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Individual differences in visual and auditory processing of emotional material

Abstract: *Presented studies investigated the specificity of visual and auditory modalities in attentional processing of emotion, and its association with temperamental dimensions and trait-like attentional control (AC). During preliminary study 30 participants were presented with the paper-pencil visual search task (Emotional Faces Attentional Test) and emotional prosody detection tasks (Emotional Prosody Test). Results revealed visual happiness superiority and auditory sadness superiority. During the main study, in addition to attentional performance, 51 subjects were administrated two questionnaires: EPQ-R and Attentional Control Scale. Introducing individual differences into analysis limited the general pattern of modality distinctiveness in attentional processing of emotional stimuli obtained in the preliminary study. Findings for all personality traits studied separately showed that Extraversion and low Neuroticism were associated with the visual sadness superiority. Whereas interactional analysis indicated effective visual threat processing in extraverts with good AC and effective friendly prosody detection when Neuroticism and AC remain in inverse relationship. Hence, we have found that processing emotional targets in both modalities is associated with temperament dimensions and their interactions with attentional control. Additionally, findings from both studies suggest that general psychological laws might be challenged by individual differences.*
Key words: *temperament, attention, emotional facial expression, emotional prosody*

Introduction

A large number of empirical studies have demonstrated that humans can correctly recognize others affect both from facial expressions and voice samples, regardless of the verbal content spoken (Johnstone & Scherer, 2000). Accuracy of affective state recognition depends primarily on communication channel of emotion expression (Wallbott & Scherer, 1986), which is linked to diverse functioning of attention in vision and audition (Styles, 2006), and on receivers personality characteristics, such as anxiety, temperament, style of coping (Fajkowka & Eysenck, 2008) or depression (Siegmand & Boyle, 1993). However, research on the accuracy of basic emotions detection in visual and auditory attentional tasks have left unexplained variance. Moreover, most investigations examining attentional biases in emotion perception, which are greatly influenced by arousal-related and effort-related personality predispositions, have focused on visual tasks that primarily engage the reactive *posterior attentional system* (Fajkowka & Eysenck, 2008; Fox, 2008). Nevertheless, it is convincible that voluntary attention is also recruited in the detection of emotional facial expressions and prosody. It has been indicated that anxious good attenders show smaller orienting effect toward threatening stimuli than anxious participants with poor attentional control (AC) (Derryberry & Reed, 2002). We argue that, in addition to their automatic attentional biases, personality dimensions, such as Extraversion or Neuroticism, are also heterogeneous with regard to AC, and differ in terms of recruiting volitional attention in processing of emotional material (cf. Fajkowska & Derryberry, 2010). Hence, the purpose of our studies is to identify the patterns of basic emotion detection in both modalities, and to investigate how personality and trait-like AC influence the accuracy of emotional expression detection in visual and auditory channels.

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Preliminary study: Detection of basic emotions in vision and audition

Early studies on emotional facial expressions' processing investigated mainly the accuracy of facial displays recognition (Ekman, 1992; Izard, 1977) and showed that happiness is the easiest and most accurately identified emotion in visual modality, with its mean recognition accuracy equal about 90%. It is hypothesized that happiness may be the easiest facial expression to reproduce voluntarily and might be the most frequently used one (Ekman & Friesen, 1976; Gainotti, 2000), hence such high detection correctness. More recent studies on the processing of facial expressions which additionally measured reaction times of face detection, demonstrated that there also exists a genuine enhancement of the recognition of angry target faces (Fox, 2002; Hansen & Hansen, 1988; Őhman, Lundqvist, & Esteves, 2001). Accordingly, it is probable that the detection of angry and happy faces engages different components of the attentional system. Orienting our attention towards threatening faces may be dictated by reactive *posterior attentional system* (Posner & Petersen, 1990; Posner & Rothbart, 1998), whereas detecting happy face may be influenced by *anterior attentional system* (e.g., Derryberry, 2002). Precisely, Fajkowska and Derryberry (2010) postulated the strategic nature of positive information, which consists in a less automatic and more voluntary properties of attention to happiness than to threat. Thus, along with these findings we expect that the effortful AC may modulate the accuracy of detection of specific emotional facial expression.

Contrary to vision, some studies on detection of emotional prosody (global patterns of emotional acoustic cues that indicate the intentional emotional tone of a speaker) suggest that anger and sadness are the easiest and most accurately recognized emotions in auditory modality (Johnstone & Scherer; 2000; Juslin & Laukka, 2003). Johnstone and Scherer (2000) suggested that voice is probably more suitable for signaling certain emotions than other and, therefore, being able to threaten others in a fairly indirect way over large distances has a clear adaptive value. High recognition of sadness can be explained in terms of bandpass filter. Styels (2006) indicated that sound frequency appears to be a more effective selective cue than spatial location in case of vocal stimuli. Auditory attention acts as a filter, only passing frequencies with limited frequency band. Hence, individuals can orient their attention to the expected frequency and filter out other frequencies. Since sadness is associated with a decrease in speech rate and loudness (Scherer, 1986), it is probably recognized through its relatively unique vocal profile.

However, a study by Trimmer and Cuddy (2008) on recognition of emotional prosody, did not confirm these patterns of results. They revealed that participants showed greater recognition accuracy in case of happy utterances than in case of angry, fearful or sad ones, and suggested that these results indicate cross-sensory processes of emotion recognition.

Since the above-mentioned results provide unclear evidence, we have designed two separate studies utilizing the same procedure as to, in the first one, identify the general patterns of attentional processing across visual and auditory modality, and the second one, as to exam any changes in these general patterns after introducing individual differences to the analysis.

Method

Participants
30 participants (19 females) with a mean age of 30.5 years (SD_{age} = 9.77) took part in a study.

Procedure
Visual and auditory attentional tests were administrated separately with a one week interval.
Emotional Faces Attentional Test – paper and pencil visual search task (EFAT; Fajkowska, 2013). The set of stimuli consisted of 384 Ekman colored pictures of emotional facial expressions and included threatening (Th), friendly (F), sad (S), and neutral (Ne) faces (Ekman & Friesen, 1976). Pictures were taken from 16 individuals (8 males) and were arranged in 24 x 16 blocks on a standard sheet of paper. Stimuli were randomly presented. Participants were instructed to cross out as quickly as possible a target face expression, Th, F, and S face respectively, in matrix within 2 minutes. The order of the emotional faces search was controlled.
Emotional Prosody Test (EPT; Bryan, 1989; Łojek, 2007) is composed of 16 spoken, meaningless utterances pronounced with three randomly presented target intonations: threatening (Th), friendly (F), and sad (S). The task is recorded on a CD and was presented via computer loudspeakers. Participants were instructed to indicate on the separate sheet of paper the particular target intonation. The order of the emotional intonation search was controlled.

Results
Repeated measures two-way multivariate analyses of variance (MANOVAs) consisting of facial affect (3) or prosody (3) as within-subject factors were performed in order to investigate the effectiveness of processing the emotional material. Response accuracy (the percentage of participants' correct responses consistent with the original coding) indicating effectiveness of attentional processing, and total number of errors, which constitute of the percentage of participants' responses inconsistent with the original coding (false alarms) and omitted target expressions (omissions) denoting ineffectiveness of attentional processing were taken into investigation.

The analysis of visual response accuracy showed that the emotional facial expression effect has reached significance, $F(2,28)= 63.75$, $p < .001$, $\eta^2 = .82$. Positive facial targets were detected most effectively. More precisely, F faces (.72[mean]) were detected more accurately than Th (.43) and S (.37) ones, $p < .001$; .001, respectively. Moreover, participants recognized Th facial expressions with more hits than S faces, $p < .03$.

Additionally, it was revealed that the type of emotional facial expression had a significant effect on mistakes made during the detection task, $F(2,28) = 32.61$, $p < .001$, $\eta^2 = .70$. Participants made less mistakes while identifying F faces (.03) as compared with Th (.09) and S (.11) ones, $p < .001$; .001, respectively (see Figure 1).
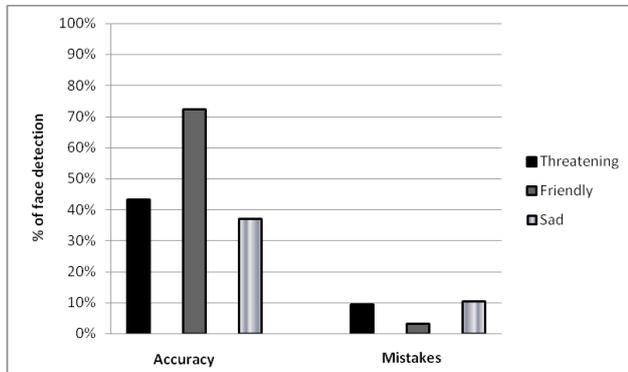

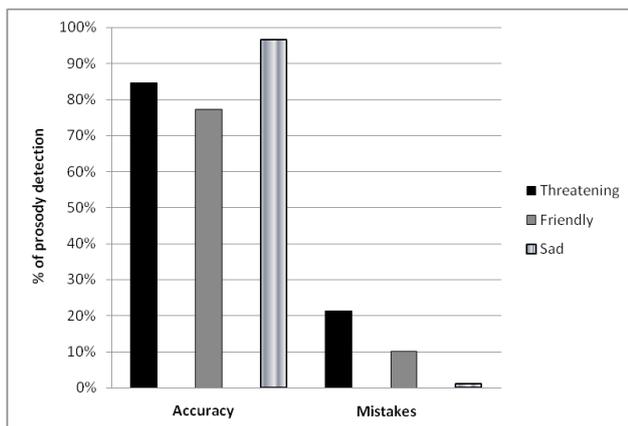**Figure 1. Response accuracy and mistakes in visual modality.**

Figure 2. Response accuracy and mistakes in auditory modality.

Furthermore, the analysis of auditory response accuracy showed significant main effect of vocal affect, $F(2,28) = 13.68$, $p < .001$, $\eta^2 = .49$, revealing that S intonation (.96) was detected more accurately than Th (.85) and F (.77) ones, $p < .01$; .001, respectively. In addition, the type of emotional prosody had a significant effect on mistakes, $F(2,28) = 23.9$, $p < .001$, $\eta^2 = .63$. S intonation (.01) was identified with less mistakes than both Th (.21) and F (.10) ones, $p < .001$; .001, respectively. Moreover, analysis showed that F vocal signals were detected with less mistakes than Th one, $p < .001$ (see Figure 2).

Discussion

The results of the preliminary study clearly demonstrate a modality differentiation over responses to affective material. In visual channel, happiness is the most effectively processed emotional facial expression, which confirms early studies on facial emotion detection (Ekman,

1992; Izard, 1977). Since reaction times were not measured, enhancement of the recognition of angry target faces could not be observed (e.g., Pinkham et al., 2010). The results of auditory response accuracy indicate that sadness is the most effectively recognized prosody, probably due to its unique vocal profile (Scherer, 1986).

However, regardless of the engaged modality, detection of emotional stimuli also depends largely on the level of one's arousal and cognitive properties. Arousal is considered as the basis for individual differences in temperament (Strelau, 2000) and is crucial for regulating the interplay between an individual and environment. It can be assumed that temperamental traits determine one's level of arousal, which may be activated under emotional stimulation and, hence, they can also specifically differentiate the recognition accuracy of this stimulation (Fajkowska & Krejtz, 2006). Moreover, personality dimensions are crucial in terms of posterior and anterior attentional systems functioning (cf. Fajkowska, 2013). Consequently, the main study is aimed at investigating how individual differences in temperament traits and AC, seen as relatively stable individual predispositions, influence the general pattern of emotion recognition in visual and auditory modality.

Main study: Individual differences in detection of basic emotions in vision and audition

It has been indicated that personality traits, such as Extraversion or Neuroticism, are associated with attentional biases to process different classes of information (see Fox, 2008). These biases are mainly related to the functioning of stimulus driven attentional system. In visual modality, for example, Extraversion is associated with faster reaction times to positive words or faces (Rusting & Larsen, 1998), which implies faster encoding of positive material. Moreover, extraverts are slower to disengage their attention from the location where a positive incentive has been presented, while introverts are slower to disengage their attention from the location where a negative incentive have been presented (Derryberry & Reed, 1994). However, most of the research on attentional biases of extraverts were focused solely on visual tasks. Nevertheless, since many studies indicate that Extraversion is greatly associated with positive affect (e.g., DeNeve & Cooper, 1998; Lucas & Fujita, 2000) and sensitivity to visual positive stimuli (e.g., Depue & Collins, 1999; Gomez, Gomez, & Cooper 2002), we hypothesize that this preferential processing of positively valenced material may also occur in auditory modality. Moreover, it has been indicated that Extraversion is positively correlated with voluntary AC (see Derryberry, 2002; Derryberry & Reed, 2001, 2003; Fajkowska & Derryberry, 2010). Therefore, extraverts should be superior in comparison to introverts during emotion detection task constraining their automatic attentional reactions to positive material and focusing their cognitive resources on detecting other basic emotions in both modalities. Alternatively, it is also highly probable that neither extraverts nor introverts are the homogeneous groups with regard to AC. Thus, detection of affective material in attentional task might not

only depend on temperamental traits, but also on the scope of effortful attention recruitment. Extraverts with good AC may perform better during visual and auditory attentional detection tasks than extraverts with poor AC. The same principle can possibly apply to introverts.

Although anxiety, but not Neuroticism, is referred to in most attentional studies (Szymura, 2007), and many researchers use these terms interchangeably (see Fox, 2008), it is suggested that neurotics exhibit attentional biases towards negatively valenced information, especially threat. Some research indicate that high anxiety (ipso facto Neuroticism) is associated with an impaired ability to actively inhibit threat-related emotional material (Derryberry & Reed, 2002; Fox, 1994), and reduced ability to recruit attentional control (Bishop, Duncan, Brett, & Lawrence, 2004). Hence, highly anxious individuals may process emotional facial expressions more automatically than those with low levels of anxiety (Fox, Russo & Georgiou, 2005). It has been shown that the same biases occur in auditory modality. During a dichotic listening task participants with higher levels of trait-anxiety (Neuroticism) experience more disruption to the shadowing task when threat-related words are presented to the non-shadowed ear (Foa & McNally, 1986; Mathews & MacLeod, 1985). Moreover, Corbetta, and Shulman (2002) indicated that anxiety (Neuroticism) impairs efficient functioning of the goal-directed attentional system, and increases the extent to which processing is influenced by the 'bottom-up' attentional system. On the other hand, additional studies (Derryberry & Reed, 2002; Fajkowska & Eysenck, 2008) have shown that highly anxious individuals form a heterogeneous group, which differs in the level of 'top-down' attentional control. Thus, anxious good attenders are able to constrain their automatic tendencies to preferentially process threatening material, as opposed to anxious poor attenders. Therefore, we hypothesize that, similarly to extraverts and introverts, neurotics are possibly not a homogeneous group with regard to the functioning of anterior attentional system, and their performance in emotion detection attentional task will depend on the level of 'top-down' AC.

To conclude, we expected that participants would preferentially process facial and acoustic emotional information congruent with their temperamental traits studied solely or in interactions. The level of volitional AC, however, might moderate these effects.

Method

Participants

51 undergraduate students (34 females) with a mean age of 24.3 years (SD_{age} = 6.59) completed two questionnaires: Eysenck Personality Questionnaire – Revised (EPQ-R; Eysenck & Eysenck, 1994) and Attentional Control Scale (Fajkowska & Derryberry, 2010). They were categorized into two groups (low and high intensity of the given trait) based on the median split on Extraversion, Neuroticism, and Attention Control.

Procedure

EFAT (Fajkowska, 2013) and EPT (Bryan, 1989; Łojek, 2007) were administered separately with a one week interval.

Results

Repeated measures two-way multivariate analyses of variance (MANOVAs) consisting of facial affect (3) or prosody (3) as within-subject factors were performed to analyze processing of visual and auditory emotional material across the whole group. Analogically, response accuracy and total number of errors were analyzed.

The results revealed the same pattern of processing, as obtained in the preliminary study: visual happiness superiority and auditory sadness superiority. On a more elaborated level, the analysis of visual response accuracy showed that there was a main effect of facial affect, $F(2,49)$ = 170.42, $p < .001$, $\eta^2 = .87$. F faces (.75) were detected more accurately than Th (.47) and S (.37) ones, $p < .001$; .001, respectively. Moreover, Th faces were recognized with more hits than S faces, p < .001. In addition, the results denoted significant effect of emotional facial expression on mistakes, $F(2,49) = 42.74$, $p < .001$, $\eta^2 = .64$. F faces (.04) were identified with less mistakes than Th (.10) and S (.11) ones, $p < .001$; .001, respectively.

The analysis of the auditory response accuracy revealed significant emotional intonation effect, $F(2,41)$ = 13.34, $p < .001$, $\eta^2 = .39$. Results indicated that S prosody (.97) was detected more accurately than Th (.90) and F (.77) ones, $p < .01$; .001, respectively. Furthermore, participants identified Th vocal samples more accurately than F ones, $p < .001$. In addition, it was shown that the type of emotional intonation had a significant effect on mistakes, $F(2,41) = 24.8$, $p < .001$, $\eta^2 = .55$. S intonation (.01) was recognized with less mistakes than both Th (.18) and F (.11) prosody, $p < .001$; .001, respectively. Analysis also indicated that F intonation was identified with less mistakes than Th one, $p < .001$.

Subsequently, repeated measures two-way multivariate analyses of variance (MANOVAs) using facial affect (3) or prosody (3) as within-subject factors and between-subject factor Group (2) were conducted, to test whether there are any differences in response accuracy and mistakes between the distinguished groups.

Evidence for all personality traits studied separately showed that Extraversion and low Neuroticism were associated with the visual sadness superiority. There were no significant results for AC across both modalities and all differential traits and auditory modality. Thus, between-group differences in visual response accuracy reached significance, $F(2,47) = 2.96$, $p < .05$, $\eta^2 = .16$. Extraverts (.42) detected S faces more effectively than introverts (.32), $p < .01$. Moreover, it was revealed that the type of emotional facial expression had a significant effect on mistakes, $F(2,47) = 3.73$, $p < .02$, $\eta^2 = .19$, with non-neurotics (.08) making less mistakes during S faces recognition than neurotics (.15), $p < .01$.

Repeated measures two-way analyses of variance (ANOVAs) using facial affect (3) or prosody (3) as within-subject factors and between-subject factor Group (2) have been conducted in order to investigate interactions between temperamental traits, and temperamental traits and AC. There were no significant results on relation between temperamental traits interaction and visual and auditory processing.

Results indicate significant *Extraversion x AC* interaction for response accuracy of Th facial expressions, $F(1,51)= 4.08$, $p < .05$, $\eta^2 = .08$. Extraverts with good AC detected Th faces more accurately than introverts, who score high on AC, $F(1,47) = 5.96$, $p < .02$, $\eta^2 = .11$ (see Figure 3).
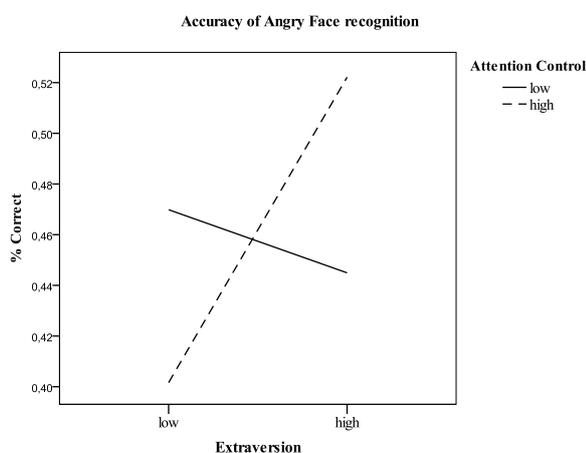

Accuracy of Angry Face recognition

Figure 3. Means of accuracy of threatening faces detection in Extraversion and AC.

Accuracy of Friendly Prosody recognition
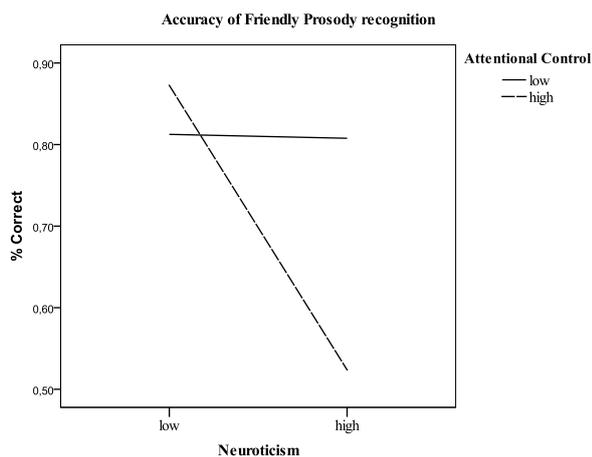
Figure 4. Means of accuracy of friendly prosody detection in Neuroticism and AC.

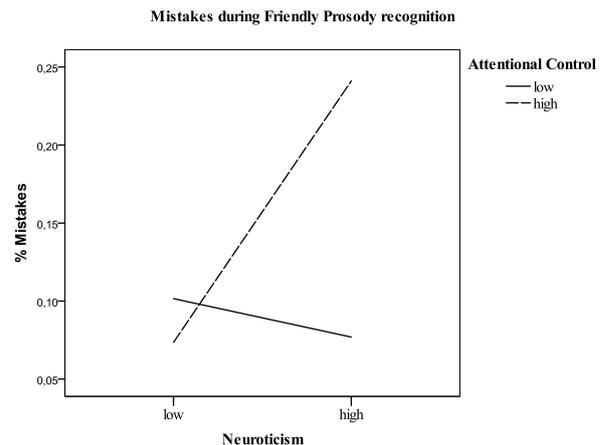**Mistakes during Friendly Prosody recognition**

Figure 5. Means of mistakes of friendly prosody detection in Neuroticism and AC.

Moreover, analysis of response accuracy in auditory modality revealed significant Neuroticism x AC interaction for F prosody, $F(1,45) = 6.14$, $p < .01$, $\eta^2 = .13$. Non-neurotics with good AC detected F prosody more accurately then neurotics with good AC, $F(1,41) = 12.63$, $p < .01$, $\eta^2 = .23$. On the other hand, neurotics with poor AC recognized F utterances significantly more accurately than neurotics with good volitional AC, $F(1,41) = 7.68$, $p < .01$, $\eta^2 = .16$ (see Figure 4). In addition, *Neuroticism x AC* interaction for mistakes of F prosody recognition reached significance, $F(1,45) = 7.78$, $p < .01$, $\eta^2 = .16$. Neurotics with good AC made significantly more mistakes than non-neurotics with good AC, $F(1,41) = 11.83$, $p < .001$, $\eta^2 = .22$. Furthermore, neurotic poor attenders made less mistakes during F prosody recognition than neurotic good attenders, $F(1,41) = 10.42$, $p < .01$, $\eta^2 = .20$ (see Figure 5).

General Discussion

The purpose of this paper was to identify the pattern of basic emotion recognition in visual and auditory modalities, and to investigate how temperament and trait-like AC influence the accuracy of emotional expression detection in these channels. Our studies revealed distinct emotional stimuli recognition with visual happiness superiority and auditory sadness superiority. This pattern of results confirms studies on facial expression recognition (Hansen & Hansen, 1988) and, to some extent, results of Johnstone and Scherer's (2000) research on emotion recognition in auditory modality. Since sad voice, in comparison with other basic emotions, is characterized by noticeable decease in frequency, we believe that it is quite effective selective cue for auditory attention. High recognition of angry prosody was not confirmed, as both anger and happiness have similar vocal profile.

However, involvement of temperamental traits into analysis produced the reverse pattern of results compared to that obtained in the preliminary study and replicated in the main study. Extraverts and non-neurotics demonstrated enhanced sadness processing in visual modality. These

personality dimensions are typified by low cortical and visceral arousal respectively, and efficient functioning of 'top-down' attentional system. These underlying characteristics may be responsible for the improved processing of sadness in this channel. Sad facial expression communicates requests for help, comfort, or support (Hortsmann, 2003) and evoke social interaction (Huebner & Izard, 1988). Hence, it can be assumed that for highly aroused (introverts) and emotionally reactive individuals (neurotics) providing comfort to sad individuals is of great effort and, therefore, their recognition accuracy of this emotion is decreased. A growing literature also suggests that individuals high in Extraversion have greater working memory capacity (Lieberman, 2000) and, consequently, may have greater freedom than introverts to attend to particular aspects of an emotional stimulus (Lieberman & Rosenthal, 2001). Moreover, Hutcherson and colleagues (2008) revealed that attentional focus does not influence the relationship between Extraversion and neural response to positive stimuli, but does impact the response to negative (sad) stimuli. Our results regarding *Extraversion x AC* interaction in visual modality by some means confirm their findings and show that volitional attention also moderates the detection accuracy of negative (threatening) facial expressions. However, a complete understanding of this phenomenon requires further studies.

Involvement of temperamental traits in auditory attentional task produced specific patterns of responses to emotional stimuli. However, this effect is modulated by the level of effortful AC. Non-neurotics with good AC detected friendly prosody more effectively than neurotics with good AC. Moreover, neurotic poor attenders recognized happy utterances significantly more effectively than neurotic good attenders. It seems that in order to detect friendly prosody correctly, these two traits (N and AC) should remain in proportionally inverse relationship. In line with theoretical assumptions proposed by Fajkowska (2013) this relation might be explained by functional overlapping between Neuroticism and trait-like AC in their controlling functions. Speculatively, low Neuroticism and high AC or high Neuroticism and low AC alternatively co-occur with auditory happiness superiority as they play a similar controlling function in this situational (experimental) arrangement. As stated earlier in the text, both auditory detection and happiness detection activate more strategic ways of processing. Thus, these two traits may participate in directing and monitoring the ongoing auditory positive stimulation adequately to the organism's capacities of processing stimulation. It seems that inverse relation of both traits denotes their regulative functions in auditory processing happiness (cf. Fajkowska, 2013).

It is worth noticing that when personality traits were studied separately, results for AC across both modalities and for all studied traits and auditory modality were not found. One possible explanation might be addressed to the utilized tasks. It seems that performance on these tasks imposes substantial demands on the posterior, not anterior attentional control system. However, AC has revealed itself in the interactions with Extraversion and Neuroticism and

'serves' them as the 'intentional controller' of processing emotions, not congruent with these temperamental traits. In addition, the processing across auditory modality may be considered as connected with intentional aspects of attention, and engages traits' constellations rather than a single trait.

To sum up, we have found that processing emotional targets in both modalities is associated with temperament dimensions and their interactions with AC. Several findings are novel and constitute a subject for future research in order to clarify their optimal interpretation.

References

Bishop, S.J., Duncan, J., Brett, M., & Lawrence, A.D. (2004). Prefrontal cortical function and anxiety: Controlling attention to threat-related stimuli. *Nature Neuroscience, 7,* 184-188.

Bond, N.W., & Siddle, D.A. (1996). The preparedness account of social phobia: Some data and alternative explanations. In R.M. Rapee (Ed.), *Current Controversies in the Anxiety Disorders* (pp. 291–316). New York: Guilford Press.

Bryan, K. (1989). *Right Hemisphere Language Battery*. Leicester: Far Communications.

Corbetta, M., & Shulman, G.L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience, 3*, 201-215.

Depue, R.A., & Collins, P.F. (1999). Neurobiology of the structure of personality: dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences, 22*, 491-569.

DeNeve, K.M., & Cooper, H. (1998). The happy personality: A meta-analysis of 137 personality traits and subjective well-being. *Psychological Bulletin, 124*, 197–229.

Derryberry, D. (2002). Attention and voluntary self-control. *Self and Identity, 1*, 105-111.

Derryberry, D., & Reed, M.A. (1994). Temperament and attention: Orienting toward and away from positive and negative signals. *Journal of Personality and Social Psychology, 66*, 1128–1139.

Derryberry, D., & Reed, M.A. (2001). *Attentional control, trait anxiety, and the regulation of irrelevant response information*. Manuscript.

Derryberry, D. & Reed, M.A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology, 111*, 225-236.

Derryberry, D., & Reed, M.A. (2003). Information processing approaches to individual differences in emotional reactivity. In R.J. Davidson, K.R. Scherer, & H.H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 681-697). New York: Oxford University Press.

Ekman, P. (1992). An argument for basic emotions. *Cognition & Emotion, 6,* 169-200.

Ekman, P., & Friesen, W.V. (1976). Measuring facial movements. *Journal of Environmental Psychology, 1*, 56–75.

Eysenck, H.J., & Eysenck, S.B. (1994). *Manual of the Eysenck Personality Questionnaire: Comprising the EPQ-Revised (EPQ-R) and EPQ-R Short Scale*. San Diego, CA: EdITS.

Fajkowska, M. (2013). P*ersonality coherence and incoherence: A perspective on anxiety and depression*. Clinton Corners, NY: Eliot Werner Publications.

Fajkowska, M., & Krejtz, I. (2006).Temperament, lęk i uwagowe przetwarzanie informacji emocjonalnych [Temperament, anxiety and attentional processing of emotional stimuli]. In M. Fajkowska, M. Marszał-Wiśniewska, & G. Sędek (Eds.), *Podpatrywanie myśli i uczuć. Zaburzenia i optymalizacja procesów emocjonalnych i poznawczych. Nowe kierunki badań* (pp. 45-62). Gdańsk: GWP.

Fajkowska, M., & Eysenck, M.W. (2008). Personality and cognitive performance. *Polish Psychological Bulletin, 39,* 178–191.

Fajkowska, M., & Derryberry, D. (2010). Psychometric properties of Attentional Control Scale: The preliminary study on a Polish sample. *Polish Psychological Bulletin, 41*, 1-7.

Foa, E.B., & McNally, R.J. (1986). Sensitivity to feared stimuli on obsessive-compulsives: A dichotic listening analysis. *Cognitive Therapy and Research, 10,* 477-485.

Fox, E. (1994). Attentional bias in anxiety: A defective inhibition

hypothesis. *Cognition & Emotion, 8*, 165-195.

Fox, E. (2002). Processing emotional facial expressions: The role of anxiety and awareness. *Cognitive, Affective, & Behavioral Neuroscience, 2*, 52-63.

Fox, E. (2008). *Emotion Science. Cognitive and Neuroscientific Approaches to Understanding Human Emotions*. Basingstoke, Hampshire, UK: Palgrave Macmillian.

Fox, E., Russo, R., & Georgiou, G.A. (2005). Anxiety modulates the degree of attentive resources required to process emotional faces. *Cognitive, Affective, & Behavioral Neuroscience, 5*, 396-404.

Gainotti, G. (2000). Neuropsychological theories of emotion. In J.C. Borod (Ed.), *Neuropsychology of Emotion* (pp. 214-136). New York: Oxford University Press.

Gomez, R., Gomez, A., & Cooper, A. (2002). Neuroticism and extraversion as predictors of negative and positive emotional information processing: Comparing Eysenck's, Gray's and Newman's theories. *European Journal of Personality, 16*, 333-350.

Hansen, C.H., & Hansen, R.D. (1988). Finding the face in the crowd: An anger superiority effect. *Journal of Personality and Social Psychology, 54*, 917–924.

Horstmann, G. (2003). What do facial expressions convey: Feeling states, behavioral intentions, or action requests? *Emotion, 3*, 150–166.

Huebner, R.R., & Izard, C.E. (1988). Mothers' responses to infants' facial expressions of sadness, anger, and physical distress. *Motivation and Emotion, 12*, 185–196.

Hutcherson, C.A., Goldin, P.R., Ramel, W., McRae, K., & Gross, J.J. (2008). Attention and emotion influence the relationship between extraversion and neural response. *Scan, 3*,71-79.

Izard, C.E. (1977). *Human Emotions*. New York: Plenum Press.

Johnstone, T., & Scherer, K.R. (2000). Vocal communication of emotion. In M. Lewis & J.M. Haviland-Jones (Eds.), *Handbook of emotions, 2nd ed.* (pp. 220–235). New York: Guilford Press.

Juslin, P., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: different channels, same code? *Psychological Bulletin, 129*, 770-814.

Lieberman, M.D. (2000). Introversion and working memory: central executive differences. *Personality and Individual Differences, 28*, 479–86.

Lieberman, M.D., & Rosenthal, R. (2001). Why introverts can't always tell who likes them: multitasking and nonverbal encoding. *Journal of Personality and Social Psychology, 80*, 294–310.

Lucas, R.E., & Fujita, F. (2000). Factors influencing the relation between extraversion and pleasant affect. *Journal of Personality and Social Psychology, 79*, 1039–1056.

Łojek, E. (2007). B*ateria Testów do Badania Funkcji Językowych i Komunikacyjnych Prawej Półkuli Mózgu, RHLB-PL.* [Test battery to assess linguistic and communications functions of the right hemisphere]. Warszawa: Pracownia Testów Psychologicznych Polskiego Towarzystwa Psychologicznego.

Mathews, A., & MacLeod, C. (1985). Selective processing of threat cues in anxiety states. *Behavioral Research Methods, 23*, 317-323.

Öhman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology, 80*, 381–396.

Pinkham, A., Griffin, M., Baron, R., Sasson, N., & Gur, R. (2010). The Face in the Crowd Effect: Anger Superiority When Using Real Faces and Multiple Identities. *Emotion, 10*, 141-146.

Posner, M.I., & Petersen, S.E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13*, 25-42.

Posner, M.I., & Rothbart, M.K. (1998). Attention, self-regulation and consciousness. *Philosophical Transactions of the Royal Society of London B, 353,* 1915-1927.

Rusting, C.L., & Larsen, R.J. (1998). Personality and cognitive performance of affective information. *Personality and Social Psychology Bulletin, 24*, 200-213.

Scherer, K.R. (1986). Vocal affect expression: A review and a model for future research. *Psychological Bulletin, 99*, 143–165.

Siegman, A., & Boyle, S. (1993). Voices of fear and anxiety and sadness and depression: The effects of speech rate and loudness on fear and anxiety and sadness and depression. *Journal of Abnormal Psychology, 102*, 430–437.

Strelau, J. (2000). Temperament [Temperament]. In J. Strelau (Ed.), *Psychologia. Podręcznik akademicki. Tom 2: Psychologia ogólna* (pp. 683-719). Gdańsk: GWP

Styles, E.A. (2006). *The psychology of attention, 2nd* ed. New York: Psychology Press.

Szymura, B. (2007). *Temperament uwagi* [Temperament of attention]. Kraków: Universitats.

Trimmer, C.G., & Cuddy, L.L. (2008). Emotional intelligence, not music training, predicts recognition of emotional speech prosody. *Emotion, 8,* 838-849.

Wallbott, H.G., & Scherer, K.R. (1986). Cues and channels in emotion recognition. *Journal of Personality and Social Psychology, 51*, 690-699.