target and 3 different all-distractor matrices (neutral, happy, angry). There were a grand total of 216 randomly ordered trials (54 matrices with a target face; 54 matrices with only distractors; and 2 matrix duration).

Results

One-way ANOVA involving the faces factor with repeated measurement was performed to study the efficiency of processing the emotional material in the whole group of participants (N=97). Response accuracy and reaction times for correct responses were measured. Data were analysed both with and without distractors.

The response accuracy analysis showed that was a significant effect of the nature of the target ($F_{(2;\ 95)} = 3.01$; $p < 0.05$ without distractors; $F_{(5;\ 73)} = 21.64$; $p < 0.001$ with distractors). Across all participants, threatening faces were detected with the lowest percentage of false responses. Threatening targets were detected with significantly fewer false responses than friendly faces (F

(1; 96) = 1.54; p < 0.04) but there was a non-significant difference in false response rate between threatening and neutral faces. Threatening faces against friendly distractors were detected with the lower false responses than friendly faces against threatening distractors ($F_{(1; 92)} = 5.15$; $p < 0.03$).

The analysis of the reaction times indicated that type of face had a significant effect on performance ($F_{(2; 75)} = 40.13$); $p < 0.001$), with threatening and neutral faces being detected faster than friendly ones. More detailed analysis indicated that threatening faces were detected significantly faster than friendly ones ($F_{(1; 76)} = 2.79$; $p < 0.01$) and neutral faces were detected faster than friendly ($F_{(1; 76)} = 40.53$; $p < 0.001$) and threatening ones ($F_{(1; 76)} = 80.66$; $p < 0.001$). The further elaboration of data showed the significant effect of the target presented against the background of distractors ($F_{(5; 73)} = 21.64$; $p < 0.001$). The finding that threatening faces were detected significantly faster than friendly or happy ones regardless of whether the distractors were emotional or neutral provides replicates the face-in-the-crowd effect with schematic faces reported by Őhman et al. (2001b). The same pattern was observed in case of neutral faces presented against the friendly or threatening distractors.

The above results lead to the conclusion that not only an angry-face-in the crowd effect but also a neutral face-in-the crowd effect was observed in this study. Participants efficiently processed threatening and neutral faces. Those findings are congruent with results from the study on validity of selection of the schematic facial stimuli conducted by Fajkowska-Stanik (2005). The good level of validity of the chosen stimuli to their assumed signalling role was demonstrated in happy and angry faces and, at a slightly lower level, in sad ones. According to the results, neutral face seemed to be a *projective stimulus*. The expression of neutral face conveyed different emotional signals, and different valence connected with the emotional state of the receivers. For instance, individuals high in anxiety more frequently than those low in anxiety perceived neutral face as negative e.g., threatening, hostile and aggressive [t (143)=3.230; p<0.002] than neutral [t (143)=2.761; p<0.007]. Additionally, depressed mood subjects more often than non-depressed ones regarded neutral face as negative e.g., sad, melancholic, guilty [t (145)=2.188; p<0.03] than neutral [t (145)=2.312; p<0.02]. In the light of these findings the representativeness of neutral face as a 'control material' for emotional faces is questionable.

The next step in the analysis explored the effects of individual differences in personality on the detection speed and accuracy for the three types of target faces. The exploratory multi-multivariable analysis of regression (structural equations estimated by LISREL 8.51) was used to check relations between the individual characteristics and differentiation of processing the facial schematic stimuli. The influence of the interactions among personality

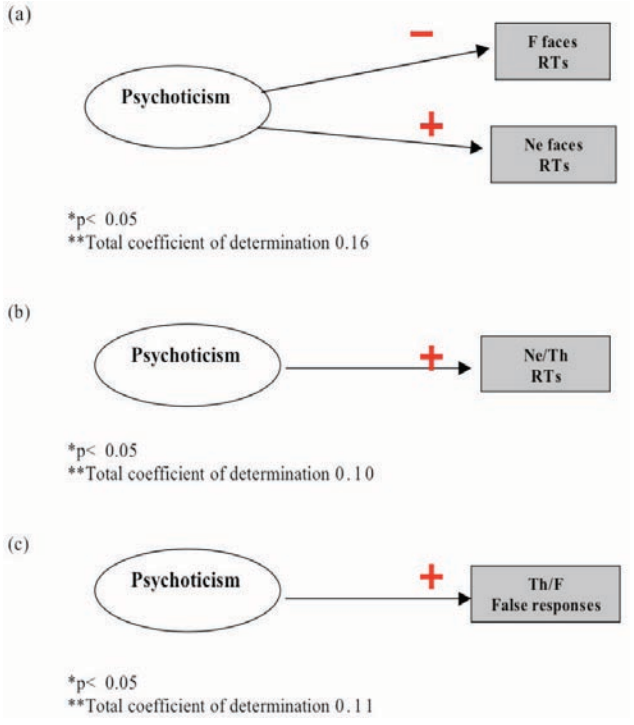


Figure 3. Results of the exploratory multi-multivariable analysis of regression for reaction times for correct responses (in ms) to friendly (F), neutral (Ne) and threatening (Th) faces (a) across distractors; (b) against distractors; and for false responses to friendly (F), neutral (Ne) and threatening (Th) faces (c) against distractors.

dimensions and copying styles on processing the emotional stimuli was also analysed. A three-way ANOVA with repeated measures on one factor (facial expression) was performed to compare the different personality traits (psychoticism, neuroticism, extraversion) with groups of different styles of coping (low-anxious, repressors, high-anxious, and defensive high-anxious) in their reaction times and response accuracy to facial targets.

The exploratory multi-multivariable analysis of regression revealed significant negative relations between psychoticism and reaction times to friendly faces (F), and the significant positive relations between psychoticism and reaction times to neutral faces (Ne) and neutral faces against threatening crowd (Ne/Th), and positive relation with response accuracy to threatening faces against friendly crowd (Th/F) (see Figure 3 (a); (b); (c)]

High psychoticism relates to faster detection of friendly faces, slower detection of neutral faces, and neutral faces against threatening distractors, and higher percentage of false responses to threatening faces against friendly distractors. These results suggest that individuals high in psychoticism are attentionaly biased to friendly faces not to angry and neutral ones.

There was a significant interaction between anxiety and psychoticism for the reaction times for the correct responses to friendly, neutral and threatening faces ($F_{(3; 71)} = 2.93$; $p < 0.04$) (see Figure 4).

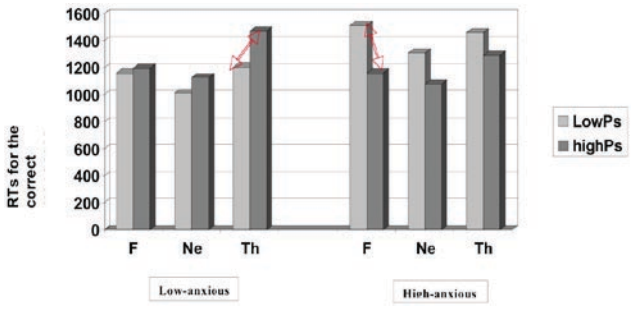


Figure 4. Means of reaction times for the correct responses (in ms) to friendly (F), neutral (Ne) and threatening (Th) faces (without distractors) in low-anxious and high-anxious groups low and high in psychoticism.

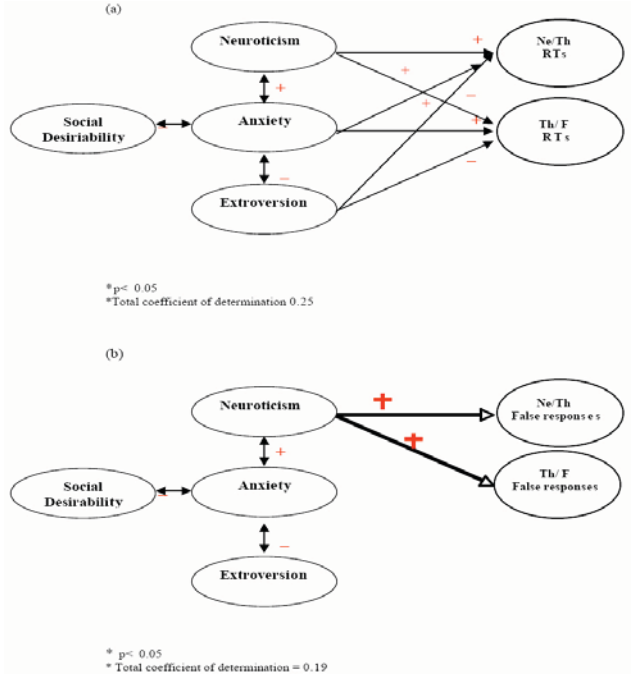


Figure 5. Results of the exploratory multi-multivariable analysis of regression for (a) reaction times for correct responses to friendly (F), neutral (Ne) and threatening (Th) faces with distractors and for (b) false responses to friendly (F), neutral (Ne) and threatening (Th) faces with distractors.

Participants low in psychoticism were significantly faster than those high in psychoticism in detecting threatening faces among those with a low anxiety ($F_{(1; 15)} = 4.52$; $p < 0.05$). In addition, individuals low in psychoticism were significantly slower than those high in psychoticism in detecting friendly faces among high- anxious subjects ($F_{(1; 19)} = 4.80$; $p < 0.04$) [see also Figure 3 (a)]. These findings suggest that individuals high in psychoticism (low- or high-anxious) tend towards an opposite face-in-the-crowd effect, taking relatively longer to detect threatening faces than friendly ones. Thus, these individuals tend to react in the opposite direction to the whole group examined in this study. In other words, high anxious psychotics processed efficiently friendly faces.

The findings in terms of effects of the combinations of neuroticism, anxiety and extraversion on target detection times are demonstrated in Figure 5 (a) and (b).

According to Figure 5 (a), there is a direct and positive relation between neuroticism and anxiety and direct and negative between extraversion and reaction times to neutral target faces with threatening distractors (Ne/Th) and threatening target faces with friendly distractors (Th/F). It means that neurotics, high-anxious individuals, and introverts are slower in processing Ne/Th and Th/F than non-neurotics, low anxious, and extraverts ones. There is also an indirect relation between social desirability (through its relation with anxiety) and reaction times to Ne/Th and Th/F. Thus, high-anxious individuals with low social desirability (non-defensive style of coping) are slower in processing these stimuli than low-anxious participants with high social desirability (repressive style of coping). Moreover, as is seen in Figure 5 (b), neuroticism positively and directly relates to false responses to Ne/Th and Th/F while anxiety, extraversion and social desirability indirectly.

Referring to the analysis of relations among independent variables [(see Figure 5 (a) and (b)], there are two coherent types of personalities, which can be compared. Coherent melancholic individuals (high-anxious, neurotic introverts with non-defensive coping style) show slower detection of neutral target faces with threatening distractors and threatening target faces with friendly distractors, and had more false responses in these two conditions. Coherent sanguine individuals (low-anxious emotionally stable extraverts with repressive style of coping) were faster in detection of neutral faces with threatening distractors and threatening faces with friendly distractors, and had fewer false responses in those conditions.

Discussion

The face-in-the-crowd effect (higher accuracy and faster detection of threatening than of friendly target faces) has not been obtained consistently (see Őhman et al., 2001a; 2001 b, for a review). Nevertheless, when schematic faces have been used to minimise methodological problems, there has been consistent evidence for the existence of the face-in-the-crowd effect (e.g., Őhman et al., 2001a; 2001b; Juth et al., 2005). However, it was still the case that neutral faces with emotional background were detected faster than emotional faces with the opposite emotional distractors (see Őhman et al., 2001). The findings of Experiment 1 are to some extent consistent since there was a highly significant face-in-the-crowd effect with schematic faces. We also found that neutral faces were preferentially detected; sometimes they were processed faster and more accurately than angry faces. This pattern of detection of emotional faces was also observed in other studies (e.g. Fajkowska & Krejtz, 2007; 2006; Fajkowska & Marszał-Wiśniewska, 2006).

Contrary to the hypothesis of personality congruent processing (e.g., Fox, 2008) the findings from Experiment 1 indicated an opposite face-in-the-crowd effect pattern of

detection in psychoticism. Thus, high psychoticism scorers showed a tendency to detect friendly target faces more rapidly than threatening target faces opposite to the pattern observed in the great majority of individuals. Interestingly, even interaction between high psychoticism and anxiety had not changed this attentional bias toward happiness into anxious- related bias toward threat. Relating these results to the attentional control theory proposed by Eysenck et al. (2007) we can say that high degrees of psychoticism and anxiety are associated with an enhanced allocation of attentional resources toward happiness relative to other types of emotional information. In other words, high anxiety and high psychoticism effectively disrupt the balance between top-down attentional control and stimulus-driven processing of information what is reflected in more efficient processing of positive than negative emotion. Thus, the pattern of results found in high anxious psychotics suggests the personality incongruent orienting effect. One reasonable interpretation of these results refers to the well-established principle that novel stimuli attract attention at fairly automatic levels (e.g., Őhman, Hamm and Hugdahl, 2000). On the logical ground, this means that friendly faces could be detected by high anxious psychotics as unfamiliar or novel ones what determine the nature of this attentional bias. This brings us to question addressed to a role of anxiety in producing this attentional bias in psychotics. Presumably, anxiety involved in interaction with high psychoticism probably speeds reactions to friendly faces in high psychotics who generally possess a relatively less sensitive temporal processing system than low psychoticism scorers (Eysenck & Eysenck 1985). And, generally impaired inhibitory selective mechanisms in high psychotics (Eysenck 1967; 1992; Szymura & Śmigasiewicz, manuscript) may operate effectively for the sake of efficient processing of friendly faces and efficient inhibition of concurrently presented distractors (crowd).
This study also found that processing of threatening and neutral faces was associated with two coherent types of personalities, in which the level of temperamental traits (neuroticism and extraversion) was consistent with the level of anxiety [compare with Figure 1 (a)]. However, efficient processing of threatening and neutral faces was connected with coherent, emotionally stable extraverts with repressive style of coping (sanguine quadrant) while inefficient processing of these facial targets was bound with coherent neurotic introverts with a non-defensive coping style (melancholic quadrant).

As predicted, the repressive coping in coherent sanguine types is associated with the vigilance for threat in order to eliminate a potential neglecting of significant information. It was explained earlier in this paper that high capacities of processing stimulation and positive emotions typical for sanguine types broaden their attentional focus (see Fox, 2008) what potentially does not allow them to detect accurately significant threatening signals and protect themselves against negative or painful outcomes. In other words, it is possible that repressive coping has been developed in coherent sanguine individuals in order to narrow their attentional focus and to be more reactive to a threatening encounter.

In context of processing social and emotional material this seems likely that worse processing efficiency of threat might be related to low level of social desirability in coherent melancholic individuals (high-anxious, neurotic introverts). However, with a variety of stimuli in a number of studies have been found evidence suggesting that impaired attentional control and attentional selectivity is tied to introversion and neuroticism –the key components of melancholic type (e.g., Szymura & Nęcka, 1998; Szymura & Wodniecka, 2003). Nevertheless, it seems to be possible that an important function of defensive coping is to facilitate adaptive reactions and behaviours to social threat in individuals with low capacities of processing stimulation.

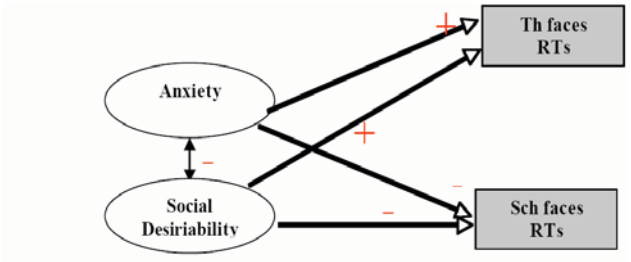
In sum, the findings from Experiment 1 revealed that effect of anxiety on cognitive performance relates to other personality characteristics. As we have seen, anxiety: (1) enhances the processing efficiency of positive emotional material when interacts with high psychoticism; (2) affects the processing efficiency of threatening and neutral stimuli when is „hidden" in repressive coping in coherent sanguine personality; (3) has impact on inefficient processing of threatening and neutral stimuli when is a part of coherent non-defensive melancholic structure of personality.

Experiment 2

The findings from Experiment 1 indicated that the magnitude and existence of the emotional facial stimuli processing depend on various dimensions of individual differences. However, that experiment was limited in that participants were only required to detect a narrow range of negative stimuli. As a consequence, it is thus unclear whether the impact of various dimensions of individual differences on detection speed of negative target faces is specific to threatening faces or whether it is a more general effect encompassing most (or all) negative target faces.

Accordingly, Experiment 2 included a much wider range of negative emotional faces. Three categories of negative emotional faces were used as targets in addition to positive (friendly) targets: threatening; sad; and scheming faces. There is an important difference between Experiment 2 and Experiment 1. In Experiment 1, there were three types of faces (threatening, friendly, and neutral), and two types of distractor faces were used across trials for each type of target face (e.g., threatening or friendly with neutral targets). In contrast, in Experiment 2, there were no neutral target faces, and the distractor faces were always neutral. This difference is significant because target faces are typically detected much faster when distractors are neutral

Figure 6. The sample of faces used in the Experiment 2, adapted from Öhman, Lundqvist, and Esteves (2001).



*p< 0.05
*Total coefficient of determination 0.21

Figure 7. Results of the exploratory multi-multivariable analysis of regression for reaction times for correct responses to threatening (Th), friendly (F), sad (Sa), and scheming (Sch) faces.

rather than emotional (Őhman et al., 2001 b). This implies less detailed processing of the faces within the stimulus array when the distractors are neutral than when they are emotional, which might influence the impact of personality and coping style on target detection times.

Considering the level of complexity Experiment 2 was selected from the range of *face-in-the-crowd* experiments elaborated by Őhman et al. (2001b) as the most similar to Experiment 1.

Method

Participants

A total of 95 psychology undergraduate students were included to the research. There were 80 females and 15 males with a mean age of 20.86 years and SD of 2.91 years. As in Experiment 1, they completed three questionnaires: the Revised Eysenck Personality Questionnaire (EPQ-R; Eysenck & Eysenck, 1994), the Spielberger State-Trait Anxiety Inventory (STAI; Wrześniewski & Sosnowski, 1996), and the Marlowe-Crowne Social Desirability Scale. (Crowne & Marlowe, 1960; Drwal & Wilczyńska, 1980). Median splits on the trait anxiety and defensiveness scores were used to classify the 95 participants into four coping styles groups.

Procedure

The experimental procedure was designed after Öhman et al. (2001 b, p. 391). There were used four categories of target faces (i.e., friendly, sad, threatening, and scheming) all of which were presented concurrently with neutral distractor faces (see Figure 6).

The experiment was divided into 3 blocks of 72 trials each, and the total number of trials, presented in a random order, was 216. Each of the four targets was presented once in each of the nine positions in the matrix, and there were an equal number of non-target matrices in each block. The duration of the matrix was either 1 s or 2 s.

Results

One-way ANOVAs with repeated measures on face target were utilised to analyse the reaction times and response accuracy across all participants (N=95). There was no effect of category of target face on response accuracy, but there was a significant effect of target type ($F_{(3; 92)} = 17.87$; $p < 0.001$), with the scheming and threatening faces being detected faster than sad and friendly ones. Threatening target faces were detected faster than friendly target faces ($F_{(1; 94)} = 24.01$; $p < 0.001$) and sad faces ($F_{(1; 94)} = 7.88$; $p < 0.006$); scheming faces were detected faster than sad ($F_{(1; 94)} = 17.73$; $p < 0.001$) and friendly faces ($F_{(1; 94)} = 37.76$; $p < 0.001$); and sad faces were detected faster than friendly ones ($F_{(1; 94)} = 37.76$; $p < 0.001$).

According to these results all participants were more sensitive to threatening and scheming faces what indicate angry and scheming faces in the crowd effects. The general pattern of the findings is consistent with that reported by Őhman et al. (2001 b), with threatening faces being detected the fastest and friendly faces the slowest. A comparison of detection times for threatening and friendly target faces in this experiment with those in Experiment 1 points out that they were more than 300 ms faster in this experiment. This support the results of Őhman et al. (2001 b), who found emotional faces were detected much faster against a background of neutral than of emotional faces.

The exploratory multi-multivariable analysis of regression (structural equations estimated by LISREL 8.51) provided results on relations between personality characteristics and processing facial expressions. A direct and positive relation was identified between anxiety and direct and negative relation between social desirability and reaction times to threatening and scheming faces (see Figure 7). In other words, high-anxious individuals were slower than low-anxious individuals in processing those stimuli, and individuals scoring high on social desirability were faster in detection threatening and scheming faces than those low on social desirability.

Analysis of relations between independent variables revealed that the repressive coping (low anxiety and high social desirability) is associated with faster detection of threatening and scheming faces while the non-defensive high-anxious coping (high anxiety and low social desirability) relates to slower detection of those stimuli. To some extend these findings are consistent with findings from Experiment 1, namely the efficient processing of negative emotional material is associated with the repressive style of coping.

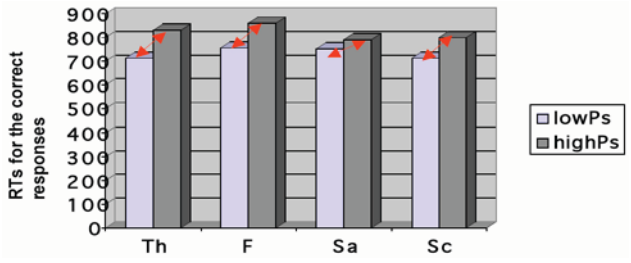


Figure 8. Mean RTs for correct responses to threatening (Th), friendly (F), sad (Sa), and scheming (Sc) in low- and high- in psychoticism groups.

A three-factor ANOVA (personality, coping style, and type of facial target) with repeated measures on type of facial target was performed to assess interactions between style of coping and personality traits, and independent variables. The main effect of psychoticism ($F_{(1; 89)} = 6.40$); $p < 0.014$) was statistically significant. Figure 8 illustrates differentiation in reaction times to facial expressions by the level of psychoticism.

As can be seen in Figure 8, individuals low in psychoticism detect threatening ($p<0.006$), friendly ($p<0.008$), sad ($p< 0.05$) and scheming ($p<0.011$) target faces faster than those high in psychoticism. Generally, psychotic individuals were slower in detection emotional signals against the neutral distractors than non-psychotic participants.

Discussion

Most previous studies of the face-in-the-crowd effect have focused on showing that threatening faces are detected more rapidly than friendly faces. Őhman et al. (2001 b) used a wider range of negative facial stimuli, finding in their Experiment 5 a face-in-the-crowd effect only with threatening faces and not with scheming ones. In contrast, evidence for a face-in-the-crowd effect was found in our Experiment 2 for scheming faces as well as threatening faces. The number of participants (95 vs. 18) was much greater in this experiment than Experiment 5 of Őhman et al. (2001 b), which may help to explain these differences. However, the same ordering across face types was found in both experiments, with threatening faces detected fastest followed in order by scheming, sad, and friendly faces.

The findings with respect to the effects of personality and copying style differed from those of Experiment 1, especially in the case of psychoticism. Moreover, there were far fewer effects of personality and of coping style on face detection times in Experiment 2 than in Experiment 1. Generally, the Experiment 2 showed efficient processing of threatening and scheming faces among individuals with the repressive style of coping, and high psychoticism scorers were slower to detect emotional material.

There are various ways of interpreting these results and discrepancies between them.

The first inconsistency concerns the non-significant effects of neuroticism and extraversion in processing emotional material in Experiment 2. As indicated in the Results section, the task was much easier with target detection times being considerably faster than in Experiment 1 because the targets were easier to discriminate from the distractors. It is likely that participants in Experiment 1 made more use of complex, controlled processes on the face detection task than those in Experiment 2. Perhaps the findings can be regarded as consistent if it is assumed that the effects of personality and of coping style on processing affect controlled processes to a greater extent than more automatic processes. Additionally, there is evidence that temperamental traits (e.g., extraversion and neuroticism) reveal themselves in difficult or demanding contexts with their adaptive and maladaptive functions (see Strelau, 2008). For instance, situational complexity (e.g., level of difficulty of experimental tasks) potentially affects the processing of emotional stimuli in neurotics and introverts (see Szymura, 2007).

The second inconsistency is associated with the role of psychoticism in processing emotional material. Contrary to the hypothesis of personality congruent processing (e.g., Fox, 2008) psychoticism was related to the efficient processing of friendly faces in Experiment 1, but consistently with this hypothesis, to the inefficient processing of emotional material in Experiment 2. Perhaps impaired inhibitory selective mechanisms in high-psychotic individuals (Eysenck 1967; 1992) are enhanced when psychoticism does not interact with anxiety. Hypothetically, anxiety constitutes the effective cognitive control in psychotics what makes them more susceptible for the social and emotional material.

There was an association between repressive style of coping and increased processing efficiency of threatening, neutral and scheming faces in both experiments. It was an indirect connection (through the other personality properties) in the more complex task and direct in the easier one. These findings suggest that the role of social desirability in efficient processing of negative emotional material deserves for further study.

An important conclusion emerged from Experiment 2 is that investigating effects of individual differences on attentional control mechanisms we should also consider the situational influences. Thus, once again this is a challenge for the hypothesis of personality congruent processing (see Fox, 2008, for a review).

General discussion

Many unresolved questions relate to the specificity of relation between anxiety and performance. For example, what affects the inconsistency of results in cognitive performance in anxious individuals? One way to address

this issue is to consider the heterogeneity of this group. This is formed by the differentiation in the level of defensiveness (e.g., Weinberger et al., 1979; Eysenck, 2006) and the differentiation in the effort-related and arousal-related individual properties in anxious individuals (e.g., Fajkowska & Krejtz, 2006; 2007).

Consequently, across two experiments using the face-in -the -crowd procedure the present study tested the hypothesis that anxious individuals process facial stimuli in a manner associated with their style of coping and the level of extraversion, neuroticism and psychoticism. We have predicted that attentional mechanisms may be modulated directly (*via* enhancing) or indirectly (*via* facilitating) by variations of a range of personality and temperamental traits, and that these traits interact or intercorrelate with each other and produce attentional biases being specific for this interaction or intercorrelation . In other words, we have assumed that several other dimensions of individual differences qualify the effects of anxiety on attentional processing of facial expressions.

The results have been obtained from two experiments support this hypothesis. It was shown that particular structure of personality promotes specific functional role of anxiety in processing facial emotional material. Subsequently a differentiation in attention biases in anxious individuals was observed. Namely, the evidence from this research indicated that anxiety combined with other personality characteristics enhances the processing efficiency of positive emotional material (when interacts with psychoticism) and of threatening and neutral stimuli (when is „hidden" in repressive coping in coherent sanguine personality). In addition anxiety affects the inefficient processing of threatening and neutral stimuli (when is a part of coherent non-defensive melancholic structure of personality). This pattern of findings suggests interpretation that, anxiety is associated with efficient processing and good attentional selectivity (searching and inhibition) when expresses itself in more formal characteristics of behaviour e.g., by enhancing speed of processing, sensivity to particular emotional stimuli.

The study also expanded on the role of psychoticism and repressive coping in processing facial stimuli. Psychoticism was associated with impaired processing of emotional material but when it interacted with anxiety detection was more effective and content-specific. In that case, psychoticism was combined with preferential processing of positive material. The reasons for that might be that facial stimuli represent a class of social stimuli, a domain that high-psychoticism individuals seem not to process selectively unless they are high on anxiety.

The repressive style of coping related to preferential processing of threatening faces. These results are interesting but appear to conflict with the findings suggesting that repressive coping relates to the automatic tendency to avoid threat (e.g., Derakshan et al., 2007). However, both patterns of behavioural reactions might be attached to repressive coping. This issue may be clarified nicely by the presented in Introduction section Figure 1 (a) and (b) which provides an indication of the inter-relationships among personality characteristics considered in this study. Once again this leads to the suggestion that particular function of repressive coping is related to particular structure of personality. For instance, the vigilance for threat occurs when repressive coping is merged with coherent sanguine personality (as reported from this study), presumably in order to eliminate a potential neglecting of significant information. Repressive motivation seems to be play an adaptive role, however „as a part of whole" by indirect relations to time and accuracy of threat processing [see Figure 5 (a) and (b)]. It initiates and facilitates threat processing. Threat recruits the posterior attentional system and induces arousal, thus efficient threat processing is more directly associated with stimulation reducing mechanism (see Strelau, 2008) typical for sanguine individuals. Hypothetically, threat avoidance may be present when repressive coping is incorporated to incoherent melancholic personality inorder to eliminate overstimulation. Melancholic individuals have temperamental traits associated with a high level of arousability and stimulation augmenting mechanism (Strelau, 2008). Thus, threat avoidance may restrict the activation of the stimulation augmenting mechanism forthe benefit of adaptive outcomes.

Thus, taken together these results are a challenge not only for the personality congruent processing hypothesis but also for the negativity hypothesis (e.g., Dowens & Calvo, 2003), which assumes that anxiety-related biases are limited to negative emotional stimuli.

In sum, we have found that processing various types of emotional targets depend on various aspects of personality and of coping style in interaction and intercorrelation. Moreover, they also depend on various aspect of situation. Several of the findings are novel, and it is a matter for future research to clarify their optimal interpretation.

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