Schizophrenia Research 152 (2014) 65–72

Contents lists available at ScienceDirect

Schizophrenia Research

journal homepage: www.elsevier.com/locate/schres

Self-reflection and positive schizotypy in the adolescent brain

Martin Debbané [a,b,*], Pascal Vrtička [d,e,f], Marine Lazouret [a,b], Deborah Badoud [a,b], David Sander [d,e], Stephan Eliez [b,c]

[a] Adolescence Clinical Psychology Research Unit, Faculty of Psychology and Educational Sciences, University of Geneva, Switzerland
[b] Office Médico-Pédagogique Research Unit, Department of Psychiatry, University of Geneva School of Medicine, Switzerland
[c] Department of Genetic Medicine and Development, University of Geneva School of Medicine, Switzerland
[d] Swiss Center for Affective Sciences, University of Geneva, Switzerland
[e] Laboratory for the study of Emotion Elicitation and Expression, Department of Psychology, University of Geneva, Switzerland
[f] Center for Interdisciplinary Brain Sciences Research, Psychiatry and Behavioral Sciences, Stanford University, USA

ARTICLE INFO

Article history:
Received 15 February 2013
Received in revised form 7 June 2013
Accepted 10 June 2013
Available online 29 June 2013

Keywords:
fMRI
Cortical midline
Psychosis
Hallucinations
Delusions
Connectivity

ABSTRACT

Clinical and phenomenological accounts of schizophrenia suggest that impairments in self-reflective processes significantly contribute to psychopathological expression. Recent imaging studies observe atypical cerebral activation patterns during self-reflection, especially around the cortical midline structures, both in psychosis-prone adults and individuals with schizophrenia. Given that self-reflection processes consolidate during adolescence, and that early transient expression of psychosis (positive schizotypy) also arises during this period, the present study sought to examine whether atypical cerebral activation during self-reflection task could be associated with early schizotypic expression during adolescence. Forty-two neurotypical adolescent participants (19 females) aged from 12 to 19 (15.92 ± 1.9) underwent a self-reflection task using functional neuroimaging (fMRI), where they had to evaluate trait adjectives (1 to 4 ratings) about themselves or their same sex best friend. The Schizotypal Personality Questionnaire (SPQ) was employed to assess positive schizotypic expression. Results showed that positive schizotypy in adolescents significantly correlated with cortical midline activation patterns in the dorsomedial prefrontal cortex (dmPFC) and the posterior cingulate cortex (PCC), as well as the dorsolateral PFC and the lingual gyrus. The results are consistent with previous imaging literature on self-reflection and schizophrenia. They further highlight that the relationship between self-reflection processes and positive schizotypy operates at the trait level of expression and can be observed as early as adolescence.

1. Introduction

Adolescence is often depicted as a critical developmental period for selfhood (Erikson, 1968), where questions such as "Who am I?" seek answers in both self-reflective and social cognitive processes (Pfeifer and Peake, 2012). Although psychiatric disorders involving anomalous self-experiences emerge during early adulthood, they are often preceded by subclinical symptom manifestations during adolescence (Rutter et al., 2006; Shiner, 2009). Schizophrenic spectrum disorders represent a good example of such developmental psychopathology. Indeed, cognitive-perceptual distortions such as transient hallucinatory, delusional and dissociative experiences during adolescence can, in some instances, be followed by adult onset of the disorder (Poulton et al., 2000; Dhossche et al., 2002; Dominguez et al., 2011). Importantly, these early cognitive-perceptual distortions, referred to as positive schizotypy (Dinn et al., 2002; Kerns, 2005; Debbané et al., 2009), can also be accompanied by social withdrawal, and together augment the risk of transitioning to clinical states commanding need for care (Miller et al., 2002). In this perspective, the cognitive processes sustaining reflective thinking about self and others during adolescence, even in those individuals that will not develop full-blown psychotic disorders, may provide critical information on the development of normative or clinical states of psychotic experiences.

Research on adolescent development has more recently involved structural and functional neuroimaging investigations (sMRI and fMRI), which are starting to uncover the profound cerebral modifications that characterize adolescent brain maturation (Fair et al., 2007; Shaw et al., 2008; Supekar et al., 2010). These studies have lead clinical neuroscientists to ask whether psychopathological conditions that typically arise during adulthood might be linked to atypical maturation during adolescent growth (Paus et al., 2008). Following this question, neuroimaging research involving "at-risk" youth samples seek to identify neuronal patterns signaling increased risk for severe adult psychopathology (Rotarska-Jagiela et al., 2010; Schneider et al., 2012). With regards to non-clinical positive schizotypy during adolescence, a few studies suggest that early schizotypic expression is associated with characteristic neural signature during task-free (Lagioia et al., 2010) as

* Corresponding author at: Adolescence Clinical Psychology Research Unit, Department of Psychology and Educational Sciences, University of Geneva, 40 Boulevard du Pont d'Arve, 1205 Geneva, Switzerland. Tel.: +41 22 379 94 18; fax: +41 22 379 93 59.
E-mail address: martin.debbane@unige.ch (M. Debbané).

0920-9964/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.schres.2013.06.027

well as task-engaged states (Lagioia et al., 2011). In a sample of 33 adolescents, Lagioia et al. (2011) specifically investigated self-reflectivity in a source monitoring task, by asking participants to recollect the origin of previously studied word items amongst self- versus experimenter-generated items. In contrast to a context discrimination condition, origin discrimination recruited the medial prefrontal cortex (mPFC), and more specifically the activation of BA 10 during origin trials. Importantly, self-report ratings of positive schizotypy in this adolescent group were found to correlate with diminished BA 10 activation during origin discrimination. These results are among the first to bridge non-clinical and clinical expression of positive schizotypy in youth, as atypical activation of the mPFC and other cortical midline structures (CMS) such as the anterior cingulate (ACC), the superior frontal gyrus (SFG) and the posterior cingulate (PCC) cortices during self-reflective activity is also reported in subjects in the prodromal (Shim et al., 2010), first episode (Alonso-Solis et al., 2012) and chronic stages of schizophrenia (for a review, see (Nelson et al., 2009)). Together, this nascent body of literature suggests that self-reflective processes recruit neural areas often found to show atypical activation patterns in non-clinical to clinical states of the schizophrenic spectrum disease. Such patterns of activation should be studied as early as adolescence, where self-reflective processes are thought to consolidate in parallel to neuronal maturation (Pfeifer and Blakemore, 2012).

Adolescent neuronal maturation, much like adolescent schizotypy expression, exhibits important gender differences (Shaw et al., 2008; Raznahan et al., 2011). Both gray and white matter growth pattern differences between adolescent girls and boys may ultimately lead to differential developmental trajectories towards the equifinal outcome of interest (Cicchetti and Rogosch, 2002), here schizophrenia spectrum disorders. Interestingly, the expression of schizotypy during adolescence also yields gender differences, with females generally expressing more important positive schizotypic features (Fonseca-Pedrero et al., 2008). To date however, it remains unclear whether gender differences can be observed in neural correlates of adolescent self-reflective processes, and whether putative differences might be related to schizotypy expression.

In this context, the present fMRI investigation sought to characterize the potential relationships linking neural correlates sustaining adolescent self-reflective processes and adolescent positive schizotypy. To this end, we employed a well-known trait attribution fMRI paradigm, which recruits cerebral activity along the cortical midline structures (Murray et al., 2012). As reviewed above, atypical cortical midline activity has been conceptualized as the neural signature of anomalous self-reflective processing in schizophrenia (Nelson et al., 2009; van der Meer et al., 2010). In continuation with this line of research, we hypothesized that atypical cortical midline activity during a self-reflective task be associated to adolescent positive schizotypy expression. We further investigated gender differences in the neural correlates of self-reflective processes. Finally, we tested for gender-specific patterns of association between positive schizotypy and atypical neural activation during self and other trait attribution.

2. Methods

2.1. Participants

Forty-two healthy adolescents participated in this study (23 males, 19 females), aged between 12 and 19 years (M = 15.92, S.D. = 1.9). Participants were French-native speaking adolescents recruited throughout secondary schools of Geneva, Switzerland. Exclusion criteria were current psychiatric or neurological disease. Furthermore, participants filled out the Youth Self Report (YSR) questionnaire (Achenbach, 1991) or Adult Self Report (ASR) questionnaire (>18 years old) (Achenbach and Rescorla, 2003) to ensure that expression of internalizing (INT) and externalizing (EXT) problems was below clinical cutoff. Written informed consent was obtained from participants and their parents under protocols approved by the Institutional Review Board of the Department of Psychiatry of the University of Medicine, Geneva.

The *Schizotypal Personality Questionnaire* (SPQ; (Raine, 1991)) was employed to assess the expression of schizotypy in our sample. It consists of a 74 dichotomous item instrument, yielding the three main following dimension scores: Positive (including unusual perceptual experiences, magical thinking, paranoid ideation, and ideas of reference; SPQpos), Negative (including social anxiety, constricted affects and no close friends; SPQneg) and Disorganisation (namely odd speech and behaviour; SPQdis). This scale has been validated in French-speaking adolescents (Badoud et al., 2011).

2.2. Experimental task

Stimuli were presented using the E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). During the block-designed fMRI paradigm, participants were asked to rate adjectives taken from the Anderson database (Anderson, 1968) referring to themselves (SELF condition), their same-sex best friend (OTHER condition) from 1 = "not at all" to 4 = "completely". The control condition consisted in counting syllables of the word (CONTROL condition) from 1 = one syllable to 4 = four or more syllables. At the beginning of each block, a screen with the cue ("SELF", "OTHER" or "SYLLABLE") was shown for 3 seconds. Each block comprised 5 adjective ratings (with the cue remaining at the top of the screen) of 4 seconds with a 5-second resting period between blocks. Adjectives presented an equal number (55) of positive valence words (i.e. "nice" or "generous") or negative valence word (i.e. "jealous" or "lazy") and were translated to French by two independent translators. Non-concordant translations were solved by consensus. Total task time was approximately 16 minutes.

2.3. Data acquisition and imaging

Participants were scanned at the Brain Behavioral Laboratory at Geneva University, using a 3-Tesla Trio MRI system (Siemens, Erlangen, Germany). Stimuli were presented on a screen at the back of the MRI tube, reflected in a mirror placed on the 12-channels head coil above the participant's head. A vacuum cushion was place under the participants' head to contain head movement. High-resolution structural T1-weighted images were obtained in one volume of 192 slices [TR = 2500 ms, TE = 30 ms, slice thickness = 1.1 mm, flip angle = 8°, FOV = 220 mm]. Blood Oxygenation Level (BOLD) functional images consisted of 395 volumes of 38 slices [TR = 2400 ms, TE = 30 ms, slice thickness = 3.2 mm, flip angle = 85°, FOV = 235 mm] obtained in a descending order (from top to bottom) parallel to the AC-PC line.

2.4. Imaging analyses

Functional images were analyzed using SPM8 (Wellcome Trust Center for Neuroimaging, Department of Neuroscience, London, UK, http://www.fil.ion.ucl.ac.uk/spm/software/spm8/), running on Matlab 7.12.0 (R2011a). Functional images were realigned to correct for head movement, and any subject with values greater than 3 mm in translation or 3° in rotation was excluded from further analysis. We subsequently performed slice-timing using the middle slice as a reference to correct for acquisition time differences, standard normalization to the MNI (Montreal National Institute) space, and resampling to 2 mm^3. Finally, spatial smoothing was applied with a 8 mm FWHM Gaussian Kernel and a high pass filter was applied to remove low-frequency noise.

We modeled the following conditions of interest at the single subject level: SELF > CONTROL, OTHER > CONTROL, SELF > OTHER, OTHER > SELF, and added the 6 movement regressors (from the realignment step) as variables of no interest to the design matrix. We estimated