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Affect modulated startle in schizophrenia: Subjective experience matters

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ABSTRACT

Data suggests that emotion reactivity as measured by the affect-modulated startle paradigm in those with schizophrenia (SZ) may be similar to healthy controls (HC). However, normative classification of the stimuli may not accurately reflect emotional experience, especially for those with SZ. To examine this possibility, the present study measured the affect-modulated startle response with images classified according to both normative and subjective ratings. Seventeen HC and 17 SZ completed an image viewing task during which startle probes were presented, followed by subjective valence and arousal ratings. Both groups exhibited inhibited startle responses to positive images, intermediate startle amplitudes to neutral images, and potentiated startle amplitudes to negative images. SZ rated the positive images as less positive than HC. When images were reclassified based on subjective valence ratings, both groups' startle magnitudes increased in response to subjectively rated positive images and decreased to subjectively rated neutral images. The number of trials classified into each valence condition suggested a tendency for SZ to classify neutral images as negative more often than HC. Overall, these findings suggest that affective stimuli modulate the startle response in HC and SZ in similar ways, but subjective emotional experience may differ in those with schizophrenia.

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1. Introduction

Within schizophrenia (SZ) research, there is a movement beyond consideration of broadly-defined emotional processing deficits and towards delineating the specific aspects of emotional processing that may be disrupted (Kring and Moran, 2008). Diverse methodologies have been applied in an attempt to conceptualize putative deficits and their relation to everyday functional impairments experienced by individuals with schizophrenia.

Recent reviews have suggested that present-moment subjective emotional experience is unaffected by schizophrenia across physiological and self-report measures (Kring and Moran, 2008; Kring and Caponigro, 2010). As such, individuals with schizophrenia generally rate their emotional response to emotionally-provocative images in a manner comparable to healthy controls across the spectrum of intensity of valence and arousal (Herbener, et al., 2008). However, there is also some evidence to suggest that individuals with schizophrenia may tend to report greater aversive self-reported emotional experience in response to stimuli that are generally classified as pleasant or neutral in valence by healthy controls (Cohen and Minor, 2010). Strauss and Herbener (2011) found subgroups of individuals with schizophrenia displayed "atypical" patterns of subjective emotional experience, suggesting that discrepancies in self-report amongst studies may, at least in part, reflect differences in the composition of the patient samples. Importantly, in their study the subset of patients with "atypical" image ratings had poorer functional outcomes, higher self-reported anhedonia and greater negative symptom severity, which suggests that differences in subjective experience of emotional stimuli is of relevance to the overall clinical presentation and functional impact of the disorder. Moreover, potential disturbances in present-moment emotional experience may be an important differentiating characteristic amongst individuals with schizophrenia that is typically overlooked when examination of group effects are constrained to analyses based on normative image ratings. Reliance on normative ratings may further limit the ability to accurately assess for any possible discrepancy between psychophysiological response and subjective emotional response.

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1.1. Emotion-modulated startle paradigm

Investigation of the potential impact of differences in subjective versus normative classifications of affective images on the pattern of physiological response requires a psychophysiological measure that allows for the distinction between positive and negative valence stimuli, such as the startle blink paradigm (Vrana et al., 1988; Bradley et al., 1990). In this paradigm, a white noise burst (i.e. the startle probe) is administered while the participant views images of differing valence. The startle magnitude evoked by the startle probe is measured by recording activity of the *orbicularis oculi* muscle, which is located below the eye. The startle probe evokes a defensive response (the startle blink), and the magnitude of the reflex startle response is modulated by the emotional context in which it occurs (Lang et al., 1990; Lang, 1995). When an aversive motivational state is active, such as when viewing an image of negative valence, the aversive startle stimulus results in an augmented (i.e. larger) startle response. Correspondingly, when a positive motivational state is active, the aversive startle stimulus yields an inhibited (i.e. smaller) startle response (Lang et al., 1998).

1.2. Emotion-modulated startle in schizophrenia

Several previous studies have utilized the startle paradigm to investigate emotional reactivity in individuals with schizophrenia. In the first study, Schlenker and colleagues (1995) observed a comparable linear modulation of the startle response in individuals with schizophrenia and healthy controls. The schizophrenia group tended to rate the images as more arousing compared to the control group. Similar startle findings were reported by Curtis et al., (1999); however, within their sample, the schizophrenia group tended to give lower self-reported valence ratings to positive images (i.e. they found them less positive) and negative images (i.e. they found them less unpleasant) and no difference in valence ratings of neutral images compared to healthy controls. While Volz et al., (2003) also found comparable emotion-modulated startle in schizophrenia, they reported no differences in valence ratings compared to a control group. Yee et al., (2010) replicated the pattern of comparable startle modulation between schizophrenia patients (first episode and chronic patients) and healthy controls. They also reported a linear relationship between self-reported arousal and startle magnitude such that highly arousing negative images were associated with larger startle magnitudes while highly arousing positive images were associated with lower startle magnitudes for both schizophrenia and healthy controls. While valence and arousal ratings were comparable between the schizophrenia and control groups, self-reported valence was lower to positive and neutral images in the prodromal group. More recently, Kring et al., (2011) reported significant differences in startle magnitude between positive and negative images and between positive and neutral images in a schizophrenia sample. However, the startle magnitudes to neutral and negative images did not significantly differ during picture viewing.

In light of the startle modulation studies reviewed above, the majority of studies have found that emotional reactivity as indexed by startle magnitude appears to be similar between individuals with schizophrenia and healthy controls (Curtis et al., 1999; Schlenker et al., 1995; Volz et al., 2003; Yee et al., 2010; although see Kring et al., 2011). In contrast, there is evidence of variability in self-reported valence and arousal amongst individuals with schizophrenia compared to healthy controls within the context of the startle paradigm. Since the emotional content of the stimuli modulate the startle response, differences in how the emotional content are experienced highlight a discrepancy between self-report and psychophysiological response between groups. Therefore, a vital next step is to incorporate subjective ratings of image valence into the startle modulation analysis. Yee and colleagues made an important first step in this direction by examining the relationship between individual subjective arousal ratings and startle magnitude. An alternative approach that may reveal important psychophysiological differences in emotional reactivity between individuals with schizophrenia and healthy controls is to examine the pattern of startle modulation within groups when startle responses are classified into valence categories based on self-reported valence. Such an approach would allow for potential differences in valence ratings at the individual subject level to be accounted for in the classification of psychophysiological responses. Because previous studies have suggested differences in subjective valence ratings between schizophrenia and control groups, classifying images in this way may alter the pattern of psychophysiological response observed for the newly defined valence categories.

1.3. The current study

The present study aimed to investigate patterns of emotion-modulated startle amongst individuals with schizophrenia (SZ) in comparison to healthy controls (HC). A further aim was to explore potential differences in the pattern of startle modulation when individual subject ratings are used to classify the emotion-provoking images into valence categories compared to when they are sorted based on normative classification. Towards this aim, startle responses were first sorted based on normative classification then re-classified into positive, neutral and negative valence categories for each individual based on their valence rating for each image. The startle magnitudes for each method of valence classification were then compared between SZ and HC. In line with most other studies investigating affect modulated startle, we predicted that SZ would show similar patterns of emotion-modulated startle as HC based on normative ratings. Given the findings that patients with schizophrenia subjectively rate positive and neutral emotional stimuli as more negative compared to healthy controls, our second hypothesis was that SZ would have a larger number of startle trials in the 'negative' valence condition compared to HC when the trials are categorized according to subjective valence ratings. Finally, we anticipated that re-analysis of startle amplitudes based on subjective ratings would alleviate the confound of more negatively experienced images being included in the positive and neutral conditions. If patients with schizophrenia truly experience dampened physiological responses to positive and neutral emotional stimuli that they have rated as positive and neutral, then one would expect significantly greater startle magnitudes in response to positive and neutral stimuli in the subjectively classified re-analysis.

2. Methods

2.1. Participants

Seventy participants completed the emotion-modulated startle task; 41 participants were healthy controls and 29 participants met DSM-IV diagnostic criteria for either schizophrenia ($n=25$) or Schizoaffective Disorder ($n=4$). All participants were assessed via structured interview (SCID-I or SCID-NP) by doctoral level psychologists (C.A.B. and A.R.B.) and patients included a mix of hospitalized and those receiving outpatient care. Exclusion criteria included a history of head injury with loss of consciousness of 5 min or more, alcohol or illicit drug use at the time of testing as determined by urine screen, current alcohol or drug abuse, history of neurological disorders, diagnosis of a learning disorder, or self-reported hearing loss, and for the healthy control group, the presence of any current Axis-I disorders. Three male SZ participants and one female HC participant was excluded due to the presence of neurological problems. One male SZ participant was excluded due to a history of ECT for psychotic depression. Two HC male participants were excluded due to lack of response to the startle probe (i.e. less than four detectable startles per valence condition) and one female HC was excluded due to less than four useable negative