CORTEX 91 (2017) 197–207

Available online at www.sciencedirect.com

ScienceDirect

Journal homepage: www.elsevier.com/locate/cortex

Special issue: Research report

Testing continuum models of psychosis: No reduction in source monitoring ability in healthy individuals prone to auditory hallucinations

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ARTICLE INFO

Article history:
Received 18 July 2016
Reviewed 2 October 2016
Revised 8 November 2016
Accepted 14 November 2016
Published online 22 November 2016

Keywords:
Schizophrenia
Auditory verbal hallucinations
Reality monitoring
Internal source monitoring

ABSTRACT

People with schizophrenia who hallucinate show impairments in reality monitoring (the ability to distinguish internally generated information from information obtained from external sources) compared to non-hallucinating patients and healthy individuals. While this may be explained at least in part by an increased externalizing bias, it remains unclear whether this impairment is specific to reality monitoring, or whether it also reflects a general deficit in the monitoring of self-generated information (internal source monitoring). Much interest has focused recently on continuum models of psychosis which argue that hallucination-proneness is distributed in clinical and non-clinical groups, but few studies have directly investigated reality monitoring and internal source monitoring abilities in healthy individuals with a proneness to hallucinations. Two experiments are presented here: the first ($N = 47$, with participants selected for hallucination-proneness from a larger sample of 677 adults) found no evidence of an impairment or externalizing bias on a reality monitoring task in hallucination-prone individuals; the second ($N = 124$) found no evidence of atypical performance on an internal source monitoring task in hallucination-prone individuals. The significance of these findings is reviewed in light of the clinical evidence and the implications for models of hallucination generation discussed.

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http://dx.doi.org/10.1016/j.cortex.2016.11.011

1. Introduction

Auditory verbal hallucinations (AVH), or the experience of hearing a voice in the absence of any speaker, are experienced by a large proportion of individuals with a diagnosis of schizophrenia, as well as those with other psychiatric diagnoses such as bipolar disorder and post-traumatic stress disorder (PTSD), and by approximately 1% of the healthy population (Kråkvik et al., 2015). Cognitive and neuroscientific studies aimed at understanding the underlying mechanisms of AVH have compared task performance and/or neural activation between individuals with psychiatric diagnoses who hallucinate and those who do not (Stephane, Kuskowski, McClannahan, Surerus, & Nelson, 2010), as well as between groups of individuals with no clinical diagnoses who report differing levels of hallucination-proneness (Larøi, Van der Linden, & Marczewski, 2004). One of the most prominent cognitive models of AVH holds that these symptoms occur when internal mental events, such as inner speech, are misattributed to an external, non-self-generated source (Bentall, 1990; Frith, 1992; Moseley, Fernyhough, & Ellison, 2013). As such, research has focused on the question of how we typically distinguish between different sources of information, and how these processes might fail.

The Source Monitoring Framework addresses how we make judgements about the origin (source) of remembered information, using characteristics such as perceptual, semantic, or affective content, or the nature of the earlier cognitive operations (Johnson, Hashtroudi, & Lindsay, 1993). Source monitoring can be broadly divided into three subcategories depending on the contrasts which must be made: 1. External source monitoring, where the distinction is between non-self-generated sources of information, such as whether an image appeared on the left or right side of a screen; 2. Internal source monitoring, where a distinction must be made between self-generated sources of information, such as whether a sentence had previously been spoken aloud or internally using inner speech; and 3. Reality monitoring, involving discrimination between internal and external sources of information, such as whether a sentence had been spoken by the individual or by someone else, or even whether an event had been witnessed or dreamt. Each of these variants are commonly tested using a source memory paradigm, requiring the participant to encode stimuli from different sources, and on later re-presentation of the stimuli, to judge the original source of the stimuli. For example, a reality monitoring task might present participants with a series of verbal word-pairs (e.g., *bubble and squeak*), which are shown either completed ('perceived', that is externally generated, e.g., *bubble and squeak*) or where the second word must be supplied by the participant ('imagined', that is, internally generated, e.g., *bubble and s____*). Reality monitoring ability might then be assessed by asking the participant to remember whether the second word of the word-pair had previously been perceived or imagined.

Reality monitoring ability in healthy individuals is associated with activity in the medial anterior prefrontal cortex, (PFC, e.g., Simons, Henson, Gilbert, & Fletcher, 2008; Simons, Davis, Gilbert, Frith, & Burgess, 2006; Turner, Simons, Gilbert, Frith, & Burgess, 2008), as well as to structural morphology of the nearby paracingulate sulcus (PCS; Buda, Fornito, Bergstrom, & Simons, 2011). Patients with schizophrenia show impairments in reality monitoring ability (e.g., Anselmetti et al., 2007; Brébion et al., 2000; Waters, Maybery, Badcock, & Michie, 2004), which are associated with dysfunction in the medial anterior PFC (Subramaniam et al., 2012; Vinogradov, Luks, Schulman, & Simpson, 2008), as well as to altered PCS morphology (Garrison, Fernyhough, McCarthy-Jones, Haggard, & Simons, 2015). Indeed, Garrison et al. (2015) indicated that a shorter PCS was associated with a higher likelihood of hallucinations in patients with schizophrenia, with these findings together suggesting that the PCS, and surrounding anterior medial PFC, may be associated with both reality monitoring and hallucinations. Considering the wider underlying network for AVH, an fMRI study with healthy individuals observed increased activation in the area surrounding the auditory cortices in the superior temporal gyrus (STG) during the encoding stage of a reality monitoring task, which correlated with measures of hallucination-proneness (Sugimori, Mitchell, Raye, Greene, & Johnson, 2014). Both the PCS and STG regions are often observed to be active during the experience of AVH in 'symptom-capture' fMRI studies (e.g., Zmigrod, Garrison, Carr, & Simons, 2016).

To test the suggestion that reality monitoring deficits play a causal role in the generation of AVH, research has focused on the behavioural association between atypical source monitoring and the presence or intensity of hallucinations. Two mechanisms have been proposed which might explain this deficit: an externalizing bias and a general source monitoring deficit. The idea of externalizing bias stems from the observation made during reality monitoring studies involving healthy individuals, that participants often exhibit a greater likelihood of falsely attributing new or internally generated items to an external source, than of making the reverse error (Johnson, Raye, Foley, & Foley, 1981; see Garrison, Bond, Gibbard, Johnson, & Simons, 2016, for a discussion). Bentall (1990) argued that since hallucinations are internally generated events experienced as external, atypical source monitoring in individuals with AVH is most likely to manifest itself as an enhanced externalizing bias (in which self-generated information is more likely to be misattributed as externally-generated). Behavioral evidence supports this proposal, with a recent meta-analysis finding that patients with hallucinations have a greater tendency to misattribute internal items to external sources than non-hallucinating individuals or healthy controls (Brookwell, Bentall, & Varese, 2013).

An alternative possibility is that individuals with AVH exhibit general source monitoring deficits, which can be observed in terms of poorer performance across all types of source memory tasks. Such a deficit might arise in addition to an externalizing bias (e.g., the deficit might be explained by some variation in the application of criteria used to determine the internal/external nature of mental experience), or may itself be related to the generation of the bias (e.g., if the weak application of decision-making criteria generally has a greater impact on the recognition of self-generated status than of external status). Evidence suggests that as well as deficits in reality monitoring, patients with schizophrenia do often exhibit internal and external source memory deficits when