



## Orbitofrontal cortex volume and intrinsic religiosity in non-clinical psychosis



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### ABSTRACT

Research indicates that religiosity plays a complex role in mental illness. Despite this link, little work has been done to clarify the role of religiosity in persons exhibiting non-clinical psychosis (NCP, individuals experiencing fleeting psychotic-like symptoms in the absence of a formal psychotic disorder). Further, there are no NCP investigations into whether abnormalities exist in brain structures that are associated with religiosity. Understanding these relationships in NCP is important to clarify the role of religiosity and brain structural anomalies in psychosis. Twenty individuals experiencing NCP and twenty controls were assessed for intrinsic religiosity (IR; motivation/commitment to religious beliefs and/or practices) using a well-validated self-report scale. Structural magnetic resonance imaging was used to determine volumes of the orbitofrontal cortex (OFC), a critical region that has been associated with increased religiosity. Results indicate that IR is elevated in the NCP group, and that these individuals exhibit bilateral volume reduction in both the lateral and medial OFC. Sample-wide correlations are non-significant, but show notable relationships between smaller OFC regions and increased IR. Significant negative relationships were found between OFC volume and depressive and negative symptoms. Overall, results suggest that brain abnormalities associated with NCP may also confer a heightened susceptibility for religiosity.

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### 1. Introduction

A body of evidence suggests that psychosis occurs across a continuum (Verdoux and van Os, 2002; Mittal et al., 2011; Pelletier et al., 2013a). Research supports the idea of a continuous phenotype by indicating that individuals in the general population can exhibit fleeting psychotic-like symptoms (van Os et al., 2009). These experiences, occurring in the absence of formal psychiatric illness, are often referred to as non-clinical psychosis (NCP) (Mittal et al., 2012a). Individuals experiencing NCP represent approximately 5–8% of the general population (van Os et al., 2009), and this group is also at an increased risk of developing psychosis (Poulton et al., 2000; Hanssen et al., 2005; Welham et al., 2009). There is a growing body of literature linking NCP with a variety of

risk factors commonly seen in formal psychosis, such as trauma, ethnicity, immigrant status, cannabis use, low socio-economic status, urban residence, unemployment, and prenatal complications (Kelleher and Cannon, 2011). One important component that is not investigated in the NCP population (and only minimally investigated in formal psychosis) is religion. Religion is commonly understood to reflect one's beliefs, practices, or behaviors surrounding supernatural agents (Kapogiannis et al., 2009a). Related to the concept of religion, religiosity is defined as psychological and/or behavioral traits associated with religious beliefs (Kapogiannis et al., 2009a). Because religion may often be a driving force in an individual's life that may pervade and affect all other beliefs, attitudes and behaviors (Suhail and Ghauri, 2010), the study of religion and religiosity warrants empirical attention.

The link between schizophrenia and religion is commonly recognized, but the exact nature of the relationship is not clearly understood and is often overlooked (Gearing et al., 2011). Research suggests that religion may act as both a risk and protective factor in regards to hallucinations and delusions (Gearing et al., 2011).

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For example, studies indicate that the subjective importance of religion may be positively related to the presence of religious delusions (Rudalevičienė et al., 2008). Research also suggests that having religious delusions is associated with poorer outcome in individuals with schizophrenia, and specifically, with less adherence to medication (Mohr et al., 2010). Further, it appears that differing religious appraisals (i.e., viewing God as benevolent versus God as punishing) of one's serious mental illness may also play a moderating role on prognosis (Phillips and Stein, 2007). Of note, there is some evidence to suggest that religious delusions are more likely to be held as fixed beliefs in comparison with other delusions (e.g., persecutory and body/mind control without a religious context) (Applebaum et al., 1999; Mohr et al., 2010). In individuals with a psychosis diagnosis, research indicates that the prevalence of religious delusions ranges anywhere from 6% to 36%, depending on the specific culture in question (Applebaum et al., 1999). Finally, in regards to having a more protective role, religion is associated with increased ability to cope with mental illness, and specifically with hallucinations and delusions (Mohr et al., 2006). Ultimately, although a relationship is apparent, it is not clear how religion may impact psychosis.

Research on religiosity also focuses more broadly on general psychological adjustment and other health outcomes (Hackney and Sanders, 2003; Koenig, 2008). To determine the role of religiosity in a variety of health outcomes, researchers have assessed a multitude of religious domains, including intrinsic religiosity (IR). IR is understood as the general spirituality or devoutness of an individual, and refers to one's degree of motivation and commitment to a lifestyle influenced by the presence of God and/or the Devine (Koenig et al., 1997; Lucchetti et al., 2013). IR has been linked to less alcohol use, minority status, greater optimism, female gender, recent illness onset, less depression, and less anxiety (Rajagopal et al., 2002; Cotton et al., 2006). In general, IR provides a means of assessing religiosity more broadly and is a tool for elucidating relationships with relevant health variables.

One means of furthering our understanding of religiosity in NCP is through neuroimaging. Although research indicates that NCP individuals exhibit structural abnormalities that are similar to those seen in formal psychosis (Jacobson et al., 2010), there is a need for further research to better understand associations between brain structure in NCP and clinical/behavioral components of NCP. Additionally, the literature on the neuroimaging of religiosity in NCP is non-existent. Of the limited research investigating religiosity and the brain in the field more broadly, one study assessed cortical volume and its relationship to religiosity through magnetic resonance imaging (MRI) (Kapogiannis et al., 2009a). In a recent study of 40 healthy adults (Kapogiannis et al., 2009a), investigators found that key components of religiosity (having intimate relationship with God and religious behaviors, as well as fear of God) were associated with structural differences including a decrease in the left orbitofrontal cortex (OFC). This is particularly interesting as the OFC is integral to higher order cognitive function including emotional processing, motivation, decision-making, hedonic experience, and sensory-visceral multimodal experience (Öngür and Price, 2000; Kringsbach, 2005; Chakirova et al., 2010). Additionally, studies across the psychosis spectrum, including those assessing individuals at high risk, individuals with first-episode psychosis, and those with chronic schizophrenia have found decreased volumes in the OFC (Borgwardt et al., 2008; Chakirova et al., 2010; Jung et al., 2012).

The present study seeks to address gaps in the NCP literature, specifically in regards to religiosity and brain structure. Twenty NCP and 20 matched control participants were assessed for IR and OFC volume to determine (1) whether IR is more prevalent in those individuals experiencing NCP, (2) whether there are significant volumetric differences in the OFC between groups (left

lateral OFC, right lateral OFC, left medial OFC, and right medial OFC), and (3) whether a specific directional relationship found in a previous study (Kapogiannis et al., 2009a) was present here (decreased left orbitofrontal cortex volume related to high religiosity). Given the emerging idea of a putatively significant role of religiosity and OFC volumetric abnormalities in disorders such as schizophrenia (Gearing et al., 2011; Chakirova et al., 2010), we believe the present data may help facilitate an understanding of a relationship between these two variables and the overarching implications for our comprehension of psychosis.

## 2. Methods

### 2.1. Subjects

All participants were recruited through the Adolescent Development and Preventive Treatment (ADAPT) program at the University of Colorado Boulder (UCB), and the Institutional Review Board (IRB) approved all procedures. Study details were provided to all participants and written informed consent was obtained. To identify participants for NCP group, individuals participating in the UCB Psychology Department undergraduate research pool ( $n=1285$ ) were screened using the Community Assessment of Psychic Experiences (CAPE) (Mittal et al., 2012b) positive symptom inventory. The option to participate in the study was made available to those scoring in the top 15th percentile on the CAPE positive domain ( $\geq$  a score of 15 on the CAPE). The research pool is a volunteer research database in which undergraduate students taking an introduction to psychology course participate in research studies for course credit. Several studies recruit from this subject pool. Therefore, to limit potential sampling bias (i.e., individuals knowingly selecting studies for which they are most suited or in which they are most interested), available studies are listed as numbers without descriptions. From the possible 81 students invited, a total of 20 students selected to participate in this study; none of the students declined to participate after learning the study details.

Healthy control participants ( $n=20$ ) were recruited through flyers and newspaper announcements (advertised as a study of neuroimaging and healthy development for volunteers with no psychiatric symptoms and no family history of psychosis) and selected on the basis of demographic characteristics comparable to the NCP group in age, sex, and parental educational level (a proxy for social class). Due to the desire to maximize recruitment of a normative sample, we chose not to use an extreme low NCP group (scoring low on the CAPE) in order to avoid potentially superficially increasing variability and influencing findings (Mittal et al., 2011, 2012a; Pelletier et al., 2013a). Therefore, screening with the CAPE positive domain was not an inclusion/exclusion criterion for the healthy control group.

### 2.2. Clinical symptoms

The CAPE is self-report questionnaire that measures the frequency of psychotic-like experiences on a four-item Likert scale including "Never," "Sometimes," "Often," and "Nearly Always" (Mittal et al., 2012b). The positive, negative, and depressive frequency sections were administered to all participants. The positive symptom frequency section of the CAPE contains 20 items, the negative section includes 14 items, and the depressive section includes 8 items. The CAPE is one of the most widely used, reliable, and well-validated instruments for examining NCP (Johns, 2005; Barkus et al., 2007; Vellante et al., 2012).

The B module of Structured Clinical Interview for DSM-IV Disorders (SCID) (Overall and Gorham, 1976) was administered to participants in both groups to ensure that participants with clinical levels of psychosis would not be included, as their inclusion could potentially confound results (no participants were excluded based on this criterion). Previous studies show that the SCID yields valid and reliable diagnosis for a wide age range including adolescents and young adults (Weinstein et al., 1999). This measure has been demonstrated to have excellent inter-rater reliability in adolescent populations (Martin et al., 2000). Advanced psychology doctoral students and clinical psychologists conducted the SCID interviews, and reliability exceeded 0.90.

### 2.3. Religiosity

Religiosity was measured using the Duke University Religion Index (DUREL), a brief, five-item self-report scale created for epidemiological studies assessing religious involvement (Koenig and Büssing, 2010). The DUREL assesses multiple domains of religiosity including intrinsic religiosity (IR), organizational religious activity (e.g. religious service attendance), and non-organizational religious activity (e.g., time spent in prayer) (Koenig and Büssing, 2010). Two questions assess organized and non-organized religiosity (one question for each dimension), and three questions assess IR. In general, IR represents how committed or motivated an individual is to a lifestyle characterized by religiosity. Specifically, questions assess

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