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Auditory verbal hallucinations and cognitive functioning in healthy individuals

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ABSTRACT

Auditory verbal hallucinations (AVH) are a characteristic symptom in schizophrenia, and also occur in the general, non-clinical population. In schizophrenia patients, several specific cognitive deficits, such as in speech processing, working memory, source memory, attention, inhibition, episodic memory and self-monitoring have been associated with auditory verbal hallucinations. Such associations are interesting, as they may identify specific cognitive traits that constitute a predisposition for AVH. However, it is difficult to disentangle a specific relation with AVH in patients with schizophrenia, as so many other factors can affect the performance on cognitive tests. Examining the cognitive profile of healthy individuals experiencing AVH may reveal a more direct association between AVH and aberrant cognitive functioning in a specific domain.

For the current study, performance in executive functioning, memory (both short- and long-term), processing speed, spatial ability, lexical access, abstract reasoning, language and intelligence performance was compared between 101 healthy individuals with AVH and 101 healthy controls, matched for gender, age, handedness and education.

Although performance of both groups was within the normal range, not clinically impaired, significant differences between the groups were found in the verbal domain as well as in executive functioning. Performance on all other cognitive domains was similar in both groups. The predisposition to experience AVH is associated with lower performance in executive functioning and aberrant language performance. This association might be related to difficulties in the inhibition of irrelevant verbal information.

1. Introduction

Auditory verbal hallucinations (AVH) are a characteristic symptom of schizophrenia but have also been described in the general population (Tien, 1991; Verdoux and Van Os, 2002). Thus far, the pathophysiology of AVH is still largely unknown. Many theories concerning the origin of AVH have been postulated of which several have implicated specific cognitive dysfunctions as the core abnormality to cause AVH. For example, Frith and Done (1988) hypothesized a failure in self-monitoring as the basic deficit in AVH whereas Verkammen et al. (2008) stated that increased top-down processing plays an important role in the vulnerability to experience AVH. In support of such cognitive deficits or traits, hypothesized to underlie AVH, a number of studies found prominent impairments in several cognitive functions such as speech processing (Hoffman et al., 1999), working memory (Hoffman et al., 1999), episodic memory (Berenbaum et al., 2008), source memory (Brébion et al., 2007), attention (Berman et al., 1997), inhibition (Waters et al., 2003) and self-monitoring (Seal et al., 2004; Waters et al., 2010). However, patients with schizophrenia suffer from various other symptoms besides AVH, among which avolition, lack of motivation and a general decline in cognitive functioning. Therefore, decreased performance on specific tests is not necessarily a reflection of their tendency to hallucinate. A more specific reflection of AVH may be provided by cognitive differences that occur in non-psychotic individuals with AVH, who are free of negative symptoms and have only sub-clinical levels of positive symptoms (Sommer et al., 2010a,b). The fact that that these healthy individuals with AVH function at a normal level, were able to finish their education, are medication naïve and have no history of admission to hospital is an additional advantage. Although differences in AVH have been found between healthy individuals and psychotic patients, regarding for instance frequency and emotional content, several similarities remain: no differences were found between location of AVH, loudness, number of voices and personification (Daalman et al., 2011). Based on these results one cannot conclude that both types of AVH are different. Furthermore, Diederen et al.

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(2011) found no significant differences in brain activation during the experience of AVH between healthy individuals with AVH and patients.

In order to measure cognitive functioning in non-psychotic individuals with AVH, a group of 101 persons with AVH who were screened for axis I or II pathology was compared to a matched control group with a battery of neuropsychological tests. These tests focus primarily on cognitive domains that were previously found to be affected in patients with a psychotic disorder experiencing AVH. The most important cognitive domains in that perspective were included: memory, language, executive functioning, processing speed, spatial ability, verbal and non-verbal reasoning.

The aim of the present study was to establish a cognitive profile of healthy individuals with AVH. Compared to healthy individuals without AVH, this group might show deviant cognitive performance. These cognitive differences will then provide clues for a potential cognitive mechanism that could underlie AVH since these individuals are otherwise healthy.

2. Method

2.1. Participants

A total of 101 healthy individuals with AVH were compared to 101 healthy individuals without AVH. Hallucinating individuals that were free of a DSM-IV diagnosis, as assessed by an independent psychiatrist using the Comprehensive Assessment of Symptoms and History (CASH) interview (Andreasen et al., 1992) and the Structured Clinical Interview for Personality Disorder (SCID-II, First et al., 1995), were included. Depressive disorder in complete remission was not an exclusionary criterion. Urine samples were used to screen for cannabis, amphetamine, cocaine, methadone or heroine abuse, which was an exclusion criterion. Additional exclusion criteria for both groups were alcohol abuse and IQ below 80.

For the healthy individuals with AVH, the minimum frequency to experience AVH was once every three months and the minimum duration since onset of AVH was one year.

Both healthy controls and healthy individuals with AVH were recruited with the help of a Dutch website called 'explore your mind' (www.verkenuwgeest.nl). For more details about selection and assessment procedure see previous studies by our group (Sommer et al., 2010a, b; Daalman et al., 2011). The control group was matched for gender, age, handedness and education and did not differ significantly on these variables, as shown in Table 1. All participants had four Dutch grandparents. The study was approved by the Humans Ethics Committee of the University Medical Center Utrecht. After complete description of the study to the participants, written informed consent was obtained.

2.1.1. Phenomenology of AVH in healthy individuals

To establish the phenomenological characteristics of AVH, the PSYRATS Auditory Hallucination Rating Scale (AHRS, Haddock et al., 1999) was administered. This questionnaire describes 11 characteristics of AVH. Each item of this scale is evaluated on a 5-point Likert Scale ranging from 0 to 4. For the use of this questionnaire in healthy individuals, the range of the frequency scale is extended to 0–6 (also covering options 'at least once every month' and 'at least once every three months' since AVH are experienced less often than once a week (the original minimum score of this item). This questionnaire was administered by trained psychologists.

Due to high correlations between several of these items, two new variables were computed (see also Daalman et al., 2011). The variable 'emotional valence of content' was operationalized as the sum of three items from the AHRS: 'amount of negative content of voices', 'degree of negative content' and 'amount of distress'; i.e. an ordinal variable expressing overall burden of voices with negative content. The variable 'total distress' was operationalized as the sum of two items from the AHRS: 'intensity of distress', and 'disruption to life caused by voices'. As a result, the following items were used in this study: frequency, duration, location, loudness, beliefs re-origin of voices, controllability, emotional valence of content and total distress.

Table 1
Demographic characteristics of the participants: healthy individuals with AVH and healthy controls.

Group	Individuals with AVH	Controls	Difference (significance)
n	101	101	
Male (%)	33.7	29.7	$\chi^2 = .366$ (P = 0.545)
Right handed (%)	78.2	84.2	$\chi^2 = 1.167$ (P = 0.280)
Mean age (s.d.)	43.78 (12.50)	43.30 (14.23)	t = .257 (P = 0.797)
Mean years of education (s.d.)	13.39 (2.18)	13.76 (2.40)	t = −1.17 (P = 0.245)

2.2. Measures

2.2.1. Neuropsychological assessments

The neuropsychological tests used in this study cover the domains in which impaired functioning in psychotic patients with AVH is found, and are thus candidates for examining the relationship between AVH in healthy individuals and cognitive functioning (Table 2).

Tests were administered in a fixed order and all examiners were extensively trained and supervised in the use of the tests. To rule out language deficits (aphasia, language expression and comprehension difficulties), the Boston naming task (Kaplan et al., 1983) and Tokentest (De Renzi and Vignolo, 1962) was administered. Participants who showed impaired language functioning, as measured by these tasks, were excluded.

2.3. Statistical analyses

Between-group comparison on the above described cognitive measures was achieved through multivariate analysis of variance (MANOVA), applying a General Linear Model. The independent variable was group (experiencing AVH or not i.e. controls) and the dependent variables were the raw scores on the fourteen cognitive tasks as described above. The Step-Up Hochberg correction was used to adjust P-values because of multiple testing (Westfall and Young, 1993; Benjamini and Hochberg, 1995). All data were analyzed with the Statistical package for the Social Sciences (SPSS, 2006).

3. Results

Table 3 describes how often AVH were experienced in the healthy individuals. Table 4 provides more information about the phenomenology of AVH in this group.

As expected, individuals of both groups performed the tests within the normal range, when compared to the norm reference scores of each test. There was a statistically significant difference between the groups on the combined dependent variables: $F(14,187) = 3.65$, $P<0.001$; Pillai's Trace 0.22. When the results for the dependent variables were considered separately (Table 5), the individuals experiencing AVH were more sensitive to distraction as reflected in lower performance on the Stroop interference measure, had a lower verbal working memory capacity (reflected in lower Digit-span backward performance), underperformed, compared to controls, on a task for vocabulary (Vocabulary test, WAIS III subtask) and for judging verbal similarities (Similarities test, WAIS III subtask). In addition the individuals with AVH performed slightly lower on the NART, an estimate of verbal intelligence. No differences were found on tasks tapping verbal and nonverbal memory, attention span, nor on