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Research report

Reduced olfactory sensitivity in subjects with depressive symptoms

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Abstract

Background: Clinical studies suggest that olfactory sensitivity is reduced in major depression. Nevertheless, only little is known about the relationship between depressive symptoms and olfactory functions in healthy subjects.
Methods: The present study investigated the association between depressive symptoms and olfactory performance in 48 healthy subjects (14 male). First depressive symptoms were assessed using the Beck Depression Inventory, following by olfactory testing. Olfactory threshold and discrimination performance was assessed as well as emotional arousal and pleasantness during the testing procedure.
Results: We observed a significant negative correlation between olfactory sensitivity and depressive symptoms while olfactory discrimination was not related to depressive symptoms. Limitations: The degree of depressive symptoms was assessed by questionnaire. A clinical interview might assess depressive symptoms more accurate.
Conclusion: We conclude that depressive symptoms are related to a reduced olfactory sensitivity. The observed relation between reduced olfactory sensitivity and depressive symptoms could be mediated by functional deviations within brain structures subserving primary olfactory processing such as amygdala and piriform cortex which is in line with results showing abnormal activity pattern in the amygdala and other brain regions in depression.

Keywords: Olfactory perception; Depression; Emotions; Arousal; Pleasantness

1. Introduction

Olfaction is known to be closely related to emotional processes and mood. Recent research has highlighted the close neuroanatomical connection between emotion and olfaction (Anderson et al., 2003; Bensafi et al., 2004; Gottfried et al., 2002; Royet et al., 2000; Savic et al., 2000). Imaging data have shown that the perception of odors is consistently accompanied by activation in particular brain regions including the orbitofrontal cortex, amygdala, piriform cortex, insular cortex and anterior cingulate (Anderson et al., 2003; Savic et al., 2000; Sobel et al., 1998; Wiesmann et al., 2004, 2006; Zatorre et al., 1992), structures that are – to a great extent – also involved in the processing of emotions (Phan et al., 2002).

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From a neuroanatomical perspective, the two olfactory bulbs constitute the primary solfactory sensory cortex with direct projections to the secondary olfactory regions comprising the anterior olfactory nucleus, the olfactory tubercle, the piriform cortex, the amygdala, the periamygdaloid region, and the entorhinal cortex. Important tertiary olfactory regions include the orbitofrontal cortex, the anterior insula, and the cingulate gyrus (Albrecht and Wiesmann, 2006; Cleland and Linster, 2003; Wiesmann et al., 2006). Within these structures, the representation of the intensity of odors has been associated with activity in the piriform cortex (Rolls et al., 2003) and the amygdala (Anderson et al., 2003), while the orbitofrontal cortex has been found to be involved in odor identification, odor discrimination, judgement of the hedonic value of odors, and odor memory (Small et al., 1997; Wiesmann et al., 2004; Zald and Pardo, 1997; Zald et al., 2002).

Despite the close neuroanatomical connection between emotion and olfaction, little is known about the role of odor impairment in psychiatric disorders characterized by mood disturbances (Lombion-Pouthier et al., 2006). Major depression is a serious disorder marked by depressed mood and other symptoms like loss of interest or pleasure in doing most things, fatigue, changes in sleep patterns, difficulty in thinking and concentrating, changes in appetite, feelings of worthlessness or guilt or suicidal thoughts. Research on olfaction in depression is sparse and has failed to yield consistent results (Gross-Isseroff et al., 1994; Lombion-Pouthier et al., 2006; Pause et al., 2001; Satoh et al., 1996; Serby et al., 1990). Two recent studies were able to demonstrate that olfactory sensitivity in particular – as measured by detection threshold tests – is reduced in depressed patients (Lombion-Pouthier et al., 2006; Pause et al., 2001). Moreover, Pause et al. (Pause et al., 2001) reported a positive correlation between lowered olfactory sensitivity and high depression scores. This observed effect diminished after successful medical treatment. Also Gross-Isseroff and colleagues (Gross-Isseroff et al., 1994) reported that in patients suffering from major depression a significant increase in olfactory sensitivity was observed after initiation of antidepressive treatment. A further evidence for reduced olfactory performance in depression stems from a study on the relationship between odor perception and depression in the Japanese elderly: Concerning self-reported symptoms of depression Satoh and co-workers (Satoh et al., 1996) reported a negative correlation between the degree of depression and olfactory detection measured by smell cards used in the University of Pennsylvania Smell Identification Test (Doty et al., 1984).

Given that many studies on depression (Deckersbach et al., 2006a,b; Drevets et al., 1992; Leppanen, 2006; Roberson-Nay et al., 2006; Siegle et al., 2002, 2007; Soares and Mann, 1997; Wagner et al., 2006) report abnormal activation in various brain regions including the amygdala, the anterior cingulate and the prefrontal cortex, it has been suggested that a deviant limbic functionality in depressed patients could be associated with the observed altered olfactory perception (Lombion-Pouthier et al., 2006; Pause et al., 2001; Song and Leonard, 2005). Pause et al. (Pause et al., 2001, 2003) hypothesized that functional deviations within brain regions involved in the early perceptual processing of odors, such as the amygdala and piriform cortex, could be responsible for the reduced olfactory sensitivity, as well as for alterations in the processing of emotional stimuli in depressed patients. Confirmation the assumption of altered central processing of olfactory stimuli it could be demonstrated that patients suffering from major depression had reduced amplitudes of the P2 and P3–1 peaks of the chemosensory event-related potentials it (Pause et al., 2003). The question as to whether olfaction is also affected in healthy subjects with varying degrees of depressive symptoms assessed by questionnaire remains unaddressed.

There is evidence to suggest that emotion-related personality traits have an impact on olfactory function in healthy subjects. Chen and Dalton (Chen and Dalton, 2005) investigated the effect of emotion and personality on olfactory perception. They demonstrated that neurotic and anxious individuals react faster to emotionally valenced as compared to neutral odors. In this context, it is interesting that a recent study (Jylha and Isometsa, 2006) conducted with a large general population sample was able to show a strong correlation between neuroticism and symptoms of depression as assessed by the Beck Depression Inventory (Beck, 1978). Taking both of these studies together and bearing in mind that Pause et al. (Pause et al., 2001) reported a positive correlation between lowered olfactory sensitivity and elevated depression scores as measured by the Beck Depression Inventory (BDI) in patients suffering from major depression, it can be conjectured that depressive symptoms might be related to reduced olfactory sensitivity in healthy subjects as well.

The present study aimed to investigate the association between depressive symptoms in healthy subjects and olfactory perception. As olfactory perception measured by brain activation patterns (de Araujo et al., 2005) has been shown to be modulated by cognitive factors such as self-rated pleasantness, subjects were