The crisis of minimal self-awareness in schizophrenia: A meta-analytic review

Ji-Won Hura, Jun Soo Kwon, Tae Young Lee, Sohee Park

Abstract

Disturbances of the minimal self, characterized by abnormal sense of the body, body ownership and agency have been proposed as the phenomenological phenotype of schizophrenia. However, self-disturbances have not been extensively investigated, in part, due to the subjective nature of such processes, and the associated difficulty of studying these phenomena using empirical methodology.

Of 115 potential studies on self-awareness in schizophrenia, a total of 25 studies met the inclusion criteria for the meta-analysis comprising 690 patients with schizophrenia and 979 healthy controls. We calculated Hedge’s g to obtain a better estimate for the standardized mean difference in small samples. We identified significant basic self-disturbance in schizophrenia, as compared with healthy controls (25 studies, effect size = 0.51). Additional comparison of three sub-categories of the sense of body ownership (4 studies, effect size = 0.91), the sense of agency (15 studies, effect size = 0.49), and self-reported subjective experiences (6 studies, effect size = 0.57) also confirmed group differences. The complete set of 25 studies, and the studies in the sub-categories showed the statistical homogeneity of the characteristics. After a correction for potential publication bias using the trim-and-fill method, the main findings for all studies combined remained significant. Overall, patients with schizophrenia showed deficits in the sense of the minimal self, driven by abnormal sense of body ownership and sense of agency. Interestingly, the disturbed sense of agency in schizophrenia suggests an exaggerated self-consciousness rather than a diminished sense of self. Further research that utilizes sophisticated study designs is needed to examine the nature of self-disturbances in schizophrenia.

1. Introduction

I feel I am always divided against my self by myself.

[Bryan Charnley, 18th May 1991]

One of the most haunting and beautiful images of disintegrating self can be glimpsed in a series of powerful self-portraits painted by the late Bryan Charnley during the last four months of his life (see http://www.bryancharnley.info/index.asp). Mr. Charnley was an artist of immense talent and poetic vision, who struggled with schizophrenia until his suicide in 1991. For his self-portrait series, he kept a detailed and lucid diary of his thoughts and feelings, which allows us to grasp the subjective phenomenology of self-disturbances. His final self-portrait, completed shortly before his death, is a canvas filled with swathes of hues merging into one another; there are no shapes or forms to communicate to the observer where the self begins or ends, just strips of color stranded in space and time. This is how he saw himself.

For decades, concepts of the self were considered to be abstract and vague notions that could only be discussed in phenomenological terms. The neurobiological substrates of the self, however, are becoming increasingly accessible as a result of recent advances in brain imaging techniques. Specifically, one particular intrinsic brain network, known as the default mode network (DMN), appears to play a significant role in the sense of self (Qin and Northoff, 2011) such that altered patterns of connectivity in the DMN may lead to deficits in self-referential processing and aberrant experience of self in psychosis (Carhart-Harris and Friston, 2010).

Traditionally, self-disorders and anomalous subjective experiences have always been essential to the concept of psychosis. Kraepelin noted that a loss of inner unity was the core feature in dementia praecox (Kraepelin, 1896). A basic alteration of self-consciousness, basic disorder of personality, loss of natural self-evidence or loss of ego boundary (Bleuler, 1911; Berze, 1914; Schneider, 1959; Blankenburg, 1971) are terms that have also been used to describe and define schizophrenia. The
The term 'basic' when describing self-awareness refers to the most fundamental selfhood, the minimal self. The minimal sense of self is an immediate conscious experience of oneself, which remains when the 'pre-reflective self' (the extended and relatively explicit awareness of the self as invariable and steadfast subject through time and place) and the 'narrative self' (the most complex and sophisticated level of selfhood which is formulated from autobiographical memory such as personality, body, habits and other sociocultural characteristics) are stripped away (Sass and Parnas, 2003; Zahavi, 2005). Minimal self, basic self, core self, and proto-self are other terms used interchangeably to describe this pre-reflective and primitive level of selfhood.

The important features of the core sense of self are body ownership and sense of agency, based on conceptual, neurocognitive and psychopathological evidence (Synofzik et al., 2008; Stanghellini, 2009; Blanke, 2012; Ferri et al., 2012). A sense of body ownership involves implicit and tacit feelings of possession of the physical body and identification of the self as the one who is undergoing the bodily experience (Ferri et al., 2012). Body ownership has been studied empirically with proprioceptive and somatic tasks such as the rubber hand illusion in schizophrenia (Thakkar et al., 2011) and schizophrenic (Thakkar et al., 2011; Germine et al., 2013). When subjects watch the stimulation of a rubber hand while synchronously feeling a congruent stoke on their own hand, they may feel that "the (rubber) hand being stroked is (their) part of the body".

The sense of body ownership occurs regardless of whether an action is generated by the self or other, whereas the sense of agency refers to the sense of being the one who initiates an action. In other words, one's sense of agency is linked to the ability to maintain the distinction between the individual and the environment (Kircher and Leube, 2003; Lallart et al., 2009). This type of self-awareness is often investigated empirically with action attribution or action monitoring tasks; misattributions occur when individuals misjudge the causality between an intentional action and an external event (Haggard et al., 2003; Jeannerod, 2009; Synofzik et al., 2010), and monitoring errors arise when we are unable to detect whether we are in control of action or not (e.g., being in control or out of control) (Russell, 1996; de Vignemont and Fournet, 2004; Miele et al., 2011).

Although a large body of literature comprising self-reports, neuroimaging studies, commentaries, and reviews provide evidence for abnormal sense of minimal self in schizophrenia (e.g., Ferri et al., 2012; Maeda et al., 2012; Sass, 2001; Sass and Parnas, 2003), the nature and extent of this disruption has not been precisely identified. Moreover, the wide range of methodologies and conceptual differences inherent in these studies make it difficult to directly evaluate the strength of evidence for self-disturbances in schizophrenia. The goal of the present study was to conduct a meta-analysis to test the significance of altered minimal self-awareness in schizophrenia. Furthermore, we aimed to test for homogeneity and examine sub-categories of self-disturbances: the sense of the body, body ownership, the sense of agency, and anomalous self-perceptions.

2. Methods

2.1. Literature search

Studies to be included in the meta-analysis were identified through a thorough search in MEDLINE and PsycINFO (January 1980–January 2013). See Fig. 1 for a summary of the study selection process. Studies of dissociative experiences and sensory monitoring were excluded because the former is state-dependent (Brunner et al., 2004; Schäfer et al., 2012) and the latter is more involved with signal detection and hallucination than with the genuine self-disorders (Morrison and Haddock, 1997) and we were primarily focused on trait-like disturbances of self. Additional articles were selected from the reference lists of the studies retrieved. The articles were limited to peer-reviewed articles published in the English language.

2.2. Inclusion criteria

The study design had to include patients with schizophrenia and a healthy control group. The diagnostic criteria for schizophrenia had to be made according to either the Diagnostic and Statistical Manual of Mental Disorders (DSM) or the International Statistical Classification of Diseases (ICD). The studies were required to have included one or more measures for self-awareness. Access to sufficient information for analysis had to be available. Duplicate data were removed.

2.3. Review and coding

Among 800+ papers, selected from the initial screening by electronic and manual search, 115 potentially relevant studies were selected based on the study title and abstract. Full text articles of these 115 studies were retrieved and of these, 90 records were excluded. The reasons for exclusions are provided in Fig. 1. Thus, a total of 25 publications survived for the meta-analysis. In the main meta-analysis, for studies that reported multiple outcomes, they were either combined or, when combination was inappropriate, one representative variable that best defined self-awareness was selected. Data were extracted independently and compared by two investigators. Any discrepancies were discussed until a consensus was reached.

The variables recorded were authors, year published, sample sizes, gender distribution, mean age, diagnostic system used, duration of the illness, history of medication, information on measurements, means and SDs of measurements on minimal self-disturbances (Table 1). Lastly, these 25 publications used various combinations of keywords, indicating a wide variety of experimental domains and methods for measuring minimal self-awareness (see Fig. 2 for word clouds generated from http://www.wordle.net; the physical size of the words corresponds to the frequency of the words). Therefore, we classified and coded the publication with respect to the sense of body and ownership (O), sense of agency (A), and reported anomalous self-experiences (R), according to the authors' definitions, descriptions and keywords of the measurements (Fig. 1).

2.4. Meta-analytical calculations

Statistical analyses were performed using Stata (version 11; Stata Corporation, College Station, TX, USA). Both random-effects models and fixed-effects models were adopted for each analysis. Random-effects models are usually used when the test of heterogeneity for the selected studies exists. Fixed-effects models are used when heterogeneity is absent. To assess the possible effects of publication bias, funnel plots were used and the trim-and-fill procedure was generated (Higgins et al., 2008). Unreported means and SD values were calculated from other statistics, exact t-values, or F-values. After computing effect sizes for each study, Hedges’ g, that is, the difference between the means of the experimental and comparison groups divided by the pooled SD and weighted for sample size, was used to obtain a better estimate for the standardized mean difference in small samples (Rosenthal, 1991). The effect sizes were weighted for sample size in order to correct for upwardly biased estimation of the effect in small sample sizes. All statistics were 2-sided, and \( P < .05 \) was regarded as significant.

Cochran's Q statistic and \( I^2 \) were calculated to test homogeneity of effect size across studies (Cochran, 1954; Higgins et al., 2003). Statistically significant heterogeneity was considered at \( P < .05 \) and \( I^2 > 50 \). To investigate the possible effects of publication bias, the Egger test and a funnel plot were used (Sutton et al., 2000). We used the trim-and-fill method to correct for small study effects due to publication bias (Duval and Tweedie, 2000).


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3. Results

3.1. Main outcomes from all studies combined

The summary of meta-analysis indicated significantly impaired minimal self-awareness in patients with schizophrenia \((g = 0.51, 0.26 \text{ to } 0.76, z = 3.94, P < .001)\) (Fig. 3). No statistically significant heterogeneity was found among these studies \((Q = 10.11, P = 1.000; I^2 = 0)\).

3.2. Sense of body and ownership

Meta-analyses of the sense of body and ownership \((N = 4\) studies) demonstrated large effect sizes \((g = 0.91, -0.05 \text{ to } 1.86, z = 1.87, P = .062)\). There was no significant heterogeneity between these studies \((Q = 10.11, P = .001; I^2 = 0)\).

3.3. Sense of agency

We then investigated whether patients with schizophrenia showed anomalous sense of agency \((N = 15\) studies). The effect sizes of the sense of agency were quite varied in schizophrenia, resulting in overall medium effect size \((g = 0.49, 0.17 \text{ to } 0.81, z = 3.01, P = .003)\). No significant heterogeneity for the tasks was revealed \((Q = 5.78, P = 1.000; I^2 = 0)\).

3.4. Self-reported sense of self in patients

When the meta-analysis was conducted on disturbed self-experience as indicated in self-reports and semi-structured interviews \((N = 6\) studies), effect sizes for these reported self-disturbances were medium \((g = 0.57, -0.05 \text{ to } 1.19, z = 1.80, P = .072)\). No significant heterogeneity for the tasks was detected \((Q = 2.55, P = .923; I^2 = 0)\).

3.5. Publication bias

A funnel plot and Egger test showed underlying publication bias for self-awareness in schizophrenia \((P < .001)\). However the effect size for all studies combined was still significant when the estimated 11 missing studies identified from the trim-and-fill method were included in the analysis \((g = 0.41, 0.18 \text{ to } 0.65, z = 3.43, P = .001)\). Potential publication bias therefore did not significantly affect the results.

4. Discussion

It is believed that the minimal self-awareness in schizophrenia is fragile \((Angyal, 1936; Watson et al., 2012)\). A diminished sense of self is frequently described in the prodromal stages of schizophrenia or in ultra-high risk for psychosis \((Parnas et al., 1998; Nelson et al., 2008, 2009, 2012; Hauser et al., 2011b)\), suggesting disturbed basic sense of self both as a core symptom and a psychopathological trait marker of psychosis vulnerability \((Parnas, 2000; Sass and Parnas, 2001; Parnas et al., 2003, 2011; Raballo and Parnas, 2011)\). The current meta-analysis combining 25 studies of 690 patients with schizophrenia and 979 healthy controls indicates a crisis of minimal self in schizophrenia. An additional comparison of results from the sense of body and ownership \((O)\), sense of agency \((A)\), and self-reported subjective experiences \((R)\) also implied an unstable minimal self with medium to large effect sizes in patients with schizophrenia. We also reported statistical homogeneity across the 25 studies overall, and the studies selected for the three sub-categories.

To Freud, psychosis was a matter of a conflict between the self and the external world, in contrast to neurosis which was conceived as a conflict within the self \((Freud, 1924; Pollack, 1989)\). Individuals with schizophrenia-spectrum disorders have difficulty with the boundary between self and others, often described as being blurred \((Quinlan and Harrow, 1974)\). The Schneiderian first rank symptoms, such as...
thought insertion, thought-broadcasting, somatic passivity, or delusion-
al perception are typical for people with self-disturbances (Fournet
et al., 2001; Jeannerod, 2009; Waters and Badcock, 2010). From this
viewpoint it is therefore not surprising that fundamental distortions of
selfhood make a major contribution to pathological interactions with
other people and the environment (Stanghellini, 2009). Additionally,
these anomalous subjective experiences appear to be significantly
linked to suicidality in schizophrenia (Skodlar et al., 2008; Haug et al.,
2012a,b), self-distortions should be carefully monitored.

There is also strong evidence to indicate that a disturbed sense of
body and sense of ownership are related to psychosis and psychosis-
proneness (Chapman et al., 1978; Peled et al., 2000; Waters and Badcock,
2010; Morgan et al., 2011; Thakkar et al., 2011; Germine et al.,
2013). When the integration of sensorimotor perception, stim-
uli localization, and body awareness is distorted (Balconi and
Bortolotti, 2010; Thakkar et al., 2011; Germine et al., in press), pa-
tients may experience cognitive and perceptual distortions, and po-
rous self-other boundary such that they may fail to experience self as
distinctly different from others. Moreover, disturbed sense of own-
ship leads to an inability to relate to others and a loss of tacit attune-
ment to the environment (Fuchs and Schlimme, 2009; Stanghellini,
2011), which intensi-

Table 1
Characteristics of studies included in the meta-analysis.

<table>
<thead>
<tr>
<th>Study</th>
<th>Diagnostic criteria (diagnostic system)</th>
<th>Medication</th>
<th>SZ sample (male)</th>
<th>HC sample (male)</th>
<th>SZ mean age (SD)</th>
<th>HC mean age (SD)</th>
<th>Experimental design (task)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peled et al. (2000)</td>
<td>SZ (SCID-I)</td>
<td>All AP</td>
<td>37 (19)</td>
<td>21 (11)</td>
<td>39.0 (7.2)</td>
<td>32.2 (4.0)</td>
<td>Experiment (rubber hand illusion)</td>
</tr>
<tr>
<td>Maggini and Raballo (2004)</td>
<td>SZ (NR)</td>
<td>Drug-naive or drug-free</td>
<td>38 (22)</td>
<td>25 (12)</td>
<td>39.0 (7.2)</td>
<td>32.2 (4.0)</td>
<td>Experiment (rubber hand illusion)</td>
</tr>
<tr>
<td>Thakkar et al. (2011)</td>
<td>SZ (SCID-I)</td>
<td>23 AP, and 1 AD</td>
<td>24 (15)</td>
<td>21 (11)</td>
<td>41.7 (8.3)</td>
<td>40.1 (9.1)</td>
<td>Experiment (rubber hand illusion)</td>
</tr>
<tr>
<td>Ferri et al. (2012)</td>
<td>SZ (DSM-IV)</td>
<td>All AP (484 Cpz-eq)</td>
<td>21 (11)</td>
<td>21 (11)</td>
<td>27.7 (6.3)</td>
<td>29.2 (5.9)</td>
<td>Experiment (bodily self-advantage effect)</td>
</tr>
<tr>
<td>Stirling et al. (1998)</td>
<td>SZ (DSM-III-R)</td>
<td>All but one AP (821 Czp-eq)</td>
<td>35 (21)</td>
<td>24 (25)</td>
<td>41.2 (9.2)</td>
<td>41.2 (9.2)</td>
<td>Experiment (self-monitoring)</td>
</tr>
<tr>
<td>Haggard et al. (2003)</td>
<td>SZ (DSM-IV)</td>
<td>20.2 Hpd-eq</td>
<td>8 (6)</td>
<td>6 (6)</td>
<td>44.6 (9.9)</td>
<td>42.5 (9.3)</td>
<td>Experiment (agency task)</td>
</tr>
<tr>
<td>Farrer et al. (2004)</td>
<td>SZ (DSM-IV)</td>
<td>6 AP, 1 anxiously, 1 mood stabilizer</td>
<td>8 (0)</td>
<td>5 (8)</td>
<td>44.6 (9.9)</td>
<td>42.5 (9.3)</td>
<td>Experiment (action attribution)</td>
</tr>
<tr>
<td>Bulot et al. (2007)</td>
<td>SZ (DSM-IV)</td>
<td>ND</td>
<td>24 (ND)</td>
<td>24 (ND)</td>
<td>36.7 (36.6)</td>
<td>35.7 (35.6)</td>
<td>Experiment (agency task)</td>
</tr>
<tr>
<td>Lallart et al. (2009)</td>
<td>SZ (DSM IV, SCID-I)</td>
<td>ND</td>
<td>19 (0)</td>
<td>19 (10)</td>
<td>M 29.6</td>
<td>M 28.8</td>
<td>Experiment (action attribution)</td>
</tr>
<tr>
<td>Kumari et al. (2010)</td>
<td>SZ (NR)</td>
<td>All AP</td>
<td>63 (47)</td>
<td>20 (14)</td>
<td>37.9 (9.6)</td>
<td>33.9 (6.2)</td>
<td>Experiment (self-monitoring)</td>
</tr>
<tr>
<td>Schimansky et al. (2010)</td>
<td>SZ (ICD-10)</td>
<td>33/40 AP (410.8 Cpz-eq)</td>
<td>40 (28)</td>
<td>40 (23)</td>
<td>38.0 (9.8)</td>
<td>34.4 (9.7)</td>
<td>Experiment (agency task)</td>
</tr>
<tr>
<td>Voss et al. (2010)</td>
<td>SZ (ICD-L, ICD-10)</td>
<td>728.5 Cpz-eq</td>
<td>24 (22)</td>
<td>24 (21)</td>
<td>34.8 (13.1)</td>
<td>34.4 (9.7)</td>
<td>Experiment (agency task)</td>
</tr>
<tr>
<td>Hauser et al. (2011a,b)</td>
<td>SZ (DSM-IV)</td>
<td>(709.5 Cpz-eq)</td>
<td>30 (26)</td>
<td>30 (15)</td>
<td>32.9 (9.3)</td>
<td>34.3 (11.3)</td>
<td>Experiment (action attribution)</td>
</tr>
<tr>
<td>Gawęda et al. (2012)</td>
<td>SZ &amp; SZA (Mini International Neuropsychiatric Interview)</td>
<td>All AP</td>
<td>32 (23)</td>
<td>32 (11)</td>
<td>32.8 (8.3)</td>
<td>31.78 (11.67)</td>
<td>Experiment (self-monitoring)</td>
</tr>
<tr>
<td>Maeda et al. (2012)</td>
<td>SZ (DSM-IV)</td>
<td>(140 Hpd-Eq)</td>
<td>30 (21)</td>
<td>30 (16)</td>
<td>37.9 (11.9)</td>
<td>35.9 (10.4)</td>
<td>Experiment (agency task)</td>
</tr>
<tr>
<td>Metcalfe et al. (2012)</td>
<td>SZ &amp; SZA (SCID-I)</td>
<td>All AP (362.8 Cpz-eq)</td>
<td>22 (13)</td>
<td>20 (12)</td>
<td>28.2 (3.9)</td>
<td>29.8 (5.1)</td>
<td>Experiment (action attribution)</td>
</tr>
<tr>
<td>Wilquin and Delevoye-Turrell (2012)</td>
<td>SZ (ICD-10)</td>
<td>14/17 AP (251.79 Cpz-eq)</td>
<td>17 (9)</td>
<td>36 (13)</td>
<td>21.4 (11.1)</td>
<td>25.8 (9.1)</td>
<td>Experiment (agency task)</td>
</tr>
<tr>
<td>Renes et al. (2013)</td>
<td>SZ (DSM-IV)</td>
<td>All AP (7.3 Hpd-Eq)</td>
<td>23 (20)</td>
<td>23 (19)</td>
<td>32.7 (7.1)</td>
<td>28.5 (8.6)</td>
<td>Experiment (agency task)</td>
</tr>
<tr>
<td>Self-report/semi-structured interview on self-disturbances (R)</td>
<td>Katsanis et al. (1996)</td>
<td>SZ (DSM-III)</td>
<td>Drug-naive</td>
<td>38 (ND)</td>
<td>160 (57)</td>
<td>49.6 (9.2)</td>
<td>32.8 (14.6)</td>
</tr>
<tr>
<td>Clementz et al. (1991)</td>
<td>SZ (DSM-III-R)</td>
<td>ND</td>
<td>54 (32)</td>
<td>178 (123)</td>
<td>26.0 (7.5)</td>
<td>33.3 (17.6)</td>
<td>Self-report (Scales of Perceptual Aberration Scale)</td>
</tr>
<tr>
<td>Frankie et al. (1994)</td>
<td>SZ (DSM-III-R)</td>
<td>Drug-naive or drug-free</td>
<td>355 (24)</td>
<td>35 (22)</td>
<td>27.9</td>
<td>27.2</td>
<td>Self-report (Perception Aberration Scale)</td>
</tr>
<tr>
<td>Catts et al. (2000)</td>
<td>SZ (DSM III R, ICD-9)</td>
<td>ND</td>
<td>23 (ND)</td>
<td>19 (ND)</td>
<td>18.3 (4.5)</td>
<td>ND</td>
<td>Self-report (Perception Aberration Scale)</td>
</tr>
<tr>
<td>Laurent et al. (2000)</td>
<td>SZ (SCID)</td>
<td>ND</td>
<td>23 (21)</td>
<td>34 (23)</td>
<td>31.6 (7.1)</td>
<td>41.8 (13.6)</td>
<td>Self-report (Perception Aberration Scale)</td>
</tr>
<tr>
<td>Raballo and Parnas (2011)</td>
<td>SZ spectrum (DSM-III-R)</td>
<td>ND</td>
<td>29 (5)</td>
<td>103 (57)</td>
<td>43.6 (18.9)</td>
<td>45.2 (17.8)</td>
<td>Semi-structured interview (self-disorder scale)</td>
</tr>
</tbody>
</table>

SZ, schizophrrenia; HC, healthy controls; AP, on antipsychotics; AD, on antidepressant; Cpz-eq, mean dose in chlorpromazine equivalents (mg/day); Hpd-eq, mean dose in haloperidol equivalents (mg/day); ND, no data available.

⁎ Cpz-eq was calculated on 17 SZ because no equivalents are available for paliperidone.

** Only 19 subjects’ data were available for Perceptual Aberration Scale (16 patients with invalid test-taking attitudes).
under-attribution (Stirling et al., 1998; Fuchs, 2005; Synofzik et al., 2010; Renes et al., 2013) but both have been reported in schizophrenia. Over-attribution can be observed in the intentional binding effect (Haggard et al., 2003; Voss et al., 2010; Maeda et al., 2012), which is induced when voluntary actions and perceived events are interpreted as temporally binding (Haggard et al., 2002). This effect is exaggerated in schizophrenia, indicative of these patients’ excessive sense of agency and overestimation of the causality of their actions upon the external world. Patients may be prone to perceive meaningful messages and signals from irrelevant external stimuli (e.g., delusions of reference or persecution) (Heinz and Schlagenhauf, 2010; Synofzik et al., 2010; Voss et al., 2010; Maeda et al., 2012). Such paranoid delusions are distinguished from the delusions of grandeur and omnipotence of mania, and are exacerbated by altered dopaminergic signaling in the amygdala and prefrontal cortex (Kumakura et al., 2007; Heinz and Schlagenhauf, 2010; Rosenfeld et al., 2011).

Dopamine seems to have a critical effect on both over- and under-attributions (Frith, 2012). Under-attribution, another case of misattribution of agency, is manifested in delusions of control, alienation, and thought insertion. Patients with a loss of a sense of agency
often believe their own actions are caused by external stimuli (Schmidt, 1975; Spence et al., 1997; Fournier et al., 2001). Then, do over- and under-attributes represent two sides of the same coin, or two separate coins? Recently, Hauser and her colleagues have described the exaggerated sense of agency in schizophrenia as a product of compensating for the passivity phenomenon (Hauser et al., 2011a) but further study is needed to clearly define the link between under-attribution and over-attribution.

Lastly, the subgroup analysis on anomalous self-experience, obtained from self-report questionnaires or semi-structured interviews, indicated that these experiences in patients with schizophrenia were frequent and severe. It is interesting that the patients were sensitive to these anomalous self-experiences and voluntarily reported them despite greatly reduced insight into their illness (Mintz et al., 2003). These findings suggest that it is important to attend to evidence of self-disturbances in the schizophrenia spectrum, especially in high-risk individuals in the premorbid and prodromal stages.

There are limitations to our meta-analysis. Studies of the sense of self have adopted a wide variety of experimental tasks, questionnaire and measures. We could only include a small fraction of published studies because a vast majority of studies failed to meet our criteria (comparison of schizophrenia and control groups, availability of measures etc.). Although we reached agreements in the study selection criteria based on the aims and keywords of each study, other researchers may prefer alternative classifications. When we further categorized these studies into 3 subgroups, the sample sizes for these analyses were rather small. In spite of these limitations, we believe that the results of the subgroup analyses are statistically plausible and reasonable because the homogeneity analyses guaranteed the propriety of clustering. Another limitation is the glaring absence of evidence of clustering. Another limitation is the glaring absence of evidence of clustering. Another limitation is the glaring absence of evidence of clustering. Another limitation is the glaring absence of evidence of clustering. Another limitation is the glaring absence of evidence of clustering.

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