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Looking at the other side of the coin: A meta-analysis of self-reported emotional arousal in people with schizophrenia☆

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ABSTRACT

Abnormalities in emotional experience have long been viewed as core features of schizophrenia. Numerous studies indicate that people with schizophrenia report less pleasure than controls when reporting non-current feelings using trait, hypothetical, prospective, and retrospective emotional self-report formats; however, current research has demonstrated that schizophrenia patients and controls do not differ in their subjective reactions to emotional stimuli in most laboratory studies. Although substantial attention has been paid to studies examining self-reported valence in schizophrenia, subjective reports of arousal in response to affective stimuli have been neglected. Understanding the role of arousal in schizophrenia is imperative given that valence and arousal are differentially associated with physiological and behavioral responses. To understand the role of self-reported arousal, a meta-analysis of 26 published studies employing laboratory emotion induction paradigms in patients with schizophrenia and healthy controls was conducted. Medline, PsycINFO, Web of Science, and PubMed electronic databases and reference lists from identified articles were used as data sources. Using a random effects model, analyses demonstrated that controls and people with schizophrenia reported similar levels of subjective arousal in response to pleasant and unpleasant stimuli; however, people with schizophrenia reported experiencing greater arousal than controls in response to neutral stimuli. Furthermore, moderator analyses suggested that gender and methodological factors, such as rating scale and stimulus type, may affect these patterns of results and play a key role in determining whether patients and controls differ in self-reported arousal.

1. Introduction

Anhedonia has long been considered a core negative symptom of schizophrenia (Kraepelin, 1919; Bleuler, 1953). However, recent empirical research contradicts these early conceptualizations of anhedonia as a diminished capacity for pleasure, as studies have consistently shown that individuals with schizophrenia report levels of in-the-moment positive emotion that are similar to controls in response to pleasant stimuli or real-world activities (Kring and Neale, 1996; Gard et al., 2007; Heerey and Gold, 2007; Herbener et al., 2008; Oorschot et al., in press). A recent meta-analysis of laboratory-based studies by Cohen and Minor (2010) supported the conclusions of these studies, indicating that people with schizophrenia did not report experiencing less state pleasure than controls in response to pleasant stimuli. However, patients did report experiencing increases in negative affectivity in relation to unpleasant, neutral, and pleasant stimuli. These findings have led some to conclude that anhedonia should no longer be considered a diminished capacity for pleasure in schizophrenia (see Strauss and Gold, 2012 for a review).

Although substantial attention has been paid to studies examining self-reported "valence" in schizophrenia, reports of pleasantness are only one component of emotional experience. In a prominent model of emotional experience, the valence–arousal model, it has been proposed that emotions exist within a two-dimensional space, with one axis representing arousal (*low* to *high*) and the other valence (*pleasant* to *unpleasant*) (Feldman Barrett and Russell, 1999). These two dimensions have been proposed to be critical for motivational activation, with valence determining whether the appetitive or defensive motivational system is activated, and arousal dictating the intensity of that activation (Bradley et al., 2001). There is substantial support for the existence of these two factors in studies examining the hierarchical structure of emotion (Osgood et al., 1957; Russell and Mehrabian, 1974; Smith and Ellsworth, 1985) and evidence that this structure applies to people with schizophrenia as well (Kring et al., 2003). Given the importance of arousal in determining motivational activation, and

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the known volitional deficits affecting people with schizophrenia (see Foussias and Remington, 2010 for review), it is possible that arousal may be a more important aspect of the motivational and affective deficits in schizophrenia than has previously been considered.

Understanding the role of arousal in schizophrenia, in addition to that of valence, is imperative given that valence and arousal are differentially associated with physiological and behavioral responses. For example, valence is strongly associated with startle reflex responsivity, heart rate acceleration/deceleration, and facial muscle responsiveness (e.g., Lang et al., 1993; Vrana and Gross, 2004; Wolf et al., 2005; Springer et al., 2007), whereas arousal is associated with skin conductance, viewing time, interest ratings, and early and late Event Related Potential (ERP) components (e.g., Hempel et al., 2007; Schmidt et al., 2011; Zhang et al., 2011). Additionally, arousal, rather than valence, has been found to play a more prominent role in determining the extent to which emotional stimuli influence cognitive processes (e.g., Cahill and McGaugh, 1998; Anderson, 2005). If the subjective experience of arousal is abnormal in schizophrenia, it is possible that such abnormalities could predict a variety of affective dysfunctions, aberrant cognition–emotion interactions, or psychiatric symptoms; however, few studies have examined associations between arousal and such processes.

Studies examining self-reported arousal to emotional stimuli in schizophrenia have produced mixed results. For example, several studies indicate no differences in arousal between patients and controls, while others find that patients report either higher or lower arousal than controls. These findings are further complicated by inconsistencies in patient and control responses to pleasant, unpleasant, and neutral stimuli, as well as differences in sample size, sample characteristics, rating scale procedures (e.g., whether scales range from low to high or calm to excited), and stimulus type (e.g., photographs, film clips, words). Given these considerations, the current study aimed to elucidate the nature of emotional arousal in schizophrenia via a comprehensive meta-analysis.

2. Method

2.1. Search strategy and creation of database

To identify relevant publications for the current meta-analysis, we conducted a combined Medline and PsycINFO search for all studies having "schizophren*" and "arousal" and "emotion" yielding 59 entries. We also conducted a search on Web of Science (112 entries) and PubMed (347 entries) with the same search terms. The reference lists from these articles were also examined to identify additional publications. We considered studies for inclusion if: (1) the article was an empirical study published in a peer-reviewed journal, (2) the study included an emotion induction paradigm broadly defined, (3) the study reported sufficient detail on participant subjective arousal ratings in response to the stimulus using a self-report scale following the emotion manipulation, (4) the study compared arousal ratings from a patient group diagnosed with schizophrenia to a non-psychiatric control group, and (5) the study was reported in English. Authors were contacted when there was not sufficient data to allow calculation of effect sizes. When studies appeared to use overlapping samples, we used data only from one of these studies. One study was eliminated on this basis (Herbener, et al., 2008). Studies requiring subjects to rate the "intensity" of their reaction to emotional stimuli were not included, as these ratings conflate valence and arousal. Several studies examined constructs related to arousal (e.g., activation); however, these studies were not included because they did not include a single rating scale and these ratings may reflect a combination of valence and arousal, rather than arousal alone (Earnst and Kring, 1999; Kring and Earnst, 1999). In all, 26 studies were included in the present meta-analysis (see Table 1).

When studies presented data for multiple stimuli (e.g., words, sounds, pictures) (e.g., Trémeau et al., 2009; Dowd and Barch, 2010), valence categories (e.g., Mathews and Barch, 2004), patient groups (e.g., Yee et al., 2010), or sexes (e.g., Kring et al., 2011), the means and standard deviations were averaged together.

2.2. Statistical analysis

Comprehensive Meta-Analysis version 2 (Borenstein et al., 2000) was used to conduct analyses. Effect sizes were calculated as the mean difference between schizophrenia and healthy control group divided by the pooled standard deviation and adjusted for small sample bias (Hedges g). Effect sizes were weighted and combined via a random effects model (i.e., weighted by variance). The 95% confidence interval and Q statistics based on chi-squared distributions were calculated to estimate homogeneity of effect sizes across studies. Publication bias was examined via Orwin's fail-safe N, which is the number of unpublished studies with null effects that would be needed to reduce the obtained effect size to a negligible level (0.20). Publication bias was also examined via funnel plots, which graph Hedges g for individual studies against the standard error. A lack of symmetry around the overall effect size indicates publication bias.

A series of analyses were calculated to examine group differences in self-reported arousal and potential moderator variables. First, we computed effect sizes comparing patients and controls in their subjective arousal ratings following pleasant, unpleasant, and neutral stimuli for each individual study. Second, weighted mean effect sizes were calculated for the pleasant, unpleasant, and neutral conditions. Third, to examine the degree to which effect sizes varied across studies as a function of stimulus and rating scale type, we divided studies according to stimulus type (pictures, words, faces, sounds, and a virtual reality conversation task) and rating scale type (calm to excited anchors vs. high to low anchors), and re-calculated analyses across valence conditions. Finally, we conducted meta-regressions to determine whether sex (% male) and negative and positive symptoms were possible effect size moderators. Studies typically used the PANSS (Kay et al., 1991), SANS (Andreasen, 1983), SAPS (Andreasen, 1983), and the BPRS (Overall and Gorham, 1962) to assess negative and positive symptoms. To account for the use of multiple measures across studies, a composite score was calculated by dividing the total symptom score by the maximum possible score for that scale/subscale.

3. Results

An initial meta-analysis across 26 studies yielded an effect size of $g = 0.034$. The Q statistic was nonsignificant ($Q\,(25) = 24.29$, $p > 0.05$) indicating homogeneity no greater than that expected from sampling error alone. Table 1 presents effect sizes and variance scores for individual studies (see Supplementary materials for figures).

Patient arousal ratings in response to pleasant stimuli were highly variable across studies ranging from $g = -0.65$ to 0.56. In all, 12 of the 24 studies utilizing pleasant stimuli indicated that patients reported experiencing higher arousal than controls at a small effect size or larger. Second, in 20 of 22 studies using neutral stimuli, patients reported higher arousal than controls at a small effect size or greater (gs ranged from -0.44–1.55). Finally, effect sizes for studies using unpleasant stimuli were more variable ($g = -1.85$ to 0.65), with 18 of 26 studies indicating that patients reported less arousal than controls at a small effect size or larger.

Table 2 contains the weighted mean effect sizes for patients vs. controls from the pleasant, unpleasant, and neutral conditions. Arousal ratings for pleasant and unpleasant stimuli were similar between groups, with mean weighted effect sizes of $g = -0.05$ and $g = -0.14$, respectively. However, patients reported experiencing more arousal than controls in response to neutral stimuli ($g = 0.427$). Nonsignificant