Emotional Response Deficits in Schizophrenia: Insights From Affective Science

Ann M. Kring[1,2] and Erin K. Moran[2]

[2]Department of Psychology, University of California, Berkeley, CA

Our understanding of the emotional features of schizophrenia has benefited greatly from the adoption of methods and theory from the field of affective science. This article covers basic concepts and methods from affective science on the psychological and neural mechanisms contributing to emotions and reviews the ways in which this research has advanced our understanding of emotional response deficits in schizophrenia. We review naturalistic studies and elicitation studies that evoke emotion responses among participants, including emotion expression, experience, and autonomic physiology. We also consider how these emotion response measures correspond to schizophrenia symptoms, and we focus particular attention on the issue of sex differences in emotional responding and how this may influence our understanding emotional functioning among individuals with schizophrenia.

Key words: schizophrenia/emotion experience/
emotion expression/affect

Theoretical and clinical writings in schizophrenia are replete with rich descriptions of emotional disturbance that date back to the early 20th century.[1,2] For example, Bleuler noted

> "Occasionally, a patient will maintain that he has a marked and powerful affect, whereas the observer can note none or another type of affect than that which the patient professes to feel ([3(p51)])."

This apparent disconnect between the outward display of emotion and feeling that Bleuler referred to has now been confirmed empirically, and in the present article, we review the literature on emotion responding in schizophrenia and argue that the adoption of the affective science approach has greatly advanced our understanding of the nature of emotion disturbances.

Many factors have contributed to the relatively recent increase in research on emotion in schizophrenia, but a centrally important factor has been the development and adoption of methods and theories in basic affective science. Emotion was long considered to be the "black sheep" of the family with respect to behaviors that could be empirically studied, but pioneering work by investigators such as Paul Ekman and Carroll Izard in the 1960s paved the way for emotion research to become not only well accepted and integrated into psychology and neuroscience but also as a discipline in its own right. Indeed, the explosion of brain imaging techniques has further advanced our understanding of how emotion works at the level of the brain, and taken together, we now know a great deal about emotional behavior and its neural underpinnings (see Barrett et al[4] and Wager et al[5] for recent reviews).

Constraining Emotion and Emotion Disturbances in Schizophrenia

From the affective science perspective, emotions are complex systems that have developed through the course of human evolutionary history to prepare organisms to act in response to a number of environmental stimuli and challenges. Thus, under most circumstances, emotions serve a number of important intra- and interpersonal functions,[6–9] a point which amplifies the notion that emotions are adaptive and not simply the bane of our rational or "reasoned" existence. The functions of emotion in persons with schizophrenia are comparable to those without schizophrenia[7,10]; however, emotion disturbances in schizophrenia can interfere with the achievement of these important emotion-related functions. For example, a schizophrenia patient's absence of facial expressions may evoke negative responses from others,[11] thus negatively impacting social relationships and interactions.[12]

Emotional responses are typically considered to be comprised of multiple components, including (but not limited to) expression, experience, and physiology. The extent to which these emotion components correspond with one another or cohere remains a topic of debate.[13–15] Functionalist accounts of emotion suggest that coherence among components is adaptive,[9] yet the empirical data supporting coherence is mixed.[13,16]

The terms "affect" and "emotion" are often used interchangeably in the schizophrenia literature, but from

[1]To whom correspondence should be addressed; Department of Psychology, 3210 Tolman Hall, University of California, Berkeley, CA 94720-1650; tel: 510-643-1560, fax: 510-642-5293, e-mail: akring@berkeley.edu.

the affective science perspective, there are important conceptual and empirical distinctions between the terms. Specifically, affect is most often used in reference to feeling states, whereas emotion is used in reference to multiple components (only one of which is a feeling state). By contrast, in the schizophrenia literature, affect is sometimes used to refer to a feeling state and sometimes used to refer to the expression of emotion (eg, flat affect). It does not seem likely that the affective science perspective on terminology will take hold in the schizophrenia literature, nor is it clear that it need be adopted. However, it would be of benefit to the field to forego broad and uninformative terms such as ''affect processing'' or ''emotion processing'' (see also Herbener et al[17]). These terms are used to describe anything from the study of emotion facial expressions following the presentation of emotionally evocative film clips to the reading of emotional words. Not only are these tasks different, but they also recruit different brain regions in the service of performing them[5] and the behavioral outputs from these tasks are linked to different aspects of schizophrenia, including specific symptoms and functional outcomes. Perhaps reflecting the fact that studies of emotion in schizophrenia are fewer and more recent than studies of cognitive deficits, such terminological imprecision might be expected. Indeed, ''information processing'' was long used to describe different studies of cognition in schizophrenia until the translation of cognitive neuroscience theory and methods to schizophrenia research pointed to the importance of more clearly demarcating the specific type of cognition (eg, episodic memory, cognitive control) under investigation, thus rendering the use of the more vague term less likely (As a rough index of the decline in the use of the term ''information processing,'' a PubMed search for ''information processing and schizophrenia'' in the title yielded 106 articles dating back to 1971. Three-quarters of these articles were published prior to the year 2000. A similar search in PsychInfo yielded 193 articles dating back to 1964; 80% of these were published prior to the year 2000.). As the current review will point out, there are important distinctions in which components of emotional response are (or are not) disrupted in schizophrenia, and thus, the use of vague terms such as ''emotion processing'' will likely stall progress in the field by making it difficult to integrate findings across studies that are assessing similar types of emotion disturbances.

Methodological Distinctions and Conceptual Clarity

To facilitate the field's moving beyond the vagueness of ''emotion processing,'' it is helpful to make distinctions between the types of studies and types of dependent variables or measures of emotion that are commonly employed to study emotion in schizophrenia. Broadly speaking, at least 5 types of studies can be distinguished:

(1) studies that *elicit*(*evoke, generate*) emotion responses from participants (eg, presenting emotionally evocative film clips and assessing reports of emotional experience), (2) studies that assess *perception*(*recognition*) of affective stimuli (eg, presenting pictures of faces and assessing accuracy of emotion expression identification), (3) *naturalistic* studies that assess emotion in participants' natural environments (eg, assessing emotional experience in context of daily life several times a day for several days, observing emotional behavior in an inpatient setting); (4) studies that assess *trait* or individual differences in emotion components (eg, collecting self-report measures of anhedonia or emotional expression), and (5) studies that assess the *impact* of emotion on some other process (eg, assessing how the emotional valence of words impacts the ability to recall the words). Of course, these are not rigid demarcations, and many studies combine more than one of these methods. For example, a study may present emotionally evocative pictures and assess facial expression responses to the pictures and then later test memory for the previously viewed pictures. Moreover, studies designed to elicit emotion will likely require recognition of the affective significance of the stimulus to engender a response, and studies designed to assess the perception of affective stimuli may well elicit an emotional response.[5] Nevertheless, it can be helpful to keep in mind the goals and methods of the study with respect to what aspect(s) of emotion is being manipulated and assessed.

It is also helpful to distinguish the types of dependent variables or measures of emotion included in particular studies. Studies that elicit emotion are typically interested in assessing emotional responses, such as facial expression, experience, physiology, or brain activation. Studies that assess perception or recognition of affective stimuli are typically interested in assessing accuracy of identification or discrimination, but these studies also may assess responses to these stimuli (eg, brain activation, autonomic physiology). Naturalistic studies often assess reports of emotional experience in context (eg, when at home, when with friends). Studies that assess emotion's impact on some other process typically assess the other process of interest. For example, a narrative study that asks participants to recount stories involving different emotional life events may assess the impact of the emotional valence of the stories on discourse[18] or referential language disturbances.[19]

It is not only useful to make these distinctions to be precise in describing the types of emotion processes under study, but it is also relevant for developing a more specific understanding of the neural systems that support these different processes. Recent meta-analyses in affective neuroscience point to a dissociation in relative brain region activations depending upon the emotion task that is used.[5,20] Specifically, perception studies demonstrate relatively more robust activation in areas, such as amygdalae, parahippocampal cortex, pregenual cingulate, and

dorsal portions of the inferior frontal gyrus. By contrast, elicitation studies that assess participants' reports of emotional experience demonstrate relatively greater activation in other areas, such as prefrontal cortex (ventromedial, orbitofrontal, dorsolateral), anterior insula, medial temporal lobe, ventral inferior frontal gyrus, and temporal pole (see Wager et al[5] for full details). Tasks that involve less cognitive demand are more likely to activate amygdalae; whereas studies that involve more cognitive demand, including judgments related to the self, are more likely to activate ventromedial prefrontal cortex.[20,21] These different tasks do not recruit entirely different brain regions, yet the relative emphasis of recruitment differs depending upon the task.

Finally, it is important to consider that most studies conduct group-level comparisons between individuals with and without schizophrenia. This approach is of course useful for isolating areas where individuals with schizophrenia may have particular deficits relative to healthy individuals, but it can obfuscate the heterogeneity within a group of individuals with schizophrenia. For example, some studies suggest that individuals with schizophrenia who meet criteria for the deficit syndrome[22] or who exhibit deficit syndrome symptoms[23] may exhibit a deficit in emotional experience.

The Current Review

Although there have been a few other recent reviews that have covered emotion expression and experience along with other emotion deficits in schizophrenia,[24–27] the current review focuses on elicitation and naturalistic studies that assessed one or more components of emotional response (ie, expression, experience, physiology). We include functional magnetic resonance imaging (fMRI) or positron emission tomography (PET) studies that also assessed other components of emotion response, but the review of imaging studies is more fully covered elsewhere by (for eg see[28]). We will also emphasize the role of sex differences when evaluating emotional responses among individuals with schizophrenia, a topic that has not been covered in prior reviews.

Due to space constraints, we do not include trait, perception, or impact studies in this review. Horan et al[29] review trait studies of emotion in schizophrenia. Affect perception or recognition is currently a hot topic in the study of social cognition in schizophrenia[30] and is part of National Institute of Mental Health–sponsored efforts to develop more effective assessments and treatments for cognition in schizophrenia, including Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS[31,32]) and Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia (CNTRICS)[21,33]), and has been included in other reviews.[24–26,34–36] To our knowledge, no review has specifically covered what we call impact studies, but

such a article that reviews studies that bridge emotion and cognition in schizophrenia would be of great interest to the field.

Emotional Expression

Perhaps one of the more well-replicated findings in the literature on emotion in schizophrenia is that individuals with schizophrenia are less expressive (both facially and vocally) than individuals without schizophrenia in response to a variety of contexts and evocative stimuli. Elicitation studies have used many different methods to evoke emotion, including film clips, still pictures, cartoons, music, foods, and social interactions (eg, discussion with a family member, role play test, clinical interview). Facial expression has been measured using observational coding systems, such as the Facial Action Coding System and its emotion variant,[37,38] the Facial Expression Coding System,[39] and the Specific Affect Measure[40] and electromyography. Vocal expression has been assessed with different forms of acoustical analysis.[41]

Given the diversity of methods and measures used to assess emotional expression in schizophrenia, the consistency of findings across studies is striking (see Table 1). Compared with individuals without schizophrenia, individuals with schizophrenia display fewer positive and negative facial expressions in response to emotionally evocative film clips,[42–49] foods,[42] and social interactions.[48,50–57] Moreover, schizophrenia patients' diminished facial and vocal expression distinguishes them from other patient groups, including individuals with depression, Parkinson disease, and right hemisphere brain damage.[26,42,52,56,58] Importantly, diminished expression is observed among individuals with schizophrenia both on[42,50] and off medication.[45–47]

A fundamental question that remains to be addressed involves the generalizability of the findings on diminished emotional expression to women with schizophrenia. Indeed, our review of the literature for this article yielded 62 elicitation or naturalistic studies that assessed emotional expression, experience, physiology, or some combination of these components in response to emotionally evocative stimuli, situations, or in naturalistic conditions (eg, daily life). Of these, just over half included women (n = 35). However, of the studies that included women, less than half (n = 14) analyzed the data separately for men and women. Only 3 studies examined sex differences in emotional expression among individuals with schizophrenia: 2 found that women with schizophrenia were more expressive than men with schizophrenia[57,59] and 1 found no differences between men and women.[60] One study found that girls who developed schizophrenia as adults were less expressive than boys who later developed schizophrenia,[61] indicating that diminished expression may predate the onset of the illness, particularly for men. Preliminary data from our laboratory indicate that

Table 1. Summary of Expression Studies Included in the Review

Citation	n's sz/hc/op	% Male sz/hc/op	Study Type	Stimuli/Situation	Expression Measure	Results	Sex Differences
Aghevli[50]	33 sz/15 hc	100	Elicit	Social int	Coded face	sz < hc	n/a
Berenbaum[42]	43 sz/20 hc/17 op	51/50/35	Elicit	Films, tastes	Coded face	sz < hc	Unk
Blanchard[51]	91 sz/91 rel	74; 14	Elicit	Social int	Coded int	sz < rel positive; sz = rel negative; sz > disengagement	None
Borod[52]	6 sz/5 op/6 pd; 4 hc	100/80/67; 100	Elicit	Faces	Coded face; coded voice	sz < hc, pd,op	Unk
Brown[59]	6 sz/5 op	17/0	Naturalistic	Inpatient	Coded face	sz > op	Unk
Davison[60]	21 sz/30 op	67/unk	Elicit	Interview	Coded behavior	sz < op (eye contact)	None
Earnst[43]	19 deficit sz; 22 nondeficit sz; 20 hc	100; 100; 100	Elicit	Films	Coded face	deficit sz < non def sz, hc	n/a
Gaebel[53]	32 acute sz; 36 remit sz; 23 op/21 hc	66; 53; 52/71	Elicit	Interview	Coded face	acute sz, remit sz, op < hc	Unk
Henry[44]	29 sz/30 hc	45/53	Elicit	Films	Coded face	sz = hc suppress, express; sz < hc amplify	Unk
Krause[54]	10 sz/10 hc	100/100	Elicit	Social int	Coded face	sz < hc	n/a
Kring[46]	20 sz/20 hc	100/100	Elicit	Films	Coded face	sz < hc	n/a
Kring[47]	23 sz/20 hc	100/100	Elicit	Films	Coded face	sz < hc	n/a
Kring 1999[45]	15 sz/15 hc	100/100	Elicit	Films	Coded face	sz < hc	n/a
Kring 1999[66]	15 sz/15 hc	100/100	Elicit	Faces	EMG	sz = hc zygomatic; sz > hc corrugator	n/a
Kring 2003[65]	15 sz/15 hc	100/100	Elicit	Films	EMG	sz = hc zygomatic; sz > hc corrugator	n/a
Levin[58]	23 sz/8 hc/7 op	100/100/100	Elicit	Narratives	Coded voice	sz < hc	n/a
Martin[56]	20 sz/21 hc/19 op	Unk/unk/unk	Elicit	Narratives	Coded face	sz < hc	Unk
Mattes[48]	20 sz/20 hc	Unk/unk	Elicit	Films, interview	EMG	sz < hc zygomatic; sz = hc corrugator film; sz > hc corrugator interview	Unk
Salem 1999[49]	15 sz/17 hc	100/100	Elicit	Films, interview	Coded face	sz < hc	n/a
Tremeau[57]	58 sz/25 hc/25 op	64/44/40	Elicit	Narrative	Coded face	sz < hc	w > m
Walker[61]	32 sz/31sibs	78/unk	Naturalistic	Home movies	Coded face	sz girls < sibs joy; > sibs negative; sz boys = sibs joy; >sibs negative	
Wolf[67]	15 sz/19 hc	60/63	Elicit	Positive pictures	EMG	sz < hc zygomatic	Unk
Wolf[68]	32 sz/21 hc	50/33	Elicit	Positive pictures	EMG	sz < hc zygomatic	Unk

Note: Only first author of multiauthor study is listed under citation; sz = schizophrenia or schizoaffective; hc = healthy control; op = other patient group; pd = Parkinson disease; rel = relatives; int = interaction; unk = unknown; w = women; m = men; EMG = electromyography; n/a = not applicable.

Table 2. Summary of Experience Studies Included in the Review

Citation	n's sz/hc/op	% Male sz/hc/op	Study Type	Stimuli/ Situation	Rating: Stimuli/ Feeling	Results	Sex Differences
Berlin[98]	20 sz/20 hc/20 op	55/35/35	Elicit	Taste	Stimuli	sz = hc	
*Berenbaum[42]	43 sz/20 hc/17 op	51/50/35	Elicit	Films, foods	Stimuli	sz = hc	Unk
Blanchard[125]	32 sz/13 op	49/39	Elicit	Films	Feelings	sz = op	None
*Brown[59]	6 sz/5 op	17/0	Naturalistic	Inpatient	Feelings	sz < op	Unk
Burbridge[85]	49 sz/47 hc	63/49	Elicit	Words, pictures faces, films, sounds	Stimuli	sz = hc; sz < hc—negative arousal	Unk
Crespo-Facorro[113]	18 sz/16 hc	89/44	Elicit	Odors	Stimuli	sz = hc—unpleasant; sz < hc—pleasant	Unk
Curtis[91]	36 sz/48 rel/56 hc	75/40/41	Elicit	Pictures	Feelings	sz < hc, relative—positive; sz < hc—negative	Unk
Doop[112]	17 sz/14 hc	Unk	Elicit	Odors	Stimuli	sz > hc pleasant	n/a
*Earnst[43]	19 deficit sz; 22 nondeficit sz/20 hc	100; 100/100	Elicit	Films	Feelings	sz = hc pleasant; deficit sz > hc unpleasant	n/a
Habel[94]	13 sz/13 rel	100/100	Elicit	Faces	Feelings	sz = rel	
Heerey[102]	40 sz/31 hc	65/48	Elicit	Pictures	Stimuli	sz = hc	w > m
Hempel[104]	28 sz/30 hc	93/70	Elicit	Pictures	Stimuli	sz = hc	Unk
Hempel[103]	26 sz/21 hc	100/100	Elicit	Pictures	Stimuli	sz = hc	n/a
*Henry[44]	29 sz/30 hc	45/53	Elicit	Films	Feelings	sz < hc amusement	Unk
Herbener[86]	33 sz/28 hc	58/46	Elicit	Pictures	Feelings	sz = hc	None
Herbener[17]	34 sz/35 hc	53/54	Elicit	Pictures	Feelings	sz = hc	Unk
Holt[109]	18 sz/16sz	100/100	Elicit	Faces	Stimuli	sz = hc	n/a
Horan[100]	36 sz/26 hc	100/100	Elicit	Social int	Feelings	sz = hc	n/a
Horan 2006[99]	30 sz/31 hc	83/68	Elicit	Films, foods	Feelings	sz = hc pleasant; sz > hc unpleasant	Unk
Hudry[114]	40 sz/40 hc	50/50	Elicit	Odors	Stimuli	sz < hc pleasant	None
*Kring[46]	20 sz/20 hc	100/100	Elicit	Films	Feelings	sz > hc PA happy, neutral; sz > hc NA happy neutral	n/a
*Kring[47]	23 sz/20 hc	100/100	Elicit	Films	Feelings	sz > hc NA; sz = hc PA	n/a
*Kring 1999[45]	15 sz/15 hc	100/100	Elicit	Films	Feelings	sz = hc pleasant, activated; sz > hc unpleasant	n/a
Lee[92]	21 sz/20 hc	48/40	Elicit	Pictures	Feelings	sz < hc pleasant	Unk
Moberg[115]	30 sz/20 hc	50/37	Elicit	Odors	Stimuli	sz < hc pleasant	w > m
Myin-Germeys[124]	58 sz/65 hc	62/67	Naturalistic	Daily life	Feelings	sz > hc negative; sz < hc positive	Unk
Myin-Germeys[119]	42 sz/47 rel/49 hc	52/53/49	Naturalistic	Daily life	Feelings	sz > hc, rel NA; sz < hc, rel PA	None
Myin-Germeys[122]	42 sz/38 op/46 op/49 hc	52/20/43/49	Naturalistic	Daily stress	Feelings	sz > hc NA; <op NA; sz < hc PA; > op	Unk
Myin-Germeys[121]	42 sz	52	Naturalistic	Daily stress	Feelings	w > m negative; w < m positive	
Paradiso[107]	18 sz/17 hc	89/41	Elicit	Pictures	Stimuli	sz = hc negative; sz < hc positive	Unk
Plailly[116]	12 sz/12 hc	100/100	Elicit	Odors	Stimuli	sz = hc unpleasant; sz < hc pleasant	n/a
Quirk[87]	20 sz/10 op	100/100	Elicit	Pictures	Feelings	sz = op	n/a
Quirk[93]	30 sz/10 op	100/100	Elicit	Pictures	Feelings	sz = op arousal; sz < op pleasant	n/a
Reske[97]	10 sz/10 hc	60/Unk	Elicit	Faces	Feelings	sz = hc NA; sz < hc PA	Unk
Rockstroh[105]	12 sz/12 hc	100/100	Elicit	Pictures	Stimuli	sz = hc	
Rupp[111]	33 sz/40 hc	100/100	Elicit	Odors	Stimuli	sz = hc	
Schlenker[88]	34 sz/24 hc	100/100	Elicit	Pictures	Feelings	sz = hc	n/a

Table 2. Continued

Citation	n's sz/hc/op	% Male sz/hc/op	Study Type	Stimuli/ Situation	Rating: Stimuli/ Feeling	Results	Sex Differences
Schneider[95]	40 sz/40 hc	53/Unk	Elicit	Faces	Feelings	sz = hc PA, NA; sz < hc happy	Unk
Schneider[110]	13 sz/13 rel/26 hc	100/100/Unk	Elicit	Odors	Feelings	sz = hc	n/a
Schneider[101]	13 sz/13 hc	100/100	Elicit	Films	Feelings	sz = hc	
Takahashi[89]	15 sz/15 hc	67/60	Elicit	Pictures	Feelings	sz = hc	
Taylor[108]	18 sz/10 hc	61/60	Elicit	Pictures	Stimuli	sz = hc NA; sz < hc PA	Unk
Volz[90]	49 sz/46 hc	47/37	Elicit	Pictures	Feeling	sz = hc	Unk

Note: Only first author of multiauthor study is listed under citation. An asterisk next to an author name indicates that the study was also referenced in table 1; sz = schizophrenia or schizoaffective; hc = healthy control; op = other patient group; unk = unknown; rel = relatives; int = interaction; NA = negative affect; PA = positive affect; n/a = not applicable.

women with schizophrenia are less expressive than women without schizophrenia but are equally inexpressive compared with men with schizophrenia (Stuart BK, Kring AM, in preparation).

Several elicitation studies have examined the linkage between emotional expression and other domains of schizophrenia. In general, these studies find that diminished expression in response to emotionally evocative stimuli or situations is correlated with negative symptoms, particularly flat affect[26,50,51,55,62] (but see Gaebel and Wolwer[53]), thus demonstrating concordance among these measures of expressive behavior. Salem and Kring[49] found that diminished expression was not related to social skill performance, suggesting that diminished expression can be distinguished from a broader deficit in social skills.[63]

Although individuals with schizophrenia display fewer observable facial expressions in response to evocative stimuli or situations, a number of studies have shown that they display subtle, microexpressive displays in a manner consistent with the valence of the stimuli.[48,64–66] For example, individuals with schizophrenia exhibit more zygomatic (cheek) muscle activity, which is typically associated with positive emotion, than corrugator (brow) muscle activity, which is typically associated with negative emotion, in response to positive facial expressions, pictures, and film clips. By contrast, individuals with schizophrenia exhibit more corrugator activity than zygomatic activity in response to negative stimuli.[65–68] Relative to healthy controls, individuals with schizophrenia have been found to exhibit comparable[65,66] or lesser[67,68] amounts of zygomatic activity and comparable[67] or greater[65,66] amounts of corrugator activity. In 2 studies, individuals with schizophrenia not only exhibited the greatest corrugator activity in response to negative stimuli (films, pictures of facial expressions), but they also exhibited greater corrugator activity than individuals without schizophrenia in response to positive and neutral stimuli.[65,66] This heightened corrugator activity may have reflected other processes, such as effort,[69,70] concentration, or puzzlement.[71] Laboratory tasks that present emotionally evocative stimuli may require more actual (or perceived) effort or concentration for individuals with schizophrenia, thus contributing to heightened corrugator activity and, as we review below, heightened reports of negative emotional experience.

Although individuals with schizophrenia may exhibit subtle microexpressions, these displays are not observable to others, and this lack of observable expressive behavior likely has a number of interpersonal consequences. For example, spouses of schizophrenia individuals with negative symptoms, including flat affect, reported greater marital dissatisfaction.[12] Healthy individuals reported experiencing more fear and sadness and were themselves less expressive when they interacted with a person with schizophrenia than when they interacted with another healthy individual.[11] Using symptom rating scales to measure diminished expressivity, Bellack et al[72] found that individuals with schizophrenia who were least expressive had poorer interpersonal relationships, poorer adjustment at home and in other social domains. Without the benefit of overt signs of emotion, others may misinterpret the ongoing emotional state of a person with schizophrenia. Unfortunately, no study has examined whether men and women with schizophrenia differ in these subtle microexpressions.

Emotional Experience

Despite the overwhelming evidence from elicitation studies that individuals with schizophrenia are less overtly expressive than individuals without schizophrenia, there is also fairly consistent evidence that individuals with schizophrenia report experiencing similar and in some cases greater amounts of emotion compared with healthy individuals. However, the findings on emotional experience are more variable compared with the findings on emotion expression (see Cohen and Minor[27] for a recent meta-analysis), a point to which we return to later.

Table 3. Summary of Psychophysiology Studies Included in the Review

Citation	n's sz/hc/op	% Male sz/hc/op	Study Type	Stimuli/ Situation	Psychophysiological Measures	Results	Sex Differences
*Curtis[91]	36 sz/48 rel/56 hc	75/40/41	Elicit	Pictures	Startle	sz = hc, relative	None
*Hempel[103]	26 sz/21 hc	100/100	Elicit	Pictures	SC, HR	sz = hc SC; sz different HR pattern	n/a
*Hempel[104]	28 sz/30 hc	93/70	Elicit	Pictures	SC, HR	sz = hc SC; sz different HR pattern	Unk
*Kring[47]	23 sz/20 hc	100/100	Elicit	Films	SC	sz > hc	n/a
*Schlenker[88]	34 sz/24 hc	100/100	Elicit	Pictures	Startle, SC, HR, fpv	sz = hc startle, HR, fpv; sz < hc SC	n/a
Taylor[106]	14 sz/13 hc	71/62	Elicit	Pictures	SC	sz < hc	Unk
*Volz[90]	49 sz/46 hc	47/37	Elicit	Pictures	Startle, SC, HR	sz = hc startle, HR, SC	None
Williams[129]	27 sz/22 hc	63/64	Elicit	Fear Faces	SC	sz > hc	Unk
Williams[130]	27 sz/13 hc	63/unk	Elicit	Faces (fear, disgust, anger)	SC	sz > hc	Unk

Note: Only first author of multiauthor study is listed under citation. An asterisk next to an author name indicates the study was also referenced in table 2; sz = schizophrenia or schizoaffective; hc = healthy control; op = other patient group; SC = Skin conductance; HR = heart rate; fpv = finger pulse volume; unk = unknown; n/a = not applicable.

To assess how people feel in response to evocative stimuli most often requires collecting self-report questionnaires or asking for verbal reports of emotional experience. Some may question whether individuals with schizophrenia can accurately and reliably report on their feelings given the cognitive and language disturbances that often accompany the disorder. However, convergent findings point to the ability of individuals with schizophrenia to provide reliable and valid reports of emotional experience and emotion-related symptoms, such as anhedonia. Individuals with schizophrenia provide self-report data on emotional experience that yield high internal consistency[73,74] and test-retest reliability,[45,73] even when assessments occur across changes in symptoms and medication status. Using multidimensional scaling techniques, schizophrenia individuals' representations of emotion are reflected in the same 2-dimensional structure (valence and arousal) as are individuals without,[75] thus bolstering confidence in schizophrenia individuals' self-reports of emotional experience.

Another concern that arises with respect to interpreting the reports of individuals with schizophrenia has to do with evidence suggesting limited insight or awareness of illness.[76–78] For example, one study found a mismatch between psychiatrists' and schizophrenia patients' reports of flat affect and anhedonia.[78] Although the authors noted that the psychiatrist rating was not necessarily "perfectly valid,"[78(p352)] this type of mismatch between psychiatrist and patient report was nonetheless considered a "less realistic"[78(p353)] assessment on the part of the patient. Deciding about the accuracy of 2 discrepant reports is never an easy task, but we would argue that an individual with schizophrenia whose report does not concur with a psychiatrist's rating may reflect something other than lack of insight or limited self-awareness. For example, asking an individual with schizophrenia whether or not they generally experience pleasure (or even to describe what kinds of things they find pleasurable) might lead to a different response compared with asking if he or she derived pleasure following the consumption of a favorite meal. This is not to say that failure to report a symptom is unimportant. Rather, our point is to suggest that the context in which questions about emotional experiences are asked can lead to different responses. Moreover and perhaps more importantly, the tendency to consider a mismatch between patient and other reports as inaccurate on the part of the patient seems to convey the message that the patient's subjective report is not meaningful.

An important methodological distinction to highlight is the difference between rating feelings in response to a stimulus and rating the stimulus itself. For example, a study may present emotionally evocative pictures and instruct participants to rate how they feel when watching these pictures or instruct participants to rate the stimulus properties. The rating scale provided for such judgments can be identical—one can rate how pleasant they feel when viewing a smiling baby and one can rate the pleasantness of the baby picture itself. This is not only an important conceptual distinction, but evidence from affective neuroscience indicates that relative differences in activation of brain regions recruited for these different types of judgments. Specifically, reporting feelings in response to evocative stimuli is associated with

activation in medial prefrontal cortex (mPFC[5]). Interestingly, rating the feelings of others also activates similar regions in mPFC,[79,80] though there appears to be distinctions in regions of mPFC activation associated with judgments about the self and others' feelings.[81,82] Further evidence suggests that reporting on feelings (self or others) is associated with activation in more dorsal/rostral areas of mPFC; whereas reporting on the affective properties of a stimulus is associated with activation in more ventral portions of the mPFC.[80,83]

Given the distinctions noted above, we divide our review on emotional experience in schizophrenia into (a) studies that assess participants' feelings and (b) studies that assess participants' judgments about the stimuli (see Table 2). At the outset, it is worth noting that both types of studies yield comparable findings. We also include a review of the handful of naturalistic studies of emotional experience in schizophrenia. Although most of the studies include individuals with schizophrenia who were taking medication, there is evidence to suggest that schizophrenia individuals' reports of emotional experience are stable across time and medication status.[45,47,59]

Rating Feelings

Elicitation studies that have assessed emotional experience in schizophrenia have included a variety of evocative stimuli and situations, including film clips, pictures, foods, and social interactions. In nearly all these studies, individuals with schizophrenia report feelings that are consistent with the valence of the presented stimuli. That is, they report experiencing negative emotion in response to negative stimuli and positive emotion in response to positive stimuli. Nevertheless, there are a handful of studies that also find that individuals with schizophrenia report experiencing emotions that were not necessarily what the stimuli were designed to elicit (eg, heightened negative emotional experience to putatively positive stimuli).

Studies that present emotionally evocative pictures most often use the International Affective Picture System collection (IAPS[84]). The majority of these studies (7 of 10) find that individuals with and without schizophrenia report experiencing comparable amounts of pleasant, unpleasant, high, and low activation emotion in response to these pictures.[17,85–90] Three studies found that, compared with healthy controls or other patient groups, individuals with schizophrenia reported experiencing less pleasant emotion to positive pictures specifically[91,92] or to all pictures.[93]

Other studies have presented pictures of emotional facial expressions along with explicit instructions to try to feel the emotion that is depicted by the pictured emotion expressions. Two studies[94,95] using this method found no differences between individuals with and without schizophrenia in reported Positive Affect and Negative Affect (as assessed with the Positive and Negative Affect Schedule[96]), though Schneider et al[95] found that individuals with schizophrenia reported experiencing less of the specific emotion "happy" than individuals without schizophrenia. An fMRI study found that individuals with schizophrenia reported less Positive Affect than healthy controls.[97]

Two studies presented different foods and found no differences in reported emotional experience between individuals with and without schizophrenia.[98,99] Horan and Blanchard[100] found no differences in reported emotional experience between individuals with and without schizophrenia in a role play test that required social interaction.

Findings from studies that presented emotionally evocative film clips are more variable. Three studies have found no differences in positive or negative emotion experience between individuals with and without schizophrenia.[85,99,101] Two studies reported differences in positive experience to positive films, with one study finding less positive emotion experience from individuals with schizophrenia[44] and one study finding more positive emotion experience[46] compared with individuals without schizophrenia. Four studies by Kring and colleagues found that individuals with schizophrenia reported experiencing more negative emotional experience across all types of films (positive, negative, neutral) compared with individuals without schizophrenia,[43,45–47] suggesting that these findings might be specific to the film stimuli used in these studies.

Rating Stimuli

Most studies in schizophrenia that have assessed ratings of stimuli have used emotionally evocative pictures from the IAPS set. Results from four behavioral or brain imaging (fMRI, PET) studies indicate that individuals with schizophrenia rate the valence of the pictures as similarly pleasant or unpleasant compared with individuals without schizophrenia.[102–106] Two imaging studies reported that individuals with schizophrenia rated positively valenced pictures as less pleasant than did healthy controls.[107,108] Three studies also assessed ratings of arousal and found that individuals with schizophrenia rated the pictures as comparably arousing as did individuals without schizophrenia.[102–104] Although less potent with respect to eliciting intense emotional experience, pictures of facial expressions were presented in one study, and individuals with schizophrenia did not differ from healthy controls in their valence ratings of the expressions.[109] Although 4 of these studies included women patients, only one[102] analyzed the data for sex differences. They found that women with schizophrenia rated the positive and negative IAPS pictures as being more pleasant and unpleasant, respectively, than did men with schizophrenia.

Studies have also investigated how individuals with schizophrenia respond to pleasant and unpleasant odors. These studies are not only typically designed to assess brain activation in response to different odors, but they also ask participants to either rate the pleasantness of the presented odors or the emotional experience evoked by the odors. The findings from these studies are a bit more variable than other studies reviewed, perhaps due to methodological differences (eg, presenting one odor vs presenting many). Two studies found no difference between controls and individuals with schizophrenia on pleasant feelings[110] or pleasantness ratings of odors[111]; 2 found that individuals with schizophrenia rated the odors as more pleasant than controls[111,112]; and 4 found that individuals with schizophrenia rated the odors as less pleasant than controls.[113–116] Of these 7 studies, only 2 analyzed the data for sex differences (and only one other included women with schizophrenia), but 1 found no sex differences in pleasantness ratings[114] and the other found that men with schizophrenia rated the odors less pleasant than women with schizophrenia and controls (both men and women).[115]

Naturalistic Studies

Naturalistic studies have been used to study symptoms, thoughts, and to a lesser extent emotions among individuals with schizophrenia. The most common method employed has been the experience sampling method (ESM). In a typical study, participants report on thoughts, feelings, and behaviors several times a day for a week or longer. Although the primary dependent variables obtained in an ESM study are self-report, because these data are collected "in the moment," they do not suffer from biases associated with retrospective reports.[117] ESM studies with schizophrenia individuals have found that they report being alone more often than individuals without schizophrenia and that they report more delusions when alone than with others.[118,119] In addition, being alone is associated with more negative thoughts and feelings for individuals with schizophrenia; experiencing delusions is associated with more negative feelings and less positive feelings than experiencing no delusions; and daily stress is associated with more negative feelings for individuals with schizophrenia than for individuals with bipolar disorder, depression, nonill relatives, or healthy controls.[119–123]

In one study explicitly designed to assess emotional experience in the course of daily life, individuals with schizophrenia reported experiencing more negative emotion and less positive emotion than individuals without schizophrenia across 6 days.[124] Myin-Germeys et al[121] found that women with schizophrenia experienced more negative and less positive emotion in response to daily life stress compared with men with schizophrenia. In the only other naturalistic study to examine sex differences,

Myin-Germeys et al[123] reported no differences between men and women in emotional experience in response to daily life stress, a finding that differs from Myin-Germeys et al.[121]

Brown et al[59] studied pleasurable experiences and positive expressive behavior among a small sample of inpatients whom were medication free (6 individuals with schizophrenia and 5 individuals with depression). Patients filled out the Pleasurable Activities Scale, indicating the frequency with which they participated in 92 activities (eg, cooking, watching people, playing a game) and the degree of pleasure they experienced from doing so. Observer ratings were made using the same scale, but instead of rating the degree of pleasure associated with each activity observers rated overt changes in facial expression. Individuals with schizophrenia displayed more positive expressions than the individuals with depression; however, individuals with schizophrenia reported experiencing less pleasure than individuals with depression.

In sum, these studies indicate that individuals with schizophrenia report experiencing emotion that is consistent with the valence of the presented stimuli or situations. That is, people with schizophrenia report more positive emotion in response to positive stimuli and more negative emotion in response to negative stimuli. In addition, over half the studies find comparable reports between individuals with and without schizophrenia. A quarter of the studies find that individuals with schizophrenia report experiencing less positive emotion than individuals without schizophrenia, and about a fifth of the studies find that individuals with schizophrenia report experiencing more negative or positive emotion than individuals without schizophrenia (see also Cohen and Minor[27]).

Of the more than 30 studies of emotional experience that included male and female participants, only 9 examined sex differences. Of these, 6 found no sex differences in reported emotional experience,[51,86,95,114,123,125] a finding that mirrors the literature on sex differences among healthy men and women.[126,127] One study found that men with schizophrenia reported experiencing less positive emotion than women with schizophrenia,[102] and 2 studies found that men with schizophrenia reported experiencing less negative emotion in response to stress in daily life[121] or in response to emotional pictures[102] than women with schizophrenia. One study found that women with schizophrenia reported less positive affect in response to stress in daily life compared with men with schizophrenia,[121] and one study found that men with schizophrenia rated unpleasant odors more pleasantly than women with schizophrenia.[115]

With respect to symptom correlates, several studies have found symptom ratings of anhedonia to be related to reports of positive,[17,44,98,99] neutral,[44,99] and negative[17] emotional experience (but see Herbener et al[86]).

Burbridge and Barch[85] found no link between self-report scales of anhedonia and emotional experience but did find a relationship between the Life Experience Questionnaire, a measure of feelings in response to different hypothetical pleasant and unpleasant life situations (eg, playing with puppies, stung by a bee) and positive and negative emotional experience in response to evocative stimuli. Paradiso et al[107] reported that severity of positive symptoms was correlated with rating unpleasant pictures as extremely unpleasant, while severity of negative symptoms was related to rating unpleasant pictures as more positive. However, Quirk et al[93] found no relationship between positive or negative symptoms and elicited emotional experience. Unlike the link between flat affect and emotion expression, flat affect does not appear to be strongly related to emotional experience.[50,91,99,100]

Physiology

To our knowledge, only one study has assessed expression, experience, and autonomic physiology in an elicitation study. Kring and Neale[47] found that individuals with schizophrenia exhibited greater skin conductance reactivity than individuals without schizophrenia in response to emotionally evocative film clips, even though they displayed very few observable facial expressions. This finding is consistent with now classic research demonstrating that schizophrenia patients with flat affect exhibited greater skin conductance responding than patients without flat affect.[128] Additional studies have assessed skin conductance responses (SCRs) to emotional pictures (scenes or facial expressions). Two studies found that individuals with schizophrenia exhibited more skin conductance responses when viewing negative (fear, anger, disgust) and neutral facial expressions compared with individuals without schizophrenia.[129,130] However, 2 studies reported no differences between individuals with and without schizophrenia,[90,104] and 2 studies found that individuals exhibited fewer SCRs to emotional and neutral pictures ($P = .06$[88]) and aversive pictures.[106] Taken together, it seems likely that not all schizophrenia patients will exhibit elevated skin conductance responding to emotional stimuli. Only one study[130] examined symptom correlates and found that SCR reactivity was positively correlated with delusions and suspiciousness.

A few studies have assessed cardiac reactivity: one study found that individuals did not differ from individuals without schizophrenia in heart rate or finger pulse volume[88]; 2 studies found that individuals with schizophrenia differed from healthy controls in their pattern of heart rate reactivity.[103,104] Emotional responses have also been examined using the affective startle modulation paradigm. In this paradigm, presentation of negatively valenced stimuli material engages an avoidance motivational state and primes associated behaviors[8,131–133] Thus, a defensive startle reflex elicited (eg, by a burst of white noise) during the engagement of the avoidance motivational system will be more potent than the same reflex engaged in the absence of this motivational activation. By contrast, presentation of positively valenced material engages an approach motivational state and primes appetitive behaviors. A defensive reflex such as the startle response elicited in an approach motivational context will be attenuated because of its incompatibility with the primed appetitive behaviors. Studies that have assessed affective modulation of the startle response find that individuals with schizophrenia exhibit the same pattern of startle modulation as those without schizophrenia.[88,90,91] Of the studies examining physiological emotional responses, only 2 included male and female participants and only one[91] analyzed the data separately for men and women and found no differences.

Linkages Among Emotion Response Components

Evidence from elicitation studies suggests a disconnect between emotion response components in schizophrenia. Compared with healthy individuals, individuals with schizophrenia are markedly less expressive, yet they do not differ as much or as consistently with respect to reported emotional experience or autonomic physiology. Further evidence of a disconnect among emotion response components in schizophrenia comes from studies that have examined the correlations among components. Some studies indicate that emotion expression and experience are not related among individuals with schizophrenia.[50,59,65] On the other hand, some studies find convergence among response components, particularly between emotional experience and physiology. For example, Kring and Earnst[65] report that skin conductance reactivity was related to zygomatic activity and reports of pleasant emotion experience in response to positive film clips. Hempel et al[103] found that arousal experience was related to skin conductance reactivity among individuals with schizophrenia.

Conclusions and Future Directions

Our review of elicitation and naturalistic studies of emotion response in schizophrenia reveals a number of important insights about emotional functioning among individuals with schizophrenia. By drawing upon the theories from affective science that point to the importance of distinguishing multiple components of emotion and the diverse methods for studying emotion, we can begin to pinpoint the nature of emotion response deficits in schizophrenia. Specifically, individuals with schizophrenia have a deficit in the expressive component but do not appear to be strongly deficient in the experiential and physiological components of emotion.

Across many different types of studies, individuals with schizophrenia do not exhibit many outwardly

observable expressions in response to evocative stimuli or situations. Individuals with schizophrenia contract their facial musculature appropriately in response to positive and negative emotional stimuli, yet these contractions are not of sufficient magnitude to be observable to others. Diminished expressiveness is correlated with the symptom of flat affect and undoubtedly has important social consequences, though these have yet to be fully investigated. One interesting study that examined the social cost of inexpressiveness had individuals with and without schizophrenia discuss an emotionally evocative political topic.[11] Consistent with other studies, individuals with schizophrenia were markedly less expressive during these interactions. However, their inexpressiveness evoked negative responses from their healthy interaction partners, but in terms of greater reports of sadness and fear and in terms of a "matching" of diminished expression by the healthy individuals over the course of the interaction. A significant proportion of the variance in healthy interaction partners' facial expressions and reports of experienced emotion was accounted for by the lack of facial expressions among individuals with schizophrenia.

The findings on emotional experience in schizophrenia are more variable, but the majority of studies find that individuals with schizophrenia report comparable amounts of emotion compared with individuals without schizophrenia. At the outset, it is worth noting that the sample sizes were small in many of the studies reviewed, and thus, some studies may been underpowered to detect group differences in reported emotional experience. On the other hand, nearly all these studies demonstrated group differences in expressive behavior as well as differences in reported experience that varied by the valence of the presented stimuli. Thus, limited power cannot fully account for finding comparable reports of experience between individuals with and without schizophrenia.

A few studies (n = 4) find that individuals with schizophrenia report experiencing less pleasant emotion, rate positive stimuli as less pleasant (n = 6), or report less pleasant emotion in naturalistic settings (n = 3) compared with individuals without schizophrenia. At first glance, these findings appear to support the clinical conceptualization of anhedonia in schizophrenia. However, the bulk of studies (n = 26) find no differences in reports of pleasant emotion between individuals with and without schizophrenia. That most elicitation studies do not find evidence for a pleasure deficit in schizophrenia is consistent with other recent evidence that the nature of anhedonia in schizophrenia is not an "in-the-moment" or consummatory pleasure deficit but is instead an anticipatory pleasure deficit.[45,85,99,134–136]

A few elicitation and naturalistic studies have also found that individuals with schizophrenia experience more negative emotion relative to individuals without schizophrenia. This finding is consistent with studies assessing trait emotion experience in schizophrenia.[27] (see also Horan et al[29]). It may also be the case that the laboratory conditions in elicitation studies require more effort and concentration from individuals with schizophrenia, thus contributing to heightened reports of negative emotion and greater corrugator activity across differently valenced emotional stimuli.

Fewer studies have examined the physiological component of emotion among individuals with schizophrenia, and even fewer have assessed all 3 components of emotion response in the same sample. This remains a fruitful avenue for future research. Studies that have assessed emotion modulation of the startle response are consistent with studies that find few differences in emotional experience between individuals with and without schizophrenia. That is, individuals with schizophrenia are responding appropriately to the stimuli in these elicitation studies, both at the experiential and physiological levels.

As we have highlighted throughout the review, we know next to nothing about emotional responding among women with schizophrenia, and this remains an urgent need in the field. Based on the limited evidence available, it appears that women with schizophrenia may be more expressive than men with schizophrenia (though 2 studies suggest that women may be as equally inexpressive as men with schizophrenia) yet report comparable levels of emotion experience compared with men with schizophrenia and healthy individuals. Only one study has examined sex differences in physiology, and this study found no differences in emotion modulation of the startle among men and women with schizophrenia.[91]

This relative disregard for studying emotional responding among women with schizophrenia is all the more surprising given the accumulated evidence indicating that schizophrenia affects men and women differently. Compared with men, women have a later age of onset, a better course and medication response, better premorbid and social functioning, lower risk for obstetric complications, fewer structural brain abnormalities, and less language dysfunction.[62,137–139] Some evidence suggests that women with schizophrenia may have more mood-related features, such as paranoia, dysphoria, or depression symptoms,[140,141] whereas men with schizophrenia may have more negative symptoms, including flat affect,[142] though other studies fail to find this pattern.[143]

Furthermore, there is consistent evidence from affective science that indicates healthy men and women differ in components of emotional responding, including expressive behavior,[126,127] emotion modulation of the startle response,[144,145] brain activation,[146,147] and neuroendocrine function.[146] The relative dearth of knowledge about schizophrenia women's emotional responding despite the frequency with which women suffer from schizophrenia as well as the evidence highlighting important sex differences in emotion among healthy individuals point to the importance of this area of research.

Another area that has not been fully investigated is the extent to which different subgroups of individuals with schizophrenia may exhibit different emotion response deficits. As noted earlier, some studies suggest that individuals with the deficit syndrome experience less negative emotion than individuals with the nondeficit syndrome,[22] though other studies do not find differences in reported emotional experience between individuals with and without the deficit syndrome.[43] More broadly, however, the variability of findings on emotional experience in schizophrenia suggests that there well may be important differences among particular groups of schizophrenia individuals or in particular contexts that have yet to be fully investigated.

For the promise of affective science to be more fully realized in the realm of schizophrenia research, it will be important to address why individuals with schizophrenia exhibit a disconnect between the expression and experience of emotion. Research thus far has worked toward solving the puzzle of why individuals with schizophrenia are not very outwardly expressive. The expressive deficit does not appear to be a function of medication status, as individuals with schizophrenia who are not taking medication also exhibit diminished expressive behavior,[45] nor does it appear to be redundant with a social skills deficit[49] or a neuromotor deficit (eg, Putnam and Kring[148]). That individuals with schizophrenia display subtle, microexpressions in response to emotional stimuli suggests the possibility that they have a different threshold for producing observable emotional displays and do so only when stimuli are of sufficient intensity.[10] Indeed, individuals with schizophrenia are better able to pose facial expressions following the presentation of a pictured facial expression and to perceive emotion in faces when the facial stimuli depict intense expressions.[148,149]

Perhaps the greatest purchase toward answering the question of why individuals with schizophrenia exhibit a disconnect between emotion expression and experience may be obtained by integrating studies of emotion and cognition. For example, to understand the nature of an anticipatory pleasure deficit, studies must explicitly link the study of emotion and cognition. Indeed, recent evidence from cognitive neuroscience suggests that anticipating future events relies upon the same neural processes involved in episodic memory.[150,151] In memory tasks, schizophrenia patients have difficulty in both recalling past episodes and in generating specific future events, particularly goal-directed events.[134,152] Thus, understanding anticipatory pleasure deficits in schizophrenia will be bolstered by studying interrelated cognitive processes and the attendant brain areas that support such processes known to be deficient in schizophrenia, including cognitive control and episodic memory.

There are a number of important treatment implications that follow from the findings of this review. First, targeting specific components of emotion response will likely be an effective strategy, whether this is done pharmacologically or psychosocially. Second, adoption of the methods from affective science can be usefully incorporated into clinical trials to assess the effectiveness of various interventions in targeting emotion response difficulties.[99,153] Third, different intervention approaches may be needed for men and women with schizophrenia,[154] though the nature of sex differences in emotional responding remains to be borne out by additional research. Efforts are already underway to develop psychosocial treatments to address negative symptoms, such as flat affect and anhedonia,[155] and the treatment of negative symptoms pharmacologically remains an unmet need and looming challenge in the field.[156–158]

In summary, the proliferation of findings from affective science and neuroscience has greatly expanded our understanding of emotion response deficits in schizophrenia. Nevertheless, much work remains to be done. The adoption of clear and consistent terms, methods, and measures in both behavioral and brain imaging studies will quicken the pace of collective research on emotion in schizophrenia. Moreover, inclusion of women with schizophrenia in studies of emotion ought to be a top priority for the field, not an afterthought or mere concession to grant funding agencies. Continued efforts to translate methods and theories from affective science and cognitive neuroscience will undoubtedly help us better understand the descriptions, causes, and specific treatment targets for emotion response deficits in schizophrenia. It is our view that the goal of reducing the burden of schizophrenia is within reach, particularly with respect to ameliorating emotion response deficits.

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