Enhanced vividness of mental imagery as a trait marker of schizophrenia?

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We assessed the vividness of mental imagery in schizophrenia patients in the context of psychopathology and cognitive abilities. A questionnaire on the vividness of mental imagery (Questionnaire Upon Mental Imagery [QMI]) and a hallucination scale were administered to 50 patients with paranoid schizophrenia. The related perceptual and cognitive skills, general intelligence level, and psychomotor speed were measured as covariates with a battery of performance tests. All measures were statistically compared to a group of 50 age- and sex-matched healthy controls. The schizophrenia group obtained higher values both for vividness of imagery and occurrence of hallucinations. These differences were independent of general intelligence and psychomotor speed and did not correlate with individual psychopathology. The correlation between the hallucination and imagery scales themselves was very low. These results suggest that patients with schizophrenia experience a significantly greater vividness of mental imagery than healthy controls, which does not seem to be an effect of other group differences or individual psychopathology (e.g., frequency of hallucinations). Vividness of mental imagery might thus prove to be an independent trait marker of schizophrenia.

Key words: mental imagery/hallucinations/schizophrenia/cognition

Hallucinations have been widely investigated but still remain among the most puzzling psychopathological phenomena. Mental imagery resembles hallucinations in that mental images also have perceptual qualities and occur in the absence of appropriate stimuli. The difference between hallucinations and mental images lies in the possibility to control the perceptual experience. While hallucinations typically occur beyond intention and control (Bentall 1990), mental images are actively generated by the subject and can thus be intentionally controlled. Subjects often describe their imagined experiences as echoes or reconstructions of former perceptual experiences. Imagery might aid cognitive functions in the respective sensory domain. It has, for example, been claimed that visual imagery ability correlates with visuospatial memory span (Kail 1997).

Some authors have suggested that hallucinations and vivid imagery are related. Mintz and Alpert (1972) claimed that individuals who hallucinate also have very vivid images and a weak ability to distinguish real perception from imagery. Theoretical models suggested that hallucinations are misinterpreted mental images derived from internal sources of information (Horowitz 1975; Cahill and Frith 1996). These images are incorrectly evaluated as arising from external sources and appear as intrusions in the perceptual process. Accordingly, hallucinations represent a failure of a reality monitoring system, which implies that internally generated experiences are erroneously ascribed to an external source. In addition, it was proposed that hallucinations are not confined to psychiatric illness but exist on a continuum between normalcy and psychopathology (Bentall 1990).

Barrett (1993) and Barrett and Etheridge (1992) carried out several studies on the incidence of hallucinations in nonclinical populations. They revealed that nearly 50 percent of their subjects had hallucinatory experiences once a month. They observed that people with hallucinations had more vivid imagery but worse control of images in comparison to people who did not experience hallucinations. These and other reports suggest that nonclinical and pathological hallucinations share at least some features and that mental imagery abilities might contribute to the experience and report of hallucinations in a variety of settings or populations.

However, the altered evaluation of mental images is not the only psychological mechanism that has been adduced to explain hallucinations. Fantasy proneness (van de Ven and Merckelbach 2003) and other types of response bias (Bentall and Slade 1985a) have to be taken into account as well.

The link between hallucinations and mental imagery is even more controversial for clinical populations. For example, Brett and Starker (1977) and Starker and Jolin (1982) did not find more vivid imagery in hallucinating schizophrenia patients than in controls. Chandiramani and Varma (1987) likewise found no significant differences in the vividness of imagery between hallucinating schizophrenia patients, nonhallucinating schizophrenia patients, and normal controls. Böcker et al. (2000) tested the hypothesis that hallucinations result from a confusion of external and internal stimulus sources. They found no group differences in mental imagery ability between the schizophrenia group and the normal controls. However, for the hallucinating schizophrenia patients, the relative
level of vividness of mental images was higher in the auditory modality, which was the modality in which most of the patients experienced hallucinations.

Several factors may have contributed to the inconsistency of results. Aleman et al. (1999) pointed out that objective and subjective mental imagery measures may yield contradictory results within the normal population. This distinction may hold true in some cases for the clinical population as well. For example, Mintz and Alpert (1972) based their finding of an association between increased mental imagery and hallucinations on suggestion paradigms or self-report measures, while Böcker et al. (2000) used a more objective mental imagery task to show that mental imagery performance did not differ between patients and controls. In addition, most studies did not incorporate measures sensitive to cognitive differences between or within patient and control groups.

In this study we investigated the vividness of mental imagery and hallucinations in a group of 50 schizophrenia patients compared to a group of 50 age- and sex-matched controls. Bett’s Questionnaire Upon Mental Imagery (QMI) was used to study mental imagery. This questionnaire involves assessing the vividness of mental imagery in seven different sensory modalities. Tendency toward hallucinations was assessed with another standard questionnaire, the Launay-Slade Hallucination Scale (LSHS). We combined the information from self-administered questionnaires with performance measures of standardized objective psychometric tests that were assumed to share cognitive characteristics with mental imagery (Kosslyn 1994). Moreover, by statistically controlling for potentially confounding factors such as general intelligence, psychomotor speed, and individual psychopathology, we aimed to elucidate further the imagery abilities of schizophrenia patients.

Methods

Subjects

We recruited from our department 50 inpatients and outpatients (31 males and 19 females; mean age 36.4 years; standard deviation [SD] = 9.8; range = 19–57) diagnosed with paranoid schizophrenia (ICD–10: F20.0) for at least 5 years. All patients received antipsychotic medication (20 treated with atypical, 13 with typical, and 17 with both). Fifty age- and sex-matched healthy controls (31 males and 19 females; mean age 36.4 years; SD = 9.7; range = 19–57) were also tested. All subjects were provided with a complete description of the study and gave written informed consent before participation. Control subjects were compensated for participation.

Procedure and psychometric measurements

A test battery consisting of two questionnaires and five standardized cognitive tests (table 1) was assessed in both groups. The assessment, done for every subject individually, lasted approximately 1 hour. The study program also included clinical ratings on the Scale for the Assessment of Positive Symptoms (SAPS; Andreasen 1984) and the Scale for the Assessment of Negative Symptoms (SANS; Andreasen 1981), but only 31 of the patients were willing to participate in this portion of the program.

Self-administered questionnaires. The predisposition toward hallucinations was measured with the LSHS (Launay and Slade 1981). The LSHS consists of 12 descriptions of hallucinatory experiences. Some of the items are related to daydreams (“In my daydreams I can hear the sound of a tune almost as clearly as if I were actually listening to it”), while others refer to psychotic experiences (“I have heard the voice of the devil”). For each of the 12 statements, the subjects have to score along a 5-point Likert scale (Bentall and Slade 1985b: 0 = certainly does not apply [to me]; 4 = certainly applies). A high score on the LSHS indicates an increased predisposition to hallucinations. Vividness of mental imagery was assessed using the short version of the QMI (Sheehan 1967). The 35 items of the QMI are statements regarding the imagery ability in seven different sensory modalities (visual, auditory, olfactory, cutaneous, kinaesthetic, gustatory, and organic). Subjects are asked to rate their imagery vividness on a 7-point scale (1 = I perceive it perfectly clearly, as if it were real; 7 = I think about it, but I cannot imagine it). A low score on the QMI indicates more vivid imagery (table 1).

Objective psychometric test battery. As an objective measure of different perceptual and cognitive skills, three subscales of the General Performance Test (Leistungsprüfsystem [LPS]; Horn 1962) were assessed. The LPS is a standardized, valid, and highly reliable (total test-retest reliability rt = 0.95) measurement of 14 different cognitive skills, which are related to Thurstone’s primary mental abilities (Thurstone 1938). We assessed the LPS subscale 10 (flexibility of closure; rt = 0.69), 11 (object-based speed of closure; rt = 0.71), and 12 (verbal-based speed of closure; rt = 0.88). Subscale 10 consists of 40 complex geometrical forms. One of five predefined target figures is embedded and thus “hidden” within these forms. The respective target figure has to be detected. The test is limited to 3 minutes. Subscale 11 requires fast object recognition. Subjects are asked to recognize 40 sketches of common objects (e.g., car, apple, house) with portions of them erased. Subjects have to recognize and name the respective objects. Subscale 12 demands fast recognition of 40 visually degraded words. Each word contains one false letter, which has to be identified and crossed out. Subjects have 1 minute each to complete subscale 11 and subscale 12 (table 1).
Psychometric covariates. Measures of verbal intelligence (Multiple Choice Word Comprehension test [Mehrfachwahl-Wortschatz-Intelligenztest (MWT)]; \(r_{tt} = 0.87\); Lehrl 1989; Brüne 2003) and of psychomotor speed (Number-Pathfinding Test [Zahlen-Verbindungs-Test (ZVT)]; \(r_{tt} = 0.95\); Oswald and Roth 1987) were included in the test battery.

The MWT is a widely used German test that assesses crystallized intelligence—the semantic knowledge- and language-related factor of intelligence (Horn and Cattell 1966). The average correlation coefficient between the MWT (median from 32 investigations) and other global intelligence tests is relatively high at \(r = 0.72\), which makes the MWT a good screening instrument for general intelligence. The MWT can be considered the German equivalent to the Spot-the-Word test (Baddeley et al. 1993).

The ZVT is a short, nonverbal test for examining cognitive speed. The task material consists of four numerical matrices, each comprising numerals from 1 to 90 in changing arrangements. Subjects are asked to connect these numerals in ascending order by drawing lines as quickly as possible. The mean speed in seconds for each matrix is calculated as the score for psychomotor speed. Test-retest reliability for the individual administration is \(r_{tt} = 0.95\), and the internal consistency ranges from \(\alpha = 0.95\) to \(\alpha = 0.97\) (table 1). The ZVT is the equivalent to the Trail Making Test A (Reitan 1956).

Table 1. Overview of the administered battery of psychometric tests and self-administered questionnaires

<table>
<thead>
<tr>
<th>Test/questionnaire</th>
<th>Item example</th>
<th>Construct</th>
<th>Type of variable</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>QMI</td>
<td>“The smell of leather” “The meowing of a cat”</td>
<td>Vividness of mental imagery</td>
<td>Dependent variable (questionnaire)</td>
<td>(r_s = 0.97)</td>
</tr>
<tr>
<td>LSHS</td>
<td>“In my daydreams I can hear the sound of a tune almost as clearly as if I were actually listening to it.”</td>
<td>Tendency toward hallucinations</td>
<td>Dependent variable (questionnaire)</td>
<td>(r_s = 0.83)</td>
</tr>
<tr>
<td>LPS 10</td>
<td></td>
<td>Flexibility of closure</td>
<td>Dependent variable (objective test)</td>
<td>(r_{tt} = 0.69)</td>
</tr>
<tr>
<td>LPS 11</td>
<td></td>
<td>Object-based speed of closure</td>
<td>Dependent variable (objective test)</td>
<td>(r_{tt} = 0.71)</td>
</tr>
<tr>
<td>LPS 12</td>
<td></td>
<td>Verbal-based speed of closure</td>
<td>Dependent variable (objective test)</td>
<td>(r_{tt} = 0.88)</td>
</tr>
<tr>
<td>MWT</td>
<td>NOSE–VOSE–GLOST–NAIS–NUM</td>
<td>Crystallized intelligence</td>
<td>Covariate (objective test)</td>
<td>(r_{tt} = 0.87)</td>
</tr>
<tr>
<td>ZVT</td>
<td></td>
<td>Psychomotor speed</td>
<td>Covariate (objective test)</td>
<td>(r_{tt} = 0.95)</td>
</tr>
</tbody>
</table>

Note.—LPS = General Performance Test; LSHS = Launay-Slade Hallucination Scale; MWT = Multiple Choice Word Comprehension Test; QMI = Questionnaire Upon Mental Imagery; ZVT = Number-Pathfinding Test.

\(^{1}\)The reliability indexes of the QMI and the LSHS refer to the internal consistency of Cronbach’s alpha, while all others represent the retest reliabilities.

Psychometric properties. The psychometric properties of both questionnaires were analyzed. In addition, the factor structure of the QMI was assessed.

Individual psychopathology. To account for differences in the psychopathological symptoms of the schizophrenia patients, a subsample of 31 patients were interviewed and rated on the basis of the SAPS (Andreasen 1984) and the SANS (Andreasen 1981).

Evaluating the psychometric properties of the German versions of the QMI and the LSHS. Prior to the psychometric assessment, the QMI and the LSHS were translated into German by three independent translators. These versions were administered to a sample of 100 healthy controls to analyze the respective psychometric properties of the German versions of the QMI and the LSHS.

Statistical analyses

Psychometric properties. The psychometric properties of both questionnaires were analyzed. In addition, the factor structure of the QMI was assessed.

Multivariate correlation analyses. We computed multivariate correlation analyses between all tests and questionnaires of the test battery independently for both groups.

Statistical group comparisons and analyses of covariance. The performances of patients and controls in the different questionnaires and tests were compared, and group
differences were tested for statistical significance using analysis of variance (ANOVA). To statistically control for potential differences in crystallized intelligence and psychomotor speed between both groups, two analyses of covariance (ANCOVAs) were computed, comparing the differences in both questionnaires and the three subscales of the LPS with general crystallized intelligence and psychomotor speed as covariates.

Analysis of individual psychopathology and medication. Within the subsample (n = 31) of patients assessed by standardized clinical interviews, a potential effect of positive and negative symptoms on the questionnaires was investigated with a correlation analysis. In addition, a one-way ANOVA with medication as a fixed factor was used to investigate the influence of different antipsychotic medication on the scores of the different questionnaires.

Results

Psychometric properties

The psychometric properties of the German translation of the QMI were analyzed on the basis of 100 healthy controls. The computed exploratory factor analysis (principal components analysis, extraction criterion: eigenvalues > 1, rotated solution) revealed seven factors that corresponded to the seven sensory modalities of imagery described by the items. The total reliability of the German QMI version proved to be very high, with a Cronbach’s alpha of 0.97. The total reliability of the German LSHS (Cronbach’s alpha = 0.83) was also satisfactory.

Multivariate correlation analyses and factorial structures

The principal components analysis (extraction criterion: eigenvalue > 1; rotated solution) identified a five-factor solution for the patient group’s LSHS that accounted for 76 percent of the total variance. Within this factorial structure we were able to identify one factor (explaining 25% of the variance) that best reflected the hallucinatory experiences of the patients. For the control group the computed principal components analysis of the LSHS revealed a three-factor solution that accounted for 82 percent of the total variance. The first factor alone accounted for 52 percent of the variance and could be characterized as the general hallucinatory tendency, with a loading pattern similar to that found for the patient group. For the following statistical analyses regarding the correlation between hallucinatory tendency and vividness of mental imagery we used both the total score in the LSHS (LSHS–T) as well as the factor value representing the “cleaned” hallucinatory tendency ratings (LSHS–H) of both groups.

The exploratory factor analysis of the QMI (extraction criterion: eigenvalue > 1; rotated solution) revealed that for the patient group, as for the sample of 100 healthy controls, a seven-factor solution could be found. The loading pattern of this factorial structure clearly corresponded to the seven different sensory modalities of imagery represented by the items of the QMI.

The correlation analyses revealed no correlation between the QMI and the LSHS–T in either of the two groups (patients: r = −0.205, p = 0.157; controls: r = −0.100, p = 0.491), or between the QMI and the LSHS–H (patients: r = −0.108, p = 0.556; controls: r = −0.005, p = 0.980). The correlation between the LSHS–T or LSHS–H and the seven subscales of the QMI representing the different sensory modality of mental imagery was not significant either.

Furthermore, no correlations could be found between the QMI and the three objective measures of perceptual closure, including flexibility of closure (patients: r = −0.085, p = 0.558; controls: r = 0.124, p = 0.391), object-based speed of closure (patients: r = −0.242, p = 0.090; controls: r = 0.261, p = 0.067), and verbal-based speed of closure (patients: r = −0.033, p = 0.821; controls: r = −0.019, p = 0.896).

Statistical group comparisons and analyses of covariance

The calculated mean of the QMI was significantly lower in the patient group (patients = 77.5, controls = 111.3). Because a lower score on the QMI indicates more vivid imagery (see Methods), the patients scored significantly higher on the imagery questionnaire (F(1, 98) = 22.4, p < 0.001) compared to controls (figure 1). The separate analyses of the seven subscales of the QMI revealed that this difference in vividness of mental imagery between patients and controls was also significant when each modality of the QMI was considered separately. Hence, the schizophrenia patients showed a significantly higher vividness of mental imagery in all seven sensory modalities in comparison to the control group.

Conversely, the patients performed significantly worse in all three subscales of the LPS, including flexibility of closure (F(1, 98) = 28.8, p < 0.001), object-based speed of closure (F(1, 95) = 14.8, p < 0.001), and verbal-based speed of closure (F(1, 97) = 19.2, p < 0.001), while scoring significantly higher on the hallucination scale (F(1, 97) = 48.8, p < 0.001) in comparison to the controls (table 2, ANOVA).

To control for possible confounding effects of the differences between both groups in general crystallized intelligence and psychomotor speed on these results, two independent ANCOVAs were computed, using MWT and ZVT as statistical covariates. These analyses revealed that even after statistically controlling for the variance that can be explained by the group differences in general crystallized intelligence, the observed differences between both groups in fluid intelligence (LPS scales), vividness of mental imagery (QMI; figure 1, left histogram), and
tendency toward hallucinations (LSHS; figure 1, right histogram) remained significant (table 2, middle part).

The statistical adjustment for the influence of psychomotor speed on the group differences resulted in a non-significant difference between both groups in the three measures of fluid intelligence (LPS 10, 11, 12) but left the significant differences between both groups in the QMI and the LSHS unchanged (table 2, right part).

Analyses of individual psychopathology and medication

The correlation analyses for the 31 patients who were rated with the SAPS and SANS revealed no correlation between the vividness of mental imagery or hallucinations (LSHS-T and LSHS-H) and positive or negative symptoms as measured by the total score in the SAPS and SANS (figure 2, table 3). Additionally, we computed three different subsets of psychotic symptoms from the SAPS ratings, representing hallucinations (item 7), delusions (item 20), and passivity (item 15). The correlation analyses with these three items of the SAPS again revealed no correlation with the vividness of mental imagery (SAPS hallucinations: $r = 0.136, p = 0.480$; SAPS delusions: $r = -0.066, p = 0.733$; SAPS passivity: $r = 0.056, p = 0.772$) or the tendency toward hallucinations as measured with the LSHS–H (SAPS hallucinations: $r = 0.360, p = 0.130$; SAPS delusions: $r = -0.148, p = 0.454$; SAPS passivity: $r = -0.023, p = 0.925$).

A statistical comparison of this subsample with 31 age- and sex-matched controls confirmed our result of a higher vividness of mental imagery in schizophrenia patients. Hence, there was no confounding effect of the differences

![Fig. 1. Comparison of imagery and hallucination scores for patients and controls.](https://academic.oup.com/schizophreniabulletin/article-abstract/31/1/97/1884636/1884636)

**Table II.** Comparison of questionnaire score and test performance between patients and controls

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>One-Factorial ANOVA Without Covariates</th>
<th>ANCOVA With MWT–B as Covariate</th>
<th>ANCOVA With ZVT as Covariate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>F</td>
<td>df</td>
</tr>
<tr>
<td>QMI</td>
<td>Controls</td>
<td>111.3</td>
<td>22.4</td>
<td>1, 98</td>
</tr>
<tr>
<td></td>
<td>Patients</td>
<td>77.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSHS</td>
<td>Controls</td>
<td>6.2</td>
<td>48.8</td>
<td>1, 97</td>
</tr>
<tr>
<td></td>
<td>Patients</td>
<td>17.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPS 10</td>
<td>Controls</td>
<td>28.3</td>
<td>28.8</td>
<td>1, 98</td>
</tr>
<tr>
<td></td>
<td>Patients</td>
<td>20.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPS 11</td>
<td>Controls</td>
<td>21.0</td>
<td>14.8</td>
<td>1, 98</td>
</tr>
<tr>
<td></td>
<td>Patients</td>
<td>17.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPS 12</td>
<td>Controls</td>
<td>25.2</td>
<td>19.2</td>
<td>1, 97</td>
</tr>
<tr>
<td></td>
<td>Patients</td>
<td>18.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note.—ANCOVA = analysis of covariance; ANOVA = analysis of variance; LPS = General Performance Test; LSHS = Launay-Slade Hallucination Scale; MWT–B = Multiple Choice Word Comprehension Test–B; QMI = Questionnaire Upon Mental Imagery; ZVT = Number-Pathfinding Test.

1Comparison between subjects and patients in their mean test performances and questionnaire results. Group differences were analyzed with a one-factorial ANOVA (left part) as well as two separate ANCOVAs with general intelligence (middle part) or psychomotor speed (right part) as covariates.
in psychopathology, which is illustrated by the lack of direction within the scatterplots of figure 2. The comparison between the different types of medication (three levels: typical, atypical, both) within a one-factorial ANOVA revealed no significant differences between these medication groups in the questionnaires.

**Discussion**

In this study we were able to show that patients with paranoid schizophrenia report more vivid mental imagery in comparison to age- and sex-matched healthy controls. This difference in vividness of mental imagery between patients and controls was also significant when each modality of the QMI was considered separately. Furthermore, the higher imagery vividness of the patients was revealed to be statistically independent of the differences in general intelligence and psychomotor speed and unrelated to the individual psychopathology of the patients, including the presence of hallucinations. The exploratory factor analysis revealed that the factorial structure of the QMI was unchanged in the patient group, resulting in a seven-factor solution corresponding to the seven modalities targeted by the questionnaire (Sheehan 1967). The patients thus not only showed a higher vividness of mental imagery but maintained a differentiation of this imagery ability.

The exploratory factor analysis of the LSHS revealed a five-factor solution for the patient group and a three-factor solution for the control group. These results conform to former studies on the factorial structure of the LSHS. The loading pattern of the factor solution in the patient group was similar to the results of Levitan et al. (1996), while the loading pattern of the three-factor solution in the control group largely replicated the findings by Aleman et al. (2001).

No significant correlation was found between mental imagery and tendency toward hallucinations in the patient group, which suggests that these two constructs might be independent. Nor does the higher imagery vividness of the patients seem to be an effect of individual psychopathology. The lack of correlation between the SAPS (and even the hallucination subscale) and the LSHS was especially unexpected. For an explanation, we may point to the different time intervals addressed by the two measures. While the LSHS probes hallucinatory experiences that occurred at some point in the past, the SAPS covers a very restricted time period of 1 week.

Our finding of higher imagery vividness in schizophrenia patients is consistent with the results of Mintz and Alpert (1972), who also found a significantly higher vividness of mental imagery in schizophrenia patients. In addition, strong correlations between increased vividness of mental imagery and the presence of positive schizotypal traits have been reported (van de Ven and Merckelbach 2003). However, the majority of studies did not find a significant difference in global mental imagery between schizophrenia patients and controls (Bret and Starker 1977; Starker and Jolin 1982; Böcker et al. 2000), even though the correlation between imagery vividness and hallucinatory tendencies was reported in the study of Mintz and Alpert (1972).

**Table III.** Correlation matrix between imagery and hallucination scores and individual psychopathology

<table>
<thead>
<tr>
<th></th>
<th>LSHS–T</th>
<th>LSHS–H</th>
<th>SANS</th>
<th>SAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>QMI</td>
<td>−0.205</td>
<td>−0.108</td>
<td>0.200</td>
<td>0.036</td>
</tr>
<tr>
<td>LSHS–T</td>
<td></td>
<td>0.972*</td>
<td>−0.067</td>
<td>0.238</td>
</tr>
<tr>
<td>LSHS–H</td>
<td></td>
<td></td>
<td>−0.093</td>
<td>0.211</td>
</tr>
<tr>
<td>SANS</td>
<td></td>
<td></td>
<td></td>
<td>−0.118</td>
</tr>
</tbody>
</table>

*Note.—LSHS–H = Launay-Slade Hallucination Scale, hallucinatory tendency; LSHS–T = Launay-Slade Hallucination Scale, total; QMI = Questionnaire Upon Mental Imagery; SANS = Scale for the Assessment of Negative Symptoms; SAPS = Scale for the Assessment of Positive Symptoms. *p < 0.001.
when scores on questionnaires of mental imagery were compared (Chandiramani and Varma 1987). This discrepancy in the literature could be brought about by differences between the studies regarding the methods employed and the extent to which possible covariates were considered. Our study revealed that when information from self-administered questionnaires is combined with that from objective cognitive tests and when confounding factors such as general intelligence and psychomotor speed are controlled for, schizophrenia patients do show a much higher vividness of mental imagery.

Even so, our patient group performed worse on tasks that are supposed to recruit cognitive processes related to mental imagery (the LPS subscales). This result is compatible with theories that attribute the group difference in vividness of mental imagery not to an enhancement of mental imagery abilities as such (Bentall 1990; Aleman et al. 1999) but to altered information processing as a result of stable beliefs (Lobban et al. 2002) or a deficient source monitoring system (McGuire et al. 1996). However, the impaired performance on the LPS was partly explained by deficits in psychomotor speed, which further complicates the interpretation of the results.

A recent study on differences in perceptual closure between schizophrenia patients and healthy controls avoided this confound (Doninger et al. 2001). This study used a different perceptual closure task that did not involve time constraints. Instead, performance was assessed by the level of picture degradation that could be manipulated, and patients were found to perform significantly worse than healthy controls. Further research will thus be needed to investigate whether patients with schizophrenia are at all able to use their enhanced vividness of imagery for cognitive tasks that require good mental imagery abilities. It will also be worthwhile to conduct functional imaging studies of mental imagery in schizophrenia in other modalities than the auditory (Shergill et al. 2000) in order to reveal potential neural correlates of the enhanced vividness of the perceptual experience.

It is interesting to note that the enhanced vividness of mental imagery is independent of the severity of positive and negative symptoms, which indicates that it is not merely an effect of the current psychopathological state of the patient but related to the presence of the disease. In this context it could be speculated that subjectively reported enhanced vividness of mental imagery might prove to be a new trait marker of schizophrenia. However, such a claim needs to be based on further replication, including appropriate family and genetic studies.

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