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Differences in the internal structure of hallucinatory experiences between clinical and nonclinical populations

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ABSTRACT

We investigated differential patterns of hallucinatory experiences between nonclinical and clinical samples. A total of 223 nonclinical individuals (108 females) and 111 subjects with schizophrenia (54 females) completed the Launay–Slade Hallucination Scale-Revised (LSHS-R) and Perceptual Aberration Scale (PAS). The Minnesota Multiphasic Personality Inventory-2 (MMPI-2) was used for the nonclinical group, and the Positive and Negative Syndrome Scale (PANSS) hallucination item was used for the clinical group. Cronbach's alpha values showed good internal consistency for the LSHS-R. In the two groups, significant associations were found between LSHS-R and PAS scores. Two factors were extracted through a principal component analysis (PCA) in the nonclinical group, and three factors were identified in the clinical group. The results of a hierarchical cluster analysis (HCA) revealed that a perception–cognition dimension was clear cluster discriminating element for the nonclinical group, whereas alterations in perception–cognition dimension were characteristic in cluster structure of the clinical group. Our findings suggest that the nature of hallucinatory experiences may differ qualitatively between a nonclinical population and subjects with schizophrenia. Perceptual or cognitive aberrations may add a psychopathologic dimension to hallucinatory experiences. Exploring the internal structure of hallucinatory experiences may provide explanatory insight into these experiences in the general population.

1. Introduction

There is currently a great deal of interest in the clinical significance of hallucinations, not only in psychiatric disorders but also in persons without psychopathological disorders (Johns and van Os, 2001; Kot and Serper, 2002; Verdoux and van Os, 2002; Serper et al., 2005). The results of community-based studies have demonstrated that hallucinatory experiences can occur in the general population (Larøi et al., 2012; Johns et al., 2014), and a recent meta-analysis showed that the median 1-year incidence of psychotic experiences in the general population is 3.1% (van Os et al., 2009). In contrast, subthreshold psychotic symptoms may lead to an increased risk of psychotic disorders in the general population (Poulton et al., 2000; Welham et al., 2009) and in treatment-seeking populations (Cannon et al., 2008). However, it remains disputed whether aberrant experiences (i.e., hallucinations or delusions) in community samples are variations of the 'psychoticism' dimension of personality (fully dimensional) or phenotypic expressions of schizotypal features, such as attenuated psychotic symptoms (quasi-dimensional) (Meehl, 1989; Kim, 2004). Given the phenotypic diversity of psychotic-like experiences in the general population, whether or not psychotic-like experiences reach levels of clinical psychosis may depend on multidimensional determinants of the symptom structure, including psychosocial distress, preoccupation, and conviction, rather than the contents of the experiences (Jung et al., 2008). This hypothesis has been supported by previous studies of religious and psychotic populations (Peters et al., 1999; Murray et al., 2012).

Although the inconsistent prevalence rates of hallucinatory experiences across studies and samples may be attributable to diverse definitions and methods, these inconsistencies may also reflect inherent characteristics based on gender, culture, and context

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(Larøi et al., 2014). In comparison to a 4% endorsement rate for hallucination questionnaires in a Caucasian sample, the rate was 2.5 times higher in a Caribbean sample, suggesting inter-ethnic or trans-cultural issues in assessing hallucinatory experiences (Johns et al., 2002). There is a very wide range in the estimates of cross-national prevalence of hallucinations in the general population, with several countries with an extremely high percentage of subjects reporting hallucinations (e.g., 32.0% in Nepal) (Nuevo et al., 2012). Previous studies suggest the importance of cultural factors in understanding how members of particular societies respond to people who report hallucination-like experiences (Larøi et al., 2014). For example, the tradition of Korean shamanism, also known as Muism, considers the hallucinatory experiences as providing guidance or predicting future (Kim and Chang, 1998). The prophetical role of hallucinatory experiences is commonly found in Korean folk tales. On the other hand, young Koreans are familiar with Western culture and uncomfortable in sharing hallucination-like experiences. Many self-report items related to hallucinatory experiences are often influenced by cultural factors that affect the validity and reliability of the endorsement rate (National Institutes of Health, 1998). Therefore, the use of common standardized assessment tools is necessary to objectively assess hallucinatory experiences in the general population (Beavan et al., 2011; Vellante et al., 2012).

The Launay–Slade Hallucination Scale (LSHS) is one of the most widely used tools for the assessment of hallucinatory predisposition (Launay and Slade, 1981). It was revised (LSHS-R) by Bentall and Slade (1985) and has been validated for measuring hallucinatory vulnerability in both nonclinical (Levine et al., 2004) and clinical populations (Kot and Serper, 2002). Many studies have explored the psychometric and structural properties of the LSHS-R (Cella et al., 2008; Paulik et al., 2008). The results of factor analyses have shown that the LSHS is multifactorial and that the number of factors varies from two to four (Larøi et al., 2004; Serper et al., 2005). A two-factor solution included auditory and visual hallucinations based on sensory modality (Morrison et al., 2000) whereas a three-factor solution revealed 'tendency towards hallucinatory experiences', 'subjective externality of thought', and ' vivid daydreams' (Aleman et al., 2001). Finally, a four-factor solution included 'vivid daydreams', 'clinical auditory hallucinations', 'intrusive thoughts', and 'sub-clinical auditory hallucinations' (Levitan et al., 1996). These findings suggest that the internal structure of the LSHS-R may reflect the complex interactions between perception and cognition, and assess some essential features of hallucination, formal thought disorder, and cognitive alterations.

In characterizing hallucinatory experiences, comparisons between nonclinical and clinical samples can identify both similarities and differences (Larøi, 2012). In this study, we examined the psychometric properties of the Korean version of the LSHS-R and explored the differential patterns of hallucinatory experiences between nonclinical and clinical Korean samples. Based on the inherent characteristics of the LSHS-R, we hypothesized that subjects with clinical psychosis would exhibit altered interactions between perception and cognition, indicating leading to psychosocial distress and maladaptation.

2. Methods

2.1. Participants

Our study sample consisted of 223 community members (115 males and 108 females) and 111 subjects with schizophrenia (57 males and 54 females). The nonclinical sample was recruited from community residents. Individuals with a professional background in mental health were excluded. The inclusion criteria for the nonclinical group were 1) male or female aged 18 through 65 years, 2) Korean ethnicity, 3) fluency in written and spoken Korean, 4) no history of any psychiatric disorder, 5) no first-degree relative with a history of a psychiatric diagnosis or treatment, and 6) no neurological conditions associated with hallucinations. As for the clinical group, subjects who reported active auditory verbal hallucinations (AVHs) were recruited in collaboration with co-investigators who worked in Seoul and Gyeonggi area of Korea, namely at the Seoul National University Hospital and Boramae Medical Center, Seoul, Republic of Korea. Active AVHs were operationally defined as including both the experience of hearing 'voices' and a minimum score of three on the hallucination item (P3) of the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987). The inclusion criteria for the patient group were 1) DSM-IV diagnosis of schizophrenia (American Psychiatric Association, 2000), 2) presence of active AVHs, 2) male or female between the ages of 18 and 65, 3) Korean ethnicity, and 4) fluency in written and spoken Korean. Patients were excluded if there was any evidence of DSM-IV-defined substance dependence (except nicotine and caffeine), mental retardation, or neurological disorders, including epilepsy, stroke, or severe head trauma. All patients were on antipsychotic medication. In the clinical group, we conducted unstructured clinical interview for DSM-IV and the presence of hallucinations. On the other hand, only self-report questionnaire was used in the nonclinical group. Both the nonclinical and the clinical groups completed the Korean version of the LSHS-R and the Korean version of the Perceptual Aberration Scale (PAS). The Minnesota Multiphasic Personality Inventory-2 (MMPI-2) was used in the nonclinical group, and the PANSS hallucination item was used in the clinical group based on structured interview using the PANSS instructions. The investigators were trained for high reliability in using the PANSS items. Written informed consent was obtained from all subjects prior to enrollment. The study protocol was approved by the institutional review boards of Seoul National University Hospital and SMG-SNU Boramae Medical Center.

2.2. Instruments

2.2.1. LSHS-R

The 12-item LSHS-R (Bentall and Slade, 1985) was translated into Korean by two board-certified psychiatrists (HYJ and JSC) and translated back into English by a native English speaker (SH) to verify the consistency of the original items. The translation was rechecked by both Korean- and English-language specialists. Each item was scored 'certainly applies to me' (4), 'possibly applies to me' (3), 'unsure' (2), 'possibly does not apply to me' (1), and 'certainly does not apply to me' (0). The LSHS-R total score ranges between 0 and 48, with higher scores indicating a greater predisposition toward hallucinatory experiences.

2.2.2. PAS

We used the Korean version of the PAS (Chapman et al., 1978), which was previously standardized and validated in a Korean sample (Cronbach's alpha = 0.92, test–retest reliability = 0.90) (Choi and Yang, 1997; Yang, 1997). This instrument was developed for the assessment of perceptual distortions related to body image (28 items) and other objects (seven items). It consists of 35 items with a true/false response format, with higher scores indicating a greater tendency toward perceptual aberrations. Total scores range from 0 to 35 points.

2.2.3. MMPI-2

The MMPI-2 has been shown to have the ability to detect both schizophrenia and schizophrenia-related conditions (Matsui et al., 2002). Among the 10 clinical scales of the MMPI-2, only the schizophrenia scale (Sc) showed a statistically significant correlation with the LSHS total score in a nonclinical sample (Butcher et al., 1989; Han et al., 2006). Therefore, we used the Korean version of the MMPI-2 and computed the Sc score for further analysis. The Sc scale was the primary component to distinguish subjects with either schizophrenia or schizophrenia spectrum disorder from students without such disorders (Matsui et al., 2002). The Sc scale may be an indicator of a heightened risk of schizophrenia (Subotnik et al., 2005). In this study, the Sc scale of the MMPI-2 was used to screen the subjects with a potential risk of psychosis in the nonclinical group (cut-off T-score = 60).

2.2.4. PANSS

To assess the severity of hallucinations in the clinical group, we used the P3 item on the Korean version of the PANSS (Kay et al., 1987; Yi et al., 2001). We previously reported that a self-report questionnaire of AVHs showed good agreement with the P3 on the PANSS (Kim et al., 2010).

2.3. Data analysis

The internal consistency of the LSHS-R was analyzed using Cronbach's alpha (Cronbach, 1951). The PAS total score was utilized to assess the concurrent validity of the LSHS-R. Correlational analyses were conducted to confirm the validity of the LSHS-R in the nonclinical group using the PAS and the MMPI-2 total scores. The factor structures of the LSHS were explored in the clinical sample using a principal component analysis (PCA) with a single varimax rotation. The Kaiser criterion (Eigenvalue > 1) was used to determine the number of factors. Based on the results of the PCA, we performed the confirmatory factor analysis (CFA) in the nonclinical sample. The parameters for fit estimation in the CFA were the relative chi-square (χ^2/d.f.), the root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR), and the Tucker–Lewis index (TLI). Although there is no consensus regarding an acceptable ratio for χ^2/d.f., ratios smaller than

5.0 are acceptable (Wheaton et al., 1977; Tabachnick and Fidell, 2012). RMSEA values of between 0.8 and 0.10 provide a mediocre fit and below 0.08 show a good fit (MacCallum et al., 1996). SRMR values of 0.09 or lower and TLI values of 0.80 or higher are considered acceptable (Hu and Bentler, 1999; Hooper et al., 2008). Between-group comparisons of the endorsed items and the distribution of total scores were performed between the LSHS-R and the PAS. In addition, a hierarchical cluster analysis (HCA) using Ward's minimum variance method was performed to compare interrelationships among all 12 items on the LSHS-R between the two groups. The HCA yields a dendrogram visualizing how the items merge and form clusters (Aldenderfer and Blashfield, 1984). The LSHS-R items were grouped into clusters based on the degree of similarity in a sequential manner. Ward's minimum variance method provides the cluster structure leading to the smallest increase of the sum of the squared Euclidean distance, minimizing the information loss associated with cluster fusion. The cluster structure can be validated based on a variety of validation measures in conjunction with relevant clinical information (Datta and Datta, 2006). We used three internal validation measures and four stability measures: the connectivity, the Dunn index, the Silhouette width, the average proportion of non-overlap (APN), the average distance (AD), the average distance between means (ADM), and the figure of merit (FOM). The connectivity relates to what extent observations are placed in the same cluster as their nearest neighbors in the data space. The connectivity has a value between zero and infinity, and should be minimized (Handl et al., 2005). The Dunn index and silhouette width assess cluster homogeneity based on the intra-cluster variance and the degree of separation between clusters (Dunn, 1974; Rousseeuw, 1987). The Dunn index has a value between zero and infinity, and should be minimized. The silhouette width ranges between −1 and 1, and should be maximized. The stability measures (APN, AD, ADM, and FOM) compare the results from clustering based on the full data to clustering based on removing each item on the LSHS-R, and all measures should be minimized. The CFA was performed using AMOS 21.0 software and a *lavaan* package of R version 3.1.1. via Korean mirror site (R Foundation for Statistical Computing, Vienna, Austria). The HCA was conducted using R version 3.1.1. and validated using *clValid* package running in R. All statistical analyses except the CFA and the HCA were performed using SPSS 21.0 for Windows (SPSS Inc., Chicago, IL).

3. Results

3.1. Participant characteristics

No significant difference was found in the mean age between the nonclinical group (Mean=33.9, S.D.=10.7) and the clinical group (Mean=34.1, S.D.=10.3). However, mean years of education was longer in the nonclinical group (Mean=15.0, S.D.=2.4) compared to the clinical group (Mean=13.3, S.D.=2.4). Mean scores of the LSHS-R (Mean=5.8, S.D.=5.6) and the PAS (Mean=2.8, S.D.=3.1) were significantly lower in the nonclinical group than the clinical group (LSHS-R Mean=22.5, S.D.=10.0, $p<0.01$; PAS Mean=6.0, S.D.=5.4, $p<0.01$). The mean P3 on the PANSS in the clinical group was 4.3 (S.D.=1.0). Significant gender differences for mean LSHS-R scores were observed in both the nonclinical group (Male Mean=6.51, S.D.=6.1; Female Mean=5.0, S.D.=4.9; $t=2.06$, $p=0.04$) and the clinical group (Male Mean=20.0, S.D.=9.31; Female Mean=25.19, S.D.=10.12; $t=-2.81$, $p=0.01$) with the mean LSHS-R score higher in male for the nonclinical group and higher in female for the clinical group. Although no significant association was found between age and mean LSHS-R score in the clinical group ($r=-0.01$, $p=0.94$), a significant positive association was found in the nonclinical group ($r=0.22$, $p=0.001$).

3.2. Internal consistency

The internal consistency of the LSHS-R was evaluated using Cronbach's alpha (Cronbach, 1951). Cronbach's alpha value was 0.84 for the nonclinical group and 0.83 for the clinical group, suggesting good internal consistency. To examine the influence of different items on the consistency of the scale, Cronbach's alpha values were re-calculated for the LSHS-R scale by systematically removing each of the 12 items for the nonclinical group (0.81–0.84) and for the clinical group (0.80–0.83). These results indicated that the internal consistency of the scale was stable and that no single item disproportionately affected the homogeneity of the instrument.

3.3. Inter-correlations among the instruments

Significant correlations were observed between the LSHS total score and the PAS total score in both the nonclinical group ($r=0.54$, $p<0.001$) and the clinical group ($r=0.47$, $p<0.001$). In the nonclinical group, the LSHS total score correlated only with the Sc of the MMPI-2 ($r=0.28$, $p<0.01$) among the 10 clinical scales. The Sc showed a significant correlation with the PAS total score ($r=0.25$, $p=0.03$) (Table 1). In the clinical group, the LSHS total score showed a significant correlation with the P3 on the PANSS ($r=0.31$, $p<0.001$). The P3 significantly correlated with the PAS total score ($r=0.28$, $p=0.003$). In assessing the individual items on the LSHS-R, all item scores were positively associated with the PAS total score in the nonclinical group ($r=0.21$–0.44, Table 2) and the clinical group ($r=0.21$–0.42, Table 3) except for items 7 and 8. Items 3–7, 10, and 12 were positively associated with the Sc of the MMPI-2 in the nonclinical group ($r=0.17$–0.35, Table 2). In the clinical group, items 3–7 and 9–11 were positively associated with the P3 on the PANSS ($r=0.18$–0.36, Table 3).

3.4. Endorsement rates of items on the LSHS-R

The items with the highest mean scores for the nonclinical group were item 1 (unrelated thoughts) followed by item 3 (thoughts seem real). For the clinical group, the items with the highest mean scores were item 12 (the voices in my head) followed by item 8 (hear a

Table 1
LSHS-R characteristics, endorsement rates, and correlations with MMPI-2 Sc and PAS in the nonclinical group ($n=223$).

	Mean	S.D.	Skewness	Kurtosis	Possibly applies	Certainly applies	Item to total correlation	Sc	PAS
L1. Unrelated thoughts	1.16	1.06	−0.36	−1.14	13.9	1.8	0.60[a]	0.13	0.34[b]
L2. Tunes in daydream	0.64	0.98	0.47	−1.27	4.0	2.7	0.64[a]	0.15	0.25[b]
L3. Thoughts seem real	0.84	1.00	0.21	−1.29	11.2	0.4	0.68[a]	0.24[b]	0.32[b]
L4. Frighteningly real thoughts	0.68	0.87	−0.20	−1.33	8.1	6.3	0.59[a]	0.17[a]	0.28[b]
L5. Clear sounds	0.42	0.72	−0.51	−0.97	0.9	0.9	0.74[a]	0.23[b]	0.29[b]
L6. People seem real	0.34	0.62	−0.02	−1.38	1.3	2.2	0.75[a]	0.35[b]	0.37[b]
L7. Voices say my thoughts	0.43	0.78	0.05	−1.51	1.8	1.3	0.65[a]	0.22[b]	0.43[b]
L8. Hear a person's voice	0.43	0.79	−0.51	−1.19	3.6	0.4	0.57[a]	0.04	0.40[b]
L9. See a person's face	0.22	0.53	1.10	0.04	1.3	1.3	0.57[a]	0.09	0.44[b]
L10. Voices of devil	0.12	0.36	0.53	−1.31	–	–	0.57[a]	0.19[a]	0.23[b]
L11. Voices of god	0.28	0.68	0.21	−1.53	1.8	0.9	0.45[a]	0.09	0.21[b]
L12. Voices in my head	0.20	0.55	−0.75	−0.63	2.2	–	0.63[a]	0.18[a]	0.41[b]

Key: LSHS-R=Launay–Slade Hallucination Scale-Revised; P3=hallucination item; PANSS=Positive and Negative Syndrome Scale; PAS=Perceptual Aberration Scale; possibly applies=item score of 3; certainly applies=item score of 4; S.D.=standard deviation.

[a] $p<0.05$.
[b] $p<0.01$.

Table 2
LSHS-R characteristics, endorsement rates, and correlations with PANSS P3 and PAS in the clinical group ($n=111$).

	Mean	S.D.	Skewness	Kurtosis	Possibly applies	Certainly applies	Item to total correlation	P3	PAS
L1. Unrelated thoughts	2.25	1.36	0.74	−0.31	33.3	19.8	0.54	0.07	0.30[b]
L2. Tunes in daydream	1.41	1.40	1.73	2.61	23.4	8.1	0.63	0.18[a]	0.37[b]
L3. Thoughts seem real	1.72	1.41	1.09	0.25	20.7	13.5	0.71	0.23[a]	0.33[b]
L4. Frighteningly real thoughts	1.99	1.37	1.24	0.85	36.0	11.7	0.63	0.20[a]	0.42[b]
L5. Clear sounds	2.34	1.32	2.14	5.79	39.6	18.9	0.57	0.35[b]	0.23[a]
L6. People seem real	1.93	1.43	2.21	5.74	26.1	16.2	0.60	0.36[b]	0.27[b]
L7. Voices say my thoughts	1.86	1.50	2.29	5.98	26.1	17.1	0.59	0.33[b]	0.17
L8. Hear a person's voice	2.38	1.49	2.07	4.07	29.7	28.8	0.50	0.11	0.16
L9. See a person's face	0.98	1.28	2.88	9.75	7.2	7.2	0.53	0.22[a]	0.28[b]
L10. Voices of devil	1.41	1.53	2.85	7.86	18.0	13.5	0.64	0.21[a]	0.33[b]
L11. Voices of god	1.72	1.54	3.14	11.15	22.5	17.1	0.63	0.26[a]	0.26[b]
L12. Voices in my head	2.53	1.33	3.50	13.60	39.6	25.2	0.48	0.15	0.21[a]

Key: LSHS-R=Launay–Slade Hallucination Scale-Revised; P3=hallucination item; PANSS=Positive and Negative Syndrome Scale; PAS=Perceptual Aberration Scale; possibly applies=item score of 3; certainly applies=item score of 4; S.D.=standard deviation.

[a] $p<0.05$.
[b] $p<0.01$.

Table 3
Factor structure showing the items loading over 0.4 on LSHS-R in the clinical group ($n=111$).

Items	Experiences attributed to oneself	Illusion-like experiences	Experiences with delusional nature
L1. Unrelated thoughts	0.64		
L2. Tunes in daydream	0.63		
L3. Thoughts seem real	0.80		
L4. Frighteningly real thoughts	0.83		
L5. Clear sounds		0.75	
L6. People seem real	0.57		
L7. Voices say my thoughts		0.79	
L8. Hear a person's voice		0.49	
L9. See a person's face			0.58
L10. Voices of devil			0.82
L11. Voices of god			0.71
L12. Voices in my head			0.67
Eigenvalue	4.2	1.2	1.5
Variance (%)	35.2	10.3	12.5
Cumulative variance (%)	35.2	58.0	47.7

Key: LSHS-R=Launay–Slade Hallucination Scale-Revised.

person's voice). In the nonclinical group, 77 (34.5%) endorsed at least one item with a rating of 3 ('possibly applies to me') or 4 ('certainly applies to me'), and 15 (6.7%) endorsed at least one item with a rating of 4. In the clinical group, 107 (93.7%) endorsed at least one item with a rating of 3 or 4, and 63 (56.8%) endorsed at least one item with a rating of 4. In the nonclinical group, no subject provided a rating of 4 for items 4, 6, 9, 10, or 12 (Table 2).

3.5. Internal structure of the LSHS-R

3.5.1. Principal component analysis

The factor structure of the LSHS-R was explored using a PCA with varimax rotation in the clinical group. The Kaiser criterion (eigenvalue greater than 1) was applied to determine the number of significant factors. The results demonstrated that the LSHS-R was composed of three factors for the clinical group. The rotated factor loadings above 0.40 are presented in Table 3. The factor that accounted for 35.2% of the variance (items 1–4, 6) contained items that refer to experiences that are recognized as one's own. There were two additional factors that were separated into a factor containing items referring to vivid illusion-like experiences (items 5, 7, 8) and another factor containing items referring to visual and auditory hallucinations of a delusional nature (items 9–12). Cronbach's alpha value was 0.80 for the first factor, 0.68 for the second factor and 0.73 for the third factor, suggesting a generally acceptable range of reliability.

Table 4
Goodness of fit indexes for the three factor model of LSHS-R factor structure in the nonclinical group ($n=223$).

χ^2	d.f.	p	χ^2/d.f.	RMSEA (90% CI)		SRMR	TLI
213.75	51	<0.001	4.2	0.12	0.10–0.14	0.078	0.784

Key: CI=confidence interval; d.f.=degree of freedom; LSHS-R=Launay–Slade Hallucination Scale-Revised; RMSEA=Root mean square error of approximation; SRMR=Standardized root mean square residual; TLI=Tucker–Lewis index.

3.5.2. Confirmatory factor analysis

The results of the PCA were tested for the goodness of fit in the nonclinical group. Although the RMSEA value was higher than is typically desirable, the three-factor model for the LSHS-R was acceptable in the nonclinical group (Table 4).

3.5.3. Hierarchical cluster analysis

The HCA results are summarized as two dendrograms in Fig. 1. The HCA yielded two main clusters for the nonclinical group and three clusters for the clinical group. An abrupt increase in the within-cluster sum of squares indicates the fusion of dissimilar clusters (Norusis, 2010). As shown in Table 5, the cluster validation measures (e.g., internal measures) supported hierarchical clustering with two main clusters. On the other hand, the values of the AD and the FOM indicated the possibility of hierarchical clustering with three or four clusters. In the nonclinical group, 12 items on the LSHS-R formed two main clusters within a perception–cognition dimension. Items referring mainly to perceptual characteristics formed one cluster (cluster I), and items referring mainly to

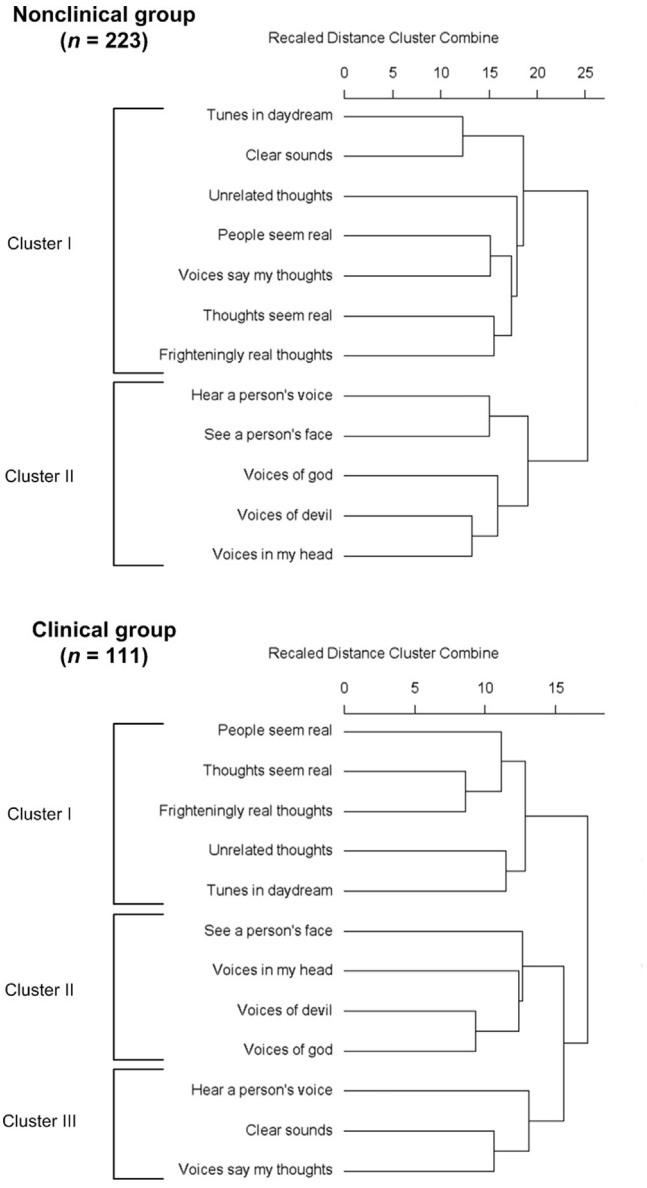

Fig. 1. Comparison of the cluster structures between the participant groups. The subjective associations between items are reflected by the horizontal distance.

Table 5
Cluster validation measures.

Cluster size	Nonclinical group (n=223)			Clinical group (n=111)		
	2	3	4	2	3	4
Internal measures						
Connectivity	49.64	61.56	73.52	25.30	51.40	62.00
Dunn index	0.07	0.08	0.08	0.23	0.27	0.27
Silhouette width	0.29	0.30	0.10	0.19	0.13	0.13
Stability measures						
APN	0.08	0.17	0.18	0.15	0.25	0.34
AD	3.63	3.45	3.24	4.28	4.06	3.99
ADM	0.30	0.65	0.64	0.67	0.85	1.07
FOM	0.91	0.89	0.88	0.93	0.90	0.90

Key: AD=average distance; ADM=average distance between means; APN=average proportion of non-overlap; FOM=figure of merit.

cognitive interpretations formed the other cluster (cluster II). In contrast, in the clinical group, the items referring to perceptual characteristics formed one cluster (cluster I), and the other items yielded two clusters (clusters II and III) that showed mixed features of a perception–cognition dimension.

4. Discussion

In this study, in addition to quantitative differences, we identified differential patterns of the internal structure of hallucinatory experiences between a nonclinical and a clinical group. Subjects with schizophrenia showed altered integration of perceptual experiences and cognitive interpretations compared to a nonclinical population. We used the 'perception' dimension to imply the perceptive aspects of hallucinatory experiences and 'cognition' dimension to denote the active interpretation of hallucinatory experiences such as the origin of voices. As shown in the results of the HCA, in contrast to the separation between the two clusters of perception and cognition in the nonclinical group, the clinical group showed the mixed features of the two closely related clusters in addition to the cluster of perception. These differences in the patterns of clustering may not only implicate some qualitative changes in the psychotic process but also suggest the inadequacy of clinical evaluations for patients with psychotic disorders based on all-or-none phenomena or merely on the physical characteristics of AVHs (Chang et al., 2009b). Deviated interplay between perception and cognition may trigger unusual thoughts as well as delusion formation (Rossell, 2006). These results implicate that the cognitive interpretation and subsequent emotional responses are key components in determining clinical significance of psychotic-like experiences (Morrison et al., 2004; Peters et al., 2014), and suggest that although nonclinical populations experience hallucinations, the nature of these experiences may differ qualitatively between nonclinical and clinical populations.

The Korean version of the LSHS-R demonstrated good psychometric properties in assessing hallucinatory experiences in both nonclinical and clinical Korean samples. In our sample, more than one-third of the nonclinical group reported 'possible' to 'certain' hallucinatory experiences. In line with previous studies (Levine et al., 2004), the LSHS-R total score showed a significant correlation with the PAS total score in the nonclinical group. In subjects with schizophrenia, significant correlations were observed between the LSHS total score, the P3 score, and the PAS total score. However, the correlation coefficients between the PAS and two key items of the LSHS-R ('I often hear a voice speaking my thoughts aloud' and 'In the past I have had the experience of hearing a person's voice and then found that no one was there') showed discrepancy between the clinical and the nonclinical groups. Higher correlations in the nonclinical group may suggest that these two items partly reflect the degree of insight (Lera et al., 2011). In our recent study (Kim et al., 2010), the total score of the Hamilton Program for Schizophrenia Voices Questionnaire (Van Lieshout and Goldberg, 2007), a self-report questionnaire measuring auditory hallucinations, showed a significant correlation with the P3. These results support the usefulness of the Korean version of the LSHS-R in both nonclinical and clinical samples.

The nonclinical group showed a distribution skewed toward low LSHS-R total scores, whereas a broad range of LSHS-R total scores was observed in the clinical group. The LSHS-R total scores in this study sample appeared to be lower than the results of previous Western studies (Bentall and Slade, 1985; Young et al., 1986; Aleman et al., 2001). In addition, overall endorsement rates were lower than the results of previous studies (Waters et al., 2003; Aleman and Larøi, 2008). These differences may be partly attributable to a higher mean age of the nonclinical group in this study compared to previous Western studies that were conducted mainly among undergraduate students. It is noteworthy that the studies involving college students, in which exceedingly high rates of auditory hallucination were reported, were all conducted using the same questionnaire with

self-reported responses (Pierre, 2010). On the other hand, high endorsement rates of items on 'intrusive and unrelated thoughts (item 1)' and 'thoughts seem real (item 3)' in the nonclinical group may reflect some characteristics of Korean culture which emphasizes the individual's interaction with inner or outer world (Kim and Chang, 1998). Further studies on transcultural differences in hallucinatory experiences are needed.

We found a two-factor structure for the nonclinical group in this study, which is similar to the two-factor model previously reported in undergraduates (Serper et al., 2005), with the exception that item 7 ('voices say my thoughts') was clustered in a different factor. Interestingly, these results are in accordance with previous suggestions that although the three-factor model (Aleman et al., 2001) is a better fit than the two-factor model (Serper et al., 2005), when 'item 7' was moved from the 'clinical' factor to the 'subclinical' factor, the two-factor model showed better fit (Paulik et al., 2008).

Given the subjective nature of psychopathologies, quantitative methodologies comparing the sums of scaled scores are likely to cause substantial information loss in understanding psychosocial distress associated with hallucinatory experiences (Peralta and Cuesta, 1994; Chang et al., 2009b). In addition, listing various types of hallucinatory experiences may fail to provide useful information about clinical significance (Haddock et al., 1999). Therefore, as shown in this study, investigating the interrelationships among the components of hallucinatory experiences may detect the qualitative differences between nonclinical and clinical populations.

The study has several limitations. First, all of the participants were Korean which limits the generalizability of the findings of this study. Second, because hallucination are not exclusively tied to specific psychiatric diagnoses, recruiting only subjects with schizophrenia may compromise the interpretation of the complex interaction among various components pertaining to hallucinatory experiences (Markova and Berrios, 1995). Third, because AVHs in the clinical group tend to be highly associated with delusional thinking compared to hallucinatory experiences in the nonclinical group, our results of the comparisons of internal structure of the LSHS-R between the two groups should be interpreted with caution given the lack of instruments for delusional ideas in this study. The lack of the conventional psychotic symptom rating scales weakened the generalizability of this study. Finally, because the HCA is inherently descriptive and non-inferential, the interpretation of this multivariate data is exploratory. However, the flexibility of this method is advantageous in understanding some complex psychopathologies such as auditory hallucination and depression (Chang et al., 2009a, 2009b).

In conclusion, the results of this study suggest qualitative differences in hallucinatory experiences between nonclinical and clinical populations, indicating altered integration of perceptual and cognitive interpretations of hallucinatory experiences in a clinical population. These differences may be closely associated with the complex psychopathology of hallucinations. Given the importance of culture in shaping hallucinations, the cultural background needs to be taken into account when conducting studies of hallucination in the nonclinical population. The findings of this study also suggest that the Korean version of the LSHS-R is a valid and reliable tool for assessing hallucinatory experiences in both nonclinical and clinical Korean populations.

Conflict of interest

None.

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