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Distinct associations of insula and cingulate volume with the cognitive and affective dimensions of alexithymia

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ABSTRACT

Alexithymia ("no words for feelings") is a major risk factor for psychosomatic and psychiatric conditions characterized by affect dysregulation. The alexithymia personality construct comprises an affective dimension, the level of subjective emotional experience (emotionalizing and fantasizing), and a cognitive dimension, referring to the cognitive control of emotions (identifying, analyzing, and verbalizing feelings). These two dimensions may differentially put individuals at risk for psychopathology, but their specific neural bases have rarely been investigated. Therefore, the aim of the present study was to find out whether the two alexithymia dimensions are associated with discriminable neural correlates. By means of voxel-based morphometry (VBM), differences in gray matter volumes were compared between 20 (10 male) high-scorers and 20 (9 male) low-scorers on the Toronto Alexithymia Scale (TAS-20), reflecting the cognitive alexithymia dimension. In a subset of 32 subjects, the impact of the affective alexithymia dimension was tested in addition, as assessed with the affective subscale of the Bermond–Vorst Alexithymia Questionnaire (BVAQ). Analysis 1 (cognitive alexithymia dimension) revealed significantly larger gray matter volumes in the right posterior insula in high-scorers compared to low-scorers on the TAS-20. Analysis 2 (affective alexithymia dimension) revealed that the affective alexithymia dimension, specifically the emotionalizing factor indicative of low emotional reactivity, was associated with larger gray matter volumes of the right cingulate cortex. These results suggest that the two alexithymia dimensions are associated with distinct structural correlates.

1. Introduction

With a prevalence rate of ten percent in the general population, alexithymia ("no words for feelings") is a major risk factor for a range of medical and psychiatric disorders (Taylor, Bagby, & Parker, 1997), including somatoform (Waller & Scheidt, 2004) and panic disorders (Parker, Taylor, & Bagby, 1993). In general, men seem to exhibit higher levels of alexithymia than women, though gender differences are small (Levant, Hall, Williams, & Hasan, 2009). Although alexithymia has long been thought of as a unidimensional construct, it is now acknowledged that it comprises two dimensions, an affective and a cognitive one (Vorst & Bermond, 2001). The cognitive dimension refers to the processing of emotions at the cognitive level and comprises low abilities to identify, analyze, and verbalize one's feelings. These three cognitive alexithymia facets are traditionally assessed with the TAS-20 Toronto Alexithymia Scale (Bagby, Parker, & Taylor, 1994a; Bagby, Taylor, & Parker, 1994b), which comprises the three subscales 'difficulty identifying feelings', 'difficulty describing feelings', and 'externally oriented thinking'. For the TAS-20, a clinical cut-off score has been established that classifies a score equal to or higher than 61 as a clinically relevant alexithymia score (Taylor et al., 1997). The affective alexithymia dimension refers to the level of subjective emotional experience and comprises low degrees of emotional arousal in response to emotion-inducing events (emotionalizing factor), and reduced imaginative capabilities (fantasizing factor). While these affective factors are not part of the TAS-20, they can be assessed by means of the Bermond–Vorst Alexithymia Questionnaire (BVAQ, Vorst & Bermond, 2001).

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Based on these two dimensions, different subtypes of alexithymia have been proposed (Bermond et al., 2007). Individuals with type 1 alexithymia are characterized by high scores on both alexithymia dimensions (i.e., the cognitive processing of emotions as well as the level of subjective emotional experience is reduced) and may be perceived as 'cold-blooded' personalities as they experience little emotional arousal. This type has been proposed to underlie schizoid personality (Moormann et al., 2008) and psychopathy, in which physiological reactions to emotional stimuli are low (Levenston, Patrick, Bradley, & Lang, 2000) and the cognitive processing of emotions is impaired (Lander, Lutz-Zois, Rye, & Goodnight, 2011). In contrast, individuals with type 2 alexithymia may experience emotional arousal to a normal or even heightened extent, but have difficulty regulating their feelings at the cognitive level (i.e., the cognitive processing of emotions is reduced while the subjective experience of emotions is unaffected). Individuals with type 2 alexithymia tend to be emotionally labile as seen in patients with borderline personality disorder (Moormann et al., 2008). This subtype has also been linked to schizophrenia (van der Meer, van't Wout, & Aleman, 2009), which is in line with the theory of the emotional paradox stating that these patients do experience emotions but are unable to show them (Aleman & Kahn, 2005). Taken together, type 1 and type 2 alexithymia might differentially put individuals at risk for psychopathology. However, the neural correlates of the cognitive and affective dimensions underlying the alexithymia subtypes are still poorly understood.

Three brain regions seem to be particularly implicated in emotion processing deficits associated with alexithymia: the anterior cingulate cortex (ACC), the amygdala, and the insula. The ACC is involved in the awareness and monitoring of one's emotional experiences (Heinzel et al., 2010a; Medford & Critchley, 2010) and has been proposed to be a key region in alexithymia (Lane, Ahern, Schwartz, & Kaszniak, 1997). Given its involvement in both emotional experience and cognitively demanding emotional tasks, the ACC could be implicated in both alexithymia dimensions (Bermond, Vorst, & Moormann, 2006; Lane et al., 1997; Larsen, Brand, Bermond, & Hijman, 2003; Wingbermühle, Theunissen, Verhoeven, Kessels, & Egger, 2012). The amygdala is an essential structure for the processing of emotions as it is involved in the evaluation of emotional significance, fear conditioning, emotional reactivity, and general salience detection (Adolphs, 2008, 2010; Sergerie, Chochol, & Armony, 2008). The insula takes part in the cognitive processing of emotions as well as in the generation of emotional states (Medford & Critchley, 2010; Phillips, Drevets, Rauch, & Lane, 2003), and is a key region in the subjective experience of feelings derived from bodily states and emotional arousal (Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004; Diekhof, Geier, Falkai, & Gruber, 2011). In addition, the insula regulates autonomic activity in reaction to salient stimuli (Menon & Uddin, 2010), is directly involved in pain perception (Craig, Chen, Bandy, & Reiman, 2000; Ostrowsky et al., 2002), and lesions to the insula may cause deficits in balance, light touch, proprioception, pain, taste (Cereda, Ghika, Maeder, & Bogousslavsky, 2002), and heartbeat perception (Khalsa, Rudrauf, Feinstein, & Tranel, 2009). The amygdala and the insula are thought to relate to both alexithymia dimensions, given their involvement in empathy, emotionalizing as well as analyzing emotions (Wingbermühle et al., 2012). Functional imaging studies have reported altered functioning of the ACC (Berthoz et al., 2002; Frewen et al., 2008; Heinzel et al., 2010a; Huber et al., 2002; Moriguchi et al., 2007), the amygdala (Goerlich-Dobre et al., 2013b; Kugel et al., 2008; Miyake, Okamoto, Onoda, Shirao, & Yamawaki, 2012; Reker et al., 2010; Zotev et al., 2011) as well as the insula (Frewen, Pain, Dozois, & Lanius, 2006; Heinzel et al., 2010b; Kano et al., 2003; Kano, Hamaguchi, Itoh, Yanai, & Fukudo, 2007; Moriguchi et al., 2007; Reker et al., 2010; Silani et al., 2008) in relation to alexithymia (for a meta-analysis, see van der Velde et al., 2013). However, all these studies used the TAS-20 scale for alexithymia assessment, which assesses only the cognitive alexithymia dimension. To date, only one functional imaging study took the affective alexithymia dimension into account and found that low emotional reactivity was linked to hyperactivity of the dorsal ACC in response to fearful faces (Pouga, Berthoz, de Gelder, & Grezes, 2010).

Supplementing functional studies, structural imaging studies have begun to reveal changes in cerebral morphology associated with the cognitive alexithymia dimension. Initial studies using manual tracing techniques focused on the ACC as a region of interest (ROI), based on Lane's hypothesis of a core deficit in emotional self-awareness in alexithymia. The first study of this kind found a positive correlation between the cognitive alexithymia dimension and the surface area of the right ACC (Gündel et al., 2004), whereas a second study reported a negative correlation between alexithymia and gray matter volumes of the right rostral ACC (Paradiso, Vaidya, McCormick, Jones, & Robinson, 2008). Subsequent studies using automated Voxel-Based Morphometry (VBM) methods reported reduced ACC volumes (Borsci et al., 2009; Ihme et al., 2013; Sturm & Levenson, 2011) or no volume differences of the ACC in relation to the cognitive alexithymia dimension (Heinzel et al., 2012; Kubota et al., 2011; Zhang et al., 2011). Besides the ACC, structural differences of the insula were observed in some studies (Borsci et al., 2009; Ihme et al., 2013; Zhang et al., 2011), but not in others (Heinzel et al., 2012; Kubota et al., 2011; Sturm & Levenson, 2011). Regarding the amygdala, one study reported smaller amygdala volumes in high-scorers on alexithymia compared to gender-matched low-scorers (Ihme et al., 2013). In addition to the ACC, insula, and amygdala, structural differences in other regions have sporadically been found in relation to the cognitive alexithymia dimension, including middle temporal gyrus (Borsci et al., 2009; Ihme et al., 2013), superior temporal sulcus (Borsci et al., 2009), orbitofrontal gyrus (Borsci et al., 2009), ventral striatum, ventral premotor cortex, and supramarginal gyrus (Kubota et al., 2011). All of these previous studies used the TAS-20 for the assessment of alexithymia, and therefore previous findings can only be related to the cognitive alexithymia dimension, while the impact of the affective alexithymia dimension on morphometric differences has not been investigated yet.

Taken together, results of previous structural studies are equivocal, and no clear picture has yet emerged regarding the morphological underpinnings and the directionality of differences in gray matter volume in relation to alexithymia. Conclusions with respect to gray matter volume differences are further complicated by the fact that such differences may be interpreted in the light of recruitment of additional (compensatory) processing resources, or in the light of a positive relationship between the regular use of a brain region and its size (Maguire et al., 2000). Discrepancies between previous structural alexithymia studies may be due to variance in the range of alexithymia scores between studies (below or above the clinical threshold score on the TAS-20), differences in analysis strategies (region of interest versus whole brain approach), and finally, the fact that all previous structural studies considered only the cognitive alexithymia dimension, despite findings indicating that also the affective alexithymia dimension modulates emotion processing (Bermond, Bierman, Cladder, Moormann, & Vorst, 2010; Goerlich, Aleman, & Martens, 2012; Moormann et al., 2008; Pouga et al., 2010).

The present VBM study investigated the impact of the cognitive ($_c$) alexithymia dimension on gray matter volume in 40 female and male age- and education-matched individuals with either low scores (Low ALEX$_c$ group) or scores equal to or higher than the clinical cut-off score on the TAS-20 alexithymia scale (High ALEX$_c$ group), in keeping with previous studies. In addition, we tested