Chapter 7

Mental imagery and perception in hallucination-prone individuals

Summary
College students screened for hallucination-proneness using the Launay-Slade Hallucination Scale (LSHS) were compared on measures of self-report vividness of imagery and on behavioral measures of imagery and perception (visual and auditory). Specifically, we tested the hypothesis whether hallucination-prone individuals would show smaller differences between imagery and perception performance, which may be indicative of increased sensory characteristics of mental images. We replicated earlier findings of higher self-report imagery ratings in the high hallucination-prone group. However, the two groups did not differ on five of six behavioral imagery-perception comparisons. Although vividness of mental images may be subjectively associated with mild hallucinatory experiences, we suggest that cognitive processes associated with reality discrimination rather than increased perceptual characteristics of mental images may play a role at the information processing level.

Introduction

Despite decades of research, the exact mechanisms underlying the puzzling phenomenon of hallucination remain poorly understood. As a working definition, hallucinations may be considered “sensory experiences that occur in the absence of external stimulation of the relevant sensory organ, have the compelling sense of reality of a true perception, are not amenable to direct and voluntary control by the experiencer, and occur in an awake state” (Aleman and De Haan 1998; see also Slade and Bentall 1988). Hallucinations may occur in a wide range of medical and psychiatric conditions (Asaad and Shapiro 1986; Brasic 1998; Slade and Bentall 1988) and are one of the characteristic disturbing symptoms of schizophrenia (Schneider 1962). Slade and Bentall (1988) estimated the prevalence of auditory hallucinations to be 60% in schizophrenia, based on 16 published reports including 2924 cases. However, hallucinations are not always indicative of pathology, as indicated by numerous studies which have established the occurrence of hallucinatory experiences in a substantial number of persons from the normal population (Aleman et al. 2000; Barrett and Etheridge 1992; Bentall and Slade 1985; Tien 1991). Such auditory-verbal hallucinatory experiences may, to an important degree, resemble the hallucinations characteristic of schizophrenia (Barrett and Caylor 1998; Honig et al. 1998). Indeed, it has been proposed that psychosis-like experiences may be thought of as existing on a continuum, ranging from very mild expressions in the normal population to the bizarre symptoms characteristic of severe mental illness (Crow 1998; Slade and Bentall 1988). Thus, the study of cognitive mechanisms underlying hallucinatory experiences in individuals from the normal population may provide important information about the possible mechanisms underlying hallucinations in mental disorders.

Although theories of hallucination differ considerably (e.g. Bentall 1990; David 1994; Frith and Done 1988; Hoffman 1986), some consensus is emerging that hallucinations are a result of the confounding of internally-generated experiences with externally-generated events (Slade 1994). It has been hypothesized that such confounding may arise from biases in reality monitoring, i.e., the processes involved in discriminating memories of internal generated information from memories of external derived information (Bentall et al. 1991; Morrison and Haddock 1997). However, a recent study (Keefe et al. 1999) showed that hallucinating and nonhallucinating patients with schizophrenia did not differ on measures of reality monitoring, although both groups showed...
Mental imagery and hallucination-proneness

significant more reality monitoring errors compared with a healthy comparison group.

Alternatively, it may be hypothesized that the erroneous attribution of internally-generated events to external sources may result from mental images having more perceptual characteristics than expected by the cognitive system. The idea that hallucinations are extreme vivid manifestations of mental imagery was already stated by Galton more than a century ago (Galton 1883). Results from studies in which this claim was investigated are contradictory. For example, Mintz and Alpert (1972), Roman and Landis (1945), and Slade (1976) found evidence of more vivid imagery in hallucinating patients compared to non-hallucinating patients. Moreover, Barrett (1992) compared high-scoring college students on a verbal hallucination scale with low scoring participants and found high scoring participants to report more vivid self-rated imagery. In contrast, Brett and Starker (1977), Seitz and Molholm (1947), and Starker and Jolin (1982) failed to find evidence of increased imagery vividness in hallucinating schizophrenic patients. However, these studies all concerned introspective measures of imagery, which are limited to the subjective experience of imagery.

The aim of the present study was twofold. First, to replicate the relation reported by Barrett (1992) between hallucination-proneness in subjects from the normal population and self-rated imagery vividness. Second, to investigate whether a relation would be found between hallucination-proneness and imagery on behavioral comparisons of measures of imagery and perception. According to Johnson and Raye (1981) percepts, which originate from externally presented stimuli, are characterized by more detailed sensory, contextual and semantic information than internally generated images. Evidence that mental images are less rich in perceptual details than ‘real’ percepts and that, as a consequence, images are more difficult to perform mental operations upon, was recently presented by Kosslyn et al. (1999). The hypothesis that imagery and perception are more alike (and therefore harder to discern from each other) due to increased sensory characteristics of mental images in individuals that experience hallucinations thus predicts that these subjects will show smaller performance differences between a perception and an imagery condition of the same task.

Methods
Subjects were two groups selected out of 243 undergraduate students (mean age 22.6 years, SD =5.6) from Utrecht University, who completed the Launay-Slade
Chapter 7

Hallucination scale\(^1\) (LSHS; Launay and Slade, 1981; revision Bentall and Slade, 1985). The LSHS consists of 12 descriptions of hallucinatory experiences, e.g. "I often hear a voice speaking my thoughts aloud". LSHS items were scored on a five point scale as follows: 0="certainly does not apply to me", 1="possibly does not apply to me", 2="unsure", 3="possibly applies to me" and 4="certainly applies to me". The questionnaire was scored by summing the ratings. A high score on the LSHS indicates increased predisposition towards hallucination. We selected 19 high scoring participants (from the upper 15%) and 17 low scoring participants (from the lower 15%) from the sample of 243 students. The mean LSHS rating of the high group was 26.7 (SD = 3.6), and the mean rating of the low LSHS group was 4.0 (SD = 1.9). The difference between the two groups was significant, \( t = 23.7, p < .0001 \). The male/female ratio was comparable in both groups, 6:13 for the high LSHS group and 5:12 for the low LSHS group.

Procedure

Two questionnaires and six experimental tasks were used. The questionnaires concerned the Betts QMI Vividness of Imagery Scale, and the Marks Vividness of Visual Imagery Questionnaire (VVIQ). The experimental tasks concerned a visual and auditory version of a triad imagery perception comparison task, a visual and auditory version of an imagery-perception interaction task, a letter imagery task (visual), and a Musical imagery task (auditory). A more detailed description of the measures follows.

**Betts QMI Vividness of Imagery Scale** The auditory and visual subscales of the shortened Betts QMI Vividness of Imagery Scale (Richardson 1969) consist of nine verbal descriptions, such as "the sun as it is sinking below the horizon" (visual) and "the meowing of a cat" (auditory). Participants are asked to rate their imagery vividness on a 7-point scale, ranging from 1: "Perfectly clear and as vivid as the actual experience" to 7: "No image present at all, you only 'knowing' that you are thinking of the object". The questionnaire is scored by summing the ratings. A low score indicates more vivid imagery.

**Vividness of Visual Imagery Questionnaire** The Marks Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) is an extension of the visual subscale of the Betts scale. It consists of 16 descriptions which must be rated on a 5-point

---

\(^1\) Several studies have reported evidence in favour of the reliability and validity of the Launay-Slade Hallucination Scale (Launay and Slade, 1981; Bentall and Slade, 1985; Rankin and O’Carroll, 1995; Levitan, Wards, Catts and Hemsley, 1996; Morrison, Wells and Nothard, 2000)
Mental imagery and hallucination-proneness

Likert-scale, in an identical way as the Betts scale. However, the subject must rate the items once with eyes open, and once with eyes closed. The questionnaire is scored by summing the ratings. Lower scores indicate more vivid imagery.

Object imagery. The object imagery task concerns a quantitative comparison between imagery and perception of visual form 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. 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.

Imagery-perception interaction. Imagery is known to affect certain aspects of perceptual processes, which makes it possible to obtain an indirect measure of imagery qualities by recording objective perceptual processes. Farah (1989) demonstrated that, in the visual modality, near-threshold stimuli are more easily detected if they are presented on an image (say of a letter H) than when presented off the image in a forced choice psychophysical paradigm. This effect has also been found in the auditory modality; tones presented at absolute perception threshold are detected more often when they are also imaged (Farah and Smith, 1983). Visual modality. In this test, first the absolute threshold for duration of dot presentation was determined by use of the staircase method. Second, two series of 32 trials were presented, while the participants was
imagining one of the two letters (capital T or H in a 5 x 5 grid). In 25% of the trials the stimuli were “on-image” and in another 25% the stimuli were “off-image”. For the other 50% no stimuli were present. The difference in the number of detected stimuli in the on-image condition compared to the off-image condition is a measure for the interaction between imagery and perception. In contrast to the other behavioral measures, a larger difference value implies a greater effect of imagery, which is expected in participants with hallucinatory experiences according to the hypothesis that increased perceptual characteristics of mental images are associated with hallucination. **Auditory modality.** The auditory version of this task was identical to the visual version, with the difference that the absolute threshold was determined for the loudness of two tones in 74 dB(A) white noise, and that the stimuli presented during the experiment consisted of tones which could be at a frequency of 440 or 1000 Hz. A tone at one of these frequencies had to be imaged (e.g. 440 Hz), while a tone at one of either frequency was presented as stimulus during the experiment, with 25% of the stimuli being “on-image” (in this case 440 Hz) and 25% “off-image” (1000 Hz).

**Letter imagery.** We adapted the letter imagery task used by Kosslyn et al. (1988). 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). The difference in number of correct responses between the imagery and perception condition was the dependent measure.

**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.
Mental imagery and hallucination-proneness

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. Participants responded by means of a key press. 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. Again, the difference in number of correct responses between the imagery and perception condition was calculated.

Statistical analyses. Analysis of variance was performed to investigate between group differences on vividness of imagery ratings and performance differences on imagery and perception conditions of the behavioral tasks. The level of significance was set at $p<.05$ (two-tailed). In addition, non-parametric correlation coefficients for the relation between imagery and perception performance were calculated within each group.

Results
Table 1 presents means and SDs for the high and low LSHS group on the imagery measures.

Self-rated imagery vividness
For the ratings on the VVIQ, the groups differed significantly, $F(1, 34)=4.7$, $p<.05$. Participants in the high LSHS group reported more vivid images than participants in the low group (table 1). No significant differences were observed between the high and low LSHS group on the Betts visual subscale ($F(1, 34)=3.1$, $p<.10$), nor on the Betts auditory subscale ($F(1, 34)=1.6$, $p>.10$). The Betts visual subscale as well as the VVIQ correlated significantly with ratings on the LSHS (for both $r=-0.40$, $p<.05$). The correlation between the Betts auditory subscale and the LSHS was not significant ($r=0.21$, $p>.10$).

Behavioral measures of imagery and perception
Of the behavioral measures, only the visual object imagery task showed a significant group difference in imagery/perception difference-scores. A significant larger difference between imagery and perception performance was observed in the low LSHS group compared with the high group, $F(1, 34)=7.0$, $p<.05$. The difference in number of correct responses between the imagery and perception condition was calculated.
\( p < .05 \) (see table 1). The other five behavioral measures failed to reveal significant differences between the high and the low LSHS group. There was no significant difference between imagery scores in the visual and auditory modality in either group (This was evaluated with ANOVA’s on z-transformed scores as the scales of the different measures are not comparable).

Table 1. Means and SDs for the high LSHS and the low LSHS group on measures of imagery vividness (lower scores indicate higher imagery)

<table>
<thead>
<tr>
<th>Imagery vividness measure</th>
<th>High LSHS group (N=19)</th>
<th>Low LSHS group (N=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VVIQ</td>
<td>34.1 (6.2)</td>
<td>37.5 (8.6)</td>
</tr>
<tr>
<td>Betts visual subscale</td>
<td>12.7 (3.7)</td>
<td>15.1 (4.6)</td>
</tr>
<tr>
<td>Betts auditory subscale</td>
<td>11.1 (3.9)</td>
<td>12.6 (3.3)</td>
</tr>
<tr>
<td>Object imagery visual</td>
<td>2.5 (1.7)</td>
<td>0.8 (2.2)</td>
</tr>
<tr>
<td>Object imagery auditory</td>
<td>3.9 (2.0)</td>
<td>3.2 (2.6)</td>
</tr>
<tr>
<td>Imagery-perception</td>
<td>0.7 (2.2)</td>
<td>0.4 (3.3)</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>visual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>auditory</td>
<td>2.2 (3.5)</td>
<td>1.9 (5.0)</td>
</tr>
<tr>
<td>Letter Imagery</td>
<td>3.0 (2.7)</td>
<td>2.1 (2.7)</td>
</tr>
<tr>
<td>Musical imagery</td>
<td>2.5 (3.1)</td>
<td>2.0 (3.8)</td>
</tr>
</tbody>
</table>

*higher scores indicate higher imagery performance

When performance on the perception and imagery conditions was analyzed independently, no difference between the high and low group was found on any of the six behavioral tasks (all \( p > .10 \)). In addition, the two groups did not differ in perceptual acuity as indicated by the auditory and visual threshold measures of the imagery-perception interaction task (\( p > .70 \)).

Correspondence between imagery and perception

As table 2 demonstrates, correlations between performance (number of correct responses) on the imagery and perception tasks were substantial higher in the high LSHS than in the low LSHS group for the object imagery task (visual and auditory) and the musical imagery-perception task. No differences were observed for the letter imagery-perception task. For the imagery-perception interaction task no correlations were computed, as this task measuring the interaction between imagery and perception, does not have strictly distinct imagery and perception conditions.
Table 2. Nonparametric correlations (Spearman's rho) between performance on imagery and perception conditions of the behavioral measures for the high LSHS and the low LSHS group

<table>
<thead>
<tr>
<th>Imagery measure</th>
<th>High LSHS group (N=19)</th>
<th>Low LSHS group (N=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object imagery</td>
<td>Visual .64**</td>
<td>-.11</td>
</tr>
<tr>
<td></td>
<td>Auditory .45*</td>
<td>.10</td>
</tr>
<tr>
<td>Musical imagery</td>
<td>.62**</td>
<td>.50*</td>
</tr>
<tr>
<td>Letter Imagery</td>
<td>.34</td>
<td>.39</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01

Discussion

The present study was designed to replicate the previously reported relation between self-reported vividness of mental imagery and hallucination-proneness, and more importantly, to investigate whether a relation between imagery and hallucination-proneness would be observed on behavioral measures of information processing. Subjects from the normal population with high ratings on a questionnaire for hallucination-proneness (the Launay-Slade Hallucination Scale) were contrasted with low hallucination-prone subjects on multiple behavioral measures of imagery-perception comparisons in both the visual and the auditory modality.

Consistent with earlier observations (Barrett 1992; Aleman, Böcker et al. 1999), the high group showed higher imagery vividness ratings than the low group on the self-report measures. We thus replicated the relation between hallucinatory predisposition and self-report imagery vividness in normal subjects (Barrett 1992) using a different hallucination questionnaire (LSHS in stead of Verbal Hallucination questionnaire) and including a different imagery questionnaire (the VVIQ, in addition to the Betts scale). It is important to note that the experiences considered in the LSHS as well as the imagery vividness questionnaires are highly similar phenomenologically, which may contribute to the observed association between these measures.

In contrast, there were no important differences between the high and low hallucination-prone groups in imagery-perception comparisons as measured with behavioral tests of imagery and perception. The groups differed on only one of the six behavioral measures, the visual object imagery-perception task. For this task, the difference between perception and imagery scores was larger in high LSHS participants, indicating a possible decrease rather than increase in perceptual characteristics of mental images. Cognitive dysfunction has been consistently documented in schizophrenia (Aleman, Hijman et al. 1999;
Heinrichs & Zakzanis 1998) and may to some extent be found in subjects with high ratings on schizotypy scales (Lenzenweger 1998). The LSHS has been considered a scale that provides an indication of positive schizotypy (Vollema and Van den Bosch 1995). It could thus be argued that subjects in the high hallucination-prone group may have a higher incidence of mild cognitive problems which could explain a lower performance compared to low hallucination-prone subjects. It is important to note, however, that the two groups did not differ significantly on the perception nor on the imagery condition of this task, implying that the difference between the groups can not be attributed to attentional or motivational factors. It was the relative score of the difference between perception and imagery that showed a significant difference between groups, with high hallucination-prone subjects showing larger differences between imagery and perception performance than subjects in the low group. In an earlier study, in which the object imagery task was the only behavioral measure, also a negative relation between imagery-perception differences and LSHS ratings was observed (Aleman, Böcker et al. 1999). Horowitz (1975) hypothesized that hallucinators have less vivid imagery than non-hallucinators which would lead an occasional “vivid” image to be misinterpreted as a perception. Indeed, it could be argued that there is no absolute increase in imagery vividness in hallucinating individuals, but a relative increase of imagery vividness in the modality of hallucination, caused by a decrease of vividness in other modalities. It is therefore interesting to note that the lower imagery vividness performance in the hallucination-prone group was only found on a visual imagery task, and that the LSHS mainly concerns auditory hallucinatory experiences. This is consistent with the finding by Böcker et al. (in press) of a modality-specific imagery difference in auditory hallucinating patients (larger imagery-perception interaction in an auditory, but not in a visual condition of an imagery task), which was not observed in a control group of patients without hallucinations. Certainly, more detailed investigation of imagery-perception comparisons with behavioral measures in psychiatric patients with more severe and bizarre hallucinations characteristic of psychosis is needed before strong final conclusions can be reached.

Our finding of a larger correlation between imagery and perception in the high LSHS group than in the low LSHS group may support the plausibility of an explanation in terms of cognitive processes that are involved in distinguishing internal and external sources of perceived events, which has been termed “reality discrimination” (cf. Bentall 1990). The observation may imply that the cognitive
Mental imagery and hallucination-proneness

processes involved in perception and imagery operate separately to a significant extent in low hallucination-prone participants, but are more closely related in high hallucination-prone participants. According to Johnson and Raye (1981), errors in discriminating internal from external information are more likely to occur when the cognitive processes involved are highly similar. Indeed, Rankin and O’Carroll (1995) have provided evidence of deficient reality discrimination in high LSHS participants compared to low LSHS participants.

Conclusion
In the present study, we replicated the finding of a positive relation between hallucination-proneness and self-report vividness of mental imagery. However, this relation was not observed on multiple behavioral measures of auditory and visual imagery and perception. A higher correlation between imagery and perception was observed in high hallucination-prone individuals compared to the low group, which may imply that the cognitive processes involved in imagery and perception may result less distinctive from each other in the high group, thus making reality discrimination errors more likely. Future research in psychiatric patients must be aimed at disentangling these complex relations to provide a more detailed account of the cognitive basis of hallucinations.
Chapter 7

References


Chapter 7