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CORRELATES OF HALLUCINATIONS IN SCHIZOPHRENIA: A CROSS-CULTURAL EVALUATION

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Abstract

Introduction—Demographic, clinical and familial factors may plausibly influence the manifestation of hallucinations. It is unclear if the pattern of the effects is similar in different environmental/cultural settings.

Aims—To evaluate factors associated with hallucination from a demographic, clinical and familial perspective in two distinct cultural settings.

Methods—Patients with a clinical diagnosis of schizophrenia (SZ) or schizoaffective disorder (SZA) were diagnosed systematically using DSM IV criteria. Two independent samples were recruited in India and USA using identical inclusion/exclusion criteria and assessment procedures (n = 1,287 patients total; 807 Indian and 480 US participants). The association of key demographic

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Conflicts of Interest

All authors declare that they have no conflicts of interest.

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and clinical factors with hallucinations of different modalities was examined. To evaluate the impact of familial factors, we separately analyzed correlations among affected sibling pairs (ASPs, n = 136, Indian; n = 77, US).

Results—The prevalence of different modalities of hallucinations differed in the Indian and US samples, though the rank order of frequency was similar. The pattern of associations between selected variables and the risk of hallucinations was different across cultures, except for some correlations with indices of severity. No significant concordance was observed among the ASPs after correcting for multiple comparisons.

Conclusions—The factors associated with hallucinations vary across environments. Our results are consistent with a multi-factorial etiology of psychopathology, but re-direct attention to endophenotypic features in the causal chain that precede the symptoms themselves.

Keywords

Schizophrenia; Schizoaffective disorder; Hallucination; Concordance; genetic; endophenotype; cross-cultural

Introduction

There was a resurgence of interest in hallucinations following a recent report of relatively high prevalence of hallucinatory experiences (~ 20%) even among unselected members of the Dutch population (van Os et al. 2001). The prevalence and characteristics of hallucinations were further evaluated during a survey of 265 individuals, sampled from the population in Belgium (Laroi et al. 2004). Principal components analysis suggested four factors, including sleep related experiences, vivid daydreams, intrusive thoughts and ‘true’ hallucinations. Thus, a sub-group of unselected individuals in the population may be experiencing psychotic experiences similar to psychiatrically ill individuals.

Hallucinations form a core diagnostic feature of schizophrenia (SZ). They can be debilitating and therefore are important targets for therapy. There have been several systematic surveys of hallucinations in studies predating the era of structured diagnostic schedules (e.g. Bowman and Raymond 1931). However, there have been relatively few recent, systematic studies on the prevalence of hallucination and associated factors in SZ or schizoaffective disorder (SZA), especially from non-Caucasian samples. Recently, Baethge et al. (2005) estimated the cross sectional prevalence of hallucinations among inpatients with schizophrenia at 61.1%. A systematic study of hallucinations among US patients with schizophrenia was reported in 1990 (Mueser et al. 1990). Mueser and colleagues documented different types of hallucinations among 117 patients at a hospital in Philadelphia. They reported that auditory hallucinations are the most common, followed by visual, tactile, olfactory and gustatory hallucinations. The presence of olfactory and gustatory or tactile hallucinations was correlated in this study. However, the prevalence of these types of hallucinations varies widely in different series: auditory hallucinations were present among 47% to 98% of patients (Mueser et al. 1990) (Zarroug 1975) (Bracha et al. 1989) (Suhail and Cochrane 2002) (Goldberg et al. 1965), visual hallucinations from 14 to 69% (Mueser et al. 1990) (Zarroug 1975) (Bracha et al. 1989) (Suhail and Cochrane 2002)

and tactile hallucinations from 4 to 25% of patients (Mueser et al. 1990) (Bracha et al. 1989). The wide variation suggests heterogeneity in schizophrenia, despite the use of structured diagnostic criteria. Therefore, it is of interest to examine factors that impact on the heterogeneity.

Some studies have suggested correlations between hallucinations and clinical indices of severity. For example, Mueser et al. (1990) reported that olfactory and gustatory or tactile hallucinations were the harbingers of severe delusions. The authors also noted that auditory hallucinations were correlated positively with an earlier age at hospitalization among patients with schizophrenia. The overall severity of illness was also related to the presence of visual hallucinations among patients with schizophrenia. On the other hand, no significant difference in the prevalence rates of different types of hallucinations was noted among patients with schizophrenia or schizoaffective disorders, two disorders with differing outcomes. Another study that set out to evaluate the relationship between severity and prevalence of hallucinations also did not find correlations with age at onset (a proxy for severity) (Sharma et al. 1999). Interestingly, this study reported that female gender predicted a higher frequency of hallucinations. Since women with schizophrenia tend to have a more benign course of schizophrenia than men, the relationship between severity and hallucinations remains unresolved.

The significant correlation of visual hallucinations with severity of illness is of interest because some researchers have suggested that visual hallucinations are under-reported among US samples, possibly because psychiatrists do not inquire systematically about such hallucinations (Bracha et al. 1989). These results are also of interest because visual hallucinations are reported to be relatively more common in non-western populations. A report from Saudi Arabia suggested that 62% of patients had visual hallucinations (Zarroug 1975). It was suggested that cultural factors could explain the relatively high rates. This possibility was explored systematically in a study of individuals of Pakistani origin residing in the UK, who were compared with Pakistani patients in Pakistan, as well as British white patients (Suhail and Cochrane 2002). There was greater difference in the phenomenology of delusions and hallucinations between the Pakistani individuals residing in the UK *versus* those in Pakistan, than between the UK Pakistani and the British white groups. It was thus suggested that the immediate environment may have a strong impact on the content of delusions and hallucinations. These intriguing results were based on a case note survey supplemented with interviews with clinicians as needed. It would be important to evaluate them systematically using semi-structured interviews, with due sensitivity to the cultural settings (Jablensky et al. 1994).

Studies of hallucinations and their precursors in the causal chain between genotypes and clinical diagnoses of schizophrenia may also be relevant in view of the present interest in evaluating psychopathology beyond the conventional diagnostic boundaries. In particular, there is an active effort to evaluate endophenotypes, i.e., traits that are heritable and may occur proximal to the diagnostic phenotype in the chain of pathogenesis (Gottesman and Gould 2003) (Bearden and Freimer 2006). Mapping genes contributing to such traits would presumably facilitate efforts to identify genes for disorders in which these traits can be observed. From this vantage, hallucinations themselves are not plausible endophenotypes

per se, as they are readily observed without special instruments. If, for example, exposure to low doses of cannabis elicited mild hallucinations in the clinically normal relatives of schizophrenics, but not in matched controls, we would be on the trail of an endophenotype revealed by a challenge to brain functioning (Gould and Gottesman 2006). Indeed, factor analyses of twins with psychoses spanning the schizophrenia – schizoaffective – bipolar disorder spectrum suggest patterns of familial aggregation for several factors, including hallucinations (Cardno et al. 2001). Model fitting further suggested shared genetic factors for all three diagnostic entities (Cardno et al. 2002).

Shared heritability for hallucinations can also be investigated indirectly through pairs of affected relatives other than twins. Statistically significant similarity would suggest a role for shared genetic and/or environmental factors. Using this approach, DeLisi and colleagues reported that auditory hallucinations were not associated among siblings (DeLisi et al. 1987). Another study of systematically ascertained families in Ireland also failed to detect significant correlations between pairs of affected sibling pairs (ASPs), suggesting that familial factors may not have a significant role in the onset of hallucinations (Kendler et al. 1997). Similarly, a study of Chinese ASPs (n = 46 pairs) also did not detect significant correlations with the presence of hallucinations (Hwu et al. 1997).

The present study was undertaken to estimate the types and prevalence of hallucinations among systematically evaluated groups of patients. First, we estimated the prevalence of different types of hallucinations using lifetime figures. Second, associations between the hallucination and relevant demographic and clinical factors were investigated, with emphasis on indices of severity. Third, we assessed the familial concordance for hallucination, among affected sibling pairs (ASPs). These analyses were conducted among two independently treated samples recruited from India and US using identical procedures. We reasoned that the simultaneous analyses would enable us to understand correlates of hallucinations in two very different environmental settings. Any common features observed during the analyses would be robust. Since the US and Indian samples could not be considered to be representative of their countries, direct comparisons between the samples were not conducted.

Methods

Patients were recruited as part of an ongoing study in the genetics of schizophrenia, being conducted by US and Indian investigators in parallel using identical designs (Deshpande et al. 2004). Affected individuals with either affected sibling/s or both parents willing to participate and with a consensus diagnosis of SZ/SZA disorder (DSM IV) are recruited and evaluated following written informed consent. Ethical approval has been obtained from Institutional Review Boards (IRB) at Dr. Ram Manohar Lohia Hospital and the University of Pittsburgh for the US.

Interviews were conducted using the English or Hindi version of the Diagnostic Interview for Genetic Studies (DIGS), (Deshpande et al. 1998) (Nurnberger et al. 1994). Available medical records were examined and additional clinical details were obtained from relatives as required. The clinical variables included for analysis were auditory hallucinations (voice,

threat), somatic or tactile, olfactory, visual and gustatory hallucinations (all, “ever present”), gender, age at onset, years of schooling, marital status, pattern of symptoms, severity of illness and diagnosis.

The first ascertained case in each family was considered the proband. For all the analyses, only one patient was included from each family except for the affected sib-pair analyses. There were 117 multiply affected families from India and 71 such families from the US. Two or more affected siblings participated from each of these families. Among families in which more than one affected sib participated (India: n = 17, US: n = 4), the same proband was evaluated sequentially in conjunction with all the other affected siblings. Thus, two ASPs would be counted from a family with three affected siblings and three ASPs for a family with four affected siblings. Therefore, 117 multiply affected families from India and 71 multiply affected US families contributed 136 ASPs and 77 ASPs, respectively.

Statistical analysis

Analysis carried out for the study included descriptive statistics, chi- square test, Pearson’s correlation, measures of agreement and logistic regressions. The Statistical Package for Social Sciences version 11.5 (SPSS 11.5) was used for the analysis and level of statistical significance fixed at $p = 0.05$.

Results

There were 807 participants from India, and 480 from the US. Data for “singleton” cases (i.e., patients who did not report having affected siblings, together with one proband from each affected sibling pair family) were analyzed initially, followed by analyses of affected sibling pairs (ASPs). For each set of analyses, the prevalence of different variables was estimated separately for the Indian and US samples, followed by analyses with regard to hallucinations.

Analyses of singleton cases

Demographic and clinical features

The demographic and clinical features for both samples are presented in Table 1. The samples could not be considered representative of their nationalities, hence formal statistical comparisons were not made between the US and Indian samples. Nevertheless, there were remarkable demographic and clinical differences. The Indian sample was younger than the US sample, overall. The genders were represented more evenly in the Indian samples, while there was an excess of men among the US patients. The US patients appeared to have longer periods of education than the Indian patients, but were more likely to be unmarried. Individuals with schizophrenia were over represented in the Indian samples, whereas the distribution of these two disorders was more equitable in the US sample. The ages at onset were similar, but the Indian sample appeared more severely impaired in comparison with the US sample. The patterns of symptoms and severity also were different. Indian patients were more likely to have a pattern of ‘negative’ symptoms changing to ‘positive’ symptoms

longitudinally. There appeared to be an over-representation of US cases with moderate to severe deterioration.

There were 601 patients (74.7%) from India and 423 (88.5%) from the US who reported lifetime occurrence of hallucinations (Table 2). Auditory voice hallucinations were the most common in both samples, followed in order of frequency by visual, somatic/tactile, olfactory and gustatory hallucinations. This order was present in the US, as well as the Indian samples.

Associations of relevant demographic and clinical variables with hallucinations

To evaluate clinical and demographic features associated with different types of hallucinations, a series of logistic regression analyses were conducted separately for the US and the Indian samples. In each set of analysis, the outcome was the type of hallucination (auditory, visual, somatic/tactile, olfactory and gustatory). The covariates were age, gender, level of education, age at onset, diagnosis, GAF score, pattern of symptoms and pattern of severity. In these analyses, GAF scores and educational status were classified as categorical variables. GAF scores were considered in deciles (scores 0–10, 11–20 etc) and educational status was considered in three groups (0–5 years, 6– 12 years and above 12 years of education). The following associations were detected from the logistic regression analyses (details in Table 3).

Auditory hallucinations

In the Indian sample, the only significant correlation was noted with the pattern of symptoms. Inspection of the data suggested that the significant effect was due to the increased prevalence of hallucinations in the group with ‘continuously positive’ symptoms (Odds ratio, OR 1.6) versus patients with a mixture of positive and negative symptoms. In the US sample, significant correlation with diagnosis was noted. With schizoaffective disorder as reference, the OR among patients with schizophrenia was 2.3.

Visual hallucinations

Several significant correlations were noted in the Indian samples, including patterns of symptoms (OR 1.6 for patients with ‘continuously positive’ pattern of symptoms versus patients with mixture of positive and negative symptoms), pattern of severity (in comparison with patients showing ‘episodic shift’, patients with moderate or severe deterioration were more likely to report visual hallucinations, OR.. 2.4 and 3.0, respectively); marital status (‘ever married’ patterns had a greater risk for hallucinations compared with ‘never married’ patients, OR 1.5), educational status (with reference to individuals with more than 12 years of education, individuals with 0–5 years of education had a greater likelihood of visual hallucinations, OR = 2.8, and those with 6 to 12 years of education had an OR of 1.5), sex (‘female’ gender had slightly higher risk for visual hallucination compared with ‘male’ gender) and age (younger patients were more likely to report hallucinations, beta coefficient = − 0.02, p = 0.043). Among the US cases, correlations with the following variables were noted: diagnosis (patients with SZ had 1.7 greater odds of having visual hallucinations compared with patients diagnosed with SZA), age at onset (inverse correlation, beta coefficient = − 0.03, p = 0.025) and pattern of symptoms (OR= 0.4. Patients with

continuously positive symptoms had 0.4 times less risk compared to patients with mixture of positive and negative symptoms). Thus, pattern of symptoms was a common correlate of visual hallucinations in both samples, but had contrasting results in the Indian and US samples.

Somatic hallucinations

In the Indian sample, the term 'pattern of symptoms' was correlated with presence of somatic hallucinations (patients with continuously positive symptoms had 1.5 times greater risk in comparison with patients having a mixture of positive and negative symptoms). In the US sample, the significant correlates were: marital status (those who had been married had 2.1 fold greater risk compared with never married individuals) and pattern of severity (patients with 'severe deterioration' had 3.7 times of risk for somatic hallucination and patients with relatively stable pattern of illness had 8.3 times of risk for hallucinations compared with those having episodic shifts, however the former category ("relatively stable") included only 19 patients).

Olfactory hallucinations

In the Indian sample, patterns of symptoms were correlated with the presence of olfactory hallucinations (patients with continuously positive symptoms had a 1.6 times greater probability of hallucinations compared with patients having a mixture of positive and negative symptoms). No significant correlates were detected in the US sample.

Gustatory hallucinations

The only significant correlation was with marital status in the Indian sample (ever married patients had 1.9 times greater risk than never married patients).

Analysis of ASPs

The sample included 17 families in the Indian sample and 4 US families in which more than two siblings were affected. To maximize information, all sibs were compared with the proband in each family. There were thus 136 ASPs from India and 77 ASPs from the US. The demographic and clinical features of the ASPs are presented in Table 4. Their ages, educational status, marital status, diagnoses, GAF scores and ages at onset were significantly correlated in both the samples. On the other hand, the pattern of symptoms and pattern of severity were correlated among the US, but not the Indian ASPs. The gender distribution was not significantly correlated in either sample.

We next evaluated correlations for hallucinations among the ASPs. Significant correlations for auditory hallucinations were detected among the US ASPs, but not among the Indian ASPs. The former correlation may have been inflated by the relatively high prevalence of auditory hallucination in the US sample (83.4%, see Table 2). Significant correlations with visual hallucinations were not observed in the US or the Indian ASP groups, but significant correlations were detected for gustatory hallucinations among the Indian ASPs (kappa = 0.180). Among the US ASPs, significant correlations were noted for somatic hallucinations. With regard to olfactory hallucinations, correlations were observed in opposite directions

(kappa = −0.078, and –0.250, in the Indian and US samples, respectively and also it was significant in US sample; see Table 5). The correlations for gustatory and somatic hallucinations could not be evaluated meaningfully because they were relatively infrequent. For example, only three ASPs were concordant in the Indian sample. In the same vein, only six US patients had somatic hallucinations.

Discussion

The present analyses were undertaken in order to evaluate factors associated with different types of hallucinations. Our goal was to identify correlations that might have clinical relevance. The presence and severity of hallucinations is critically dependent on the medications administered to patients. Since the cross-sectional nature of our studies precluded careful estimation of the impact of medications, we sought to circumvent this shortcoming by evaluating the lifetime occurrence of hallucinations.

We conducted our analyses simultaneously in two independent samples that were evaluated using identical procedures. We assumed that similar correlations from analyses of samples ascertained in very different settings would be more likely to be replicable in other settings, in comparison with results from solitary samples. Our analyses did not reveal any remarkable consistency between the Indian and the US samples. These analyses suggest that the factor structure of the different modalities of hallucinations vary by site.

Auditory hallucinations have been noted in all cultures investigated to date (WHO) (Sartorius et al. 1972) (Jablensky 1995) (Jablensky et al. 1994). The prevalence of auditory hallucinations differed in the samples (64.3 % in India versus 83.4% in the US sample). The prevalence of visual hallucinations was higher in the US sample (Indian sample: 36.9%, US sample: 57.2%), as also the prevalence of gustatory hallucinations. On the other hand, the prevalence of somatic and olfactory hallucinations was similar in these two samples. We did not compare the rates formally, nor did we compare other variables because these samples can not be considered representative of their nations. While the prevalence of auditory hallucinations in the present report was similar to previous studies, our study revealed higher prevalence for visual and somatic hallucinations. The higher rates may reflect that these abnormalities were sought painstakingly during the course of semi-structured interviews, complemented by methodical hospital note reviews.

A key aspect of our analyses was the putative relationship between severity of illness and the presence of particular types of hallucinations. Previous studies have suggested a positive correlation between presence of visual hallucinations and severity of illness (Mueser et al. 1990). Since illness severity is multi-dimensional, we selected a number of different variables. These variables included the GAF score during the most severe phase of the illness, as well as an overall rating of pattern of severity of illness available in the GAF. Finally, we also used age at onset, since this variable is correlated with illness severity, but unlike most other measures of severity, is unaffected by medications. Age at onset was inversely correlated with visual hallucinations in the Indian sample, consistent with Mueser’s observations, though the magnitude of the correlation was relatively small. On the other hand, a similar correlation was not observed in the US sample. However, the term

'pattern of severity' was correlated positively with the presence of visual hallucinations in the Indian sample, consistent with Mueser's results. Paradoxically, somatic hallucinations were associated with relatively stable patterns in the Indian sample. The relatively small number of individuals in this category precludes firm conclusions. Interestingly, GAF scores were not significantly associated with the presence of hallucinations in any of the analyses, suggesting that there is no straightforward relationship between the presence of hallucinations and illness severity.

A number of other interesting correlations were observed. The presence of auditory and visual hallucinations was more likely among US patients with a diagnosis of schizophrenia in contrast to those with schizoaffective disorder. Such an association was not observed among the Indian patients, possibly because there were relatively few patients with schizoaffective disorder in this group. Our results are in contradiction to an earlier report in which a diagnosis of schizoaffective disorder was associated with greater risk for visual or somatic hallucinations (Mueser et al. 1990).

Marital status was also associated with hallucinations in three sets of analyses. Among the Indian patients, individuals who had been married were more likely to manifest visual or gustatory hallucinations, compared with individuals who had never been married. There is no obvious explanation for these observations, which could be considered chance results but for the fact that the same relationship was also observed among US patients with respect to olfactory hallucinations. In the Indian sample, the presence of auditory, visual, somatic or olfactory hallucinations was increased among patients classified as having continuously positive symptoms in comparison with patients thought to have combinations of positive and negative symptoms. In contrast, among the US patients, visual hallucinations were more likely to be observed among the latter group of patients when contrasted with those classified as having 'continuously positive' symptoms. These differences suggest that the correlation with patterns of symptoms may not be observed consistently across cultures. A few other marginally significant correlations between the presence of visual hallucinations on one hand and age, gender and educational status were observed, but only in the Indian sample.

We also analyzed concordance of different modalities of hallucinations among pairs of affected siblings, since statistically significant correlations would suggest shared genetic/environmental factors in the genesis of hallucinations. In contrast to the singleton samples, the number of ASPs available for analysis was much smaller. In order to maximize the chances of observing correlations, we analyzed all combinations of ASPs with the proband when more than two affected siblings were present in a family. The Indian and the US ASPs were concordant for a number of clinical and demographic variables. Nevertheless, no striking correlations were observed with regard to the lifetime occurrence of hallucinations, barring a marginally significant concordance for gustatory hallucinations among the Indian ASPs. These analyses suggest a significant impact of non-shared environmental factors in the genesis of hallucinations. On the other hand, twin and family data suggest a multi-factorial/polygenic fits best for diagnoses of schizophrenia, overall, with heritable components predominating. (Gottesman 1991). While analysis of individual

psychopathological features has been conducted less frequently, such analyses also point to a complex etiological model (Gottesman and Shields 1972) (Cardno and Gottesman 2000).

Several previous studies reported on prevalence and types of hallucinations but inconsistencies were present. Variations in sample size could be one explanation for the inconsistencies. We sought to address some of these variables by analyzing moderately large samples that were assessed similarly. Despite this design, we did not observe any consistent correlations that could be considered useful in the clinical setting. Our analyses suggest that the factors associated with hallucinations vary across different environments. There are no clear cut associations between illness severity and particular forms of hallucinations, nor did we observe any significant concordance among ASPs.

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Table 1

Demographic and clinical characteristics of singleton cases

	India (n = 807)	USA (n = 480)
Age	30.8 ± 9.8	38.1 ± 9.3
Gender (male/female)	437/370 (54.2%/45.8%)	301/178 (62.8%/37.2%)
Education (0–5/6–12/>12 yrs)	62/435/310 (7.7%/53.9%/ 38.4%)	3/242/228 (0.6%/51.2%/ 48.2%)
Marital status (ever married/never married)	344/463 (42.6%/57.4%)	131/345 (27.5%/72.5%)
Diagnosis (Schizophrenia/schizoaffective disorder)	706/101 (87.5%/12.5%)	286/194 (59.6%/40.4%)
Age at onset	22.8 ± 7.2	20.7 ± 10.0
Global Assessment of Function	22.0 ± 9.4	38.5 ± 16.2
Pattern of symptoms *	362/19/50/4/371 (44.9%/2.4%/6.2%/0.5%/46%)	225/38/52/1/113 (52.4%/8.9%/12.1%/0.2%/26.3%)
Pattern of severity **	57/201/310/229/7 (7.1%/25.0%/38.6%/28.5%/0.9%)	29/72/120/190/19 (6.0%/16.7%/27.9%/44.2%/4.4%)

* **Pattern of symptoms:** continuously positive/predominantly negative/positive converting to negative/negative converting to positive/mixture of positive and negative symptoms

** **Pattern of severity**: episodic shift/mild deterioration/moderate deterioration/severe deterioration/relatively stable. Some data were missing for the US sample.

Table 2

Prevalence and types of hallucinations.

Type of hallucination	India (n = 807)	USA (n = 480)
Auditory	519 (64.3%)	398 (83.4%)
Visual	297 (36.9%)	267 (57.2%)
Somatic/Tactile	173 (22.0%)	118 (27.0%)
Olfactory	150 (19%)	115 (27%)
Gustatory	68 (8.5%)	63 (14.4%)

Table 3

Logistic regression analyses

	India			USA			
	p	**OR**	**95% CI**		**p**	**OR**	**95% CI**
Auditory Hallucinations							
Pattern of symptoms				**Diagnosis**			
Continuously positive	0.004	1.60	1.17– 2.19	Schizophrenia	0.004	2.27	1.31– 3.94
Visual Hallucinations							
Gender				**Diagnosis**			
Female	0.049	1.35	1.00–1.82	Schizophrenia	0.016	1.74	1.11– 2.73
Pattern of symptoms				Age onset			
Continuously positive	0.004	1.60	1.15– 2.23		0.038		
Pattern of severity				**Pattern of symptoms**			
Moderate deterioration	0.012	2.40	1.21– 4.73	Continuously positive	0.002	0.40	0.22– 0.72
Severe deterioration	0.003	2.98	1.45– 6.12				
Marital Status							
Ever married	0.050	1.45	1.00– 2.07				
Educational status							
0– 5 years of education	0.001	2.76	1.53–4.97				
6– 12 years of education	0.025	1.46	1.05– 2.05				
Age	0.043						
Somatic hallucinations							
Pattern of symptoms				**Marital status**			
Continuously positive	0.018	1.53	1.08– 2.18	Ever married	0.008	2.05	1.21– 3.49
				Pattern of severity			

	India			USA			
	p	**OR**	**95% CI**		**p**	**OR**	**95% CI**
				Severely deteriorate	0.046	3.74	1.02– 13.67
				Relatively stable	0.015	8.34	1.51– 45.96
Olfactory hallucinations							
Pattern of symptoms							
Continuously positive	0.020	1.55	1.07– 2.24				
Gustatory hallucinations							
Marital status							
Ever married	0.029	1.94	1.07– 3.51				

Reference Classes= For Pattern of symptom: Mixture of positive and negative; For Gender: Male; For Pattern of severity: Episodic shift; For Marital status: Never married; For Education status: Above 12 years of education; For Diagnosis: Schizoaffective.

Table 4

Demographic and clinical features of affected sibling pairs

	India (n = 136 pairs)			USA (n = 77 pairs)		
	Proband	**Sibling**	**Correlation**	**Proband**	**Sibling**	**Correlation**
Age	35.3 ±10.4	34.9± 10.4	r = 0.765, p = 0.001	41.3±10.3	41.4±10.4	r= 0.789, p= 0.000
Gender (male/female)	71/65 (52.2%/47.8 %)	80/56 (58.8%/41.2%)	χ^2 = 0.07, p = 0.463	42/35 (54.5%/45.5)	44/33 (57.1%/42.9)	χ^2 = 0.21, p= 0.408
Education (0–5/6– 12/>12 yrs)	8/75/53 (5.9%/55.1%/39%)	10/81/45 (7.4%/59.6%/33.1%)	χ^2 = 31.81, p = 0.001	1/52/22 (1.3%/69.3/29.3)	1/55/17 (1.4%/75.3/23.3)	χ^2 = 14.2, p= 0.007
Marital status (ever married/never married)	74/62 (54.4 %/45.6%)	67/69 (49.3%/50.7%)	χ^2 = 5.08, p= 0.018	27/49 (35.5%/64.5)	27/47 (36.5/63.5)	χ^2 = 5.9, p = 0.015
Diagnosis (Schizophrenia/schizoaffective disorder)	123/13 (90.4%/9.6%)	121/15 (89%/11%)	χ^2 = 5.71, p= 0.038	56/21 (72.7%/27.3)	46/31 (59.7%/40.3)	χ^2 = 5.63, p = 0.018
Age at onset	23.4± 6.5	24.2± 7.3	r= 0.295, p = 0.0001	22.2 ± 15.1	19.6 ± 7.3	r= 0.436; p= 0.0001
Global Assessment of Function *	23.13±9.4	23.10±9.7	r = 0.240, p = 0.027	35.2±14.4	37.6± 14.4	r= 0.341; p= 0.009
Pattern of symptoms ** 1/2/3/4/5	68/2/0/14/52 (50%/1.5/0/10.3/38.2)	66/10/11/0/49 (48.5%/7.4/0/8.1/36.0)	χ^2 = 16.01, p = 0.067	37/4/3/0/17 (60.7%/6.6/4.9/0/27.9)	29/6/5/1/21 (46.8/9.7/8.1/1.6/33.9)	χ^2 = 34.3, p= 0.001
Pattern of severity *** 1/2/3/4/5	15/32/53/33/3 (11%/23.5/39/24.3/2.2)	26/31/52/25/2 (19.1%/22.8/38.2/18.4/1.5)	χ^2 = 13.25, p = 0.655	2/3/14/40/5 (3.1%/4.7/21.9/62.5/7.8)	6/4/19/33/2 (9.4%/6.3/29.7/51.6/3.1)	χ^2= 48.3, p=0.000

* **Sample size for GAF**- India- Proband : Sib = 116 : 85 and US- Proband : Sib = 64 : 58.

** 1- continuously +ve, 2- predominantly negative, 3- positive to negative, 4- negative to positive, 5- mixture of positive and negative

*** 1- episodic shift, 2- mild deterioration, 3- moderate deterioration, 4- severe deterioration, 5- relatively stable.

Table 5

Correlations for hallucinations among affected sib-pairs

Type of hallucination	India (136 pairs)	USA (77 pairs)
Auditory	0.077 (0.363)	0.349 (0.002)
Visual	0.094 (0.247)	0.137 (0.264)
Somatic/Tactile	0.120 (0.154)	0.351 (0.004)
Olfactory	−0.078 (0.352)	−0.250 (0.046)
Gustatory	0.180 (0.033)	0.082 (0.526)

Correlations are reported as kappa values, with significance (p-values) in brackets.