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Transdiagnostic deviant facial recognition for implicit negative emotion in autism and schizophrenia

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Abstract
Impaired facial affect recognition (FAR) is observed in schizophrenia and autism spectrum disorder (ASD) and has been linked to amygdala and fusiform gyrus dysfunction. ASD patient's impairments seem to be more pronounced during implicit rather than explicit FAR, whereas for schizophrenia data are inconsistent. However, there are no studies comparing both patient groups in an identical design. The aim of this three-group study was to identify (i) whether FAR alterations are equally present in both groups, (ii) whether they are present rather during implicit or explicit FAR, (iii) and whether they are conveyed by similar or disorder-specific neural mechanisms. Using fMRI, we investigated neural activation during explicit and implicit negative and neutral FAR in 33 young-adult individuals with ASD, 20 subjects with paranoid-schizophrenia and 25 IQ- and gender-matched controls individuals. Differences in activation patterns between each clinical group and controls, respectively were found exclusively for implicit FAR in amygdala and fusiform gyrus. In addition, the ASD group additionally showed reduced activations in medial prefrontal cortex (PFC), bilateral dorso-lateral PFC, ventro-lateral PFC, posterior-superior temporal sulcus and left temporo-parietal junction. Although subjects with ASD showed more widespread altered activation patterns, a direct comparison

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between both patient groups did not show disorder-specific deficits in neither patient group. In summary, our findings are consistent with a common neural deficit during implicit negative facial affect recognition in schizophrenia and autism spectrum disorders.

1. Introduction

Facial affective recognition (FAR) is an essential prerequisite for successful social interaction and impairments in FAR may lead to dysfunctional interpersonal development. An important subsystem of the social brain (Adolphs, 2003) is involved in FAR, predominantly the fusiform gyrus (FG), the amygdala, the medial and lateral prefrontal cortex (PFC), the basal ganglia and the temporo-parietal cortices. Whereas the FG is involved in detailed face processing and face identity recognition (Haxby et al., 2002; Pourtois et al., 2009), the amygdala responds to fast and often implicit face recognition, in particular for negative facial expressions (Adolph, 2008). The medial PFC is associated with emotion regulation and self-referential reflection of an individual's emotional reaction to affective face stimuli, whereas the lateral PFC has been found to correlate with the discrimination of different (negative) emotional expressions (Heberlein et al., 2008; Tsuchida and Fellows, 2012). Moreover, the superior temporal sulcus (STS) seems to have a general role in processing affective stimuli originating from different sensory modalities (Said et al., 2011).

Two main routes for facial emotion recognition can be distinguished which differ with respect to the attentional focus during processing of facial emotion, an implicit and an explicit route (for review see Frith and Frith, 2008). *Explicit* FAR is based on slow and conscious top-down processes whereas *implicit* FAR is a fast and automatic bottom-up process. Neuroimaging studies in typically developing individuals yielded inconsistent results investigating these two FAR mechanisms. Some studies found increased activation of the FAR network during explicit compared to implicit FAR (Gur et al., 2002; Habel et al., 2007), whereas others found evidences for mixed or overlapping activation patterns for explicit and implicit processing in the FAR network (Lange et al., 2003; Fusar-Poli et al., 2009).

Abnormal FAR has been reported in mental disorders that are considered to be related to the development of the social brain, in particular in autism spectrum disorder (ASD) and schizophrenia (SCZ) (Burns, 2006; Pelphrey et al., 2011). ASD is defined by functionally impaired social communication and interaction difficulties alongside stereotyped and repetitive behaviours with onset in the early neurodevelopmental period (Lord et al., 2000). Schizophrenia is a heterogeneous, often episodic disorder with onset in adolescence or young adulthood, characterised by positive (hallucinations, delusions and thought disorder) and/or negative (apathy, speech impairment and inappropriate affect) symptoms (Crow, 1985). Although both disorders can be clearly distinguished by clinical phenotype and trajectory, both individuals with ASD and SCZ have found to exhibit FAR alterations (Eack et al., 2011; Sachse et al., 2014). FAR impairments in SCZ have mainly been described for processing of negative emotional facial expressions (for review see Tremeau, 2006). associated with reduced FG grey matter volume (Goghari et al., 2011), but also with reduced amygdala, fusiform and superior frontal gyrus activation and elevated activation of insula (Li et al., 2010). Some studies on SCZ indicate considerable difficulties explicitly processing emotional expressions with intact implicit FAR (Green et al., 2008; Shasteen et al., 2016). However, there have also been reports indicating impairment in explicit as well as implicit FAR (Li et al., 2010; Taylor et al., 2012). In addition, activation changes for neutral FAR have been described being associated with hyper-activation of frontal and cingulate cortical areas as well the amygdala (Habel et al., 2010; Mier et al., 2014).

In ASD, FAR impairments have consistently been demonstrated in neuropsychological and neuroimaging investigations (Dawson et al., 2005; Pelphrey et al., 2007), in particular for negative affect during implicit FAR associated with decreased activation in the amygdala and the FG and increased activation of other regions of the FAR network (Ashwin et al., 2007; Monk et al., 2010; Pelphrey et al., 2007). Some studies reported evidence of unimpaired FAR (Jones et al., 2011; Rump et al., 2009), possibly due to learned strategies for FAR in ASD (Harms et al., 2010). A recent fMRI study of our group using a cohort partially overlapping with the ASD cohort of this paper showed alteration in ASD exclusively during implicit, but not explicit FAR processing with pronounced reduced activation of the amygdala, FG and medial PFC (Bölte et al., 2015).

In sum, these studies do imply that neural alterations during FAR might overlap for ASD and SCZ during implicit FAR, in the amygdala, FG and MPFC. However, data are not conclusive and several methodological issues need to be addressed. To date, no fMRI study yet has directly compared both disorders during an implicit and explicit FAR task. Previous comparative studies of FAR in ASD and SCZ used behavioural measures (Sachse et al., 2014; Sasson et al., 2007), voxel-based morphology (Cheung et al., 2010; Radeloff et al., 2014) or presented meta-analytic findings (Sugranyes et al., 2011) and yielded no consistent results. Using fMRI, studies comparing ASD and SCZ directly during social cognition, have been performed for mentalising abilities (Ciaramidaro et al., 2015) and trustworthiness (Pinkham et al., 2008), but not for FAR.

The aim of this fMRI study was to investigate explicit and implicit FAR in a three groups study including of ASD, SCZ and healthy controls. We set out to directly investigate if (i) both, ASD and SCZ are associated with FAR deficits, (ii) if these deficits are implicit or explicit in nature and (iii) if so, whether they are conveyed by either common or rather disorder-specific neural abnormalities (Cheung et al., 2010; Crespi and Badcock, 2008; Pinkham et al., 2008). Common deficit-related neural changes would be supported by

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