Chapter 14

Imagery and perception in a continuously hallucinating patient

Summary

It has been hypothesized that hallucinations may be associated with vivid mental imagery or with deficient higher-order perception. In a neuropsychological case-study design, we studied a 41-year old patient (Mr. A.) with schizophrenia who experienced on-going auditory-verbal hallucinations. Performance was measured on four behavioral tasks of imagery and perception (two visual and two auditory) and compared with the performance of five patients without hallucinations. Performance on imagery conditions was compared relative to performance on the perception condition of each task. Relative to perception, Mr. A. showed substantial higher imagery scores on both auditory tasks, but not on the visual tasks. In contrast, the five comparison patients did not reveal such performance differences between the two modalities. The results support the hypothesis of an imbalance between imagery and perception specific to the modality of hallucination.

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Introduction

Hallucinations are a prominent and disturbing symptom of schizophrenia. For centuries, it has been hypothesized that hallucinations may arise from abnormally vivid mental imagery (Galton, 1883). Although the imagery hypothesis of hallucinations is usually taken to imply that hallucinating individuals will have more vivid imagery than non-hallucinating individuals, it has also been argued that people with hallucinations may suffer from an imagery deficit. For example, Horowitz (1975) hypothesized that hallucinating patients have less vivid mental images, which leads them to attribute occasional vivid images to an external source.

Studies investigating imagery in hallucinating and non-hallucinating patients do not provide consistent support for the hypothesis that imagery would be deficient or more vivid (reviewed by Bentall, 1990; cf. Evans et al. 2000). However, a shortcoming of these studies is that they did not assess imagery in relation to perception. This is important, as the absolute level of imagery vividness may not be the crucial issue, but rather the difference in vividness between imagery and perception, which determines the ease with which information of internal and external origin can be distinguished (Johnson & Raye, 1981). Recent theoretical accounts of hallucination (Grossberg, 2000; Behrendt, 1998) have suggested that a disordered balance between “mental” and “sensory” factors of perception could underlie hallucinations. Mental factors refer to top-down perceptual expectations (a form of mental imagery) and sensory factors refer to constraints imposed on perception by bottom-up sensory information. Specifically, “mental factors of perception”, rather than sensory information, take over to predominate the context and form of perception, which will in fact be a hallucination. (Grossberg [2000] hypothesized that this occurs when a chronically hyperactive volitional signal is turned on, and he specified neuronal mechanisms that could be involved). In the present study we investigate whether a imbalance between performance on an imagery and a perception condition of the same task may be associated with hallucination. In the imagery condition, “mental” factors contribute importantly to performance, whereas in the perception condition, “sensory” factors play an important role in performing the task.

Another limitation of previous studies may be that imagery performance was not evaluated in different modalities, which could reveal relative, modality-specific alterations. Shallice et al. (1991) and David (1993) have argued that the neuropsychological case-study approach may be potentially fruitful in research on cognitive functions in schizophrenia. A limitation of studies with large groups of
patients, may be that the heterogeneity of schizophrenia will lead to group means that do not reflect the behavior of any individual. In the case-study approach, multiple tests are administered to a few selected patients (on the basis of a priori criteria), where the within-subject comparison of differential test performance may reveal specific domains of dysfunction characteristic to the condition studied. In addition, with regard to hallucinations we hypothesized that the most pronounced effects may be observed when “the system is trapped in action”, i.e. studying patients with on-going hallucinations. It is hard to study such patients in a group design - most patients with hallucinations hallucinate for discrete periods and patients with ongoing hallucinations may be difficult to test due to concentration problems. In the present study, we applied a neuropsychological case-study design, in which we contrasted the performance of a patient with ongoing auditory-verbal hallucinations with the performance of 5 non-hallucinating patients on four tasks of mental imagery and perception (two in the auditory and two in the visual modality). David & Lucas (1993) applied the neuropsychological case study design to the study of continuous auditory-verbal hallucinations and demonstrated that these hallucinations do not call on the same verbal working memory resources as inner speech. Here, we focus on imagery and perception.

Method
Case study
Mr. A was a 41-year-old man with a DSM-IV diagnosis of schizophrenia, whose main complaint regarded continuous, medication-resistant auditory-verbal hallucinations. Severity of hallucination was rated ‘7’ on the hallucination-item of the PANSS (Positive and Negative Syndrome Scale). In addition, his score on the Topography of Voices Rating Scale (Hustig & Hafner, 1990) was 8 (extremes are 5 [very severe] – 25 [very mild]). Symptom ratings on the PANSS were 24 for the positive subscale, 26 for the negative subscale, and 48 for the general psychopathology subscale. Level of education was 11 years.

The phenomenology of Mr. A’s hallucinations was explored with the Cognitive Assessment Schedule (Chadwick & Birchwood, 1995), which concerns a structured interview to assess form and content of the voice; beliefs about the voices’ identity, meaning and power; patients’ evidence for their beliefs; and affective and behavioral responses. Mr. A heard one voice, in his ears (not in his head nor outside his head), and was not sure whether it concerned a male or female voice. The voice talks about him and also conversates with him. In
addition, the voice can be commanding, and Mr. A. usually obeys this commands, “to relieve myself”. The voice also insinuates and uses abusive language. There are almost no moments in which he doesn’t hear the voice. Usually, his emotional reaction is one of distress, although it can also be flat, and incidentally angry when he is scolded. He is sure that the voice is very powerful and that he exerts no control whatsoever on it. He talks back (and sometimes screams) to the voice only when he is alone. He does not know who’s voice he hears, but he is almost sure it must be a psychologist. According to the patient, the voice originates from small speakers that have been inserted by psychologists in his auditory organs. He does not know precisely why this has been done, but he suspects psychologists are interested in him because of his rare combination of a low level of education and nevertheless a high performance in chess.

**Comparison patients**

Five non-hallucinating, patients with schizophrenia who were participants in a larger study on hallucinations and cognitive functioning at our Department were included as comparison-subjects. Three of the patients had never hallucinated (which was confirmed by the consulting clinician), and the other two were hallucination-free for more than 3 months. All patients were male. DSM-IV diagnosis of schizophrenia was confirmed with the CASH interview (Andreasen, 1987). Mean age was 32 years (SD = 8.6), and level of education was 12.4 years (SD = 2.1). Symptom ratings on the PANSS were as follows: for the positive subscale, 12.6 (SD = 1.5), for the negative subscale, 19.8 (SD = 5.3), and for the general psychopathology subscale, 34.4 (SD = 6.8).

**Measures**

Performance of Mr. A was compared to the 5 control patients on four tasks of mental imagery: two in the visual and two in the auditory modality (cf. Aleman et al., 2000). First, absolute perceptual thresholds were determined with the staircase method for both the auditory and visual modality, in order to exclude the possibility of gross hearing or vision impairment. For the auditory modality these thresholds were set for the loudness of tones in 74 dB(A) white noise, and for the visual modality the threshold was determined for the duration of dot presentation (1 pixel) on the centre of a computer screen. For all participants, these values were within the normal range.

**Auditory and Visual Object imagery.** The object imagery task concerns a quantitative comparison between imagery and perception of visual form.
imagery/perception balance in continuous hallucinations

characteristics of common objects (this task was adapted from Mehta et al. 1992) or sound characteristics of common sounds (auditory version). **Visual modality.** The task consists of 22 object names printed on cards and 22 triads of line drawings of common objects (Snodgrass and Vanderward, 1980). From the triads of line drawings, the item that is most deviant in terms of visual form characteristics has to be indicated. In the perceptual condition the line drawings are actually presented, whereas in the imagery condition the object names are read from cards. For example, in the perceptual condition pictures of the following three objects are presented: “pumpkin”, “lettuce” and “tomato”, whereas in the imagery condition only the names of these three objects were presented to the subject (figure 1). Thus, the imagery condition requires the participants to form mental images in order to be able to make a correct judgement (which in the example given would be “lettuce”). A difference-score was calculated by subtracting the correct responses in the imagery condition from the correct responses in the perceptual condition. **Auditory modality.** The auditory task was similar to the visual version in that a triad of common sounds was presented, and participants had to indicate the item that is most deviant in terms of acoustic characteristics. In the perceptual condition the sounds were actually presented (by the computer), whereas in the imagery condition the names of the sounds were read from cards. An example of a sound triad that was presented is “crying baby”, “laughing baby” and “meowing cat”, where “laughing baby” was regarded the deviant item.

**Visual Letter Imagery.** This task concerned an adaptation of the task described by Podgorny and Shepard (1978). The subject is asked whether an X-mark, presented in a 4x5 grid, falls on a capital letter. In the imagery condition, the letter is not actually presented in the grid, but must be imaged by the subject. For example, after a fixation point a lowercase letter ‘f’ is presented, followed by an empty grid with the X-mark at the lower right corner. The subject must decide whether the target would fall on an uppercase letter ‘F’ or not. In the perception condition, the letter actually appeared in the grid. Eight letters were randomly presented during the task: ‘c’, ‘f’, ‘h’, ‘j’, ‘l’, ‘p’, ‘s’, ‘u’. Each condition of the task consisted of 32 trials, 4 trials for each of the letters (two “on” and two “off” trials for each letter). We modified the task slightly, in that we allowed the X-mark to appear only in cells in which the chance that the X-mark would cover a letter was equal (thus, no X-marks appeared in the most left column, as most capital letters would cover these cells). Percentage correct responses was taken as dependent measure for both conditions (perception and imagery).
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Auditory Musical Imagery - . This task of musical imagery requires participants to mentally compare pitches of notes corresponding to song lyrics, and was adapted from Halpern (1988; experiment 2). Participants viewed the lyrics from the first line of a familiar Dutch song on a screen and were asked to decide whether, of two indicated lyrics (which were marked on both sides with asterisks and appeared in uppercase letters), the pitch of the second lyric was higher or lower than that corresponding to the first lyric. Lyric refers here to a monosyllabic word, or one syllable of a two-syllabic word. An English language example would be: "*OH* say can *YOU* see", taken from the American national anthem. In the perceptual condition, participants were actually presented with the song, which was played via a tape-recorder. The imagery condition was identical, with the exception that the song was not presented, and participants had to rely on their musical imagery in order to be able to perform the task correctly. They were not allowed to hum the melody. Again, percentage correct responses was taken as dependent measure for both conditions (perception and imagery).

Results
In order to examine possible differences between the performance of Mr. A and the control patients on the imagery measures, a z-score analysis was carried out on the imagery/perception difference scores. Significant differences emerged for both auditory tasks and for the visual letter imagery task (table 1). The interesting point is that the direction of the imagery/perception difference is opposite to the direction in the control group for both auditory measures only.

Table 1. Means for the continuously hallucinating patient Mr. A and the non-hallucinating control group (means with SDs) on measures of perception/imagery concordance (lower scores indicate larger concordance)

<table>
<thead>
<tr>
<th>Imagery/ perception measure</th>
<th>Mr. A</th>
<th>Non-hallucinating patients (N=5)</th>
<th>z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object imagery</td>
<td>Visual</td>
<td>4</td>
<td>3.2 (2.9)</td>
</tr>
<tr>
<td></td>
<td>Auditory</td>
<td>-2</td>
<td>2.6 (1.1)</td>
</tr>
<tr>
<td>Letter Imagery</td>
<td>19</td>
<td>4.4 (6.5)</td>
<td>2.24*</td>
</tr>
<tr>
<td>Musical imagery</td>
<td>-6</td>
<td>2.4 (3.4)</td>
<td>-2.47**</td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.01, ***p<0.001
This difference in direction is more clearly illustrated in figure 1, that plots the performance of Mr A and the 5 controls on the auditory and the visual object imagery task (percentage correct responses). As is evident from the figure, Mr. A does not show the normal pattern of better perception performance relative to imagery performance on the auditory task (the modality of hallucination). In contrast, he does show this pattern on the visual task. Fig. 2 shows performance on the auditory musical imagery task and the visual letter imagery task. Again, Mr. A does not show the normal difference between imagery and perception on the auditory task, but does show this difference on the visual task.

Fig. 1. Percentage correct responses on perception and imagery conditions of Auditory (A) and Visual Object Imagery (B) task for Mr. A and 5 non-hallucinating control patients

**Discussion**

Cognitive theories of hallucination in schizophrenia assume that an erroneous attribution is made of internally generated information to an external source (e.g., Bentall, 1990; David, 1999; Frith, 1992; Hoffman et al., 1999). Johnson & Raye...
(1981; Johnson, Raye & Hashtroudi, 1993) have developed a theory of source discrimination and monitoring in which it is hypothesized that internally generated information (mental images) and information of external origin (percepts) are distinguished by the cognitive system by taking into account the proportion of sensory, contextual and semantic information, which is more detailed for percepts.

![Graph](image)

Fig. 2. Percentage correct responses on perception and imagery conditions of the Musical (A) and Letter Imagery (B) task for Mr. A and 5 non-hallucinating control patients

Evidence that mental images are less rich in perceptual details than percepts and that, as a consequence, images are more difficult to perform mental operations upon, was recently presented by Kosslyn et al. (1999). This implies that subjects will make more errors on an imagery condition of a cognitive task, compared to a perception condition of the same task. We recently reported that this indeed is the case for non-psychiatric college students (Aleman et al. 2000). However, in the present study we demonstrated that in a continuously hallucinating patient
this balance (of more vivid perception relative to imagery) was reversed in the modality of hallucination (auditory), but not in another modality (visual).

Thus, the results of the present neuropsychological case-study suggest that auditory hallucinations may be associated with a modality-specific distortion in the balance between imagery and perception performance. Such a distortion may also be interpreted as a modality-specific increase in vividness of mental imagery relative to perception. In this way, our results are in accordance with Böcker et al. (2000), who observed more vivid auditory than visual imagery in auditory-verbal hallucinating patients. It could be argued, however, that the observed distortion in the balance between imagery and perception is mainly caused by higher-order perceptual dysfunction in hallucinating patients. This interpretation is supported by the recent study by McKay et al. (2000), in which a wide range of auditory perception tests were administered to hallucinating and nonhallucinating schizophrenic patients and to normal comparison subjects. Although all patients with schizophrenia appeared to perform worse on higher order perceptual tasks, this dysfunction was more pronounced for the hallucinating patients.

How a distortion in the balance of imagery and perception can lead to hallucinatory experiences can be best understood within the framework of Johnson & Raye’s theory of reality monitoring (Johnson & Raye, 1981; Johnson, Raye & Hashtroudi, 1993). They hypothesize that sensory qualities of an experience help tag the event as having been perceived, whereas metacognitive processes associated with the activity of imagining would help tag the event as having been imagined. Increased sensory qualities of mental images, or decreased sensory qualities of percepts will then result in reality discrimination errors, in which internally generated information may mistakenly be attributed to an external source. In addition, metacognitive processes could also play an important mediating role. An internal attribution is based on reference to metacognitive processes, with the amount of effort involved in generation being a determining factor (Johnson & Raye, 1981). Perception may be as effortful as generating mental images for hallucinating subjects, which is evident from the relative low scores on perception conditions compared to imagery performance (and consistent with the findings by McKay et al., 2000). In contrast, in non-hallucinating individuals, mental imagery is clearly more effortful than perception. Thus, due to the smaller difference in effortful processing between imagery and perception, less information concerning the cognitive operations involved may be available to the hallucinating subjects, contributing to errors in source
attraction. There is increasing evidence that reality monitoring is deficient in hallucinating patients (Bentall et al., 1991; Morisson & Haddock, 1997; Brébion et al., 2000). The present study may contribute in elucidating a potential underlying mechanism of such confusions, namely, a distortion in the balance between imagery and perception.
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