Psychiatry Research 254 (2017) 268–274

Contents lists available at ScienceDirect

Psychiatry Research

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

Auditory and non-auditory hallucinations in first-episode psychosis: Differential associations with diverse clinical features

Chiara Galletti[a], Enrico Paolini[a], Alfonso Tortorella[a], Michael T. Compton[b,*]

[a] Department of Medicine, Section of Psychiatry, University of Perugia, Perugia, PG, Italy
[b] Department of Psychiatry, Columbia University College of Physicians and Surgeons, New York, NY, USA

ARTICLE INFO

Keywords:
Auditory hallucinations
First-episode psychosis
Hallucinations
Psychosis
Schizophrenia
Visual hallucinations

ABSTRACT

Data from 247 first-episode psychosis patients were used to explore associations between types of hallucinations and nine diverse clinical characteristics. Psychopathology was rated using the *Scale for the Assessment of Positive Symptoms* and *Scale for the Assessment of Negative Symptoms* (SANS). Childhood adversity was assessed with seven instruments; family history with an adapted version of the *Family Interview for Genetic Studies*; age at onset of psychosis and duration of untreated psychosis (DUP) with the *Symptom Onset in Schizophrenia* inventory; and insight with the *Birchwood Insight Scale*. Both principal component analysis-derived *Auditory* and *Non-Auditory Hallucinations* were similarly associated with delusions of influence, negative affect delusions (jealousy and sin/guilt), interpersonal childhood abuse, DUP, and insight. However, the two hallucination domains had different associations with grandiose/religious, paranoid, and somatic delusions; SANS score; childhood violence exposure; cannabis use disorders; and cocaine/other drug use disorders. Neither *Auditory* nor *Non-Auditory Hallucinations* were associated with childhood neglect, age at onset, alcohol use disorders, family history, or mode of onset of psychosis. Findings support considering hallucinations not as a unitary psychopathological construct. They represent at least two domains and are correlated in different ways with diverse clinical variables.

1. Introduction

Hallucinations are a core criterion in schizophrenia and related psychotic disorders. In patients with first-episode psychosis in particular, hallucinations are known to be very common (e.g., a prevalence of 73% in a study of 143 first-episode patients by Rajapakse et al., 2011, and a prevalence of 75% in a study of 160 first-episode patients by Mbewe et al., 2006). The most common hallucinations experienced are auditory (Mbewe et al., 2006; Peralta and Cuesta, 1999; Rajapakse et al., 2011) followed by visual, somatic, and other hallucinations, with different rates of prevalence in both first-episode (Rajapakse et al., 2011), as well as chronic patient samples (Chaudhury, 2010; Thomas et al., 2007).

Despite the high prevalence, knowledge about sociodemographic and clinical correlates of hallucinations is limited. Although previous studies have uncovered some associations between hallucinations and sociodemographic and clinical features, very few studies have focused on patient characteristics that are related to different types of hallucinations in first-episode psychosis. We aimed to first identify the factor structure of different types of hallucinations and then to explore clinical correlates of those types of hallucinations in a large first-episode psychosis sample.

In order to define the psychopathological areas of schizophrenia, previous studies have performed factor analyses that could identify underlying dimensions of the various symptoms. Most performed principal component analysis (PCA) of items from the *Scale for the Assessment of Positive Symptoms* (SAPS; Andreasen, 1984) and its complement, the *Scale for the Assessment of Negative Symptoms* (SANS; Andreasen, 1983). Yet, few studies have involved recent-onset or first-episode psychosis, and just one focused on latent dimensions of hallucinations specifically (Vázquez-Barquero et al., 1996), which found two factors: the first included auditory hallucinations, voices commenting, and voices conversing, and the second included visual and somatic/tactile hallucinations; olfactory hallucinations loaded onto neither factor.

Knowledge about possible relations between these domains and others clinical variables is limited, especially in first-episode psychosis. Regarding sociodemographic characteristics, female first-episode patients had a higher score for visual and auditory hallucinations than their male counterparts (Thorup et al., 2007), and patients with a

* Correspondence to: New York State Psychiatric Institute, 1051 Riverside Drive, Unit 100, New York, NY 10032, USA.
E-mail address: mtc2176@cumc.columbia.edu (M.T. Compton).

http://dx.doi.org/10.1016/j.psychres.2017.04.056
Received 15 June 2016; Received in revised form 26 February 2017; Accepted 23 April 2017
Available online 24 April 2017

positive family history of psychosis were more likely to have tactile hallucinations (Uçok and Bikmaz, 2007). Pertaining to clinical features, Evensen et al. (2011) reported better cognitive insight in first-episode patients with hallucinations only compared to patients with delusions only.

Studies of associations between childhood trauma and hallucinations have been more extensive. In a recent study investigating the correlation between auditory verbal hallucinations and childhood traumatic events, Misiak et al. (2016) found that such events, as well as sexual abuse, predicted the extent of auditory hallucinations in females. Moreover, a recent study focused on visual hallucinations uncovered that the experience of childhood interpersonal trauma increased the risk of experiencing such hallucinations (Solesvik et al., 2016). Furthermore, childhood rape was associated with non-auditory hallucinations (Longden et al., 2016). Uçok and Bikmaz (2007) investigated correlations between all types of hallucinations and childhood traumatic events; those having suffered emotional abuse were more likely to experience auditory hallucinations, and voices commenting, while physical neglect was related to visual and tactile hallucinations.

Some of the variability in the limited findings to date is likely due to the different assessment processes, varying characteristics of the samples, and the nature of statistical analyses employed. We performed a secondary analysis of data collected during a cross-sectional and retrospective study of the effects of premorbid cannabis use on the early course of psychotic disorders. We wanted to make use of the richness of the available data by exploring a broad range of clinical variables. First, we conducted a PCA of the six types of hallucinations measured with the SAPS, for data reduction purposes, and given substantial intercorrelations among the six variables. Then, we explored associations between hallucinations (specifically, domains of hallucinations derived from the PCA) and nine clinical features: age at onset of psychotic symptoms, mode of onset of psychotic symptoms (i.e., acute, subacute, or gradual onset), family history of psychosis, substance abuse/dependence, five types of delusions, negative symptom severity, three types of childhood adversity, duration of untreated psychosis (DUP), and insight.

2. Methods

2.1. Setting and sample

Consecutively admitted patients with first-episode psychosis were approached for study participation. A total of 247 participants were enrolled from August 2008 to June 2013 from three inpatient psychiatric units in Atlanta, Georgia and three in Washington, D.C. Eligible patients were 18–40 years of age, English-speaking, and able to give informed consent. Exclusion criteria included known or suspected mental retardation, a Mini-Mental State Examination (Cockrell and Folstein, 1988; Folstein et al., 1975) score of < 24, presence of a major medical condition compromising ability to participate, prior treatment for psychosis lasting longer than three months, and prior hospitalization for psychosis earlier than three months before the index hospitalization.

2.2. General procedures

Once psychotic symptoms were stabilized sufficiently for informed consent and participation, trained masters- or doctoral-level assessors conducted the in-depth assessments. When possible, collateral assessments were also carried out with family members/informants in order to gather additional information useful in the rating of family history of psychosis, mode of onset of psychosis, and age at onset/DUP. All procedures were approved by all relevant Institutional Review Boards, and all participants provided written informed consent.

2.3. Measures and rating scales

For evaluating diverse clinical variables, psychopathology, and diagnosis, patients were tested with an extensive assessment. Positive and negative symptoms of psychotic disorders were measured with the SAPS (Andreasen, 1984) and its complement, the SANS (Andreasen, 1983). The SAPS has 34 items and contains four subscales: hallucinations, delusions, bizarre behavior, and positive formal thought disorder. We previously performed a PCA involving the 12 SAPS delusions items in this sample (Paolini et al., 2016), which uncovered five delusion domains: (1) delusions of influence (being controlled, mind reading, thought broadcasting, thought insertion, and thought withdrawal), (2) grandiose/religious delusions, (3) paranoid delusions (persecutory delusions and delusions of reference), (4) negative affect delusions (jealousy and sin/guilt delusions), and (5) somatic delusions. Those domains are used in the present analysis. The SANS has 25 items included in five subscales: affective flattening, alogia, avolition-apathy, anhedonia-asociality, and attentional impairment. For each item of the SAPS and SANS the ratings range from 0 = none to 5 = severe. Test-retest reliability and construct validity have been demonstrated for these widely used instruments (Rogers, 2001). We rated the SAPS and SANS with regard to the greatest intensity of symptoms at present or in the previous month, rather than with regard to the day of the assessment only, as treatment had usually begun during the several days prior to assessment.

Age at onset of psychosis was determined using the *Symptom Onset in Schizophrenia* (SOS) inventory (Perkins et al., 2000). The date of the onset of psychosis (and thus the age at onset of psychosis) was derived based on consensus-based best estimates of the onset of hallucinations or delusions, whichever came first. Age at onset could not be reliably determined for 23 patients.

Mode of onset of psychosis was defined according to the World Health Organization International Pilot Study of Schizophrenia (Jablensky et al., 1992) as acute with sudden onset, acute with precipitous onset, subacute, gradual, and insidious. This categorization of the mode of onset of psychosis was derived using a consensus-based best-estimate approach, reviewing all available information from the patient assessment, informant assessment(s) when available, the medical record, and the treating clinician. In the present analysis, mode of onset was trichotomized as acute, subacute, and chronic. Due to the complexity of retrospectively rating mode of onset of psychosis, data on this variable were available for only 162 patients.

An adapted version of the *Family Interview for Genetic Studies* (FIGS; Maxwell, 1992) was used to collect detailed data on family history of a number of psychotic symptoms, diagnoses, and/or medications or hospitalization; participants were divided into two groups, those with and without a family history of either broadly defined psychosis or narrowly defined schizophrenia. Data on family history was missing for 23 patients.

Diagnoses of psychotic disorders and substance-related disorders were assessed using the *Structured Clinical Interview for DSM-IV Axis I Disorders* (SCID; First et al., 1998). Regarding substance use disorders, we combined the two groups of cocaine abuse/dependence and other substance abuse/dependence (e.g., ecstasy, methamphetamine, PCP) due to the small number of patients using such substances. We grouped abuse/dependence of each substance (alcohol, cannabis, and cocaine/other substances) into three categories: no abuse/dependence, current or lifetime abuse, and current or lifetime dependence. Data on alcohol use were missing for 13 patients, cannabis use for 14 patients, and cocaine/other substance use for 11 patients.

We used seven instruments that assess childhood/adolescent adversity: the *Childhood Trauma Questionnaire–Short Form* (CTQ-SF; Bernstein et al., 2003), the *Trauma Experiences Checklist* (TEC; Cristofaro et al., 2013), *Parental Nurturance* (Barnes and Windle, 1987), *Parental Harsh Discipline* (Ge et al., 1994; Mrug et al., 2008), *Violence Exposure* (Mrug et al., 2008), *Friends' Delinquent Behavior* (Mrug et al., 2012), and *School*

Connectedness Scale (Sieving et al., 2001). We referred to a previously conducted factor analysis with these seven instruments in this sample in order to reduce the large number of the variables and simplify the analysis. The previous exploratory factor analysis revealed three factors, named *Environmental Violence* (which included scales or subscales pertaining to extreme risk, danger, and violence exposure), *Interpersonal Abuse* (including scales or subscales tapping abuse and harsh conditions in the family or at home), and *Neglect* (which included physical/emotional neglect and lack of connectedness at home and school) (unpublished data).

DUP was computed as the number of weeks from SOS-derived onset of hallucinations or delusions or both to the date of first hospitalization. DUP could not be reliably determined for 24 patients.

The *Birchwood Insight Scale* (BIS; Birchwood et al., 1994) measures three dimensions of insight (ability to relabel symptoms, awareness of mental illness, and recognition of a need for treatment). The BIS previously underwent exploratory and confirmatory factor analyses in first-episode psychosis patients (the present sample) and in those with chronic serious mental illnesses (Cleary et al., 2014), revealing a single factor. Data on BIS total score were missing for 24 patients.

2.4. Data analyses

In order to understand the inter-correlations among the six SAPS hallucinations items, we examined bivariate associations using Spearman correlation coefficients. We then performed a PCA to identify any latent or underlying dimensions among the six hallucinations items. Prior to performing PCA, we verified the applicability of the data for the analysis. The Kaiser-Meyer-Olkin sampling adequacy measure was .69 (the recommended value being $\geq .6$), and the Bartlett's test of sphericity was significant ($p < .001$), both of which supported the factorability of the correlation matrix. Eigenvalues > 1.0 were chosen as the criterion for factor extraction. Components were then rotated using Promax rotation.

Because the resultant *Auditory Hallucinations* subscale score and *Non-Auditory Hallucinations* subscale score were not normally distributed (e.g., Kolmogorov-Smirnov tests were $p \leq .001$), we used Spearman correlation coefficients, Kruskal-Wallis tests, and Mann-Whitney *U* tests for subsequent analyses, all of which were performed using IBM SPSS Statistics version 21.0.

3. Results

3.1. Sociodemographic and clinical characteristics, and prevalence of and inter-correlations among the six types of hallucinations

Sociodemographic and clinical characteristics of the sample are summarized in Table 1. The mean age of the 247 patients was 23.9 ± 4.7 years (range, 18–40 years). The majority of subjects were male (184, 74.5%), single (212, 85.8%), and African American (213, 86.2%). Schizophrenia was the most common SCID-based diagnosis and accounted for 58% of the sample.

In Table 2, we report the frequency of each SAPS hallucination item and the inter-correlations among the six different types. A score of ≥2 (mild) was chosen as requisite for indicating that a patient experienced the respective type of hallucination. The two most common types of hallucinations were: auditory (182, 73.6%) and visual (95, 38.5%); the two least common were somatic or tactile (69, 27.9%) and olfactory (47, 19.0%). With regard to means, the auditory hallucination item had a higher value than all other items. The strongest inter-correlations were between auditory hallucinations, voices commenting, and voices conversing (ρ = .48–.58); the weakest inter-correlations were between somatic or tactile hallucinations and voices commenting (ρ = .09) and voices conversing (ρ = .11).

Table 1
Sociodemographic and clinical characteristics of the study sample ($n = 247$).

Age, years (M ± SD)	23.9 ± 4.7
Educational attainment, years (M ± SD)	11.9 ± 2.2
Gender, male (*n*,%)	184 (74.5%)
Relationship status (*n*,%)	
Single, never married	212 (85.8%)
Married or living with a partner	13 (5.3%)
Separated	12 (4.9%)
Divorced	8 (3.2%)
Widowed	1 (.4%)
Not declared	1 (.4%)
Living conditions (*n*,%)	
Alone	16 (6.5%)
Parents, siblings, or other family members	162(65.6%)
Boyfriend or girlfriend	10 (4.0%)
Spouse or partner	7 (2.8%)
Friends	13 (5.3%)
Structured living arrangement	2 (.8%)
Homeless	24 (9.7%)
Other	13 (5.3%)
Race (*n*,%)	
Asian	4 (1.6%)
African American	213 (86.2%)
White	19 (7.7%)
Other	11 (4.5%)
Employment status, unemployed (*n*,%)	169 (68.4%)
SCID psychotic disorder diagnoses (*n*,%)	
Schizophrenia, Paranoid Type	97 (39.3%)
Schizophrenia, Undifferentiated Type	33 (13.4%)
Schizophrenia, Disorganized Type	11 (4.5%)
Schizophrenia, Catatonic Type	2 (.8%)
Psychotic Disorder Not Otherwise Specified	38 (15.4%)
Schizoaffective Disorder, Depressive Type	26 (10.5%)
Schizoaffective Disorder, Bipolar Type	5 (2.0%)
Schizophreniform Disorder	29 (11.7%)
Delusional Disorder	4 (1.6%)
Brief Psychotic Disorder	2 (.8%)
SCID alcohol use disorders diagnoses ($n = 234$) (*n*,%)	
No alcohol abuse/dependence	164 (70.1%)
Alcohol current/past-five-year abuse	24 (10.3%)
Alcohol current/past-five-year dependence	46 (19.7%)
SCID cannabis use disorders diagnoses ($n = 233$) (*n*,%)	
No cannabis abuse/dependence	85 (36.5%)
Cannabis current/ past-five-year abuse	44 (18.9%)
Cannabis current/ past-five-year dependence	104 (44.6%)
SCID cocaine and others drugs use disorders diagnoses ($n = 236$) (*n*,%)	
No cocaine and others drugs abuse/dependence	193(81.7%)
Cocaine and others drugs current/ past-five-year abuse	36 (15.2%)
Cocaine and others drugs current/ past-five-year dependence	7 (2.9%)

Table 2
Prevalence of and inter-correlations among the six types of hallucinations measured by the *Scale for the Assessment of Positive Symptoms* (SAPS), $n = 247$.

	1	*2*	*3*	*4*	*5*	*M* ± *SD*	*N (%)* †
1. Auditory hallucinations						3.1 ± 1.8	182 (73.6%)
2. Voices commenting	.58					1.6 ± 1.8	87 (35.3%)
3. Voices conversing	.48	.57				1.3 ± 1.8	73 (29.6%)
4. Somatic or tactile hallucinations	.16	.09	.11			.9 ± 1.3	69 (27.9%)
5. Olfactory hallucinations	.29	.22	.18	.33		.6 ± 1.3	47 (19.0%)
6. Visual hallucinations	.41	.17	.26	.31	.21	1.3 ± 1.5	95 (38.5%)

† This column indicates the number and percentage of patients for whom the symptom was "present," defined as a SAPS score of 2 (mild), 3 (moderate), 4 (marked), or 5 (severe).

Table 3
Factor loadings from the principal component analysis (with promax rotation) of the six types of hallucinations measured by the *Scale for the Assessment of Positive Symptoms* (SAPS), $n = 247$.

	Factor 1[a]	*Factor 2*[b]
1. Auditory hallucinations	.75	.17
2. Voices commenting	.90	−.08
3. Voices conversing	.84	−.03
4. Somatic or tactile hallucinations	−.16	.88
5. Olfactory hallucinations	.09	.65
6. Visual hallucinations	.13	.63
Descriptive Statistics for Subscale Scores based on the Factors		
Possible range	0–15	0–15
Observed range	0–15	0–15
Mean ± SD subscale score	6.0 ± 4.7	2.9 ± 3.1
Median (mode) subscale score	5.0 (5.0)	2.0 (0)
Cronbach's alpha coefficient	.80	.56

[a] This factor was labeled "*Auditory Hallucinations.*"
[b] This factor was labeled "*Non-Auditory Hallucinations*."

Table 4
Associations between *Auditory* and *Non-Auditory Hallucinations* and clinical features of first-episode psychosis, $n = 247$.

	Auditory Hallucinations	*Non-Auditory Hallucinations*
Delusions of Influence	.45	.33
Grandiose/Religious Delusions	.06	.16
Paranoid Delusions	.14	.06
Somatic Delusions	.09	.20
Negative Affect Delusions[a]	.17	.15
SANS Total Score	25	.09
Environmental Violence	.25	.10
Interpersonal Abuse	.21	.18
Neglect	.08	.13
Duration of Untreated Psychosis	.18	.24
Insight Scale Total Score	.29	.23

[a] "Negative Affect Delusions" refers to delusions of jealousy and delusions of sin or guilt (Paolini et al., 2016).

3.2. Principal component analysis of the six variables

The PCA revealed two distinct components with eigenvalues > 1, explaining 63.3% of the total variance. As shown in Table 3, the auditory hallucinations, voices commenting, and voices conversing items loaded significantly on factor 1, hereafter labeled *Auditory Hallucinations*; visual hallucinations, somatic or tactile hallucinations, and olfactory hallucinations comprised factor 2, hereafter labeled *Non-Auditory Hallucinations*. Also shown in Table 3, the observed values for both subscales ranged 0–15, corresponding to the possible range of scores. The mean value for *Auditory Hallucinations* was 6.0 ± 4.7, and the mean for *Non-Auditory Hallucinations* was 2.9 ± 3.1. The median for the first subscale was 5.0, with a modal value of 5.0, and the median for the second subscale was 2.0, with a mode of 0. The Cronbach's alpha internal consistency reliability coefficients for the two subscales were .80 and .56, respectively, though it should be noted that alpha is heavily dependent on the number of items composing the scale, and both scales were composed of only three items.

3.3. Associations between the severity of the two types of hallucinations and other clinical variables

Neither the *Auditory Hallucinations* subscale score nor the *Non-Auditory Hallucinations* subscale score were significantly associated with age at onset of psychotic symptoms ($\rho = -.07$ and $\rho = -.13$, respectively). Neither hallucination domain was related to mode of onset of psychosis (acute, subacute, or chronic) (Kruskal-Wallis $p = .15$ and $p = .41$, respectively), and neither was associated with family history (Mann-Whitney U test $p = .45$ and $p = .97$, respectively).

No statistically significant difference was found in scores on either of the two hallucination domains between subjects with alcohol abuse ($n = 24$), dependence ($n = 46$), or neither ($n = 164$) (*Auditory Hallucinations:* Kruskal-Wallis $\chi^2 = 2.80$, $p = .25$; *Non-Auditory Hallucinations:* $\chi^2 = .31$, $p = .85$). The *Auditory Hallucination* score was lower among patients without cannabis abuse or dependence (4.88 ± 4.30) than among those with current/lifetime cannabis abuse (5.18 ± 3.80), and current/lifetime cannabis dependence (7.60 ± 4.92; $\chi^2 = 17.03$, $p < .001$). However, there were no statistically significance differences for the *Non-Auditory Hallucinations* score ($\chi^2 = 3.74$, $p = .15$) among the three categories of cannabis use. On the other hand, we found a statistically significant association between the *Non-Auditory Hallucination* score and current/lifetime cocaine/other drug abuse or dependence ($\chi^2 = 6.17$, $p = .05$), while *Auditory Hallucinations* was not associated with current/lifetime cocaine/other drug abuse or dependence ($\chi^2 = 4.50$, $p = .10$).

Results of correlation analyses pertaining to the PCA-derived hallucination domains and PCA-derived delusion domains (Paolini et al., 2016), SANS total score, and the three childhood adversity factors are summarized in Table 4. Concerning the association between hallucination domains and delusion domains, the strongest correlation was between both the *Auditory Hallucinations* subscale score and *Non-Auditory Hallucinations* subscale score and the delusions of influence (e.g., mind reading, thought broadcasting) subscale score ($\rho = .45$ and $\rho = .33$, respectively). Furthermore, both the *Auditory Hallucinations* and *Non-Auditory Hallucinations* scores were associated with negative affect delusions (jealousy and sin/guilt), although the degree of correlation was modest ($\rho = .17$ and $\rho = .15$, respectively). Interestingly, *Auditory Hallucinations* were modestly correlated with paranoid delusions but not with grandiose/religious delusions ($\rho = .14$ and $\rho = .06$, respectively), while *Non-Auditory Hallucinations* were modestly correlated with grandiose/religious delusions but not with paranoid delusions ($\rho = .16$ and $\rho = .06$, respectively). Somatic delusions were correlated with *Non-Auditory Hallucinations* ($\rho = .20$), but not with *Auditory Hallucinations*. As shown in Table 4, the *Auditory Hallucinations* domain was associated with SANS total score ($\rho = .25$), though *Non-Auditory Hallucinations* was not.

With regard to the relationship between the two PCA-derived hallucination domains and three aspects of childhood adversity (environmental violence, interpersonal abuse, and neglect), interpersonal abuse was associated with both *Auditory Hallucinations* and *Non-Auditory Hallucinations*, although the degree of correlation was modest ($\rho = .21$ and $\rho = .18$, respectively). Furthermore, the *Auditory Hallucination* score was modestly correlated with environmental violence ($\rho = .25$). On the other hand, neither *Auditory Hallucinations* nor *Non-Auditory Hallucinations* were associated with Neglect ($\rho = .08$ and $\rho = .13$, respectively).

As summarized in Table 4, the *Auditory Hallucination* score was correlated with DUP, though the degree of association was small ($\rho = .18$), and the *Non-Auditory Hallucination* score was also correlated with DUP ($\rho = .24$). As shown in Table 4, both *Auditory Hallucinations* and *Non-Auditory Hallucinations* were positively associated with BIS total score ($\rho = .29$ and $\rho = .23$, respectively) indicating that a greater severity of hallucinations is associated with better insight as measured by the BIS.

4. Discussion

Our findings inform the field of first-episode psychosis research given the limited knowledge to date on different types of hallucinations and their associations with clinical variables in first-episode patients. Although our PCA was done primarily for data reduction purposes before examining associations between hallucinations and other clinical

characteristics, the findings are informative. Prior studies with recent-onset or first-episode psychosis patients have conducted factor analyses involving SAPS and SANS subscales (John et al., 2003; Vázquez-Barquero et al., 1996), individual SAPS and SANS items (John et al., 2003; Shtasel et al., 1992), or SAPS items (hallucinations and other positive symptom items) (Vázquez-Barquero et al., 1996). To the best of our knowledge, the study by Vázquez-Barquero et al. (1996) was the only one to also investigate factors underling the six SAPS hallucinations items specifically, in a first-episode psychosis sample. In that study, the PCA revealed two factors: auditory hallucinations, voices commenting, and voices conversing loaded on the first domain, and visual hallucinations and somatic or tactile hallucinations loaded on the second domain. Olfactory hallucinations did not load onto either factor. That previous study and ours suggest that hallucinations cannot be considered as a single homogeneous category and can be characterized by two separate components. The first one includes all aspects of auditory hallucinations, and the second one includes the other forms of hallucinations (although gustatory hallucinations are not rated by the SAPS).

Pertaining to age at onset, we did not find support for an association with hallucination severity, though several studies had suggested such an association. Auditory hallucinations were associated with an earlier age of first hospitalization in a chronic psychosis sample studied by Mueser et al. (1990). Moreover, an earlier age at onset was associated with auditory hallucinations in the study by Bauer et al. (2011), which was conducted in seven countries. Furthermore, Thomas et al. (2007) showed an inverse correlation between visual hallucinations and age at onset in a sample of chronic patients. Our analysis did not reveal associations between age at onset and the severity of either auditory or non-auditory hallucinations during the month prior to hospitalization and assessment. The contrasting results in the limited literature to date may be driven by sample differences concerning treatment status, country of origin, and other characteristics.

Pertaining to mode of onset of psychosis, to the best of our knowledge, no prior studies have examined associations between mode of onset of psychotic symptoms and types of hallucinations. We found that neither *Auditory Hallucinations* score nor *Non-Auditory Hallucinations* score was related to mode of onset (i.e., acute, subacute, or chronic emergence of hallucinations and/or delusions). We also found no significant differences in hallucination severity between patients with and without a family history of psychosis. A previous study by Uçok and Bikmaz (2007) found that the SAPS tactile hallucination score was higher in patients who had a first- or second-degree relative with a psychotic disorder ($n=14$). In a recent meta-analysis on the impact of family history on different clinical variables, the authors highlighted a small but non-significant difference between patients with and without family history in terms of positive symptoms (Esterberg et al., 2010). All these results suggest that family history does not have a great impact on hallucinations, or on positive symptoms in general.

Despite the fact that, among patients with first-episode psychosis, substance use disorders are the most common comorbid diagnosis (Strakowski et al., 1993) and the prevalence of substance abuse/dependence is high (Addington and Addington, 2001; Cantwell et al., 1999; Hambrecht and Häfner, 2000), knowledge about associations between different types of hallucinations and substance misuse is very limited. A study by Dubertret et al. (2006), conducted in a sample of chronic psychotic patients, showed that patients with cannabis abuse were significantly more likely to experience some type of hallucination (i.e., running commentary, auditory hallucinations, thought echo, gustatory and tactile hallucinations) than the non-abusing group of patients, though when they excluded patients with drug abuse/dependence other than cannabis this difference was not observed. On the other hand, in a first-episode study by Sevy et al. (2010), patients with a comorbidity of cannabis use disorder showed greater delusions and hallucinations than patients without cannabis use disorder, though they did not consider other drugs. Our analysis revealed that *Auditory Hallucinations* score was related to cannabis use and *Non-Auditory Hallucinations* score was related to cocaine/other drug use (while neither type of hallucination was associated with alcohol use/dependence). Thus, while Dubertret et al. (2006) suggested that hallucinations were related only to drugs other than cannabis, and Sevy et al. (2010) indicated that cannabis use was related to positive symptoms, our results show differential associations between the two different types of hallucinations and different drugs.

With respect to the association between delusion domains and hallucination domains, a strong correlation between hallucinations (total summary score) and delusions of influence had been previously shown in this sample (Paolini et al., 2016), as well as by Kimhy et al. (2005), though specific types of hallucinations were not examined. Here, we found that among the PCA-derived types of delusions (Paolini et al., 2016), the strongest correlation—for both *Auditory Hallucinations* and *Non-Auditory Hallucinations*—was with the delusions of influence domain (e.g., delusions of being controlled, mind reading, thought insertion). On the other hand, both *Auditory Hallucinations* and *Non-Auditory Hallucinations* were associated with delusions of jealousy and sin/guilt, but the degree of correlation was modest. Of note, while *Auditory Hallucinations* were modestly correlated with paranoid delusions but not with grandiose/religious delusions, *Non-Auditory Hallucinations* were modestly correlated with grandiose/religious delusions but not with paranoid delusions. The differential associations could inform improved subtyping efforts based on commonly co-occurring clinical features (and such subtyping could inform clinical and treatment research). With respect to the correlation between PCA-derived SAPS domains of hallucinations and SANS total score, our analysis found a correlation only with *Auditory Hallucinations* and not with *Non-Auditory Hallucinations*.

In the analysis pertaining to childhood adversity, we decided to use the results of a previous factor analysis on seven instruments rating childhood/adolescent adversity because we had so many measures of adversity (seven) and using all of them (e.g., physical abuse, sexual abuse) would have created too many additional (and somewhat redundant) variables. The association between an increased risk of psychosis and different types of childhood adversity has been detailed in several recent meta-analyses (Matheson et al., 2013; Read et al., 2005; Varese et al., 2012), which highlight particularly the association between sexual abuse and auditory hallucinations (Bentall et al., 2012). However, few studies have focused on first-episode psychosis and on associations with specific types of hallucinations. Neither Rajkumar (2015) nor Uçok and Bikmaz (2007) found an association between auditory hallucinations and sexual abuse, though in the latter study the authors showed higher SAPS total scores in patients exposed to childhood sexual abuse. On the other hand, recent studies highlighted the role of sexual abuse in auditory verbal hallucinations in females, as well as the correlation between non-auditory hallucinations and childhood rape, and visual hallucinations and interpersonal abuse (Misiak et al., 2016; Longden et al., 2016; Solesvik et al., 2016). In our analysis, interpersonal abuse (which included childhood physical and sexual abuse and other forms of interpersonal adversity) was associated with both *Auditory Hallucinations* and *Non-Auditory Hallucinations*, although the degree of the correlation was modest. Sitko et al. (2014) showed an association between hallucinations and different types of childhood adversity, except for neglect, in a first-episode sample, though specific types of hallucinations were not specified. In the first-episode study by Uçok and Bikmaz (2007) visual and auditory hallucination, and voices commenting SAPS scores, were correlated with severity of childhood emotional abuse. Furthermore, in our study environmental violence (that occurring outside of the home/family) was moderately correlated with *Auditory Hallucinations*, but not with the other type of hallucinations. On the other hand, neither *Auditory Hallucinations* nor *Non-Auditory Hallucinations* were associated with neglect. This finding is in contrast to results from the first-episode psychosis study by Uçok and

Bikmaz (2007), which suggested a correlation between physical neglect and visual and tactile hallucinations, but was in line with the study by Sitko et al. (2014). The contrasting results could be due to different compositions of study samples and to the influence of possible comorbidities. While neglect does not seem to be implicated in the presence of hallucinations, we could speculate that interpersonal abuse constitutes a risk for hallucinations in general, and environmental violence is a specific risk for auditory hallucinations.

DUP is related to both types of hallucinations, which is consistent with extensive evidence showing that DUP is associated with greater positive symptom severity. Our analysis showed that both *Auditory Hallucinations* score and *Non-Auditory Hallucinations* score were related to BIS total score. This result is in line with previous studies, though they compared patients with hallucinations only or with delusions only, and with both hallucinations and delusions or with neither of them (Evensen et al., 2011; Engh et al., 2010). However, the first study involved only 16 first-episode psychosis patients experiencing hallucinations, and insight was measured only with the individual Positive and Negative Syndrome Scale (PANSS) lack of judgment/insight item, and the second study relied on a sample with chronic psychotic disorders and used the Beck Cognitive Insight Scale. Furthermore, both of these studies assessed hallucinations only with the single PANSS hallucinations item and thus could not specify the different types of them. We could speculate that hallucinations represent a greater breaking experience from the outside world, which patients can recognize more easily as not their own (compared to the experience of delusions), accounting for the finding of increasing insight with increasing hallucination severity.

This study has several limitations. First, this was a secondary analysis of data collected for a prior study on the effects of premorbid cannabis use on the early course of psychotic disorders. We conducted an exploratory analysis in order to identify potential associations between different types of hallucinations and diverse clinical features; as such, we did not use Bonferroni correction for multiple testing, though a more conservative approach seeking generalizable data would have done so. Second, in the analysis pertaining to substance use, we did not differentiate current from lifetime abuse/dependence due to limited sample sizes in the various categories. Furthermore, we could not specify if the symptoms began before, after, or during the substance misuse. Third, information about family history of psychosis was divided into only two categories (yes/no) and we could not perform a more accurate analysis of different types of symptoms in the relatives. Fourth, our sample was composed of hospitalized patients only; as such, they likely represent a more severe form of illness. Future studies should also include never-admitted outpatients with first-episode or early-course psychosis.

Despite the limitations, our results contribute to a growing body of work that attempts to analyze individual symptoms of psychosis in the early course in order to uncover clinical correlates and the determinants of the longer-term course of illness. Our findings suggest that hallucinations cannot be considered as a homogeneous and undifferentiated dimension; rather, they comprise at least two types and are correlated in different ways with other clinical variables. These results could be potentially helpful in further research into genotypes and phenotypes of psychotic disorders and they could be used in future studies in order to clarify the significance of these symptoms and define targeted therapeutic strategies.

Conflicts of interest

None.

Acknowledgment

Research reported in this publication was supported by National Institute of Mental Health grant R01 MH081011 (“First-Episode Psychosis and Pre-Onset Cannabis Use”) to the last author. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health or National Institute of Mental Health.

References

Addington, J., Addington, D., 2001. Impact of an early psychosis program on substance use. Psychiatr. Rehabil. J. 25, 60.
Andreasen, N.C., 1983. Scale for the Assessment of Negative Symptoms (SANS). Department of Psychiatry, College of Medicine, The University of Iowa, Iowa City, IA.
Andreasen, N.C., 1984. Scale for the Assessment of Positive Symptoms (SAPS). Department of Psychiatry, College of Medicine, The University of Iowa, Iowa City, IA.
Barnes, G.M., Windle, M., 1987. Family factors in adolescent alcohol and drug abuse. Pediatrician 14, 13–18.
Bauer, S.M., Schanda, H., Karakula, H., Olajossy-Hilkesberger, L., Rudaleviciene, P., Okribelashvili, N., Chaudhry, H.R., Sunday, E., Idemudia, S.E., Gscheider, S., Ritter, K., Stompe, T., 2011. Culture and the prevalence of hallucinations in schizophrenia. Compr. Psychiatry 52, 319–325.
Bentall, R.P., Wickham, S., Shevlin, M., Varese, F., 2012. Do specific early-life adversities lead to specific symptoms of psychosis? A study from the 2007 Adult Psychiatric Morbidity Survey. Schizophr. Bull. 38, 734–740.
Bernstein, D.P., Stein, J.A., Newcomb, M.D., Walker, E., Pogge, D., Ahluvalia, T., Stokes, J., Handelsman, L., Mendrano, M., Desmond, D., Zule, W., 2003. Development and validation of a brief screening version of the Childhood Trauma Questionnaire. Child Abus. Negl. 27, 169–190.
Birchwood, M., Smith, J., Drury, V., Healy, J., Macmillan, F., Slade, M., 1994. A self-report Insight Scale for psychosis: reliability, validity and sensitivity to change. Acta Psychiatr. Scand. 89, 62–67.
Cantwell, R., Brewin, J., Glazebrook, C., Dalkin, T., Fox, R., Medley, I., Harrison, G., 1999. Prevalence of substance misuse in first-episode psychosis. Br. J. Psychiatry 174, 150–153.
Chaudhury, S., 2010. Hallucinations: clinical aspects and management. Ind. Psychiatry J. 19, 5.
Cleary, S.D., Bhatty, S., Broussard, B., Cristofaro, S.L., Ramsay Wan, C., Compton, M.T., 2014. Measuring insight through patient self-report: an in-depth analysis of the factor structure of the Birchwood Insight Scale. Psychiatry Res. 216, 263–268.
Cockrell, J.R., Folstein, M.F., 1988. Mini-Mental State Examination (MMSE). Psychopharmacol. Bull. 24, 689–692.
Cristofaro, S.L., Cleary, S.D., Ramsay Wan, C., Broussard, B., Chapman, C., Haggard, P.J., Jananeh, S., Myers, N.L., Compton, M.T., 2013. Measuring trauma and stressful events in childhood and adolescence among patients with first-episode psychosis: initial factor structure, reliability, and validity of the Trauma Experiences Checklist. Psychiatry Res. 210, 618–625.
Dubertret, C., Bidard, I., Adès, J., Gorwood, P., 2006. Lifetime positive symptoms in patients with schizophrenia and cannabis abuse are partially explained by co-morbid addiction. Schizophr. Res. 86, 284–290.
Engh, J.A., Friis, S., Birkenaes, A.B., Jónsdóttir, H., Klungsøyr, O., Ringen, P.A., Simpnsen, C., Vaskinn, A., Opjordsmoen, S., Andreassen, O.A., 2010. Delusions are associated with poor cognitive insight in schizophrenia. Schizophr. Bull. 36, 830–835.
Esterberg, M.L., Trotman, H.D., Holtzman, C., Compton, M.T., Walker, E.F., 2010. The impact of a family history of psychosis on age-at-onset and positive and negative symptoms of schizophrenia: a meta-analysis. Schizophr. Res. 120, 121–130.
Evensen, J., Røssberg, J.I., Haahr, U., ten Velden Hegelstad, W., Joa, I., Johannessen, J.O., Langeveld, H., Larsen, T.K., Melle, I., Opjordsmoen, S., Rund, B.R., Simonsen, E., Sundet, K., Vaglum, P., Friis, S., McGlashan, T., 2011. Contrasting monosymptomatic patients with hallucinations and delusions in first-episode psychosis patients: a five-year longitudinal follow-up study. Psychopathology 44, 90–97.
First, M.B., Spitzer, R.L., Gibbon, M., 1998. Structured Clinical Interview for DSM-IV Axis I Disorders. Biometrics Research Department, New York State Psychiatric Institute, New York, NY.
Folstein, M.F., Folstein, S.E., McHugh, P.R., 1975. Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. J. Psychiatr. Res. 12, 189–198.
Ge, X., Conger, R.D., Lorenz, F.O., Simons, R.L., 1994. Parents' stressful life events and adolescent depressed mood. J. Health Soc. Behav. 35, 28–44.
Hambrecht, M., Häfner, H., 2000. Cannabis, vulnerability, and the onset of schizophrenia: an epidemiological perspective. Aust. N. Z. J. Psychiatry 34, 468–475.
Jablensky, A., Sartorius, N., Ernberg, G., Anker, M., Korten, A., Cooper, J.E., Bertelsen, A., 1992. Sociodemographic, clinical and diagnostic description of the study population. Psychol. Med. 20, 18–42.
John, J.P., Khanna, S., Thennarasu, K., Reddy, S., 2003. Exploration of dimensions of psychopathology in neuroleptic-naïve patients with recent-onset schizophrenia/schizophreniform disorder. Psychiatry Res. 121, 11–20.
Kimhy, D., Goetz, R., Yale, S., Corcoran, C., Malaspina, D., 2005. Delusions in individuals with schizophrenia: factor structure, clinical correlates, and putative neurobiology. Psychopathology 38, 338–344.
Longden, E., House, A.O., Waterman, M.G., 2016. Associations between non-auditory hallucinations, dissociation and childhood adversity in first episode psychosis. J. Trauma Dissociation 17, 545–560.
Matheson, S.L., Shepherd, A.M., Pinchbeck, R.M., Laurens, K.R., Carr, V.J., 2013. Childhood adversity in schizophrenia: a systematic meta-analysis. Psychol. Med. 43, 225–238.

Maxwell, M.E., 1992. Family Interview for Genetic Studies (FIGS): A Manual for FIGS. Clinical Neurogenetics Branch, Intramural Research Program, National Institute of Mental Health, Bethesda, MD.
Mbewe, E., Haworth, A., Welham, J., Mubanga, D., Chazulwa, R., Zulu, M.M., Mayeya, J., McGrath, J., 2006. Clinical and demographic features of treated first-episode psychotic disorders: a Zambian study. Schizophr. Res. 86, 202–207.
Misiak, B., Moustafa, A.A., Kiejna, A., Frydecka, D., 2016. Childhood traumatic events and types of auditory verbal hallucinations in first-episode schizophrenia patients. Compr. Psychiatry 66, 17–22.
Mrug, S., Loosier, P.S., Windle, M., 2008. Violence exposure across multiple contexts: individual and joint effects on adjustment. Am. J. Orthopsychiatr. 78, 70–84.
Mrug, S., Madan, A., Windle, M., 2012. Temperament alters susceptibility to negative peer influence in early adolescence. J. Abnorm. Child. Psychol. 40, 201–209.
Mueser, K.T., Bellack, A.S., Brady, E.U., 1990. Hallucinations in schizophrenia. Acta Psychiatr. Scand. 82, 26–29.
Paolini, E., Moretti, P., Compton, M.T., 2016. Delusions in first-episode psychosis: principal component analysis of twelve types of delusions and demographic and clinical correlates of resulting domains. Psychiatry Res. 243, 5–13.
Peralta, V., Cuesta, M.J., 1999. Dimensional structure of psychotic symptoms: an item-level analysis of SAPS and SANS symptoms in psychotic disorders. Schizophr. Res. 38, 13–26.
Perkins, D.O., Leserman, J., Jarskog, L.F., Graham, K., Kazmer, J., Lieberman, J.A., 2000. Characterizing and dating the onset of symptoms in psychotic illness: the Symptom Onset in Schizophrenia (SOS) inventory. Schizophr. Res. 44, 1–10.
Rajapakse, T., Garcia-Rosales, A., Weerawardene, S., Cotton, S., Fraser, R., 2011. Themes of delusions and hallucinations in first-episode psychosis. Early Interv. Psychiatry 5, 254–258.
Rajkumar, R.P., 2015. The impact of childhood adversity on the clinical features of schizophrenia. Schizophr. Res. Treat. http://dx.doi.org/10.1155/2015/532082.
Read, J., van Os, J., Morrison, A.P., Ross, C.A., 2005. Childhood trauma, psychosis and schizophrenia: a literature review with theoretical and clinical implications. Acta Psychiatr. Scand. 112, 330–350.
Rogers, R., 2001. Handbook of Diagnostic and Structured Interviewing. The Guilford Press, New York, NY.
Sevy, S., Robinson, D.G., Napolitano, B., Patel, R.C., Gunduz-Bruce, H., Miller, R., McCormack, J., Lorell, B.S., Kane, J., 2010. Are cannabis use disorders associated with an earlier age at onset of psychosis? A study in first episode schizophrenia. Schizophr. Res. 120, 101–107.
Shtasel, D.L., Gur, R.E., Gallacher, F., Heimberg, C., Cannon, T., Gur, R.C., 1992. Phenomenology and functioning in first-episode schizophrenia. Schizophr. Bull. 18, 449–462.
Sieving, R.E., Beuhring, T., Resnick, M.D., Bearinger, L.H., Shew, M., Ireland, M., Blum, R.W., 2001. Development of adolescent self-report measures from the National Longitudinal Study of Adolescent Health. J. Adolesc. Health 28, 73–81.
Sitko, K., Bentall, R.P., Shevlin, M., Sellwood, W., 2014. Associations between specific psychotic symptoms and specific childhood adversities are mediated by attachment styles: an analysis of the National Comorbidity Survey. Psychiatry Res. 217, 202–209.
Solesvik, M., Joa, I., Larsen, T.K., Langeveld, J., Johannessen, J.O., Bjørnestad, J., Anda, L.G., Gisselgård, J., ten Velden Hegelstad, W., Brønnick, K., 2016. Visual hallucinations in first-episode psychosis: association with childhood trauma. PLoS One 11, e0153458.
Strakowski, S.M., Tohen, M., Stoll, A.L., Faedda, G.L., Mayer, P.V., Kolbrener, M.L., Goodwin, D.C., 1993. Comorbidity in psychosis at first hospitalization. Am. J. Psychiatry 150, 752–757.
Thomas, P., Mathur, P., Gottesman, I.I., Nagpal, R., Nimgaonkar, V.L., Deshpande, S.N., 2007. Correlates of hallucinations in schizophrenia: a cross-cultural evaluation. Schizophr. Res. 92, 41–49.
Thorup, A., Petersen, L., Jeppesen, P., Ohlenschlæger, J., Christensen, T., Krarup, G., Jorgensen, P., Nordentoft, M., 2007. Gender differences in young adults with first-episode schizophrenia spectrum disorders at baseline in the Danish OPUS study. J. Nerv. Ment. Dis. 195, 396–405.
Uçok, A., Bikmaz, S., 2007. The effects of childhood trauma in patients with first-episode schizophrenia. Acta Psychiatr. Scand. 116, 371–377.
Varese, F., Smeets, F., Drukker, M., Lieverse, R., Lataster, T., Viechtbauer, W., Read, J., van Os, J., Bentall, R.P., 2012. Childhood adversities increase the risk of psychosis: a meta-analysis of patient-control, prospective, and cross-sectional cohort studies. Schizophr. Bull. 38, 661–671.
Vázquez-Barquero, J.L., Lastra, I., Cuesta Nuñez, M.J., Herrera Castanedo, S., Dunn, G., 1996. Patterns of positive and negative symptoms in first episode schizophrenia. Br. J. Psychiatry 168, 693–701.