Schizophrenia Bulletin vol. 38 no. 4 pp. 741–750, 2012
doi:10.1093/schbul/sbq144
Advance Access publication on December 8, 2010

Self-recognition Deficits in Schizophrenia Patients With Auditory Hallucinations: A Meta-analysis of the Literature

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Theories about auditory hallucinations in schizophrenia suggest that these experiences occur because patients fail to recognize thoughts and mental events as self-generated. Different theoretical models have been proposed about the cognitive mechanisms underlying auditory hallucinations. Regardless of the cognitive model being tested, however, experimental designs are almost identical in that they require a judgment regarding whether an action was self-originated or not. The aim of the current study was to integrate all available literature for a meta-analysis on this topic and reach conclusions about self-recognition performance in (1) patients with schizophrenia compared with healthy controls and (2) patients with auditory hallucinations compared with patients without these symptoms. A comprehensive literature review identified 23 studies that contrasted the performance of schizophrenia patients with healthy controls (1370 participants) and 9 studies that directly compared patients with and without auditory hallucinations (315 participants). We found significantly reduced self-recognition performance in schizophrenia patients, which was more pronounced in patients with auditory hallucinations compared with patients without. In patients with hallucinations, this pattern of performance was specific to self-recognition processes and not to the recognition of new external information. A striking finding was the homogeneity in results across studies regardless of the action modality, timing delay, and design used to measure self-recognition. In summary, this review of studies from the last 30 years substantiates the view that self-recognition is impaired in patients with schizophrenia and particularly those with auditory hallucinations. This suggests an association, perhaps a causal one, between such deficit and hallucinatory experiences in schizophrenia.

Key words: schizophrenia/auditory hallucinations/self-recognition/monitoring

Introduction

Schizophrenia is a severe psychiatric disorder, characterized by highly distressing symptoms which include auditory verbal hallucinations ("hearing voices") and delusional beliefs. Auditory hallucinations are some of the most common symptoms of schizophrenia, occurring in approximately 60%–80% of affected individuals, and are used as a diagnostic criterion for the illness (Diagnostic and Statistical Manual IV, 1994). The pathological mechanisms underlying auditory hallucinations are still not clearly understood, but several theories exist. The most influential theory proposes that auditory hallucinations occur because of a failure to recognize self-generated thoughts and actions, which is accompanied by false beliefs that these arise from an external agent.[1–6] In support for this theory, experimental studies show that schizophrenia patients with auditory hallucinations and other phenomenon such as passivity symptoms have difficulties in identifying their own actions and thoughts, and commonly misattribute self-generated behaviors to an external source.[7–11] Further support is provided by neuroimaging studies of patients with hallucinations showing abnormalities in the cortical midline structures, which are thought to be important neural substrate for self-processing.[12–14]

Several explanations have been proposed to explain self-recognition failures in schizophrenia and auditory hallucinations (see[15] for an overview). One theory posits a dysfunction of the feed-forward model system, whose role consists in predicting the sensory consequences of one's intended actions and inner speech.[16–18] A dysfunction in this system is thought to result in incorrect sensorimotor predictions, and an ensuing failure to recognize self-generated thoughts and actions. A task commonly used to test this model requires participants to monitor voluntary movements online and determine whether the actions arise from themselves or another person.[19–21] Another class of theories proposes dysfunctions in memory and reasoning processes that are involved in the identification of the source of actions and mental events.[7,8,22–25] It is proposed that there are fundamental abnormalities in the processing of perceptual details, contextual information, and cognitive operations, which are tied to internal mental events and memories. Such dysfunctions are posited to lead directly to difficulties with self-recognition,[23,26,27] or indirectly through faulty logical reasoning when making decisions about the origins of mental events.[3,7,22] Typically, this is tested by asking participants to identify whether items in memory originated from the self or from the experimenter or whether they represent "new" (external) information, which was not presented during the study session. Yet another theory proposes abnormalities in mental imagery.[28] This model suggests that an over abundance of vivid imagery imposes excessive influences on perception, so that it is increasingly difficult to identify mental events as having an internal self-origin. This has been tested by using measures of mental imagery without conclusive results.[29] Effects of putatively strong mental images can be assessed indirectly by asking participants to generate words by imagining speaking them or to listen to words presented by the experimenter.[30] After an interval, these words are interleaved with a list of new words. The model predicts a failure of self-recognition as a result of an imbalance between mental imagery and perceptual salience and misattribution of words to an external source.

These models differ in proposed underlying mechanisms but are not necessarily mutually exclusive in view of the multiple interactions that exist between sensorimotor information, imagery, and memory processes.[31,32] In addition, several similarities exist given that studies: (1) have used comparable experimental designs which require a behavioral response regarding whether an action has a self-origin or not and (2) have identical assumptions that patients with auditory hallucinations will perform more poorly on self-recognition compared with patients without. Given the similitude in tasks requirements and hypotheses, we sought to integrate past research on self-recognition in patients with auditory hallucinations and examine accuracy of performance on self-generated material without consideration of the theoretical model being tested. In addition, questions remain whether self-recognition deficits are related to auditory hallucinations specifically or to all patients with schizophrenia more broadly.[22,33,34] Considering these issues, we conducted a meta-analysis which aimed to make decisions regarding the specificity of self-recognition deficits to auditory hallucinations. As a control condition, we examined performance accuracy on new items, as an index of information that was presented externally. The literature was systematically searched for suitable studies, and results were quantitatively summarized to reach a mean weighted effect size.

Methods

Search Strategy and Selection Criteria

Articles were identified through a literature search in PsychINFO and MEDLINE in the period January 1970 to April 2010. Combinations of the following keywords were used: auditory hallucination, voice, schizophrenia, psychosis, source monitoring, self-monitoring, source memory, self-recognition, reality monitoring, external monitoring, and externalizing. Additional references were retrieved by cross-referencing the reference lists of selected articles and reviews of auditory hallucinations. The inclusion criteria used during the search were:

1. Articles were published in English and in international peer-reviewed journals
2. The study comprised adults diagnosed with schizophrenia or schizoaffective disorder according to the Diagnostic and Statistical Manual of Mental Disorders or International Statistical Classification of Disease criteria and a comparison group of healthy nonpsychiatric healthy controls OR clearly defined groups of patients with and without auditory hallucinations. "Current hallucinators" comprised individuals with auditory hallucinations present in the week preceding testing. "Nonhallucinators" comprised participants with no recent experience of auditory hallucinations (at least > 1 wk).
3. A source memory task which involved at least one internal source and which required participants to make a self-recognition judgment.
4. Sufficient statistical data reported for all groups (means and SDs of the performance accuracy) or exact P or T-values of the appropriate tests.

For publications which contained insufficient or incomplete data and which were published in the period 2005–2010, the corresponding authors were contacted and invited to send additional data so that their study could be included in the meta-analysis. For older studies, we regarded the chances minimal that sufficient details would still be available or that the authors' contact details were still current.

Method of Review

A review of the literature was performed as recommended in the Prisma statement.[35] The electronic search yielded 480 hits. One rater (F.W.) screened titles and abstracts through database searches to determine potential inclusion. After removal of duplicate records, the number of articles identified through database searches was 286. Two raters (I.S. and T.W.) independently read each abstract to identify the studies that were eligible. Cross-referencing by all the authors contributed to an additional 11 articles. This process resulted in a total of 81 full-text articles, which were examined in further detail for suitability. Forty-nine records were excluded for failing to meet inclusion criteria. Reasons for exclusions were not providing enough data to calculate the effect size (n = 21), no self-recognition judgment (n = 25), unsuitable diagnostic grouping (n = 6), not peer-reviewed (n = 3), or sample overlap with a previous study (n = 3). The final selection, which met all inclusion criteria, comprised 23 studies of schizophrenia and 9 studies of hallucinations. The data was extracted by two raters (F.W. and T.W.) using a pro forma. The variables recorded were (1) name of authors and year of publication, (2) description of the self-recognition paradigm, (3) sample sizes, (4) means and SDs of recognition accuracy on self-generated items, and (5) mean and SDs of performance accuracy on new items. When studies reported on two internal sources (imagined vs said), we reported on the scores for the "said" condition, given that verbal outputs have better defined perceptual and cognitive operations than thought processes. In studies that comprised distorted feedback, the results are presented for moderate "distortion" conditions.

Statistical Analyses

For each study, Hedges' g (the difference between the mean of the experimental group and the mean of the comparison group, divided by the pooled SD and weighted for sample size) was calculated.[36] In this case, the mean performance accuracy (on self-generated items and on new item recognition) of the experimental group was subtracted from the mean accuracy of the control group, divided by the pooled SD of both. When means and SDs were not available, effect sizes were computed from exact P-values, T-values, or F-values (cf[37]). After computing effect sizes for each study, the meta-analytic method was applied in order to obtain a combined effect size: Hedges's g,[38] which indicates the magnitude of the association across all studies. Effect sizes were weighted for sample size in order to correct for upwardly biased estimation of the effect in small sample sizes. The individual and mean effect size data were computed using Comprehensive Meta-Analysis Version 2.0 in a Random Effects model by one of the authors (I.S.), in consultation with another (A.A.). A homogeneity statistic, I^2 [39] was calculated to test whether the studies could be taken to share a common population effect size and to provide a statement regarding observed variance in study effect sizes. An I^2 statistics of less than 30% annotates mild heterogeneity and 50% a moderate heterogeneity in study effect sizes. To investigate the possible effects of publication bias, funnel plots were obtained and the fill and trim procedure as proposed by Sutton et al[40] was applied.

Results

A total of 23 studies were identified as meeting the inclusion criteria for the schizophrenia vs control comparisons, which included a total of 1370 participants (789 patients and 581 controls). Nine studies were suitable for the analysis of patients with and without auditory hallucinations, which comprised a total of 315 participants (150 patients with and 165 without, hallucinations). table 1 shows the studies included in the meta-analysis.

Comparisons of Schizophrenia Patients vs Healthy Controls

The sample size for the schizophrenia samples ranged from 8[22,58] to 91,[44] and the sample size for the controls ranged from 8[58] to 54,[41] with a mean of 33 patients and 26 controls per study. Based on the available data, the groups were well matched for age (M = 35.5 for patients, M = 35.4 for controls), although the controls had a greater number of years of education compared with patients (M = 16.4, M = 13.7) and higher Intelligence Quotient (IQ) (M = 109.2, M = 102.1).

We first compared self-recognition accuracy in patients and controls. A meta-analysis of these studies yielded a mean weighted Hedge's g of −0.73, indicating significantly lower performance in patients with schizophrenia ($P < .00001$) (see figure 1) with a moderate-to-large effect size. However, heterogeneity was moderate to high with an I^2 value of 52%. One study[58] deviated more than 2 SDs from the other studies and was a clear outlier. The study's small sample sizes (n = 8 in each group) and functional magnetic resonance imaging setting may have affected the results. We repeated the analyses without this study, so that a total of 22 studies and 1312 participants were included. Hedge's g was now −0.71, again highly significant ($P < .00001$). Heterogeneity dropped to a moderate value of I^2 = 41%. This indicates that patients show consistently lower accuracy on self-recognition compared with controls. In order to check for possible effects of publication bias, a funnel plot was created (figure 2), which showed that, apart for the single outlier study (lower left corner), no clear publication bias had occurred. Indeed, application of the trim and fill method[40] did not change the results.

We then conducted a meta-analysis of new item recognition between patients and controls. For this analysis, a total of 22 studies could be included in which 1328 subjects participated. The mean weighted Hedge's g was −0.39, which was significant ($P < .00001$) and indicated a small to moderate effect size (See online supplementary figure A). Heterogeneity was moderate: I^2 = 45%. A funnel plot was created to check for the possible effects of publication bias (See online supplementary figure B), which showed that publication bias may have affected results

Table 1. Studies Included in the Meta-analysis

SCZ[a] vs HC[b]	SCZ (*n*)	HC (*n*)	Tasks
Anselmetti et al[41]	45	54	Word-stem completion task
Brunelin et al[42]	15	15	Word recognition task
Brunelin et al[43]	30	24	Word recognition task
Fisher et al[44]	91	30	Sentence completion task
Franck et al[45]	17	17	Word recognition task
Harvey[22]	10	10	Word recognition task
Harvey et al[46]	26	25	Word recognition task
Keefe et al[10]	29	19	Word recognition task
Lee et al[47]	20	19	Face recognition task
Moritz et al[48]	30	21	Semantic association task
Moritz et al[49]	30	17	Semantic association task
Mortiz et al[50]	30	15	Word recognition task
Nienow et al[51]	52	52	Sentence completion task
Posada et al[21]	15	15	Recognition of movements
Stephane et al[52]	39	26	Word recognition task
Stephane et al[53]	32	26	Word recognition task
Stirling et al[54]	35	24	Recognition of drawings
Stirling et al[55]	40	36	Recognition of drawings
Szoke et al[56]	54	42	Semantic association task
Vinogradov et al[57]	26	21	Sentence completion task
Vinogradov et al[58]	8	8	Sentence completion task
Waters et al[59]	43	24	Object-pairing recognition task
Woodward et al[60]	51	20	Word recognition task
Halls[c] vs NonHalls[d]	**Hall (*n*)**	**NonHall (*n*)**	**Tasks**
Allen et al[61]	15	13	Voice recognition task
Allen et al[33]	10	10	Voice recognition task
Bentall et al[62]	22	16	Paired associates word task
Brunelin et al[63]	30	31	Word recognition task
Fu et al[64]	13	13	Voice recognition task
Johns et al[65]	10	8	Voice recognition task
Johns et al[66]	15	15	Voice recognition task
Waters et al[67]	19	24	Object-pairing recognition task
Woodward et al[60]	16	35	Word recognition task

[a]SCZ: Schizophrenia patients.
[b]HC: Healthy controls.
[c]Halls: Patients with auditory hallucinations.
[d]NonHalls: Patients without auditory hallucinations.

in a minor way. However, when the trim and fill method was applied, results did not change.

Comparison of Patients With and Without Auditory Hallucinations

The sample size of patients with auditory hallucinations ranged from 9[64] to 30[63] and the sample size for patients without hallucinations ranged from 8[65] to 35[60], with a mean of 16 patients with hallucinations and 18 patients without hallucinations per study. Based on available data, groups were well matched for age (M = 34 years for patients with hallucinations and M = 36 years for patients without), years of education (M = 12, M = 11), age of onset (M = 23, M = 22.4), and duration of illness (M = 11.4, M = 13.7). IQ was slightly lower in patients with hallucinations compared with patients without (M = 100.0, M = 103.7), although 6 of the 7 studies that reported on intelligence scores showed nonsignificant group differences.

Analyses of self-recognition performance revealed a mean weighted Hedge's g of −0.58, significant at $P < .00001$, which indicated a moderate effect size (figure 3). Heterogeneity was low: I^2 = 17%. One study was a clear outlier[61]. Hedge's g remained moderate without this study ($g = -0.51$, $P < .00001$) and I^2 dropped to 0. To investigate potential influence of publication bias, a funnel plot was created. figure 4 shows that, except for the single outlier, publication bias did not play a measurable part in the obtained results. In support, application of the trim and fill method did not change the results.

We then conducted separate meta-analyses on studies that required two different types of responses. Five studies required an identity-recognition ("that's me/not me") judgment[33,61,64–66] and another 4 studies required an action-recognition ("that's mine/not mine") judgment.[60,62,63,67] Both meta-analyses showed that performance was significantly worse in patients with hallucinations regardless of the task and that the effect size was

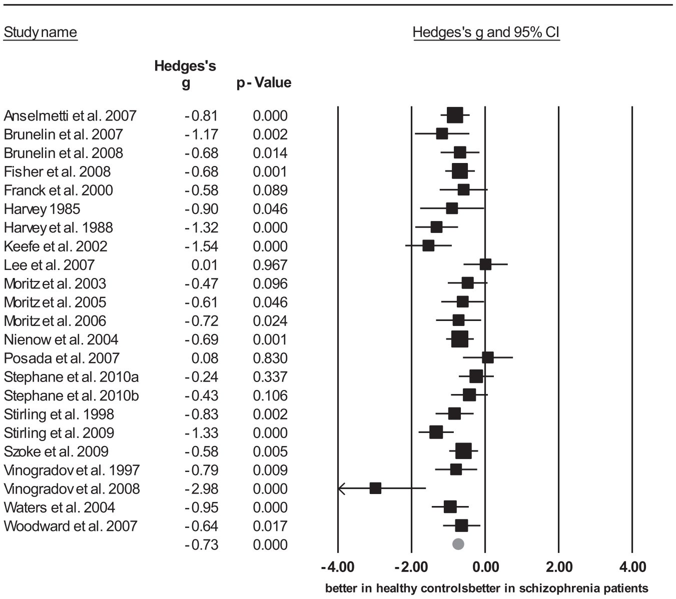

Fig. 1. Effect Size Estimates of the Difference in Self-recognition Accuracy Between Schizophrenia Patients and Healthy Controls. The red dot (at the bottom of the figure) shows the mean weighted Hedge's *g*; the black squares are the Hedge's *g* for each study, together with 95% CI. The size of the square reflects the sample size of the study.

similar on the action-recognition (Hedge's $g = -0.60$, $P < .0001$) and identity-recognition paradigms (Hedge's $g = -0.55$, $P = .03$).

Next, a meta-analysis on new item recognition in patients with and without hallucinations was performed, which included a total of 5 studies with a total of 214 participants. The mean weighted Hedge's *g* was -0.13, which was not significant ($P = .352$). In addition, heterogeneity was high: $I^2 = 71\%$ (See online supplementary figure C). To investigate potential influence of publication bias, a funnel plot was created which showed that publication bias did not contribute to the obtained results (See online

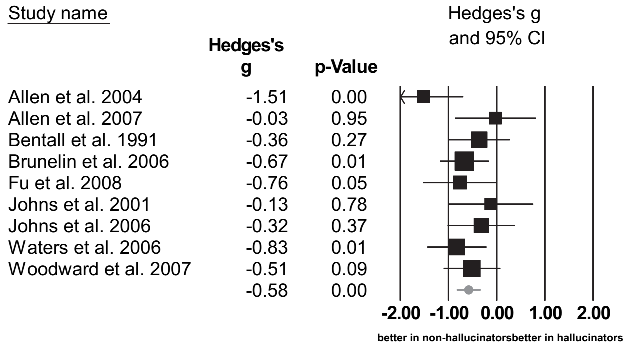

Fig. 3. Effect Size Estimates of the Difference in Self-recognition Accuracy Between Patients With and Without Hallucinations. The red dot shows the mean weighted Hedge's *g*; the black squares are the Hedge's *g* for each study, together with 95%CI. The size of the square reflects the sample size of the study.

supplementary figure D). Application of the trim and fill method did not change the results.

Discussion

The current study sought to conduct a meta-analysis of studies examining self-recognition performance in patients with schizophrenia and auditory hallucinations. To our knowledge, this is the first quantitative review of this literature. Analyses showed poorer self-recognition performance in schizophrenia compared with healthy controls, which was accompanied by significant deficits in new item recognition. The second set of analyses showed that patients with auditory hallucinations had greater impairments in self-recognition than patients without these symptoms. The effect size of this impairment was moderate and was observed across different experimental paradigms. Importantly, patients with and without hallucinations did not differ in performance accuracy on items that were externally presented (new items), pointing to specific deficits in self-recognition performance.

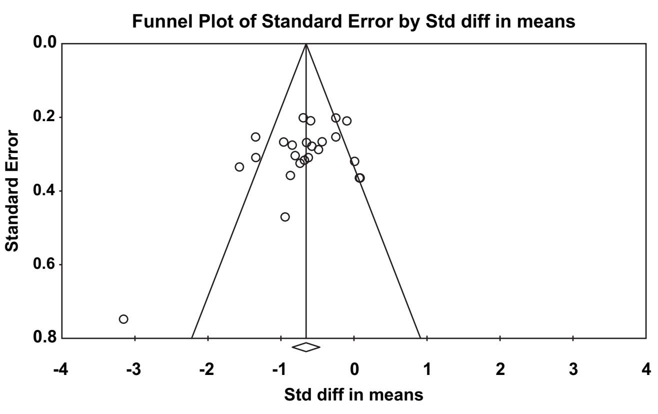

Fig. 2. Funnel Plot of Studies of Self-recognition in Schizophrenia Patients and Healthy Controls.

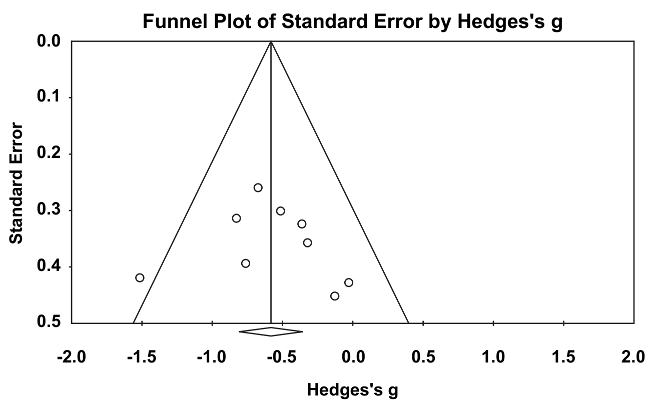

Fig. 4. Funnel Plot of Studies of Self-recognition in Patients With and Without Hallucinations.

Self-recognition Performance in Patients with Auditory Hallucinations

The current findings clearly point to a breakdown in self-recognition in patients with auditory hallucinations, supporting early suggestions[1,2] and contemporary models that suggest that difficulties recognizing the self are a prominent feature of auditory hallucinations. These results could not be otherwise explained by demographics or clinical variables as, apart from hallucination status, these characteristics were comparable in the two groups. One striking finding was the consistency in results across studies, despite methodological variations on tasks assessing self-recognition. Some studies used a traditional source memory design asking for a delayed judgment regarding the origin of actions and words.[60,62,63,67] Other studies required an immediate source judgment while participants spoke aloud or listened to prerecorded speech.[33,61,64,65] A sensorimotor task was also used which required immediate reporting on the origins of hand movements.[21] Common to all studies, however, was the specific requirement to make a self-recognition judgment. The remarkable consistency across studies indicates that self-recognition deficits occur across all action modalities, timing delays, and regardless of the design measuring self-recognition.

As self-recognition deficits are seen on immediate conditions and after a delay, it seems likely that processing abnormalities in patients with auditory hallucinations occur in the early stages of presentation (which in memory tasks might be referred to as encoding), rather than in mnestic processes. Johnson and Raye[68] suggested the term *reality testing* to refer to the processes by which people make distinctions during current and ongoing experiences and the term *reality monitoring* for the processes by which people discriminate between memories derived from perception and mental contents generated via thought, imagination and dreams. Thus, it could be hypothesized that the self-recognition difficulties in patients with hallucinations primarily arise during reality testing, which will undoubtedly influence reality monitoring (including memory) performance subsequently.

Importantly, we found evidence of the *same deficit* on tasks, which were designed to assess separate theoretical models. Thus, our finding illuminates the cognitive basis of hallucinations by implying an important role for self-recognition, although it does not further specify the nature of this impairment, be it at attentional/perceptual or meta-cognitive levels. However, there has been much progress in our understanding of the cognitive and neural basis of self-recognition deficits,[69–74] and these contributions allow for the search for candidate abnormalities to progress. An additional fact worth noting is that multiple interactions exist between sensorimotor information, memory and imagery processes[31,32] so that the models are not mutually exclusive. Given that schizophrenia is characterized by deficits in multiple cognitive domains, another explanation lies in the possibility that such combination of deficits provokes a vulnerability for experiencing auditory hallucinations. Further research should now examine which deficit is necessary and sufficient for self-recognition impairments to occur, although plausible models of auditory hallucinations must also incorporate a role of gene-by-environment interactions.

Another interesting finding was the consistency of results across studies of auditory hallucinations that have used different groups of patients without these symptoms. Studies comprised patients who had never hallucinated[33,61,64–66] and some a documented history of (but not current) hallucinations.[60,62,63,67] These findings point to a dysfunction that may represent a state marker for auditory hallucinations.

Recognition of External (new) Information in Patients With Auditory Hallucinations

While patients with auditory hallucinations showed self-recognition deficits, they were no more impaired in the recognition of external information (on new items) when compared with patients without these symptoms. Self-recognition and new item recognition rely on different cognitive processes and brain neural networks.[75–79] Source memory depends on the retrieval of specific contextual details in memory and draws heavily on the frontal lobes for controlled activations and monitoring processes. By contrast, new items recognition relies on "online" and automatic processes in the absence of source information.[75–79] Specific deficits in self-recognition therefore points to impairments in intentional and controlled, rather than automatic, processes,[27,80] consistent with theories of auditory hallucinations which advocate for a lack of modulatory control of the frontal cortex over activities generated by the posterior brain areas.[81–83]

For the current study, we focused on new items rather than on information that was generated by another agent (typically the experimenter). Several reasons support this choice: (1) new items comprise information that is externally presented, so it is a suitable condition to index recognition of nonself information, (2) the recognition of self and other is not easily differentiated experimentally given overlapping cognitive and neural requirements associated with source recognition,[30,31] (3) a failure of self-recognition might influence the belief that information arises from another agent and hence produce distortions in the recognition of information that is generated by another agent, Finally, (4) auditory hallucinations occur in "real time", but the differentiation between the self and other agents frequently relies on the retrieval of specific information in memory. As a result, "new items" are better tailored to parsing online processes from memory processes.

Misattributions, Source Discrimination, Delusions, and Limitations

It should be noted that a failure of self-recognition may be a necessary but not sufficient condition to produce auditory hallucinations. At least two steps are likely to be required to produce hallucinations[84]: (1) alienation (nonrecognition) of self-generated events, for which evidence has been provided here and (2) misattribution of self-generated events to some other specific origin/location combination. The first type of cognitive process involves the loss of the cognitive representations, which code the self-generated nature of mental events. The second occurs when hallucinators incorrectly attribute internal events to an external agent. The latter can be detected with the examination of systematic biases in responding. Biases are reliant on higher-level decision-making and judgment processes,[30,31] and evidence shows that they may be secondary to self-recognition deficits[7,8,33,66] and at least partially independent.[57,60,62] This indicates a need for future empirical studies to clearly differentiate these variables and to examine the role of other symptoms, such as delusions, in mediating their relationship. This point is particularly important in view of the observation that hallucinating schizophrenia patients often have delusions. Clinically speaking, the interchange between hallucinations and delusions is important. However, while hallucinations and delusions share common mechanisms, the link between self-recognition and delusions remains speculative.

The ability to differentiate between different agents (ie source discrimination) was not directly addressed in this article. Information regarding this topic is mixed. Notably, recent studies have failed to find significant group differences[85,86] (Achim and Weiss [2008][85] study was not included in this meta-analysis as the data on self-recognition performance was no longer available from the corresponding authors.). The limitations reviewed above regarding the choice of control condition may have contributed to these results.

The study had limitations. First, nearly all studies of auditory hallucinations have involved patients with schizophrenia so the current study necessarily focused on this clinical group. One exception is the study by Johns et al[66] which included a bipolar disorder group with hallucinations who did not show the same level of deficits as hallucinating patients with schizophrenia. The performance of patients with different psychiatric disorders is of interest given the recent focus of the psychiatric research community on symptoms rather than diagnosis.[87] However, the observation that self-recognition deficits are particularly characteristic of schizophrenia supports the view that a continued focus on diagnosis may be useful. Second, there was not enough information in the studies reviewed here to examine for possible confounder effects such as IQ differences or type/dose of medication. While it is possible that low IQ plays a partial role in self-recognition and auditory hallucinations,[88,89] the failure to find deficits on new item recognition argues against a global dysfunction in people with hallucinatory experiences.

A strength of the current study, however, is that it included patients with a range of clinical characteristics. The study comprised patients with first-episode psychosis and in the acute, chronic, and remitted stage of the illness, as well as unmedicated patients, suggesting that self-recognition deficits in schizophrenia are relatively stable across the stages of the illness.

Our findings have a number of important implications. The results suggest that self-recognition deficits must become an important treatment target in future studies, especially in the early stages of the disease. Another important implication concerns the relationship between cognitive deficits and functional outcomes.[90] The functional implications of self-recognition deficits are currently unclear, although recent studies point to a fundamental relationship between self-awareness in schizophrenia and the expression of social behaviors and emotions[44,91] (termed "social dysmetria"[91]). Self-recognition deficits in patients with auditory hallucinations might therefore contribute to deficits in social and interactive behaviors, although this idea must be pursued in future prospective studies.

In conclusion, we found consistent evidence for impaired self-recognition in schizophrenia, which was most pronounced in patients with auditory hallucinations. This suggests an association, which may be causal in nature, between this deficit and auditory hallucinatory experiences in schizophrenia.

Supplementary Material

Supplementary material is available at http://schizophreniabulletin.oxfordjournals.org.

Funding

Australian National Health and Medical Research Council grants (634328, 404117 to F.W.).

Acknowledgments

The authors have declared that there are no conflicts of interest in relation to this subject of this study.

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