

Emotional Experience in Patients With Schizophrenia Revisited: Meta-analysis of Laboratory Studies

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Our understanding of the emotion deficits in schizophrenia is limited. Findings from studies employing trait emotion instruments suggest that patients have attenuated levels of positive emotion (ie, anhedonia) and increased levels of negative emotion. Conversely, patients and controls have not statistically differed in their subjective reactions to positive or negative valenced stimuli in most laboratory studies to date. Further obfuscating this issue is the fact that many of these laboratory studies are underpowered and a handful of emotion induction studies have found evidence of anhedonia. We conducted a meta-analysis of 26 published studies employing laboratory emotion induction procedures in patients with schizophrenia and healthy controls. Patients did not differ from controls when strictly rating their subjective hedonic reactions to the stimuli. However, they reported experiencing relatively strong aversion to both positive and neutral stimuli (Hedges *D* .72 and .64, respectively). These findings were not the result of demonstrable sample or methodological differences across studies. Patients' ability to experience hedonic emotion is preserved, although they also show relatively strong, simultaneously occurring aversive emotion when processing laboratory stimuli considered by others to be pleasant or neutral.

Key words: schizophrenia/anhedonia/emotion/meta-analysis/negativedeficit/affect/ambivalence/emotion regulation

Introduction

The emotional deficits of schizophrenia have long been considered integral features of the illness.^{1–4} However, our understanding of these deficits is limited. As yet, it is clear that many patients evidence an attenuation in

the outward expression of emotion, often referred to as blunt or flat emotion.⁵ The degree to which their phenomenological experience of emotion is altered is much less clear. Some theorists have postulated that patients have a relatively uniform declination in their capacity to experience nearly all emotion¹ while others have proposed that schizophrenia is associated with an innate and diminished capacity to experience hedonic emotion (eg, anhedonia or hypohedonia) but a heightened experience of aversive emotion.³ In part due to increasing awareness regarding the importance of emotional functioning across a wide range of activities^{6,7} and the recognition that emotional abnormalities are associated with a number of functional impairments in schizophrenia^{8,9,10} this issue has seen near-exponential growth in empirical attention within the last 2 decades.

At the heart of the obscurity over whether patients' phenomenological experience of emotion is abnormal concerns the seemingly inconsistent findings from relevant literatures. On one hand, studies comparing patients with schizophrenia and nonpatient controls on measures of emotional disposition, such as the Multidimensional Personality Questionnaire,^{8,9,11} the Minnesota Multiphasic Personality Inventory,¹² the NEO-PI,¹³ and the Chapman Anhedonia Scales,^{8,9} find that individuals with schizophrenia report experiencing abnormally low levels of positive emotion and abnormally high levels of negative emotion.¹⁴ Similarly, trained interviewers evaluating patients using standardized clinical measures report that patients show high levels of both anhedonia^{5,10} and negative emotion (eg, hostility, guilt, anxiety, fear¹⁵). However, studies employing emotion induction procedures under controlled laboratory conditions have generally reported that patients do not differ from nonpsychiatric controls in their subjective reactions to emotionally charged stimuli. These studies include 3 seminal works^{16–18} that have used stimuli ranging from emotional film clips to flavored drinks to induce emotion. In each of these studies, patient and control groups did not show significant attenuations in their phenomenological experience of emotion and in one case, reported stronger hedonic responses to neutral stimuli.¹⁸ In support of these findings, other published studies have reported similar results.^{11,19–30}

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There are 2 important factors to consider when interpreting this body of laboratory emotion induction studies. First, the majority of these studies employ relatively small sample sizes that offer insufficient power for detecting all but large effect sizes. For example, an average sample size of 29 patients was employed across the 3 aforementioned studies.^{16–18} While this sample size is typical of many schizophrenia studies employing experimental methodology, limited power may have obscured true group differences. Second, similarity between patients and controls in reaction to laboratory stimuli is not ubiquitous across all studies. At least 5 published studies have reported that patients experienced significantly less potent emotional reaction to laboratory stimuli.^{31–35} Given these considerations, it seems that a comprehensive meta-analysis of the subjective emotion induction literature might shed some light on the issue of whether schizophrenia is characterized by abnormal phenomenological emotional states under laboratory conditions. This was the primary goal of the present study.

Methods

Search Strategy for the Meta-analysis

In order to identify relevant studies for the meta-analysis, we conducted a combined MEDLINE and PsychINFO search for studies published between 1986 and June 2007 having the following terms: a word base of “schizophren*” and either “emotional experience” (yielding 80 entries), or “mood induct*” (yielding 7 additional entries). We also reviewed all published articles citing Berenbaum and Oltmanns,¹⁶ Kring et al,¹⁷ and Kring and Neale¹⁸ using a PsychINFO citation function. This yielded an additional 170 articles. In all, 257 journal articles were considered for the present study. Our inclusion criteria included the following: (1) the article is written or translated in English (15 studies excluded), (2) the article is an empirical study that is published in a peer-reviewed journal (57 studies excluded), (3) the article includes an emotion manipulation broadly defined (68 studies excluded), (4) the article reports means of patients’ phenomenological experience of emotion using a self-report scale following the emotion manipulation (41 studies excluded), and (5) the article reports data on a patient group diagnosed with schizophrenia or schizoaffective disorder and compares their emotional experience to a nonpsychiatric control group (45 studies excluded). Additionally, 5 studies were excluded because they reported data published elsewhere. Authors were contacted when missing data impeded our analyses except in one case,³⁶ where we were able to estimate standard deviation values using formulas from Hurlburt.³⁷ In all, 26 studies were included in the present meta-analyses. These studies are detailed in table 1.

Creation of the Database

Careful consideration was paid to organizing the data from the individual studies so they were uniform for analysis. One notable challenge concerned the variability in subjective emotion scales used across these studies. Fourteen of the studies conceptualized positive and negative emotion as being orthogonal in nature. These studies employed unipolar scales to separately measure “hedonic” and “aversive” emotion. Conversely, 12 studies conceptualized hedonic and aversive emotion as opposing ends on a single continuum. Given that these unipolar and bipolar scales are based on fundamentally different theories of emotion (ie, “orthogonal” vs “circumplex” models⁴¹), we considered them separately in the present study. We transformed each of these scales so that increasing unipolar scores reflect higher hedonic/aversive emotion and increasing bipolar scores reflect higher hedonic emotion. For the present study, hedonic and aversive emotions refer to subjective emotion states following stimulus presentation. “Unipolar” refers to subjective rating scales assessing either hedonic or aversive emotion, and “bipolar” refers to subjective rating scales set up with both extreme hedonic and aversive emotion on opposing ends of a continuum. Finally, “positive” refers to stimuli generally judged to activate neurocircuitry involved in the phenomenological experience of pleasurable emotions while “negative” refers to stimuli judged to activate avoidance, threat, sadness, or other negative emotional states. “Neutral” refers to stimuli regarded as neither positive nor negative.

When studies presented separate data for multiple stimuli that were designed to elicit similar emotion, the means and standard deviations were averaged together. For one study,¹⁶ where subjects were presented with both flavored liquids and film clips, we averaged together ratings by valence condition (eg, positive condition) and presented them as a single effect size except for the analyses examining stimulus type (see below). When data were presented for separate schizophrenia patient groups (eg, those with blunted affect vs those without), we weighted their means and standard deviations by sample size and averaged them together. All measures of variance were converted to a standard metric (standard deviation) to ensure consistency. All data were carefully checked and rechecked for accuracy.

Analyses

We used MetaWin statistical package⁴² to conduct our analyses. Effect size values were independently computed for each emotion induction condition for each study using the Hedges *D* statistic. Cumulative effect sizes were computed using a procedure that statistically weighs individual effect sizes by their variance scores. The rationale for this weighting procedure is that the closer a sample’s effect size approximates that of the population, the

Table 1. Descriptive Data, ES, and VAR Computed for Unipolar Hedonic, Unipolar Aversive, and Bipolar Emotion Ratings from the Positive, Negative, and Neutral Emotion Induction Conditions

| Patients vs Controls: Unipolar Scales | | | | | | | | | |
|---------------------------------------|------------|--------------------|--------|------------------------------|------------|------------------------------|------------|-----------------------------|------------|
| Study Citation | Medicated? | Patient-Control, n | % Male | ES ± VAR: Positive Condition | | ES ± VAR: Negative Condition | | ES ± VAR: Neutral Condition | |
| | | | | Hedonic | Aversive | Hedonic | Aversive | Hedonic | Aversive |
| Habel et al ^{34,a} | Yes | 69-69 | 72 | -.41 ± .03 | .63 ± .03 | .22 ± .03 | -.13 ± .03 | — | — |
| Earnst et al ^{26,b} | Yes | 41-20 | 100 | -.26 ± .07 | .54 ± .08 | .44 ± .08 | .14 ± .07 | .42 ± .08 | .39 ± .08 |
| Habel et al ^{20,a} | Yes | 13-26 | 100 | -.04 ± .12 | .51 ± .12 | .22 ± .12 | .21 ± .12 | -.15 ± .12 | .71 ± .12 |
| Iwase et al ^{25,a} | Yes | 25-20 | 44 | -.68 ± .10 | — | — | — | — | — |
| Kring et al ^{18,a} | No | 23-20 | 100 | .12 ± .09 | .95 ± .10 | .24 ± .09 | .08 ± .09 | .59 ± .10 | 1.04 ± .11 |
| Kring et al ^{17,a} | No | 20-20 | 100 | .70 ± .11 | .92 ± .11 | -.10 ± .10 | .47 ± .10 | 1.28 ± .12 | .73 ± .11 |
| Salem et al ^{19,a} | Yes | 17-15 | 100 | -.61 ± .13 | .84 ± .14 | .94 ± .14 | .60 ± .13 | — | — |
| Schneider et al ^{33,a} | Yes | 40-40 | 53 | -.34 ± .05 | .63 ± .05 | -.48 ± .05 | .43 ± .05 | — | — |
| Schneider et al ^{27,a} | Yes | 13-13 | 100 | -.25 ± .16 | 1.31 ± .19 | .68 ± .16 | .17 ± .15 | -.17 ± .15 | 1.14 ± .18 |
| Flack et al ^{36,a} | Yes | 22-29 | 100 | -.86 ± .09 | — | .88 ± .09 | — | — | — |
| Horan et al ^{11,a} | Yes | 36-15 | 100 | .39 ± .10 | .61 ± .10 | .46 ± .10 | .75 ± .10 | .07 ± .09 | .48 ± .10 |
| Berenbaum et al ^{16,a} | Yes | 43-20 | 51 | .41 ± .07 | — | -.48 ± .08 | — | — | — |
| Horan et al ^{30,a} | Yes | 30-31 | 83 | -.32 ± .07 | .62 ± .07 | — | — | -.28 ± .07 | .41 ± .07 |
| Habel et al ^{38,a} | Yes | 20-20 | 50 | .11 ± .10 | 1.06 ± .11 | .76 ± .11 | .28 ± .10 | — | — |

| Patients vs Controls: Bipolar Scales | | | | | | |
|--------------------------------------|------------|--------------------|--------|------------------------|------------------------|-----------------------|
| Study Citation | Medicated? | Patient-Control, n | % Male | ES: Positive Condition | ES: Negative Condition | ES: Neutral Condition |
| Hempel et al ^{24,b} | Yes | 28-30 | 93 | -.09 ± .07 | -.17 ± .07 | .00 ± .07 |
| Mathews et al ^{21,b} | Yes | 27-28 | 67 | -.50 ± .08 | -.27 ± .07 | .60 ± .08 |
| Taylor et al ^{45,b} | Yes | 14-14 | 71 | -.81 ± .15 | .03 ± .14 | — |
| Taylor et al ^{31,b} | Yes | 18-10 | 61 | -1.03 ± .17 | -.47 ± .16 | .42 ± .16 |
| Volz et al ^{23,a} | Yes | 49-46 | 53 | -.28 ± .04 | .04 ± .04 | .16 ± .04 |
| Quirk et al ^{22,a} | Yes | 20-10 | 100 | -.22 ± .15 | .33 ± .15 | .15 ± .15 |
| Quirk et al ^{32,a} | No | 30-10 | 100 | -.53 ± .14 | .79 ± .14 | -.32 ± .13 |
| Burbridge et al ^{39,a} | Yes | 49-47 | 63 | .17 ± .04 | .03 ± .04 | -.11 ± .04 |
| Lee et al ^{35,a} | Yes | 21-20 | 48 | -.13 ± .10 | -.03 ± .10 | — |
| Seok et al ^{40,a} | Yes | 25-25 | 52 | -.85 ± .09 | .98 ± .09 | .24 ± .08 |
| Crespo-Facorro et al ^{28,b} | No | 18-16 | 89 | -.64 ± .12 | .12 ± .12 | — |
| Heerey et al ^{29,a} | Yes | 41-31 | 63 | -.04 ± .06 | .25 ± .06 | -.26 ± .06 |

Note: ES, Effect sizes, VAR, variance scores. Positive effect size values from hedonic and bipolar ratings reflect patients reporting more euphoria than controls following stimulus presentation. Positive effect size values from aversive ratings reflect patients reporting more dysphoria than controls following stimulus presentation.

^aTask instructions involved having subjects asked to rate their subjective reactions to the stimuli.

^bTask instructions involved having subjects rate the stimuli itself.

smaller the variance of that effect size will be.⁴² Q statistics, based on chi-square distributions, were also reported here. The Q_{total} , a measure of the total heterogeneity of a sample, was used to determine whether the variability of individual effect size values within a group were greater than that predicted by sampling error and the $Q_{between}$,

a measure of variability across mean weighted effect size, was used. To address the “publication bias” phenomenon—that null finding studies tend to be unpublished—we computed Orwin statistic. This statistic reports the number of studies with null findings (Hedges $D = 0$) that would need to be included in the meta-analysis to reduce the weighted

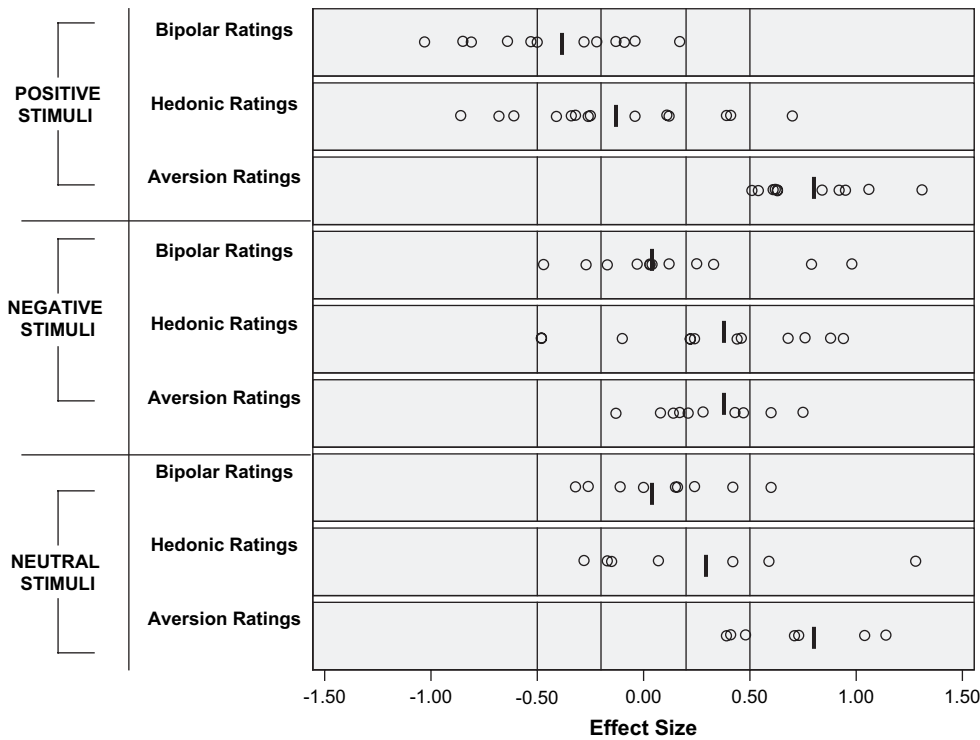


Fig. 1. Patients vs Controls: Effect Sizes Computed for Unipolar Hedonic, Unipolar Aversive, and Bipolar Emotion Ratings from the Positive, Negative, and Neutral Emotion Induction Conditions. Positive effect size values from hedonic and bipolar ratings reflect patients reporting more euphoria than controls following stimulus presentation. Positive effect size values from aversive ratings reflect patients reporting more dysphoria than controls following stimulus presentation. Dotted lines denote small ($-.20$ and $.20$) and medium ($-.50$ and $.50$) effect sizes. Dark solid line reflects weighted means.

mean below a “small” effect size level (defined as $.20$). All meta-analyses reported here used random effects models.

The analyses were conducted in 3 steps. First, we computed effect sizes comparing patients and controls in their subjective emotion following positive, negative, and neutral stimuli for each individual study. Second, we computed weighted mean effect sizes for the positive, negative, and neutral conditions. Third, we examined the degree to which variability in these effect sizes across studies was a function of stimulus type, gender composition of the sample, and whether the sample was medicated vs unmedicated and outpatient vs inpatient.

Results

Table 1 contains the effect sizes and variance scores for each individual study. These data are presented in figure 1. There are several notable findings. First, patient reactions to positive stimuli were highly variable across studies. In all, 66% of studies (8 of 12) using bipolar scales and 57% of studies (8 of 14) using unipolar hedonic scales reported that patient reactions were more dysphoric or anhedonic (respectively) than controls at a small effect size or higher. Second, patients reported aversive emotion at a small effect size or higher following exposure to positive stimuli in nearly all studies (eg, 100% of studies using unipolar aversion scales). Simi-

larly, patients reported aversive emotion at a small effect size or better in response to neutral stimuli in most studies (eg, 100% of studies using unipolar aversion scales). Finally, the effect sizes across studies examining reaction to negative stimuli were much more variable, although 75% of studies employing unipolar hedonic scales reported that patients enjoyed the stimuli more than controls at a small effect size or better.

In 5 of the studies examined here, subjects were specifically asked to rate the stimuli, whereas in the other 21 studies, subjects were asked to rate their experience while processing the stimuli. One study did not specify its procedure in this regard. It is not clear how this may have affected the present results, and comparison of these groups of studies revealed no statistically significant (all P values of $Q_{\text{between}} > .05$) differences in effect size, suggesting that this methodological disparity did not contribute to variable findings across studies.

Patients vs Controls

Table 2 contains the weighted mean effect sizes for patients vs controls from the positive, negative, and neutral conditions. Patients reported experiencing more aversion to positive stimuli compared with controls (Hedges $D = .72$ and $-.33$ for unipolar aversion and bipolar scales, respectively), but there was little evidence of anhedonia given that patients and controls did not differ

Table 2. Mean Weighted Effect Sizes Computed for the Positive, Negative, and Neutral Emotion Induction Conditions

| Emotion Induction Condition | Total Number of Studies | Total Number of Patients | Total Number of Controls | Mean Weighted Effect Size | 95% Confidence Interval | Q_{Total} | Orwin Statistic |
|-------------------------------|-------------------------|--------------------------|--------------------------|---------------------------|-------------------------|--------------------|-----------------|
| Positive Stimuli | | | | | | | |
| Hedonic Emotion ^a | 14 | 412 | 358 | -.16 | -.40 to .07 | 13.72 | 0 |
| Aversive Emotion ^b | 11 | 322 | 283 | .72 | .53 to .91 | 5.36 | 29 |
| Bipolar Ratings ^a | 12 | 340 | 287 | -.33 | -.57 to -.10 | 10.68 | 9 |
| Negative Stimuli | | | | | | | |
| Hedonic Emotion ^a | 10 | 292 | 252 | .28 | .03 to .59 | 10.86 | 5 |
| Aversive Emotion ^b | 9 | 357 | 340 | .24 | -.03 to .45 | 8.56 | 2 |
| Bipolar Ratings ^a | 12 | 307 | 287 | .12 | -.12 to .36 | 11.80 | 0 |
| Neutral Stimuli | | | | | | | |
| Hedonic Emotion ^a | 7 | 176 | 145 | .25 | -.25 to .73 | 6.24 | 2 |
| Aversive Emotion ^b | 7 | 176 | 145 | .64 | .34 to .93 | 4.76 | 16 |
| Bipolar Ratings ^a | 9 | 246 | 206 | .07 | -.15 to .29 | 8.01 | 0 |

^aPositive effect size values mean patients had more hedonic emotion compared with controls.

^bPositive effect size values mean patients had more aversive emotion compared with controls.

in their hedonic appraisal of positive stimuli (Hedges $D = -.16$; see table 2). Interpretation of the confidence intervals and Orwin statistics suggest that these effect sizes are stable. Patients also reported experiencing relatively normal levels of aversive emotion to negative stimuli. Interestingly, compared with controls, patients reported experiencing modest increases in both hedonic and aversive emotion to negative and neutral valenced stimuli. In sum, while there was little evidence to suggest that patients were anhedonic in response to laboratory stimuli, they did show a relatively dramatic aversion to positive and neutral stimuli compared with controls. Put another way, it seems that both hedonic and aversive emotions were induced in patients with schizophrenia when processing positive or neutral valenced external stimuli.

Effect of Stimuli Type

In order to examine the degree to which stimuli type may have produced different patient reactions across studies, we aggregated the studies into 4 groups: those that used visual stimuli (eg, film clips, picture stills, faces), verbal stimuli (eg, reading valenced words), gustatory experiences (eg, consuming flavored liquids), and behavioral tasks (eg, maintaining facial gestures, social interactions). None of the Q_{between} values were statistically significant (all P values $> .05$). Although this analysis was underpowered in the sense that not all types of stimuli had representation for each comparison, this finding suggests that there were no demonstrable differences in stimulus effect across studies.

Patients vs Controls

Effects of Medication and Sample Characteristics. To determine whether patients on antipsychotic medication showed notable differences in emotion induction effect compared with unmedicated patients, we compared effect

sizes from studies ($n = 4$) which employed unmedicated patients (2 of which employed unipolar scales and 2 of which employed bipolar scales) and studies employing medicated patients ($n = 22$). There were no significance of otherwise notable differences. We conducted similar analyses on studies employing primarily male ($n = 11$; defined as sample $> 90\%$ male) and studies employing mixed gender ($n = 15$) samples to determine whether there were any demonstrable gender effects. Finally, we compared effect sizes from studies employing outpatient ($n = 10$), inpatient ($n = 8$), and mixed/unspecified ($n = 8$) samples. None of these comparisons were statistically significant (all P values of $Q_{\text{between}} > .05$).

Discussion

Consistent with what has been concluded in most laboratory studies (see Introduction), patients with schizophrenia did not show hedonic deficits when processing laboratory stimuli. However, positive and neutral valenced stimuli induced relatively high levels of aversive emotion in patients. Put another way, positive and neutral stimuli appeared to coactivate hedonic and aversive emotions in patients. These findings were not attributable to demonstrable differences across studies in sample gender composition or study methods.

If patients are not anhedonic in their “in the moment” experience of pleasure, what might explain the emotional abnormalities characteristic of the disorder? One possibility is that clinically rated or self-reported “anhedonia,” for most patients, actually reflects abnormal levels of negative emotion. As discussed by Horan et al,³⁰ elevated negative emotionality could reflect an emotion regulation deficit involving impairments inhibiting negative emotion. In support of this notion, patients with schizophrenia have shown impairments on neuropsychological tasks requiring effective inhibiting abilities^{43,44} and have demonstrated

pathology in orbitofrontal brain regions^{45,46}—structures known to be involved in inhibiting limbic activity.⁴⁷ Moreover, patients have demonstrated increased tonic activity in brain regions related to negative emotions (eg, amygdala^{31,48}) and report experiencing high levels of trait negative affectivity.^{8,9} Taken together, these results suggest that patients' trait negative emotionality may be abnormally disinhibited.

An alternate, but not mutually exclusive, way of conceptualizing the abnormal negative emotionality in schizophrenia involves “ambivalence.” Contemporary models of personality and emotion posit that positive and negative emotions reflect distinct neurocircuitry that gives rise to disparate hedonic- and aversive-based systems (eg, behavioral activation and inhibition systems,⁴⁹ the “evaluative space” model,⁵⁰ and emotional ambivalence⁵¹). Recent research suggests that these systems coactivate when processing certain stimuli that have simultaneous pleasant and aversive properties.^{52–54} Ambivalence has proved a valuable construct for understanding a broad range of behaviors and psychopathological states.^{51,55} Interestingly, early schizophrenia theorists heralded ambivalence—defined as a co-occurrence of hedonic and aversive emotional states—as an important feature of schizophrenia pathology.^{3,56} The limited empirical work examining ambivalence in schizophrenia has suggested that it is a useful construct for understanding schizophrenia proneness.^{57,58} Might ambivalence be a useful way to conceptualize abnormal hedonic experiences in most patients with schizophrenia? Clearly, further research on this topic is needed.

In explaining why patients show anhedonia on subjective questionnaires and symptom rating scales,^{5,59} it is noteworthy that elevations on these instruments could reflect elevated negative emotion rather than attenuated positive emotion. These assessment methods typically involve measuring attitudes (eg, “I like to make long distance phone calls to friends and family” [keyed false]⁵⁸) or behaviors (eg, “I have often enjoyed receiving a strong, warm handshake” [keyed false]⁶⁰) when measuring anhedonia without regard to the underlying cause of the putative emotional deficit. Not surprisingly, prior research has demonstrated that both the Chapman Anhedonia Scale scores and scale for the assessment of negative ratings significantly correspond to increasing levels of negative emotions in patients with schizophrenia.^{8,9} In sum, it is possible that, obscured by a lack of precision in existing instruments, clinical anhedonia actually reflects negative emotion. Efforts to remedy this issue are underway. This involves the creation of a new interview-based measure of negative symptoms^{61,62} and the development of a measure of emotion using computerized analysis of natural speech that holds potential for differentiating between positive and negative emotion states. The present findings suggest that separate unipolar assessments, as opposed to a single bipolar scale,

should be used for measuring emotions in individuals with schizophrenia because bipolar scales mask the potential coactivation of hedonic and aversive emotions.

It is important to entertain the possibility that patients' capacity to experience pleasure may be impaired in some capacity not captured by laboratory experiments. First, some have postulated that patients are impaired in appetitive hedonic activities—involving accurately forecasting experiences for future events as is done when completing trait questionnaires and interviews, but have intact “consummatory” experiential systems.⁶³ The present findings support this theory insofar because no evidence of “in the moment” hedonic deficits were revealed. Second, in contrast to laboratory studies, which typically assess state emotions, questionnaire and interview measures presumably tap more stable trait-like phenomena. It is possible that patients' capacity for hedonic experience (as elicited during laboratory studies) may be bounded by similar asymptotes as controls, but the frequency of these experiences in the real world may be relatively infrequent. Supporting this notion, patients have shown lower levels of subjective hedonic experience in studies employing experience sampling methodology,^{63–65} which involve having patients report their emotion over an epoch of days or weeks at quasi-random times throughout the day. Comparing patients and controls using more sophisticated procedures, eg, using stimuli with varying intensities under varying conditions, would be important for further clarifying the emotional abnormalities in schizophrenia. Finally, some have suggested that cognitive impairments somehow color patients' memory of hedonic stimuli after they have initially been processed. That is, the emotional abnormality is not experiential per se but rather related to how the experience is consolidated into long-term memory or in how it is recalled. Empirical evidence on this topic is mixed,^{30,66} so further research is needed.

A serious limitation in our current understanding of emotional deficits in schizophrenia concerns how these deficits differ across the various manifestations of the disorder. This is particularly important as one considers that patients with chronic idiopathic negative symptoms (estimated to be approximately 25%–30% of patients⁶⁷) are defined, in part, by global emotion deficits.⁶⁴ “Negative syndrome” patients have shown higher levels of questionnaire-based anhedonia and less severe interviewer-based negative emotions,⁶⁷ although findings from laboratory studies are more varied. To date, 2 laboratory emotion induction studies have reported a dramatic reduction in aversive emotions in negative symptom vs other patients^{68,69} while 2 other studies have reported negligible group differences.^{16,26} Interpretation of these studies is clouded by profound differences in how negative symptoms were defined across these studies. It is noteworthy that anhedonia can reflect a secondary negative symptom—caused by depression as opposed to an idiopathic disease symptom, so distinguishing between the 2 will be important. We believe

that understanding how emotional deficits differ across the heterogeneous manifestations of the disorder is a crucial and sorely neglected area of research (see Cohen et al⁸ for further discussion of this point).

Although sufficient studies have been published to allow broad conclusions about patients' emotional reactions in the laboratory, there are far too few studies to allow understanding of the effects of stimulus, methodological, or patient characteristics. Thus, it is unclear to what degree emotion reactions vary as a function of stimulus modality (eg, image still, movie, social interactions, gustatory), task instructions, medication effects, sex differences, or other patient characteristics (eg, treatment modality). There were some (albeit nonsignificant) variability across studies in effect sizes, and this could reflect influence of any of these variables. Examining the impact of these variables on emotion abnormalities in individuals with schizophrenia is an important avenue for future research.

In summary, the present meta-analysis found little evidence that individuals with schizophrenia have deficits in their ability to experience pleasurable emotion states. However, patients do show relatively strong aversive emotions when processing stimuli considered by others to be pleasant or neutral in tone. We believe that clarifying the underpinnings of this emotion abnormality will be crucial to the development of more sophisticated measures of schizophrenia pathology, as well as efforts to understand and treat the disorder more generally.

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