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Research paper

Facial emotion recognition, theory of mind and the role of facial mimicry in depression

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ABSTRACT

Background: This study examined whether acutely (aMDD) and remitted depressed patients (rMDD) show deficits in the two aspects of social cognition – *facial emotion recognition (FER)* and *reasoning* – when using ecologically valid material. Furthermore, we examined whether reduced facial mimicry mediates the association between depressive symptoms and FER, and whether FER deficits and reasoning deficits are associated.
Method: In 42 aMDD, 43 rMDD, and 39 healthy controls (HC) FER was assessed using stimuli from the *Amsterdam Dynamic Facial Expression Set*, reasoning by the *Movie for the Assessment of Social Cognition*. Furthermore, the activity of *Zygomaticus Major* and *Corrugator supercilii* were recorded.
Results: aMDD recognized happy faces less accurately, were less confident recognizing happiness and anger and found it more difficult to recognize happiness, anger and fear than HC. rMDD were less confident recognizing anger and found it more difficult to recognize happiness, anger and fear than HC. Reduced mimicry did not explain FER deficits. aMDD but not rMDD showed impaired reasoning.
Limitations: The stimulus material was comparably easy to decode. Therefore, it is possible that the FER deficits of aMDD and rMDD patients are more pronounced than demonstrated in this study.
Conclusions: aMDD show deficits in FER and reasoning, whereas rMDD only show mild impairments in the recognition of emotional expressions. There must be other processes – besides mimicry – that serve the accurate recognition of emotional facial expressions.

1. Introduction

Major Depressive Disorder (MDD) is associated with considerable impairments in social functioning (Hirschfeld et al., 2000; Judd et al., 2000) which appear to persist during remission (Coryell et al., 1993). To understand the mechanisms underlying this disruption of social behavior in MDD patients research has focused on social cognition which can be understood as one component of the broad set of metacognitive abilities that are necessary to decode, understand, reason about and master mental states (Carcione et al., 2008; Ladegaard, 2014a, 2014b) and which enables human beings to understand their own and others' thoughts, feelings, and intentions (Fiske and Taylor, 1991). Social cognitive capacities can be subdivided into (1) more basic, lower-order abilities as *decoding* others' mental states on the basis of perceivable information, and (2) more complex, higher-order abilities as *reasoning* about others' mental states by integrating multiple forms of information including, for example, the information received by the decoding process, further contextual information, and knowledge of social rules (Adolphs, 2010; Ladegaard et al., 2015; Sabbagh, 2004).

Several studies indicate that MDD is associated with deficits in one essential part of the decoding process – namely facial emotion recognition (FER). While some found a general deficit in FER with respect to basic emotions (Csukly et al., 2009; Persad and Polivy, 1993) others only found impairments concerning particular emotions (Rubinow and Post, 1992). Acute as well as remitted MDD has also repeatedly been associated with a negativity bias (Bourke et al., 2010; Gur et al., 1992; Joormann and Gotlib, 2006; Milders et al., 2010). However, even reviews come to contradicting conclusions about whether or not there are emotion-specific FER deficits (Bourke et al., 2010; Kohler et al., 2011). There are also studies that, on the other hand, did not find FER deficits in MDD at all (Air et al., 2015; Kan et al., 2004; Schaefer et al., 2010). Yet, it is important to note that the majority of these studies used dynamic instead of static facial stimuli. Thus, FER deficits in MDD might be limited to static stimuli that are of low ecological validity and that have relatively small information

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content compared to dynamic stimuli. If FER deficits in MDD were limited to static stimuli, it would not be reasonable to assume that the impaired social functioning in MDD is due to FER deficits, as one is confronted with dynamic rather than with static facial expressions in everyday life. In addition, studies dealing with FER in MDD have exclusively focused on the FER accuracy and have neglected other aspects that might also be of relevance for the quality of social interactions – namely, the questions how confident people are about their assessment and how difficult people find it to recognize specific facial expressions. In this study we want to go beyond the *accuracy* as a measurement for FER ability in MDD and extend the measures to *confidence* and *perceived simplicity* ratings. Especially when investigating FER using ecologically valid stimulus material this approach is likely to bring forth new insights. We assume that FER deficits of MDD patients as assessed by dynamic stimuli are particularly pronounced when it comes to confidence and simplicity ratings.

When dealing with FER deficits in MDD the question arises, what enables us to recognize other people's emotional facial expressions. As Adolphs (2002) pointed out "recognizing facial emotion draws on multiple strategies subserved by a large array of different brain structures" (p. 21) as, for example, drawing on social learning or perceiving one's own emotional response that is elicited by looking at an emotional facial expression of someone else. One source of information may also be facial feedback signals that are generated by automatically mimicking others' facial expressions (Dimberg, 1982; Dimberg et al., 2000). An increase in the activity of *Musculus corrugator supercilii* (COR) can be measured in response to sad facial expressions, an increase in *Musculus zygomaticus major* (ZYG) activity in response to happy expressions (Lundqvist, 1995). These muscular reactions are assumed to play an important role in FER (Nielsen, 2002). It has been shown that facial mimicry is associated with greater FER accuracy and that the blocking of facial mimicry is associated with a lower FER accuracy (Neal and Chartrand, 2011; Oberman et al., 2007; Ponari et al., 2012). Furthermore, an enhancement of facial feedback as produced by a gel that allows for – but produces a subjective feeling of resistance to – muscular contractions, and thus increases afferent signals to the central nervous system, is associated with increased FER accuracy (Neal and Chartrand, 2011). Facial mimicry has also been associated with an acceleration of the FER process (Schneider, 2008; Stel and van Knippenberg, 2008). Some data, however, are not in line with the assumption that mimicry is important for FER (Blairy et al., 1999; Hess and Blairy, 2001). Individuals suffering from facial paralysis, for example, perform normally on FER tasks (e.g. Bogart and Matsumoto, 2010). A possible explanation for the latter finding is that the observation of other's emotional expressions directly activates the neural substrate that is implicated in the experience of the observed emotion (Gallese, 2001, 2003; Wicker et al., 2003). This point of view has been referred to as *unmediated resonance model* (Goldman and Sripada, 2005). The core assumption of this model is that the observation of an emotional facial expression results in emotional contagion which then allows the observer to attribute his/her own emotional state to the observed person. As Goldman and Sripada (2005) state, this assumption would also parallel the finding of mirror-neuron matching systems. Nonetheless, it seems as if mimicry plays a facilitating role in the FER process – at least in some cases. Based on these findings and in line with a weaker version of the facial feedback hypothesis (Hess et al., 1992; McIntosh, 1996) it can be assumed that mimicry, which is probably due to an emotional contagion taking place when people are confronted with emotional facial expressions, might intensify the observer's emotional state and thereby facilitate FER. Based on this assumption it can be hypothesized that the FER impairments of MDD patients are associated with reduced mimicry. Thus far, there is no study that has investigated the association between FER and mimicry in clinically depressed patients. There are, however, studies indicating generally reduced muscular reactivity in MDD patients in response to different unspecific emotional stimuli (Bylsma et al., 2008; Gaebel and Wölwer, 2004; Gehricke and Shapiro, 2000; Renneberg et al., 2005). Only a few studies have investigated facial mimicry in association with depression: Sloan et al. (2002), for example, investigated mimicry in subclinical dysphoric and non-dysphoric subjects. While both groups showed an increase of COR in response to sad expressions, only the non-dysphoric group showed an increase of ZYG in response to happy expressions. Interestingly, the dysphoric group also displayed an increase in COR activity in response to happy expressions. The authors found no group difference concerning emotion recognition, which again supports the assumption that mimicry at most facilitates emotion recognition, rather than being a necessary component thereof. In contrast to Sloan et al. (2002), Wexler et al. (1994) found that MDD patients are hyporesponsive to happy *and* sad faces compared to healthy controls (HC). Likowski et al. (2011), who induced different kinds of mood in healthy participants before measuring facial mimicry, found that subjects in a sad mood showed nearly no mimicry, whereas subjects in a happy mood reproduced the expected reactions. Based on these studies, we hypothesize that MDD patients show reduced mimicry compared to HC. As mimicry appears to facilitate FER instead of being a necessary precondition, we further hypothesize that there is an association between mimicry and the confidence and simplicity ratings but not between mimicry and FER accuracy.

Regarding reasoning findings with respect to MDD patients are inconsistent. This may be due to a high variety of different methods used to measure reasoning. Uekermann et al. (2008), for example, let their subjects find the correct punch line of joke stems and asked questions concerning the perspective of the joke's protagonists. MDD patients performed worse than HC in these tasks. In another study MDD patients made more mistakes in identifying faux-pas than HC (Wang et al., 2008). Doody et al. (1998) found that patients with affective disorders perform as well as HC in first and second order false belief tasks. Another study found an impairment in second order questions in currently remitted MDD patients (Inoue et al., 2004). Only a few studies thus far used an ecologically valid method to investigate reasoning abilities of MDD patients: Wilbertz et al. (2010) were the first who used a naturalistic video-based test called Movie for the Assessment of Social Cognition (MASC; Dziobek et al., 2006) to investigate reasoning abilities in depressed patients. Patients did not perform worse than HC. However, Wilbertz et al. (2010) only focused on a sample of chronically depressed subjects, and did not control for possible psychopathology in HC, which might have caused the non-significant finding. Wolkenstein et al. (2011), who used the same test in a more heterogeneous MDD sample and controlled for possible psychopathology in HC, found that MDD patients made significantly fewer correct answers and answered significantly more often in a manner showing "less ToM" than HC. Ladegaard et al. (2014a, 2014b, 2015) investigated social cognition in acutely and remitted depressed subjects and found reasoning deficits in chronically depressed as well as first-episode depressed patients. Patients performed significantly better after remission on nearly all measures and up to a level of HC on some, but not all social cognitive tasks. More precisely, HC outperformed remitted patients in the ability to comprehend their own mental states, to represent the mind of others and to identify paradoxical sarcasm (Ladegaard et al., 2015). In summary, these results suggest that acutely and remitted MDD patients show deficits in reasoning about other's mental states. It remains unclear, however, whether reasoning deficits in MDD are associated with FER deficits.

1.1. Aims of the study

The first goal of the present study is to examine whether the FER abilities of acutely and remitted MDD patients prove to be impaired when using dynamic and thus ecologically valid stimulus material and going beyond the sole measure of accuracy. The second goal is to examine whether FER impairments of MDD patients are associated