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The internal structure of the phenomenology of auditory verbal hallucinations

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Abstract

Background: Auditory verbal hallucinations (AVH) do not have uniform pathological significance. They affect patients with different brain disorders, and vary along multiple phenomenological dimensions. Evidence indicates that some of the phenomenological variables have specific neural substrates. Therefore, a comprehensive characterization of the phenomenological variations of AVH and the interrelationship between these variables was undertaken. Method: Twenty phenomenological variables were identified; on each AVH had a binary value (present or absent). Information about 11 of these variables were obtained from 30 patients. Hierarchical cluster (HC) and multidimensional scaling (MDS) analyses were performed to investigate the hidden structure and dimensions of these variables. Results: HC yielded two main clusters with further sub-clusters in each. The first cluster included hallucinations with low linguistic complexity, repetitive content, attributed to self, located in outer space, and associated with different kinds of control strategies. The second cluster included hallucinations with high linguistic complexity, systematized content, multiple voices, attributed to others, and located in inner space. In MDS, three dimensions were identified: linguistic complexity, self-other attribution, and inner-outer space location. Conclusion: The patterns of clustering and dimensional configuration of AVH characteristics were in accord with intuitive expectation and validated the patients' descriptions of their experiences. These findings could reflect aspects of the neural mechanisms of AVH. For example, the presence of neural specificity for each phenomenological variable, intermediate neural commonality for groups of variables, and a final common pathway for all subtypes of AVH. Another example is a differential level of language dysfunction according to the linguistic complexity of AVH. © 2003 Elsevier Science B.V. All rights reserved.

Keywords: Auditory verbal hallucinations; Schizophrenia; Phenomenology; Language; Multidimensional scaling; Hierarchical cluster analysis

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Auditory verbal hallucinations (AVH) refer to the auditory perception of speech in the absence of corresponding external stimuli. AVH vary along multiple phenomenological dimensions such as acoustic clarity, inner or outer space location, and presence or

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absence of insight. This variability has been recognized for a long time and has led to sub-classifications of AVH. For example, Jaspers (1959) divided hallucinations into hallucinations proper and pseudohallucinations, depending on concomitancy to normal external stimuli, location in the internal subjective or external space, and clarity. He also identified another subgroup ("sense-memory") defined as "subsequent, deceptive yet real hearing of words already heard." It is noteworthy that only the latter subgroup, known also as experiential hallucinations, could be evoked by electrical stimulation of the speech perception area (Penfield and Perot, 1963).

Claude and Ey (1932a) grouped abnormal perceptions into "hallucinations" and "hallucinosis", where the latter implied the presence of insight into the abnormality of the experience. In addition, they distinguished a pseudohallucination subgroup when hallucinations had reoccurring content without resistance from the patient ("etats obssessionels parasites") (Claude and Ey, 1932b). Finally, Sedman (1966) grouped AVH into three categories: imagery, pseudohallucinations, and true hallucinations. In the first, the perception lacks the concrete reality of perception and is located in inner space; in the second, insight into the unreality of the perception is present; and in the third, perceptions are clear, but insight is lacking.

More recent studies have examined in more detail various characteristics of AVH. Lowe (1973) examined several variables, including frequency, inner or outer space location, similarity to the perception of external speech, loudness, constancy, effect on the patient behavior, causal attribution, affective reaction, and content. It was found that these characteristics "can be used as discriminatory indicators for differential diagnosis among psychotics." Nayani and David (1996) examined additional variables, including personification (accent, gender, familiarity of the voice), coping mechanisms and degrees of control, number of voices, some aspects of linguistic complexity, and insight and reality testing. They found that over time, AVH are more likely to be experienced inside the head, and their complexity of hallucinations increases, while distress and coping improve. Finally, Junginger and Frame (1985) assessed the reliability of patients' reports on some characteristics of AVH such as loudness, clarity, location, and reality. They found that clarity was

the most reliable and reality testing (insight) the least reliable characteristic.

In summary, a number of phenomenological variables of AVH have been recognized over time. However, the classifications of hallucinations according to these variables were mostly based on clinical case observations and were inconsistent. For example, pseudohallucinations were defined according to different phenomenological criterias (Hare, 1973). Furthermore, this term is used inconsistently in clinical practice and considered to constitute a premature closer to understanding hallucinations subtypes (Dening and Berrios, 1996). In our opinion these classifications lead to coining new terminology, but did not provide a useful framework for the clarification of the neural mechanisms of AVH.

One could question the need for studying the phenomenological variables of AVH. In our view, this endeavor is worthwhile. First, AVH do not have a uniform pathological significance, as they are encountered in many psychiatric and neurological illnesses as well as in substance abuse. Second, some of the phenomenological variables (i.e., anosognosia, repetitive content, and level of linguistic complexity) are usually associated with specific neural correlates. Consequently, some aspects of the underlying neural substrates of AVH will probably vary according to the presence or absence of these variables.

Anosognosia is a term originally coined by Babinski (1914) to describe non-recognition of a neurological symptom. Anosognosia is correlated with lesions of the visual associative cortex (Magitot and Hartmann, 1926), and frontal lobes (McDaniel and McDaniel, 1991) in the case of Anton Syndrome (cortical blindness), and with lesions of the minor hemisphere in the case of unawareness of left side hemiplegia (Babinski, 1914). This indicates that there are symptom specific neural substrates underlying the unawareness of symptoms. AVH is a symptom of brain disease just like blindness or hemiplegia. Therefore, the term anosognosia could also be used to describe the non-awareness of the abnormal nature of AVH ("AVH-anosognosia"). (Insight is an equivalent term, but has, commonly in psychiatry, a more general connotation such as the awareness of having a mental illness or need for treatment (Amador et al., 1991). Given the evidence from neurology mentioned above, it is reasonable to suppose that AVH-anosognosia has specific, yet unknown, neural substrates.

Similarly, AVH with repetitive content could have different underlying neurobiology than AVH with systematized content. The first subtype has been shown to respond to treatment by an antiobsessional agent (Stephane et al., 2001b). Furthermore in a PET study, repetitive verbal stimulation relative to neutral stimulation was associated with increased regional cerebral blood flow (rCBF) in the orbitofrontal regions (Cottraux et al., 1996). Finally, hallucinations with variable linguistic complexity (hearing words, sentences, or conversations) might be associated with different neurobiological substrates, given that brain activation patterns vary with linguistic complexity (Caplan et al., 1998, 1999).

These considerations indicate that the diversity within the phenomenology of AVH could reflect equally diverse neural mechanisms. It is possible that the somewhat inconsistent findings in functional neuroimaging research (Stephane et al., 2001a) could be attributed to the inherent diversity of AVH phenomenology. Therefore, understanding better this diversity may prove useful for understanding the neural mechanisms underlying it. We believe that a crucial step towards achieving this goal is to elucidate the patterns of clustering of the diverse AVH variables as well as their dimensional organization. Inference about the underlying neuropathology could be made based on these analyses, although these inferences would require validation and specification using cognitive and neurophysiological measurements. We are not aware of a study that used these methods to investigate the structure within an individual symptom (such as AVH). However, the overall approach is well established in psychiatry and neuroscience. For example, Liddle (1987a), using factor analysis, found that the symptoms of schizophrenia segregate into three factors. He inferred that this reflects differences of the underlying pathological processes. This inference was later confirmed by cognitive (Liddle, 1987b) and neurophysiological correlations (Liddle et al., 1992). Another example is the use of MDS to study the organization of the semantic networks in schizophrenia (Tallent et al., 2001). In the present tudy, we subjected the data from 30 schizophrenic patients to multivariate statistical methods.

1. Methods

1.1. Phenomenological variables

Twenty AVH variables were identified based on the literature and clinical experience of the authors (Table 1). The selection of the variables was guided by the possibility of specific pathophysiology underlying the variables. Records of 100 patients with history of AVH in outpatient treatment in the Minneapolis VA Medical Center were reviewed for information about the patients' descriptions of their hallucinations. Patients were selected from the caseloads of three psychiatrists in the clinic. The three psychiatrists usually have patients with similar demographics and severity of illness. Only the records of patients of one psychiatrist (MS) obtained information about the characteristics of AVH. These patients were participating in a project to develop a structured interview instrument to assess the phenomenology of AVH. Their mean age was 50.6 years (range: 31-70 years), and the mean duration of illness was 22 years (range: 4-40 years). Table 2 summarizes the demographic and clinical characteristics of these patients.

The information were obtained using a semistructured interview, which included questions such as: how many voices do you hear, what do they say, do they talk about the same topic all the time or different topics over time, do you hear conversations, do you hear statements, do you hear single words, are they clear like your voice and mine, are they like thinking or like hearing, what do you think makes you hear voices no one else can hear. Hypnagogic and hypnopompic hallucinations and functional hallucinosis (hearing their names being called or the phone ringing and the answering machine going on while in the shower) were excluded. Thirty records contained information about the following variables: (1) nosognosia or insight, awareness of the abnormal nature of AVH, as judged by the presence or absence of explanatory delusions or congruent behaviors; (2) number of voices; (3) content; (4) location (5) strategies to control their occurrence; (6) mode of occurrence; (7) source attribution; (8) linguistic complexity; (9) acoustic qualities; (10) time course; and (11) association with other types of hallucinations.

Table 1

Twenty phenomenological variables were identified. Exhaustive description of these variables generates features that lend themselves to binary coding (present or absent)

1. Acoustic qualities:	
1A. Clarity:	Clear (like external speech)
	Deep (like internal speech or
	thinking in words)
1B. Personification:	Man's voice
	Women's voice
	Robot voices
1C. Loudness (do AVH	
have loudness) (if yes)	
1Ca. Level:	Like normal conversation
	Louder
	Softer
1Cb. Does loudness	
change over time	
2. Location:	
2A. Inner space:	Head
	Other parts of the body
2B. Outer space (if yes)	
Distance:	Within hearing range
	Outside of hearing range
2C. Relation to the sensation	
field (through ears)	
3. Number:	
One	
More than one	
(if more than one)	
Time course:	Simultaneously
	One at a time
4. Direction:	
Voices talk between themselves	
Voices talk to the patient	
5. Content:	
5A. Range:	Repetitive
	Systematized
5B. Focus:	Self
	Non-self
6. Linguistics:	
6A. Syntax:	First person
	Second person (You, name)
	Third person (he/she, name)
6B. Complexity:	Hearing words
	Hearing sentences
	Hearing conversations
7. Relation to the moment	
(related to thoughts or action	
at the moment when heard)	
8. Order:	
First order (hear)	
Second order	
(talk back to the voices)	
Third order	
(converse with the voices)	

Table 1 (continued)

9. Replay:	
Experiential	
(replay of heard material)	
9. Replay:	
Replay of the patient speech	
Replay of the patient thoughts	
10. Source attribution:	
Self	
Other (if other)	
Someone familiar	
God or spiritual being	
A deceased person	
11. Time course:	
11A Time dimension	Constant
	Episodic
11B Modulation	Worsening modulators
	Improvement modulators
12. Mode of occurrence:	improvement modulators
Spontaneous	
Triggered (if triggered)	
Inducible by will	
Other triggers	
13 Concomitance (to):	
Speaking	
Listening to speech	
Listening to non-speech sounds	
Activities requiring attention	
14. Control strategies:	
Listening to speech	
Speaking	
Listening to non-speech sounds	
Activities requiring attention	
Other control strategies	
15. Safety:	
Affect safety	
Does not affect safety	
16. Affective relatedness:	
Comforting	
Bothersome	
17. Nosognosia	
18. Association with other	
abnormal perceptions	
19. Concomitance with other	
abnormal perceptions	
20. Stability of the	
characteristics overtime	

1.2. Coding of information

All information was coded in a binary fashion. Variables with mutually exclusive attributes (e.g. "time course": the voices were either constant or episodic) were coded as 1 for one attribute (episodic) and 0 for the other (constant). For other variables,

 Table 2

 Demographic and clinical characterization of the patients

Sex	Race	Treatment diagnosis	Co-morbidity
% Male 90	White 83 Black 13	Schizophrenia 66 Schizoaffecive 17	ETOHA 17 Other illicit drugs 13
	Hispanic 03	Psychotic depression 17	Psychogenic polydepsia 3 Schizoid personality 3 Avoidant personality 3 Schizotypal personality 3 Borderline personality 3 Sexual identity disorder 3

which did not have mutually exclusive attributes (e.g. "space locations": AVH were sometimes experienced both in inner and outer space), each attribute (inner space location, outer space location) were coded separately by giving values of 0 or 1, depending on the absence or presence of the attribute. This overall approach is similar to that followed by Tversky (1977) to describe the features of an object exhaustively in a feature-space. Such exhaustive description produces features that lend themselves to binary coding with minimal loss of information. (For example, hearing sentences can be either present or absent, and perceptual experience can be located outside or inside the head.)

1.3. Statistical analyses

To examine the internal structure (interrelationship) of the phenomenological variables, Hierarchical cluster (HC) and Multidimensional Scaling (MDS) were used. MDS, relative to HC, is more sensitive to larger distances (global structure) than small distances (local structure) between variables (Kruskal and Wish, 1978).

Kruskal and Wish (1978) provide an illustrative example to understand MDS. Suppose that you are required to construct a table of distances between cities from a map. This would be an easy matter; it is enough to measure the distances between pairs of cities on the map and convert it to real distances using the scale of the map. To resolve the reverse problemconstructing a map from a table of distances—is no trivial matter and one would need to use MDS. However, unlike constructing a map where twodimensional space is sufficient, a multidimensional space could be necessary for adequate representation of a given data. MDS is a method that translates the measured relationship between two objects into a best-fit geometric configuration of points in space, such that closely related object pairs are reflected by points that are close together, and dissimilar objects correspond to points that are far apart. The resultant geometric configuration would make apparent the hidden structure of the data (that cannot be seen by examining the table) and make the data easier to comprehend.

Clustering analyses, on the other had, are widely used methods for investigation of useful conceptual schemes for grouping entities (classification). The most common algorithm is hierarchical clustering method (HC) (Aldenderfer and Blashfield, 1984). HC groups entities together depending on a given similarity measure, however without multidimensional configuration.

The similarity measure we used in both analyses is the Jaccard coefficient (the ratio of co-occurrence between a pair of variables over the sum of the occurrence of either one). The Jaccard coefficient was selected because it excludes joint absence and therefore is more appropriate for examining the commonality within each pair of variables. If joint absence is not excluded, some variables would appear very similar because of the features they lack rather than the ones they share (Aldenderfer and Blashfield, 1984).

1.3.1. HC analysis

A rectangular raw data matrix was constructed that contains 30 rows (subjects) and 21 columns (phenomenological variables). Each cell contained a value (1, present), (0, absent) or no value for the missing data. The Hierarchical Cluster procedure of the SPSS package (version 11.0.1, Chicago, IL, 2001) was employed using squared Euclidean distance as the measure and between-groups linkage as the cluster method. The distance was extracted from the binary data by calculating the ratio of joint occurrence to the occurrence of either for each pair of variables. The program generates a dendogram in which the horizontal distance reflects dissimilarity whereas the vertical distance is arbitrary (the amount of dissimilarity between to variables equals the sum of the horizontal lines that separates them).

1.3.2. MDS analysis

A proximity matrix was generated using the Jaccard coefficient. Given that all control strategies were clustered together, they were collapsed into one variable with value "present" (i.e., 1) if any was present and "absent" (i.e., 0) if all were absent. This procedure reduced the original 21 variables to 16; this then yielded a 16×16 rectangular matrix, which was symmetric about the long diagonal. Therefore, only the lower triangular portion of it was used in this analysis. This proximity matrix was transformed to a dissimilarity matrix by subtracting the constant number 2 from all elements of the previous matrix. The ALSCAL procedure of the SPSS statistical package above was employed using ratio as the level of measurement and Euclidean distance as the scaling model.

2. Results

2.1. Hierarchical cluster analysis

HC yielded a two-cluster solution (Fig. 1). The first cluster includes "all control strategies", "self attribution", "repetitive content", "other hallucinations", "clear acoustics", "low linguistic complexity, words", and "outer space location". The second includes "systematized content", "high linguistic complexity, conversation", "inner space location", "multiple voices", "attribution of the voices to others", "nosognosia", "episodic occurrence", "spontaneous occurrence", and "intermediate linguistic complexity, sentences". Within each of these two main clusters, variables segregated further in sub-clusters "Control strategies" clustered together and with the "self attribution". "Low linguistic complexity, words" clustered with "clear acoustics" and "outer space location". "Systematized content", clustered with "hearing conversations" and "inner space location". Finally, "multiple



Fig. 1. Hierarchical cluster analysis using average between group linkage. Horizontal distance reflects dissimilarity between variables. The vertical distance is arbitrary. The dissimilarity between any two variables equals the sum of all the horizontal lines that separate them. CS: control strategies, LC: linguistic complexity.

voices" clustered with attribution of the voices to others.

2.2. Multidimensional scaling

Stress (a measure of goodness of fit between the observed distances in the dissimilarity matrix and the derived distances in an R-dimensional space) decreased with the increase of the number (R) of the dimensions. It reached 0.15 at a three-dimension solution, and the decrease in stress plateaued after this point; therefore, a three-dimensional solution was adopted. This yielded a monotonic distance/dissimilarity function. The configuration space revealed three interpretable dimensions: linguistic complexity, source (self-other) attribution, and (inner-outer) space location (Fig. 2). On the first dimension, low level of linguistic complexity (hearing words) was located at



Fig. 2. Multidimensional scaling yields three dimensions: Inner– outer space location (red) and self-other attribution (green) dimensions in one plane, and linguistic complexity dimension (blue) perpendicular to that plane. lo: outer space location; so: source (other); nosg: nosognosia; csall: all control strategies; li: inner space location; ss: source (self); repc: repetitive content; lcw: linguistic complexity (words); lcs: linguistic complexity (sentences); lcc: linguistic complexity (conversations); mvoic: multiple voices; sysc: systematized content.

one end and high level (hearing conversations) at the opposite end, whereas the intermediate level (hearing sentences) was situated in between. Furthermore, (repetitive content) was at the low end and hearing (multiple voices) and (systematized content) were at the higher end. On the second dimension, the maximum separation was between the (self-attribution) of AVH and the (other-attribution). The third dimension separated (inner space location) and (outer space location). Interestingly, (clear acoustics) was in the middle of the third dimension. Finally, (nosognosia) and the collapsed control strategies variable were in the middle of the configuration space.

3. Discussion

Asking patients for detailed description of their hallucinations does not seem to be part of routine practice of general psychiatry. Only the records of patients participating in a research protocol contained information about the characteristics of AVH. This could be related to the fact that such detailed description would not affect significantly the diagnostic formulations and treatment plan. In this study, most patients welcomed the opportunity of talking about their experiences and this procedure seemed to enhance the therapeutic alliance. Therefore such questioning should be encouraged. Furthermore, this endeavor is necessary in research given the possible heterogeneity of the underlying pathophysiology of AVH.

The first important observation is that the pattern of clustering and the configuration in the multidimensional space obey mostly intuitive expectation. For example, "control strategies" were associated with "self attribution" of AVH, which means that if the voices are experienced as one's own, he/she is more likely to try to attempt to control them. Another example, hearing "multiple voices" is associated with attribution of the "voices" to others, which is plausible intuitively as well. This indicates that the patients' experiences of hallucinations could be understood, intuitively, based on common sense experiences of the world.

The patterns of clustering point to possible common neural resources underlying some groups of phenomenological variables. For example, "control strategies" could share neural commonality among themselves, and another commonality with "self attribution". High linguistic complexity may share neural commonality with hearing "multiple voices", and hallucinations with "systematized content" (Fig. 1). Therefore, intermediate levels of neural commonality between groups of variables could exist in addition to the neural specificity associated with each variable (as argued above) and a final common pathway (Wernicke's area) (Stephane et al., 2000, 2001a) for all types of hallucinations.

MDS made apparent three dimensions in the data. The first is the linguistic complexity dimension. Low complexity (hearing words) was at one end of this dimension, medium complexity (hearing sentences) was in the middle, and high complexity (hearing conversation) was located at the other end of the dimension. This is consistent with the HC analysis where low complexity was in one main cluster and medium and high complexity were in the other. This means that patients hear single words, individual sentences, or conversations. They rarely hear combinations of the three. Since language is subserved by a set of distinct but interconnected processors that underlie sublexical, lexical, syntactic, semantic, and discourse processes (Caplan, 1992); this finding could indicate differential levels of language abnormalities in hallucinating patients-lexical processing disorder in patients who hear words, sentential (semantic or syntactic) processing disorder in patients hearing individual sentences, and discourse processing disorder in patients who hear conversations. The above finding indicates that discourse planning disruption, a proposed mechanism for AVH (Hoffman, 1986), could apply only to a subset of hallucinating patients-those who hear conversations. Although it is commonly claimed that AVH result from a speech disorder (Stephane et al., 2001a; Frith and Done, 1988; Hoffman, 1986), a study of language processing in hallucinating patients is needed to confirm/disconfirm the above conclusions. In the present study, we did not have the opportunity to perform linguistic testing.

On the second dimension, attribution of the AVH to self "I hear my own voice" was situated at one end, and attribution to others "I hear someone else talking to me" was located on the other end. A wealth of literature indicates that the concept of self is underlied by specific neural substrates. For instance the supplementary motor area (SMA) is involved in self initiated (not passive) movements (Goldberg, 1985). Since most neuropsychological theories relate AVH to the perceptual experience of one's own inner speech (Stephane et al., 2001a; Frith and Done, 1988; Hoffman, 1986), the self/other attribution dimension indicates that areas underlying the concept of self (such as SMA) could be dysfunctional in a subset of patients (those attributing the "voices" to others) and intact in the subset of patients attributing the "voices" to themselves.

On the third dimension, inner space and outer space location have maximal separation. The finding is consistent with a recent functional magnetic resonance study in which differences were found in neural substrates for auditory stimuli perceived outside the head relative to those perceived inside the head (Hunter et al., in press). Therefore, AVH should be also subgrouped according to whether they are experienced in inner or outer space.

Furthermore, nosognosia was situated around the center of the multidimensional space. This points to the independence of nosognosia from other variables. HC analysis supported this finding, although nosognosia clustered, surprisingly, with the second cluster. Its distance from most variables in this cluster was almost equal to its distance from variables in the first cluster (Fig. 1).

In summary, many aspects of the inner structure of AVH exhibited by MDS and HC are consistent with current related research reports. This inner structure provides a meaningful way to sub-classify AVH, as well as insight into their possible diverse neuropathology. It is clear that the inferences made about the underlying neural substrates of AVH need confirmation and specification by methods such as brain imaging about conflicting data, which is related, in part, to not accounting for the phenomenological variability of AVH (Stephane et al., 2001a). We think that imaging methods combined with standardized evaluation of AVH phenomenological variables present a promising avenue in AVH research.

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