Psychiatry Research 267 (2018) 187–194

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Associations among domains of self-disturbance in schizophrenia

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ARTICLE INFO

Keywords:
Anomalous self-experience
Self-concept clarity
Somatosensation

ABSTRACT

Self-disturbances are increasingly recognized as important, possibly even central, features of schizophrenia. However, little is known about the associations among different manifestations of self-disturbances. The aims of the current study were threefold. We aimed to (1) replicate previous findings of increased self-disturbances in schizophrenia, (2) correlate manifestations of self-disturbances in schizophrenia across three domains, and (3) correlate self-disturbances with five symptoms domains of schizophrenia, including positive, negative, disorganized symptoms, excitement, and emotional distress. We examined three domains of self-experience, including somatosensation, anomalous self-experiences, and self-concept clarity. Participants included 48 individuals with schizophrenia and 36 non-psychiatric controls. The results of this study replicate previous findings of significantly higher levels of self-disturbances in people with schizophrenia. The results also indicate positive correlations between the domains of anomalous self-experiences and self-concept clarity, but not somatosensation, in individuals with schizophrenia. As well, anomalous self-experiences were positively correlated with positive symptoms, disorganized symptoms, and emotional distress and self-concept clarity was negatively correlated with disorganized symptoms and emotional distress.

1. Introduction

A long line of research suggests that people with schizophrenia spectrum disorders have disturbances in the experience of self (Henriksen and Parnas, 2012; Hur et al., 2014; Sass, 2014). Self-disturbances are abnormalities in the subjective experience of selfhood (Parnas et al., 2005). These self-disturbances have been conceptualized in several different ways by different research groups, including misattribution of agency (Voss et al., 2010), disrupted sense of body ownership (Röhricht and Priebe, 2006), impaired self-other distinction (Ferri et al., 2014), and disturbances in the subjective experience of self (Parnas et al., 2005). Research on self-disturbances in schizophrenia is important for several reasons. First, some theorists have suggested that self-disturbances are central to the pathology of schizophrenia, despite not being listed as a symptom in any of the major nosologies (Park, 2014; Parnas et al., 2005). Second, self-disturbances have been noted during the premorbid (Brent et al., 2014), prodromal (Nelson et al., 2012), first episode (Ebisch et al., 2014), and chronic phases of schizophrenia (Moe and Docherty, 2014). Thus, understanding self-disturbances may help to understand all phases of the disorder. Finally, self-disturbances have been linked to both positive and negative symptoms (Nordgaard and Parnas, 2014), suggesting that they may be important for understanding the underlying mechanisms of schizophrenia.

Although self-disturbances have been identified as an important feature of many recent conceptualizations of schizophrenia, few studies have explored the relation between different manifestations or conceptualizations of self-disturbance. Self-disturbances in schizophrenia have been documented in at least three domains or levels of experience, including: Domain (1) somatosensation, which includes exteroception, the perception of stimuli outside of the body, and proprioception, the perception of body position and movement based on internal stimuli; Domain (2) anomalous self-experiences, which are first-person experiences of body ownership and integrity (Raballo and Parnas, 2012); and Domain (3) self-concept clarity (Cicero et al., 2016b; Noyman-Veksler et al., 2013), which is the ability to converge the many aspects of self-concept into a coherent identity (Campbell et al., 1996). To our knowledge, no studies have examined all three of these domains in a single study. As a result, it is unclear if these conceptualizations of self-disturbances are related to one another.

The somatosensory system is the portion of the peripheral and central nervous system that processes touch, pain, body position, and internal bodily sensations. Previous research has found that people with schizophrenia are impaired on measures of somatosensation (e.g. Boettger et al., 2013; Dworkin, 1994; Javitt et al., 1999). Moreover, impairments in somatosensation may be a marker for the development

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https://doi.org/10.1016/j.psychres.2018.05.082
Received 12 September 2017; Received in revised form 9 May 2018; Accepted 29 May 2018
Available online 06 June 2018
0165-1781/

of psychosis and present in the early stages of the disorder (Hauser et al., 2011; Stanghellini et al., 2012). This study included measures of three subdomains of somatosensation: proprioception and the exteroceptive subdomains of tactile perception and haptic perception.

Tactile perception refers to the passive sense of touch. Previous work has found that people with schizophrenia (Broekma and Rosenbaum, 1975; Michael and Park, 2016), people with subclinical psychotic-like symptoms (Lenzenweger, 2000), and first-degree relatives of individuals with schizophrenia (Chang and Lenzenweger, 2001, 2005) have impaired tactile acuity. As well, impaired tactile acuity has been associated with higher levels of schizophrenia-like symptoms in a non-clinical population (Lenzenweger, 2000)

Haptic perception refers to the active exploration of the environment using the sense of touch (Lederman and Klatzky, 2009). Previous research has found abnormalities in haptic perception in individuals with schizophrenia (Kuster et al., 1975; Schooler et al., 1976; Wertheimer and Wesley, 1957). In the current study, we examined susceptibility to a haptic illusion in people with schizophrenia as compared to controls. Previous research suggests that people with schizophrenia are more susceptible to somatosensory illusions (Thakkar et al., 2011). However, to the best of our knowledge, no published research has examined illusion perception primarily recruiting haptic processes.

The third aspect of somatosensory function explored in this study is proprioception, the system responsible for ascertaining body position, motion, and balance. Proprioception has been shown to be impaired in schizophrenia (e.g., Chapin et al., 1996; Gapenne, 2010; Tanno et al., 1999; Thakkar et al., 2011; Williams et al., 2010) and first-degree relatives of people with schizophrenia. Recent work has also found poorer proprioceptive function in relatives of people with schizophrenia as compared to controls, which may indicate a link between proprioceptive dysfunction and genetic liability for schizophrenia (Chang and Lenzenweger, 2005). Abnormalities in the proprioceptive system may underlie more explicit symptoms of self-disturbance, such as distortion in the perception of body shape (Erwin and Rosenbaum, 1979; Rosenbaum et al., 1959; Rosenbaum et al., 1965) and abnormal bodily experiences (Michael and Park, 2016). This is supported by a recent study reporting an association between disturbances in self-experience and abnormalities in an electroencephalographic (EEG) index of proprioception (Arnfred et al., 2015). Examination of association between proprioception and other schizophrenia symptoms has yield mixed results, with one study finding association between poor proprioceptive integrity and positive symptoms in people with schizophrenia (Michael and Park, 2016), and another linking poor proprioception with negative symptoms and cognitive-perceptual dysfunction in first degree relatives of people with schizophrenia (Chang and Lenzenweger, 2005).

The second domain of self-disturbances examined in the current research is anomalous self-experiences. Anomalous self-experiences are disruptions of the subjective first-person experience of oneself, such as the in-the-moment sense of owning one's own body, having control of one's own actions, and being an active participant in one's environment. Anomalous self-experiences include symptoms such as derealization, unusual bodily sensations, difficulty distinguishing oneself from others, disturbances in stream of consciousness, and lack of feeling of authorship over one's own thoughts (Raballo and Parnas, 2012), as well as loss of a sense of agency and ownership of experience (Nelson et al., 2014). Anomalous self-experiences have been conceptualized as a hyper-reflexivity of self-experience, in which first-person-ness that would usually be tacit becomes the focal point of attention (Parnas et al., 1998; Sass, 2003; Sass and Parnas, 2003). This hyper-awareness may lead to a number of unusual experiences such as the feeling that one is losing oneself, a loss of connection with life experiences, dampening of the emotions, and feelings of derealization (Cicero et al., 2017)

Anomalous self-experiences may be associated with other prominent features of schizophrenia, including positive symptoms (Kim et al., 2010; Sass and Parnas, 2003), lack of insight (Bedford and David, 2014), depression (Haug et al., 2012a), suicidality (Haug et al., 2012b; Skodlar et al., 2008; Skodlar and Parnas, 2010) and social cognition and function (Ebisch et al., 2014; Fisher et al., 2008; Haug et al., 2014). Theorists have suggested that anomalous self-experiences and schizophrenia symptoms may be very closely related, and that anomalous self-experiences may underlie traditional schizophrenia symptoms such as delusions and hallucinations (Haug et al., 2014; Sass, 2003; Sass and Parnas, 2003). For example, if the implicit sensation of inhabiting one's own body is not present in an individual with schizophrenia, it may provide a starting point from which delusional beliefs about external control may develop. As well, one prominent model of hallucinations posits auditory hallucinations as misattributions of inner speech (Ford and Mathalon, 2005). These misattributions may be a result of the loss of an intrinsic sense of ownership over one's own thoughts. Thus, in some ways, it may be difficult to differentiate anomalous self-experiences from symptoms.

The third domain of self-disturbances examined in the current research is self-concept clarity (SCC). SCC is the degree to which an individual holds a stable and consistent perception of his or her own attributes and attitudes (Campbell et al., 1996). Individuals form a unitary concept of themselves by integrating their personal histories, personality characteristics, and other self-descriptions into a singular self-concept. Several researchers suggest that difficulty forming and maintaining a coherent self-concept may be a prominent feature of schizophrenia (Lysaker and Lysaker, 2010; Meehan and Machlachlan, 2008; Stanghellini and Lysaker, 2007). Instances of disturbed self-concept clarity in schizophrenia include decreased memory of self-referential information (Harvey et al., 2011), difficulty attributing meaning to autobiographical memories (Berna et al., 2011a, b), and reduced clarity of self-concept (Boulanger et al., 2013; Cicero et al., 2016a; Noyman-Veksler et al., 2013).

Although all three of these domains have been studied in people with schizophrenia, few studies have directly assessed the relations among them. However, several authors have suggested conceptual evidence for an association between these domains of self-disturbances in schizophrenia. Sass et al., (2013) posit that aberrations in bodily sensations could be explained by hyper-reflexivity, the excessive attention allocated to otherwise implicit self-experience. The authors describe how paying close attention to the sensations in a part of one's body can create the impression that the body part is no longer connected to oneself. In this way, deficits in somatosensory processing may be associated with anomalous self-experiences.

There were three primary goals of the current study. The first goal was to replicate the results of past studies indicating that individuals with schizophrenia have higher levels of self-disturbances as compared to the general population. The second goal was to examine whether measures from the three domains were correlated with each other. If the three domains represent different aspects of same broader self-disturbances construct, we would expect to find that they would be significantly positively correlated with each other. If they do not represent different aspects of the same construct, we would expect to find that they are not correlated with each other. The third goal was to examine the relation between self-disturbances and the positive and negative symptoms of schizophrenia. We expected to find that self-disturbances and positive and negative symptoms would be positively correlated with each other.

2. Methods

2.1. Participants

Participants included 48 individuals with schizophrenia or schizoaffective disorder and 36 non-psychiatric controls. The schizophrenia group was recruited via fliers and presentations in outpatient mental health facilities including the Hawaii Department of Health outpatient

Table 1
Demographic information for the schizophrenia and control groups.

	Schizophrenia group (n = 47)	Control group (n = 35)
Sex (% Female)	42.55%	45.71%
Ethnicity	–	–
Caucasian (%)	27.0%	41.7%
Pacific Islander	24.3%	4.2%
Mixed ethnicity	16.2%	29.2%
Japanese	10.8%	8.3%
Other	11.7%	14.6%
Mean (SD) age (years)	48.9 (10.7)	44.6 (13.8)
Mean (SD) parental education	14.1 (2.7)	13.3 (4.1)
Antipsychotic dosage (CPZ-Eq.)	263.4 (289.7)	0
PANSS total	63.1 (14.1)	–
PANSS positive	16.2 (5.6)	–
PANSS negative	13.9 (5.2)	–
PANSS disorganized	20.6 (6.4)	–
PANSS excitement	13.5 (3.8)	–
PANSS emotional distress	17.8 (5.0)	–

Note: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. SD = standard deviation; CPZ-Eq = therapeutic equivalent dose of antipsychotic medication, using Chlorpromazine mg/day as a reference; PANSS = Positive and Negative Syndrome Scale.

centers and clubhouses. The control group was recruited via the Craigslist online job posting forum, and by posting fliers in community areas. Control participants with a history of any Axis I mental disorder or full endorsement of any psychotic disorder criterion on the SCID were excluded. Two participants were excluded from the control group due to report of attenuated psychotic symptoms. The demographic characteristics of the two groups can be found in Table 1. The groups were matched on gender ($X^2(2, N = 84) = 0.02$, $p = .90$), ethnicity ($X^2(2, N = 84) = 6.15$, $p = .11$), age ($t(80) = -1.59$), and parental education ($t(41) = -0.77$). Participants were compensated between $50 and $75 for their time, depending on how long the study took for the individual.

2.2. Materials

2.2.1. Diagnostic and symptom ratings

Structured Clinical Interview for the DSM-IV (SCID-I). The Structured Clinical Interview for DSM-IV (SCID; First et al., 1998) was used to confirm the diagnosis of the schizophrenia group and rule out previous mental illness in the control group. In previous research, the SCID has been found to have inter-rater reliability kappa values between 0.61 and 0.83, and validity kappa values between 0.76 and 0.78 for comparisons between SCID diagnosis and diagnosis made with other standard interview methods (Lobbestael et al., 2011).

Positive and Negative Syndrome Scale (PANSS). The Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) was used to assess common symptoms of schizophrenia. The PANSS is one of the most commonly used rating scales for schizophrenia symptoms. To facilitate ratings, we used the Structured Clinical Interview for the PANSS (SCI-PANSS). We calculated five symptom domains, positive, negative, disorganized, excitement, and emotional distress (Van der Gaag et al., 2006). In the current study, the interclass correlation coefficient was 0.78, indicating strong inter-rater reliability

2.2.2. Somatosensory measures

Two-point discrimination task. A two-point discrimination task was used to measure tactile perception. Two-point discrimination is a test of tactile spatial acuity in which individuals must distinguish whether a tactile stimulus has one point or two, using no visual input (Johnson and Phillips, 1981). In the two-point discrimination task, distances between the two-point stimuli are of varying length, affording the ability to calculate a two-point discrimination threshold (the inter-point distance at which an individual is able to distinguish two points from one at more than 50% accuracy). The following methods are based on a protocol designed to optimize the ability to distinguish sensitivity from response bias in a population prone to response bias (Chang and Lenzenweger, 2001). Participants were seated comfortably in a chair, with their dominant hand palm-up on a table. The experimenter explained that they would feel a series of one or two points on the palm of their hand, and they should verbally report after each stimulus presentation whether there was one point or two. Data were coded as a "1" if the response was correct and a "0" if the response was incorrect. With eyes still open, the participant was provided an example of the largest two-point stimulus interval (10 mm), as well as the one-point stimulus. Stimuli were administered using a standard caliper tool across the transverse plane of the palm. Each participant underwent 50 stimulus trials of a pseudorandom protocol including 25 trials of 0 mm, 13 trials of 6 mm, and 12 trials of 10 mm caliper intervals. In this two-point discrimination protocol, the relatively difficult 6 mm stimulus is considered the experimental condition, while the 10 mm stimulus, a relatively easy interval, is added to mitigate participant frustration (Chang and Lenzenweger, 2001). Sensitivity was calculated using d'.

Haptic Mueller-Lyer Illusion task. A haptic version of the Mueller-Lyer Illusion (Mueller-Lyer, 1889) was employed to measure haptic perception. In the Mueller-Lyer Illusion, an individual is tricked into perceiving that two identical line segments are different lengths, based on inward and outward pointing wings on the end of the line segments (Fig. 1). In the haptic version of this task, the participant judged the length of horizontal line segments in a series of wire line drawings using only their sense of touch. These line drawings had either a single line segment or double line segments (Fig. 1). Following methods used in previous research (Heller et al., 2002), participants swiped the index finger of their dominant hand over the entire figure with their eyes closed. They were then asked to replicate the length of the horizontal line using a slide ruler. The length of the slide ruler recorded as the participant's response. In the case of double line segments, the participant estimated each line segment separately. Each participant estimated 16 separate line segments, including eight single line segments and four sets of double line segments. The line segments were one of three lengths: 1.50 in., 1.63 in., or 1.75 in.

If individuals with schizophrenia are impaired in the haptic Mueller-Lyer illusion, this could be indicative of dysfunctional perceptual processes in the haptic system (Pessoa et al., 2008). The haptic version of this illusion, in which individuals are blindfolded and feel the lines with their fingers, has not been explored in people with schizophrenia. The visual version of the Mueller-Lyer Illusion has been explored extensively in people with schizophrenia (e.g., Cromwell and Spaudling, 1978; Rund et al., 1994; Tam et al., 1998).

Weight discrimination task. The weight discrimination task tested the

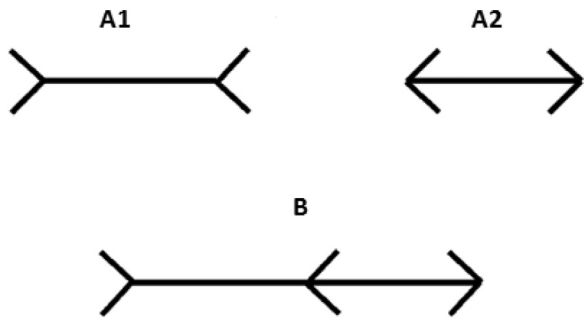

Fig. 1. Haptic Mueller–Lyer illusion. Fig. 1A and 1B show single line segments; Fig. 1B shows double-line segments. Participants typically perceive the 1A line segment as longer than the 1B line segment, likely due to perceptual heuristics for depth cues.

Table 2
Between groups comparisons of self-task performance.

	Schizophrenia Mean (SD)	Control Mean (SD)	t (df)	Significance (2-tailed)	*d*
Somatosensation					
Two-point discrimination (6 mm % correct)	39.56 (31.21)	26.45 (33.18)	2.00 (53)*	0.049	0.55
Two-point discrimination Sensitivity (d')	0.08 (1.53)	−0.18 (1.51)	−0.58 (53)	0.565	−0.16
Weight discrimination (% correct)	75.97 (10.58)	81.45 (6.03)	1.95 (32)	0.061	−0.64
Weight discrimination Sensitivity (Weber ratio)	0.12 (0.08)	0.10 (0.05)	−1.17 (32)	0.251	−0.40
Mueller–Lyer illusion Total (inches)	0.26 (0.21)	0.26 (0.22)	−0.11 (47)	0.721	0.03
Anomalous self-experience					
IPASE total	130.75 (44.73)	74.35 (19.50)	−5.73 (74)	0.000	−1.33
IPASE-cognition	15.18 (6.72)	8.51 (3.23)	−4.97 (71)	0.000	−1.18
IPASE-self-awareness and presence	51.34 (19.41)	28.00 (7.66)	−6.18 (71)	0.000	−1.47
IPASE-consciousness	15.36 (5.63)	10.31 (4.58)	−4.03 (71)	0.000	−0.96
IPASE-somatization	39.05 (14.45)	21.27 (4.88)	−6.37 (71)	0.000	−1.51
IPASE-demarcation/transitivism	9.73 (4.43)	6.24 (2.03)	−3.97 (71)	0.000	−0.94
Self-concept clarity					
Self-concept clarity scale	38.52 (9.56)	47.46 (10.03)	3.83 (72) ***	0.000	−0.91
Me-Not-Me decision task	27.74 (5.86)	32.03 (4.97)	3.62 (71) ***	0.000	−0.79

Note: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$. IPASE = Inventory for Psychotic-Like Anomalous Self-Experience.

acuity of the proprioceptive system (Ritzler, 1977). Weight discrimination has previously been shown to be impaired in people with schizophrenia (Javitt et al., 1999; Tanno et al., 1999; Williams et al., 2010).

In this task, participants were asked to differentiate between objects with slightly different weights by saying which of two successive weight stimuli was heavier. Response were coded as a "1" if the heavier weight was correctly identified, and a "0" if not. Weight stimuli were plastic egg-shaped containers filled with differing amounts of fishing weights and cotton balls. The weights of the test stimuli ranged from 40 to 56 g, with weight differences ranging from 2 to 16 g. The weight discrimination task was added later in the data collection process, thus resulting in fewer participants completing this task.

2.2.3. Anomalous self-experience

Anomalous self-experience was measured with the Inventory of Psychotic-like Anomalous Self-Experiences (IPASE; Cicero et al., 2017). The IPASE is a 57-item self-report measure of five factors of anomalous self-experience commonly reported in individuals with schizophrenia. The five factors are: Cognition, Self-Awareness and Presence, Consciousness, Somatization, and Demarcation/Transitivism. IPASE scores have been shown to be elevated in people with schizophrenia and in those at risk for developing schizophrenia, correlated with positive symptoms in people with schizophrenia, and correlated with psychotic-like experiences and self-disturbances in a general population sample (Cicero et al., 2017). Cronbach's alpha for the current study was 0.91.

2.2.4. Self-concept clarity

The first measure of self-concept clarity was the Self-Concept Clarity Scale (SCCS; Campbell et al., 1996). The SCCS is a 12-item self-report questionnaire designed to measure the degree to which one holds a stable and internally-consistent conception of herself or himself. Participants indicate how much they agree with the 12-items on a scale from 1 (*Strongly Disagree*) to 4 (*Strongly Agree*). Evidence for construct validity of the SCCS is derived from expected associations with other constructs in its nomological network. The SCCS shows convergent validity based on correlations between low levels of self-concept clarity and low levels of internal state awareness (Campbell et al., 1996). Evidence for divergent validity comes from correlations between high levels of personality constructs that are theoretically opposite and low levels of self-concept clarity, including neuroticism, self-reflection, and public self-consciousness (Campbell et al., 1996). Cronbach's alpha for the current study was 0.88.

A second task measure of self-concept clarity was the Me Not-Me Decision Task. In the Me-Not-Me Decision Task, participants decide whether 60 adjectives do or do not describe them. The participant was seated in front of a computer while adjectives were presented in the middle of the screen. The participant was directed to press either the "1" key to indicate "me", or the "0" key to indicate "not me" for each adjective. The participant was instructed to respond as quickly and accurately as possible. Embedded in the 60 adjectives of the target condition were 30 pairs of antonyms (e.g., shy/outgoing). In this task, self-concept clarity was conceptualized as the number of consistent responses to these adjective pairs (e.g., responding "me" to shy and "not me" to outgoing). Previous work has shown that scores on the Me-Not-Me Decision Task are correlated with scores on the SCCC (Campbell, 1990; Cicero et al., 2017).

2.2.5. Cognitive status

The Mini-Mental Status Exam (MMSE; Folstein et al., 1975) was used to screen for dementia. The MMSE is a 30-item screening tool for general mental status. It includes screening of the cognitive sub-domains of orientation, registration, attention and calculation, recall, and language. No participants scored below the recommended cutoff of 23/30 (Folstein et al., 1975), and no participants were excluded from the study for MMSE scores. The MMSE has adequate construct validity, correlating 0.70–0.90 with other cognitive screening tests across an array of patient and normal samples (Tombaugh and McIntyre, 1992).

2.3. Procedure

The current research was approved by the University of Hawaii Institutional Review Board. As part of a larger study, participants first gave informed consent, then completed the MMSE. Participants were administered the SCID-I and SCI-PANSS, then completed the remaining tasks and questionnaires in random order.

3. Results

3.1. Between-groups comparisons of self-disturbances

The first goal of the current research was to replicate previous findings that people with schizophrenia had disturbances in self-processing as compared to non-psychiatric controls. Results of a one-way MANOVA revealed a significant effect of group on level of self-disturbance (F (6,16) = 3.64, p = .018, Wilk's Λ = 0.423, partial η^2 = 0.58). As can be seen in Table 2, planned post hoc t-tests indicated that the schizophrenia group performed significantly worse than the control group on two-point discrimination (t (53) = 2.00, p = .049, d = 0.55). The two groups did not significantly differ in two-point

discrimination response sensitivity measure d' ($t(53) = -0.58$, $p = .585$, $d = -0.16$). There was a trend for a deficit in weight discrimination for the schizophrenia group (t (32) = 1.92, $p = .061$, $d = -0.63$), with no significant difference in sensitivity between groups, as measured by the Weber ratio ($t(32) = -1.17$, $p = .251$, $d = -0.40$). Group differences were not significant for the Mueller-Lyer Illusion (t (47) = −0.36, $p = .721$, $d = 0.03$). People with schizophrenia had significantly higher total scores on the IPASE (t (74) = −5.73, $p < .001$, $d = -1.33$), as well as all IPASE subscales. People with schizophrenia also had lower self-concept clarity scores on both the SCCS (t (72) = 3.83, $p < .001$, $d = -0.91$) and the Me-Not-Me Decision Task (t (71) = 3.62, $p < .001$, $d = -0.79$). We explored antipsychotic medication effects in the schizophrenia group by correlating chlorpromazine equivalent dosages and each main variable. There was a significant positive correlation between chlorpromazine equivalent dosage and Me-Not-Me Decision Task performance. ANCOVA indicated that between group differences on the Me-Not-Me Decision Task were still significant while covarying for chlorpromazine equivalent dosage.

3.2. Associations among three domains of self-disturbances

The second goal of the current research was to examine the correlations among the different domains of self-processing. As can be seen in Table 3, two-point discrimination was significantly correlated with the weight discrimination task. The SCCS was negatively correlated with total IPASE score as well as all five IPASE subscales. Me-Not-Me Decision Task performance was negatively correlated with total IPASE score as well as the IPASE Somatization subscale. The SCCS and Me-Not-Me Decision Task, were significantly positively correlated.

3.3. Associations among self-disturbances and other schizophrenia symptoms

The third and final goal of the current research was to examine the correlations among domains of self-processing and other symptoms of schizophrenia. As can be seen in Table 4, positive symptoms were positively associated with the total IPASE score as well as the IPASE Cognition subscale. Disorganization was positively correlated with the IPASE Cognition subscale and negatively correlated with Me-Not-Me Decision Task performance. Emotional distress was positively associated with IPASE total, Self-Awareness and Presence, Somatization, and Demarcation/Transitivism, and negatively correlated with the SCCS total.

4. Discussion

The primary goal of the current research was to simultaneously examine different domains of self-disturbance in people with schizophrenia. The results of the current research provide more evidence that people with schizophrenia have specific disturbances in the processing of information related to the self. Moreover, these results suggest that anomalous self-experiences are strongly correlated with measures of self-concept clarity. However, there was little evidence for an association between the somatosensory domain and the other domains of self-disturbances. Finally, anomalous self-experiences were associated with increased positive symptoms, disorganized symptoms, and emotional distress, and lower self-concept clarity was associated with increased disorganized symptoms and emotional distress.

The between-group comparisons of the self-disturbances tasks and questionnaires are somewhat consistent with previous work in that people with schizophrenia were impaired on some, but not all, of the tasks. Within the somatosensory domain, two-point discrimination was significantly impaired in schizophrenia. This finding is consistent with previous research indicating impaired two-point discrimination in schizophrenia (Michael and Park, 2016). Within the haptic domain, the Mueller-Lyer Illusion was not impaired in individuals with schizophrenia as compared to controls. The lack of between groups effects in the Mueller-Lyer Illusion may be attributable to differences in haptic information processing deficits based on the disorder phase and symptom profile of schizophrenia participants. Previous research has shown haptic information processing deficits in the acute, but not chronic, phase of schizophrenia (Schooler et al., 1976). In the current

Table 4
Correlations among self-processing variables and symptoms in the schizophrenia group.

	PANSS – Pos	PANSS – Neg	PANSS – Dis	PANSS - Exc	PANSS - Emo
1. MLI	0.16	0.02	0.03	−0.01	0.33
2. TPD	−0.26	−0.24	−0.08	−0.29	−0.24
3. WD	−0.37	−0.51	0.07	−0.34	−0.36
4. IPASE	0.33*	−0.07	0.18	−0.07	0.42*
5. IPASE-Cog	0.41*	0.04	0.36*	−0.05	0.26
6. IPASE-SAP	0.23	−0.06	0.05	−0.11	0.42*
7. IPASE-Con	0.31	−0.14	0.18	−0.14	0.26
8. IPASE - Som	0.33	−0.08	0.23	−0.03	0.40*
9. IPASE - DT	0.30	−0.04	0.10	0.01	0.38*
10. SCCS	−0.22	0.02	−0.08	0.17	−0.38*
11. MNMDT	−0.18	0.09	−0.43*	0.06	−0.20

*$p < .05$, **$p < .01$, ***$p < .001$. MLI = Mueller–Lyer Illusion; TPD = two-point discrimination; WD = weight discrimination; IPASE = Inventory for Psychotic-Like Anomalous Self-Experience Cog = Cognition, SAP = Self-Awareness and Presence, Con = Consciousness, Som = Somatization, and DT = Demarcation/Transitivism; SCCS = Self Concept Clarity Scale; MNMDT = Me-Not-Me Decision Task; PANSS = Positive and Negative Symptom Scale, Pos = Positive, Neg = Negative, Dis = Disorganized, Exc = Excitement, Emo = Emotional Distress.

Table 3
Correlations among self-processing variables in the schizophrenia group.

	1	2	3	4	5	6	7	8	9	10
1. TPD	–									
2. WD	0.55*	–								
3. MLI	0.08	0.01	–							
4. IPASE	−0.19	−0.04	0.16	–						
5. IPASE-Cog	−0.03	0.17	0.15	0.73**	–					
6. IPASE-SAP	−0.20	−0.13	0.14	0.94**	0.55**	–				
7. IPASE-Con	−0.22	0.11	0.08	0.71**	0.60**	0.56**	–			
8. IPASE - Som	−0.15	0.02	0.15	0.95**	0.67**	0.84**	0.63**	–		
9. IPASE - DT	−0.20	−0.16	0.15	0.88**	0.54**	0.84**	0.50**	0.83**	–	
10 SCCS	0.19	0.15	0.08	−0.70**	−0.37*	−0.72**	−0.41*	−0.69**	−0.60**	–
11. MNMDT	0.04	−0.24	−0.23	−0.35*	−0.22	−0.25	−0.25	−0.37*	0.17	0.28

*$p < .05$, **$p < .01$, ***$p < .001$. MLI = Mueller–Lyer Illusion; TPD = two-point discrimination; WD = weight discrimination; IPASE = Inventory for Psychotic-Like Anomalous Self-Experience Cog = Cognition, SAP = Self-Awareness and Presence, Con = Consciousness, Som = Somatization, and DT = Demarcation/Transitivism; SCCS = Self Concept Clarity Scale; MNMDT = Me-Not-Me Decision Task.

study, the schizophrenia sample was predominantly in the chronic phase, which may account for the lack of difference between schizophrenia and control participants on the Mueller-Lyer Illusion. In addition to the deficit in two-point discrimination, there was a trend-level deficit in weight discrimination in the schizophrenia group. Previous research has also reported weight discrimination deficits in schizophrenia participants (Javitt et al, 1999; Tanno et al., 1999; Williams et al., 2010). These results, together with findings from previous work, indicate impairment in proprioception and selective impairments in exteroceptive somatosensation in schizophrenia.

The finding that participants with schizophrenia had higher IPASE scores is consistent with a long line of research suggesting that people with schizophrenia have increased anomalous self-experiences (Nelson et al., 2014; Raballo and Maggini, 2005). Moreover, the finding that people with schizophrenia have decreased self-concept clarity on both the self-report and task measures of self-concept clarity is consistent with previous work (Cicero et al., 2016a). Although previous work has found that anomalous self-experiences are present in people with chronic schizophrenia (Skodlar and Parnas, 2010), most of the previous research has focused on early stages of the disorder such as prodromal or first episode participants (e.g. Brent et al., 2014; Haug et al., 2014; Nelson et al., 2009). The mean age of participants in the current study was nearly 50, which provides more evidence that anomalous self-experiences are not limited to the early stages of the disorder. However, the IPASE and self-concept clarity measures can be viewed as lifetime measures, and it is unclear if the self-disturbances reported were currently experienced at the same level of intensity as in the early course of participants' disorder.

The second goal of this research was to examine the associations between three domains of self-disturbances, somatosensation, anomalous self-experiences, and self-concept clarity. Although they were not correlated with anomalous self-experiences or self-concept clarity, weight discrimination and two-point discrimination were correlated with each other. These results are consistent with previous research indicating that tactile acuity and proprioception share common underlying mechanisms (Dijkerman and de Haan, 2007).

In addition to finding that people with schizophrenia had higher anomalous self-experiences and lower self-concept clarity, the current research found that these domains were correlated with each other. However, neither anomalous self-experiences nor self-concept clarity were correlated with the somatosensory domain. This may reflect some shared processes in anomalous self-experiences and the theoretically higher-level construct of self-concept clarity. Anomalous self-experiences and self-concept clarity could be processed at the same level in parallel fashion, in which a shared process at this level is disturbed in both constructs. Alternatively, self-concept clarity might be dependent on the proper processing of self-experience, such as in a serial processing pattern, in which case impaired processing of self-experience causes lower self-concept clarity. Future research could use experimental methods to determine whether anomalous self-experiences cause low self-concept clarity. As well, it is important to note that the measures for anomalous self-experience and self-concept clarity are highly cognitive tasks that require adequate self-monitoring. In contrast, the weight discrimination, two-point discrimination, and Muller-Lyer Illusion tasks are somatosensory in nature. Thus, the pattern of correlations may be related to the shared nature of the anomalous self-experience and self-concept clarity tasks, rather than the actual relations among these domains of self-disturbances.

The finding that the IPASE was correlated with both the SCCS and the Me-Not-Me Decision Task provides further support for the construct validity of the IPASE. This finding is consistent with previous research demonstrating that IPASE scores were correlated with SCCS and Me-Not-Me Decision Task scores in general population samples of nonclinical participants (Cicero et al., 2017). This is important because some methodologists have suggested that anomalous self-experiences can only be measured by extensively trained phenomenologists with unstructured interviews such as the Examination of Anomalous Self-Experiences (Parnas et al., 2005). However, anomalous self-experiences (Parnas et al., 2005) and other self-disturbances (Heering et al., 2016) have been successfully measured through self-report. Future research could use interview-based measures of anomalous self-experiences to continue to examine anomalous self-experiences and other conceptualizations of self-disturbances.

The third and final goal of the current research was to examine whether the domains of self-disturbances were associated with five symptom domains commonly observed in schizophrenia. Based on previous research, we expected to find that self-disturbances would be associated with the severity of both positive and negative symptoms. This hypothesis was partially supported. Consistent with previous research, increased total anomalous self-experiences was associated with increases in positive symptoms (Cicero et al., 2016a; Noyman-Veksler et al., 2013; Weinberg et al., 2012). As well, increased disorganized symptoms were associated with increased anomalous self-experiences in the domain of Cognition and decreased self-concept clarity. This is consistent with previous work linking disorganized symptoms with decreased ability to use higher-order cognitive processes to reflect on oneself (Fridberg et al., 2010). Emotional distress was also associated with higher levels of anomalous self-experience and lower levels of self-concept clarity. Emotional distress, particularly depression (Haug et al., 2015) and the ability to effectively use emotions (Cicero et al., 2016a) has been associated with anomalous self-experience in previous work. The link between emotional distress and anomalous self-experiences may also help to understand the role of traumatic life experiences in the etiology of psychosis, as anomalous self-experiences have been found to mediate the relation between traumatic life experiences and psychotic-like experiences in nonclinical samples (Gaweda et al., 2017, 2018). The association between emotional distress and low self-concept clarity is consistent with previous studies linking state levels of low self-concept clarity to negative in a non-psychiatric sample (Nezlek and Plesko, 2001).

One area for future research is to examine whether anomalous self-experiences and symptoms of schizophrenia are distinct constructs. Although anomalous self-experiences and schizophrenia symptoms were only moderately correlated in the current research, it is possible that anomalous self-experiences are simply a facet of schizophrenia symptoms. For example, individuals believing their bodies are disintegrating maybe be experiencing a type of delusion, and individuals hearing their thoughts echoed outside of their heads may be experiencing auditory hallucinations. Future research could include multiple measures of anomalous self-experiences and symptoms of schizophrenia and use confirmatory factor analyses to determine if anomalous self-experiences can be discriminated from symptoms of schizophrenia. If a model with anomalous self-experiences and symptoms loading on separate factors fits better than a model with them loading on a single factor, one could conclude that anomalous self-experiences and symptoms can be discriminated from each other.

One potential limitation of the current research is that the majority of the schizophrenia sample was taking antipsychotic medication at the time of testing. Antipsychotic medication can have a range of unintended effects on both the central and peripheral nervous systems, including decreased sensitivity to pain, muscle weakness, and peripheral neuropathy (McEvoy et al., 2006), that could have affected the somatosensory tasks in this study. As well, antipsychotic medications can improve perceptual deficits (Kelemen et al., 2013). Future research could examine these same effects in medication naïve samples of people in their first episode of psychosis, unmedicated participants at risk for the development of schizophrenia, or first-degree relatives of people with schizophrenia. Another limitation of the current research was that there may have been between- and within- experimenter variation in the pressure applied during the two-point discrimination task. All experimenters were trained by the first author to apply pressure that would indent the skin but not be painful to participants and were

observed during training. However, there was no objective measure of the pressure being applied. Moreover, the experimenters were not blind to whether the participant had schizophrenia or was a healthy control, which may have affected the results.

Future studies may also address the real-world implications of self-disturbances. Self-disturbances have been linked to poorer functioning in individuals with schizophrenia (Weinberg et al., 2012), but the reasons for this are not yet clear. One potential link between decline in function and self-disturbances may be social cognition and behaviors (Nelson et al., 2009). Michael and Park (2016) found that increased susceptibility to the Pinocchio Illusion and poorer performance on two-point discrimination within a sample of individuals with schizophrenia was associated with increased levels of perceived social isolation. The authors put their results in the framework of Hoffman's Social Deafferentation Hypothesis of schizophrenia (Hoffman, 2007), which suggests that the brain of an individual isolated from social inputs may create compensatory activity in the form of hallucinations. Other work has found that anomalous self-experience is associated with poorer social functioning (Haug et al., 2014) and impaired social cognition independent of positive and negative symptoms (Cicero et al., 2016a). Future work in self-disturbances and social cognition may employ a more comprehensive battery of social cognition to better understand the connection between social cognition and self-disturbances.

Future work may also address psychosocial therapies that may target self-disturbances, especially in the early stages of schizophrenia. Stanghellini and Lysaker (2007) propose a focus on therapy techniques aimed to help re-integrate bodily selves and life narrative in individuals with schizophrenia. Metacognition Reflection and Insight Therapy (MERIT; Van Donkersgoed et al., 2014; Lysaker and Roe, 2016) is one such technique, with preliminary research indicating increased ability to self-reflect (de Jong et al., 2016) and increased insight into illness (Vohs et al., 2017), which is in turn associated with a range of positive clinical outcomes (Vohs et al., 2016).

Acknowledgments

This project was funded by an internal grant from the University of Hawaii, College of Social Sciences.

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